ORGANIZATIONAL FLEXIBILITY MANAGEMENT

IN CONSTRUCTION

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SUMMARY

The concept of organizational flexibility is explored in the context of the construction industry by integrating four predominant perspectives of organizational studies. These are: (1) the complex adaptive system perspective; (2) the organizational learning perspective; (3) the resource-based view of firms; and (4) the dynamic contingency view of firms. The developed theoretical framework postulates that firms should manage their flexibility potential, by engaging into a continuous process of developing and managing their resources and capabilities, for their continued existence.

The aim of this thesis is to investigate the organizational flexibility management of construction firms in Singapore. Organizational flexibility is hypothesized as a multi- rather than single-dimensional concept. It may be influenced, to varying degrees, by six key determinants (i.e., factors): (1) organizational learning culture; (2) organizational structure; (3) employees' skills and behaviour; (4) technological capabilities; (5) supply chain capabilities; and (6) business strategies. The research method is based on survey. The data collection instrument is a structured questionnaire specially designed for this study. Data were collected using a face-to-face interview approach involving 41 senior executives of large and medium-sized construction firms in Singapore.

Based on the data collected, two structural equation models were developed to: (i) identify the key dimensions and determinants of organizational flexibility, and (ii) examine the effects of inter-relationships among the determinants on the three dimensions of organizational flexibility. The results support the view that organizational flexibility is a multi-dimensional concept, comprising: (1) operational flexibility; (2) tactical flexibility; and (3) strategic flexibility, where individual

dimensions have their own configuration of determinants. Of the six determinants, employees' skills and behaviour, supply chain capabilities and business strategies are found to have highest positive impacts on firms' operational flexibility, tactical flexibility and strategic flexibility, respectively. Also, it is found that supply chain capability is the only determinant that has statistically significant impacts on two dimensions of organizational flexibility, i.e., operational and tactical flexibilities.

Three sets of structural models were also developed to examine the moderating effects of market and technological conditions on the relationships between the three flexibility dimensions and their respective determinants. No moderating effect was detected in the results. However, market and technological conditions are found to have statistically significant direct impacts on firms' operational and strategic flexibilities, respectively.

It is concluded that construction firms need to develop the right kind and range of resources and capabilities to achieve the desired level of flexibility. It is recommended that construction firms use the flexibility indices developed by this study to ascertain their flexibility potential. The findings may also help contractors to attain organizational flexibility and offer managers an insight into different practices and organizational attributes in building up their firms' flexibility potential.

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CHAPTER 1

INTRODUCTION

1.1 Background

The complex and dynamic environment, signifying uncertainty in decision-making, is a representative type of the environment in the construction industry (Shirazi et al., 1996). Betts and Ofori (1994:205) observed that the environmental dynamism in construction “is growing at an increasing fast pace and is offering proportionately greater strategic opportunities with time, while posing significant threats”. In this study, environmental dynamism refers to the rate of change, absence of pattern and unpredictability of the environment (Dess and Beard, 1984). As a result, contractors have to effectively deal with changes in their business environment in order to maintain their existence.

In general, the changes in the construction industry can be classified into five categories, namely: (i) construction demand (Male, 1991a; Runeson, 2000); (ii) intensity of competition (Cox and Thompson, 1997; Cheng et al., 2000); (iii) procurement trend (Cartlidge, 2004; Royal Institution of Chartered Surveyors, 2004); (iv) clients’ performance criteria of construction services (Winch, 2000; Cartlidge, 2004); and (v) technological possibilities (Gann, 1994; Gruneberg, 2009). The Singapore construction industry, which is the focus of this research, is faced with similar changes (Construction 21 Steering Committee, 1999; Ofori et al., 2002; Ministry of Finance, 2008), like its counterparts in other countries.

A growing need for organizational flexibility arises from a convergence of the above changes in the construction industry. As a result, construction firms have to gain flexibility in their endeavours to be adaptive and responsive to changes in the business environment within which they operate. It was Lansley et al. (1979), who in their pioneering study on flexibility and efficiency in construction, asserted that flexibility and diversity are needed to provide favourable conditions during initial stages of firms' creative process in exploring new strategies for their continued existence. They found that flexible contractors in the United Kingdom (UK), who were successful in adapting to changing demands of the environment, exhibited a different set of characteristics compared with their less successful counterparts.

1.2 Research problem

The concept of flexibility is not new and has attracted interest from many organizational researchers since 1960s, focusing on how companies within the manufacturing industry attain flexibility (Ansoff, 1965; Oke, 2005). Flexibility appears to be the next strategic weapon in the battlefield of competition (Parker and Wirth, 1999; Oke, 2005); an attribute contributing to firms' ability to survive and prosper in a turbulent and unpredictable environment (Dreyer and Gronhaug, 2004). Avison et al. (1995) added that the feature of being flexible has become so vital that it may take a central role as an organization's critical success factor.

Although the use of the term 'flexibility' is ubiquitous, its meaning is not always clear (Evans, 1991; Golden and Powell, 2000). Boyle (2006) expressed that it is not easy to understand, implement and manage organizational flexibility because flexibility is not general and cannot be simply purchased and plugged into any firm's operations. As a result, it becomes essential for firms to recognize the nature and constitution of flexibility and the determinants of achieving flexibility, if the potential benefits of being flexible are to be fully realized (Koste and Malhotra, 1999).

Many studies highlighted that flexibility is an integrative multi-dimensional rather than single-dimensional concept that can be defined and measured in isolation, especially in the manufacturing literature where flexibility management is commonly called manufacturing flexibility (Slack, 1987; Beach et al., 2000). Researchers have attempted to operationalize organizational flexibility into different dimensions (Carlsson, 1992; Volberda, 1997; Koste and Malhotra, 1999), and to identify the flexibility types (Sethi and Sethi, 1990; Upton, 1994). However, Oke (2005) and Beach et al. (2000) noted that there is a lack of widely accepted means for assessing organizational flexibility, considering the broad range of measures available. These measures are considered either as flexibility dimensions and/or flexibility types in manufacturing-related studies. The review of literature revealed that the identified flexibility dimensions and types could be streamlined and classified into three categories of flexibility dimensions, namely: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility, and 15 flexibility types, respectively (see Sections 3.6.1 and 3.6.2).

In construction, although there have been studies done on flexibility management (see Section 2.6 for a review of construction-related literature), it appears that the concept of flexibility is not well-understood. Many studies (Handa and Adas, 1996; Walker and Loosemore, 2003) considered organizational flexibility as a single-dimensional rather than a multi-dimensional concept comprising different flexibility dimensions and types, as found in manufacturing-related studies. This raises the question of “what are the key dimensions and types of flexibility in construction business?” Construction firms may not adopt manufacturing flexibility because of the stark differences between the construction and manufacturing industries. These differences comprise: (i) production process; (ii) marketing services; and (iii) workforce management (see Section 2.2).

Next, it appears that little empirical research has been done to examine the collective effect of different organizational attributes on flexibility. Many construction-related studies specifically examined the influence of individual organizational attributes towards achieving flexibility. The organizational attributes involve: (i) human resource (Lansley et al., 1979; Ofori and Debrah, 1998); (ii) organisational structure and management style (Lansley, 1983; 1987; Handas and Adas, 1996); (iii) information and process technologies (Betts, 1991; Ekstrom and Bjornsson, 2005; Gil et al., 2005); and (iv) organizational culture (Walker and Loosemore, 2003). These identified organizational attributes are labelled as determinants (see definition in Section 1.5) and are, to some extent, similar to those identified in manufacturing-related studies (see Section 3.7); where two additional determinants are included: supply chain capability and business strategy. Each of these is reviewed in Chapter 4.

In view of the above scenario, this study argues that it is important to examine the identified determinants as a group (rather than individualized effectors) and as matters of the extent (rather than either/or phenomena) to which they influence organizational flexibility (following Pugh and Hickson, 2007). This is because there appears to be no single explanation of how an organization gains flexibility; what influences the organization could be due to the collective effect of several possible determinants, each posing certain degrees of influences towards achieving organizational flexibility. Also, some of the determinants could be used to examine the behaviour of other determinants on organizational flexibility, for example, how an organization's culture influences the behaviour of its employees, and in turn, how the resultant shapes the organization's flexibility potential. Accordingly, a multivariate causal approach is necessary to address the following questions:

1. "What are the key determinants of organizational flexibility in construction business"? and

2. “How do the key determinants of organizational flexibility interrelate among each other towards achieving organizational flexibility?”

1.3 Knowledge gap

Hitherto, few studies have been done on the organizational flexibility of construction firms in the context of Singapore. Debrah and Ofori (1997) and Ofori and Debrah (1998) are the two closest studies done on flexibility. Both studies focused on the labour flexibility aspect of firms, exploring the nature of the employment systems, strategies and structures, and the application of the flexible firm model in the Singapore construction industry. The flexible firm model focuses on the core-periphery strategy of labour utilization, segregating an entire workforce into permanent (i.e., core) and temporary (i.e., periphery) bases where the later acts as a buffer against fluctuation in demand (see Section 2.6.1.1 for further discussion of these two studies).

Although the aforementioned studies did examine the human aspect of flexibility, they did not consider: (i) the aspect of how employees’ behaviour and skills could contribute to a firm’s flexibility potential, and (ii) the effect of other determinants (for example, organizational cultures and structures) on the firm’s flexibility. Previous studies thus offered merely an insight into the heavy reliance of Singapore construction firms on casual workers (i.e., labour subcontracting) for better competitiveness. The gap in knowledge is that there is no comprehensive view of how construction firms could achieve flexibility in Singapore. Details are discussed in Section 2.6.2.

Next, considering the impact of the 1997-2005 period of continuous decline within the Singapore construction industry, no study has been done to examine the flexible behaviour of construction firms in response to the eight long years of unprecedented economic downturn. While many firms have gone out of business, others have survived the long downturn. The gap in knowledge is that it is not known if they have ingrained a considerable degree of flexibility capacity. These firms' organizational attributes and their adopted practices in managing the attributes are also not known. Details are discussed in Section 2.5.

Based on the knowledge gaps identified, fieldwork was conducted to investigate the flexible behaviour of Singapore construction firms that survived the long economic downturn, in terms of their organizational attributes; how they responded to changes in the construction industry, from the periods 1997 – 2007. The aim and objectives are discussed next.

1.4 Research aim and objectives

The aim of this study is to investigate the organizational flexibility management of construction firms in Singapore. The specific objectives are to:

1. develop and test a conceptual framework for organizational flexibility in construction firms;

2. identify the key determinants of organization flexibility in construction firms;

3. investigate the effects of inter-relationships among the key determinants on organizational flexibility dimensions;

4. investigate the moderating effects of market and technological conditions on the relationships between the determinants and organizational flexibility dimensions; and

5. design and test flexibility indices that measure construction firms' flexibility potential.

1.5 Definition of terms

Major terms of this study are defined as below.

(i) Organizational flexibility (Y)

In this study, organizational flexibility is the predicted construct or dependent variable, Y. It is characterized by three dimensions, namely: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}), which could be operationalized into 15 flexibility types. Each of these dimensions could be influenced by several determinants.

(ii) Determinants (X)

This study defined determinants as the enablers or factors that contribute to the attainment of organizational flexibility. Determinants are the predictor constructs or independent variables, X, comprising: (i) organizational learning culture (X1); (ii) organizational structure (X2); (iii) employees' skills and behaviour (X3); (iv) technological capabilities (X4); (v) supply chain capabilities (X5); and (vi) business strategies (X6). These are further operationalized into respective blocks of measurement items.

(iii) Measurement items

Measurement items are the observed variables or items that are used to assess or measure the value of its respective constructs, which could be of single-dimensional or multi-dimensional nature.

(iv) Construction firms

Construction firms, also variously termed as contractors, contracting firm, main contractors, general contractors are considered synonymous in this study.

1.6 Research hypotheses

Nineteen hypotheses for empirical investigation are set out below.

H$_1$: Organizational flexibility (Y) can be characterized by three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}).

This hypothesis is related to the dimensionality of the organizational flexibility concept. The implication of this hypothesis is that organizational flexibility is a multi-dimensional rather than a single-dimensional concept.

In examining the effects of inter-relationships among the six determinants on organizational flexibility, the following hypotheses were developed (see Chapter 4).

H$_2$*:* Organizational learning culture (X1) has a significant direct impact on organizational structure (X2).

H$_3$*:* Organizational learning culture (X1) has a significant direct impact on employees' skills and behaviour (X3).

H$_4$*:* Organizational learning culture (X1) has a significant direct impact on technological capabilities (X4).

H$_5$*:* Organizational learning culture (X1) has a significant direct impact on business strategies (X6).

H$_6$*:* Organizational structure (X2) has a significant direct impact on business strategies (X6).

H_7: Organizational structure (X2) has a significant direct impact on organizational flexibility (Y).

H_8: Employees' skills and behaviour (X3) have a significant direct impact on technological capabilities (X4).

H_9: Employees' skills and behaviour (X3) have a significant direct impact on supply chain capabilities (X5).

H_{10}: Employees' skills and behaviour (X3) have a significant direct impact on business strategies (X6).

H_{11}: Employees' skills and behaviour (X3) have a significant direct impact on organizational flexibility (Y).

H_{12}: Technological capabilities (X4) have a significant direct impact on organizational structure (X2).

H_{13}: Technological capabilities (X4) have a significant direct impact on supply chain capabilities (X5).

H_{14}: Technological capabilities (X4) have a significant direct impact on business strategies (X6).

H_{15}: Technological capabilities (X4) have a significant direct impact on organizational flexibility (Y).

H_{16}: Supply chain capabilities (X5) have a significant direct impact on business strategies (X6).

H_{17}: Supply chain capabilities (X5) have a significant direct impact on organizational flexibility (Y).

H_{18}: Business strategies (X6) have a significant direct impact on organizational flexibility (Y).

The last hypothesis developed focuses on the environmental conditions, key determinants and organizational flexibility:

H_{19}: Market and technological conditions moderate the relationships between the key determinants and organizational flexibility.

This last hypothesis may be regarded as supported if the market and technological conditions are found to have statistically significant moderating effects on the relationships between the key determinants and organizational flexibility.

1.7 Scope of research

There are several factors that enhance the performance of organizations. These include capable leadership, offering differentiated product or service, effective knowledge management and being flexible. This study focuses on contractors' organizational flexibility (see definition in Section 1.5) in a changing environment, but does not claim that it is the panacea to achieve business success.

Studies have defined construction business in different ways (Hillebrandt and Cannon, 1990; Ive and Gruneberg, 2000): (i) general contracting; (ii) house building; (iii) plant hire; (iv) material production; (v) mining; (vi) property development; and (vii) property investment. However, it is beyond the scope of this research to cover all categories of construction business. The focus here is on general contracting operations of construction firms in Singapore.

Next, although the business environment within which contractors operate may be fuelled by various forces (for example, political, economic, social and technological forces), this research only focuses on how construction firms achieve organizational flexibility in response to the economic and technological changes. Political and social forces are not studied because of the relative social and political stability in Singapore (see Section 2.5).

Lastly, the focus of this research is on the flexibility of general contracting operations of construction firms in Singapore, and not on other categories of construction business (for example, plant hire, property development and investment). The targeted groups of large and medium-sized general building contractors (i.e., Groups A1, A2 and B1) were selected from the Singapore Building Construction Authority (BCA) 2007 Contractor Registry. Through the pilot study and archival searches, other groupings (i.e., B2, C1 and C2) were found to be unsuitable for this research because: (i) they are small firms that tend to work as subcontractors to large contractors and have small contract award values, and (ii) they tend to bid for small repair and maintenance works only. This group of contractors may not exhibit various flexibility management practices on a comprehensive scale. Likewise, it was found that some of these small firms are subsidiaries of large construction firms, which reside in the targeted groups. Therefore, these groups of small-sized contractors were excluded in this research.

1.8 Research method

With reference to the research objectives stated in Section 1.4, this research employed a survey research design owing to its abilities to provide a relatively quick and efficient method to: (i) obtain information from the targeted sample, and (ii) generalize the research findings based on the sample involved (Robson, 2002; Yin, 2003). This research was conducted in three phases, namely: (i) exploratory phase; (ii) questionnaire development phase; and (iii) data collection and analysis phase, which combined both the qualitative and quantitative approaches. This combination capitalizes on the strengths and complements the weaknesses of each approach, and thus provides a synergistic research design. Survey data were collected mainly via face-to-face interviews with targeted respondents at different phases of the study. Details of the research method are discussed in Chapter 5.

The data were analyzed using SmartPLS2.0 M3 statistical software. Using structural equation modelling (SEM) Partial Least Square (PLS) approach, two models were specified. The first PLS model (PLS M1) seeks to identify the key determinants and dimensions of organizational flexibility. The second PLS model (PLS M2) examines the effects of inter-relationships among the key determinants on organizational flexibility (see Section 6.4.2 for the specification of the two PLS models).

Following this, a model validation exercise was conducted to examine the robustness and accuracy of the developed mathematical models. Details of the validation process are discussed in Chapter 9.

1.9 Research significance

This research contributes to knowledge by investigating the potential application of organizational flexibility management in the context of the construction industry. The research significance is realized by its theoretical, practical and methodological significance discussed below.

1.9.1 Theoretical significance

Firstly, this research developed a broad but potentially powerful theoretical framework for studying organizational flexibility by integrating four perspectives of organizational studies (see Sections 3.8 and 3.9). These are: (i) the dynamic contingency view of firms (Child, 1972); (ii) the organizational learning perspective (Cyert and March, 1963); (iii) the resource-based view of firms (Penrose, 1959); and (iv) the complex adaptive system perspective (Prigogine and Stengers, 1984).

Hitherto, it appears to be the first empirical research, which integrated the unique characteristics of the construction industry with these perspectives of organizational studies in finding ways to attain organizational flexibility. These four theoretical perspectives on the organization-environment relations were integrated to collectively explain how contractors behave, learn, adapt, compete and evolve in response to changes in the business environment within which they operate.

Secondly, it filled the gap in the flexibility-related studies in the construction management literature by defining: (i) the concept of flexibility; (ii) the dimensions of organizational flexibility; and (iii) the constituents of key determinants of organizational flexibility. Although there are many mainstream organizational studies on flexibility, few studies have systematically investigated the conceptualization and measurement of the flexibility concept, and few have taken them together and tried to integrate them into one comprehensive model to investigate the relevance of flexibility within the context of the construction industry. This study followed a contextualization-then-re-contextualization procedure (see Figure 3.1) for developing a generic taxonomy for assessing construction firms' flexibility from an integrative multi-dimensional perspective. As a result, a conceptual framework of organizational flexibility in construction business was developed by integrating the flexibility types and flexibility dimensions, and the key determinants of organizational flexibility (see Figure 3.3). This provides a general framework on the functioning of organizational flexibility, offering guidance to researchers and practitioners for discovering alternative means of exploiting opportunities for gaining flexibility in construction business management.

Lastly, it explored the inter-relationships among construction firms' resources, capabilities and strategies (which are labelled as determinants in this study). As highlighted Section 1.2, construction-related studies on flexibility have focused on the effects of individual organizational attributes on organizational flexibility, and less has been done to investigate the inter-relationships among the key determinants towards the attainment of organizational flexibility. For example, (i) what are kinds of determinants that firms should focus on in their attempt to achieve superiority in different dimensions of organizational flexibility such as strategic flexibility and tactical flexibility, and (ii) how the inter-relationships among different key determinants would impact on the different dimensions of organizational flexibility, are questions which have not yet been addressed in the construction management literature. The identified inter-relationships provide a useful insight into the functioning of firms' resources, capabilities and strategies in attaining organizational flexibility.

1.9.2 Practical significance

This research is also of practical significance. The findings provide an empirical understanding of what kinds of resources and capabilities construction firms actually accumulate, and how these valuable resources help firms to respond flexibly to the changes in the business environment within which they operate. It also offers the industry practitioners in-depth insight into different flexibility building practices and their roles in determining firms' flexibility potential. For firms that struggle to remain competitive and viable in a changing business environment, flexibility building practices are of special importance.

1.9.3 Methodological significance

The methodological significance of this research is related to the application of structural equation model (SEM) building and the moderating effect testing by using the PLS approach (a component-based SEM). The SEM modelling technique is characterized by its abilities: (i) to predict multiple and interdependent relationships simultaneously, and (ii) to assess unobservable concepts (i.e., constructs or latent variables) in the presence of interdependent relationships without being contaminated by measurement errors (Hair et al., 1998; Dilalla, 2000). Although it has been widely used in social and behavioural research for developing and testing theories, its application in construction management is hitherto limited. The chosen PLS approach, as implemented in SmartPLS2.0 M3 statistical software in this study, does demonstrate its potential application in construction management research, especially for exploratory studies oriented towards predictive applications (Chin et al., 2003). Moreover, the ability of the PLS method to handle the two complex PLS models in this study with more than 10 constructs and approximately 70 measurement items is also of methodological significance.

1.10 Structure of the thesis

This thesis is structured into three parts. Part One, Chapters 1 to 4, presents the background of this research and reviews the literature. Part Two, Chapters 5 to 9, contains the research design and empirical findings. Part Three, Chapter 10, summarizes and concludes the work.

Chapter 2 explores the need and possibilities for flexibility in construction firms in view of the changes in the construction industry. It describes the changes within the business environment of construction firms, and subsequently provides a discussion concerning the changes within the Singapore construction market that lead to the growing need and opportunities for flexibility in construction firms.

Chapter 3 contains a literature review on the concept and definitions of flexibility, and the definition of organizational flexibility formulated for this study. It also discusses the other defining features, multi-dimensionality and key determinants of organizational flexibility, and presents a theoretical framework of organizational flexibility in construction business that involves three dimensions and 15 flexibility types, which could be influenced by six key determinants. Four predominant theoretical perspectives of organizational studies are used to underpin the theoretical framework. Following this, Chapter 4 discusses the operationalization of the six key determinants of organizational flexibility and development of the research hypotheses.

Chapter 5 describes the research process along with the data collection techniques, using the survey research design. The three phases of the research process, namely: (i) exploratory phase; (ii) questionnaire development phase; and (iii) data collection and analysis phase, that combined both the qualitative and quantitative approaches, are discussed. The sample data, the statistical modelling techniques chosen for the data analysis – the PLS approach, and the specified PLS models are explained in Chapter 6.

The empirical results of the construct validation processes, both classical and contemporary, that provide the confidence of reliability and validity of constructs (i.e., measurement models of the two specified PLS models) are presented in Chapter 7. Before proceeding to reporting the results, it examines the sample profile of interviewees and response rate in an attempt to establish the trustworthiness of the sample data. Chapter 8 focuses on the development and evaluation of the corresponding structural models of the two specified PLS models. Three sets of moderated structural models are also presented to examine the moderating effects of market and technological conditions on the relationships between the key determinants and organizational flexibility.

Chapter 9 discusses the model application and validation of the developed PLS models. Finally, a summary of the research findings and the results of the research hypotheses testing are presented in Chapter 10. This is followed by a discussion of the theoretical and practical contributions of this research, and the research limitations and suggestions for further research.

CHAPTER 2

THE BUSINESS ENVIRONMENT OF CONSTRUCTION FIRMS

2.1 Introduction

This chapter starts with an overview of the construction industry (Section 2.2), construction firms and their business environment (Section 2.3). This is followed by a description of changes within the business environment of construction firms (Section 2.4). The subsequent sections focus on the changes in the Singapore construction industry (Section 2.5) and the need for flexibility (Section 2.6).

2.2 Nature of the construction industry

The construction industry has been recognized as an important sector of a nation's economy, both in terms of its sizeable contribution to the total output of a nation and the number of workers employed by the industry (Hillebrandt, 2000). The industry's products are seen as investment goods that are produced, not only for their own sake, but on account of the goods and services which they can create or help to create (Ofori, 1990; Hillebrandt, 2000). Therefore, satisfactory performance of the industry is vital for the well-being of any economy considering the industry's effect on the production of other interrelated sectors such as the manufacturing and services industries.

In characterizing the construction industry, nine features were proposed by Ofori (1990). These are: (i) the large size; (ii) the influence of government as a client; (iii) the high production cost; (iv) the unique nature of demand; (v) the unattractive nature of work; (vi) the wide range of technologies; (vii) the temporary and multi-disciplinary collaborative nature of organizations; (viii) the lengthy production process; and (ix) the complex structure of the industry. It appears that these features can be broadly classified into Hillebrandt's (2000) four-characteristic taxonomy: (i) the physical nature of the project; (ii) the structure of the industry together with the organization of the construction process; (iii) the determinants of demand; and (iv) the method of price determination.

However, Towill (2001) expressed that there is no single characteristic which is unique to the construction industry. According to Ive and Gruneberg (2000), many individual characteristics of the construction industry can be found in at least one other sector of the economy. For example, the dependence of the construction industry on climate conditions is similar to the agriculture industry, and also like the film industry, the product of the construction industry is of temporary and one-off nature. In fact, it is this particular unification of characteristics, which are separately shared by other industries, that made construction processes distinctive and justified the industry status (Ive and Gruneberg, 2000; Towill, 2001).

Lim and Low (1992) compared the nature of construction and manufacturing, and pointed out that there are fundamental differences between these two industries. First, the marketing of construction services and manufactured products is quite different; whereby the former is intangible in which clients have little opportunity to appreciate the end products until they have been constructed. Second, building clients are often involved and have considerable influence on the design and construction process, whereas general buyers of manufactured products seldom have access to the manufacturing facilities and influence on the product production process. Third, unlike the manufacturing of products, each construction project is unqiue and discrete (in terms of design, use and location), which involves establishment of temporary multi-disciplinary organizations comprising teams of professionals who operate independently and interdependently all others at different construction stages. Fourth, the nature of construction is considerably dependent on site conditions (for example, type of soil and contour of land), and thus leading to uncertainty in decision-making and planning. However, this scenario is less applicable in manufacturing, whereby the production process is almost invariably conducted in a factory under conditions of certainty (Lim and Low, 1992).

The review above shows that construction is a unique and complex industry involving transient players and where clients have considerable influence in the design and construction process. Also, the products of the construction industry are often constructed under uncertain conditions, whereby the ability to make decisions on non-routine events becomes important.

2.3 Construction firms and their business environment

The characteristics of construction firms and their business environment are now discussed.

2.3.1 Construction firms

A firm, in general terms, is "an organization that brings together different factors of production, such as labour, land and capital, to produce a product or service which it is hoped can be sold for a profit" (Myers, 2004:89). This agrees with Robben (1983), who considered an organization as the planned coordination of collective activities of a group of people seeking to achieve a common goal or set of goals. Translating into the context of construction, Runeson and Skitmore (1999:286) expressed that contractors sell "their skills to assemble buildings; the management services necessary to combine manpower, machinery and material into new buildings". Thus, the output of construction firms can be seen as a service rather than a product (Hillebrandt, 2000). At this point, it appears necessary to clarify that terms like 'construction firms', 'contractors', 'contracting firms', 'main contractors', 'general contractors' and 'prime contractors' are considered synonymous in this study, and used interchangeably.

The type of ownership in construction firms may take several forms, ranging from a one-man enterprise to a public listed construction company. Typically, construction firms are quite small with small capital expenditure since their equipment is often leased or hired (Dulaimi and Hong, 2002). For example, more than 90% of the 2509 companies registered under the general building projects section of the Singapore Building and Construction Authority's (BCA) Contractors Registry are only eligible to undertake building projects with the value of less than S$5 million. Of these contractors, 82% (1887 out of 2276 contractors) can only undertake work of up to S$750,000 (BCA, 2008a). This group of small-sized contractors usually undertake small repair and maintenance works only, or operate in a subordinate productive role to large-sized contractors who normally obtain their works through competitive tendering from private or public sector clients (Loosemore et al., 2003). In some cases, owing to their established reputation and past relationship with clients, some large-sized contractors become the preferred contractors of some private sector clients, thus gaining privileged access to private sector projects. This may explain why reputation and relationship have been identified as the key critical factors for increased firms' competitiveness (Hillebrandt et al., 1995; Green et al., 2008).

According to Hillebrandt (2000), even in the case where the product of the construction industry is seen as a service, the product within individual construction markets is not completely homogeneous. This is because different specialist firms, possessing different productive skills and management expertise, are required to assemble different types of construction work. In line with this, Gruneberg and Ive (2000) classified construction firms, based on their specialization, under four dimensions. They are: (i) the customer; (ii) the technology for final product; (iii) the transaction type; and (iv) the project size and complexity. For example, some construction firms practise specialization according to their customers rather than products with a defined base of major customers, say, to work for the public sector clients only.

2.3.2 Business environment

According to Hillebrandt et al. (1995), the behaviour of construction firms is strongly influenced by the environment within which they operate; “first the overall economic and political conditions and secondly the state of the construction industry and the nature of demands being made upon it” (p.3). Newcombe (1990a) and Lansley et al. (1979) classified the environment within which UK contractors operate into: (i) the national environment concerning the governmental policies and laws, the influence of professional institutions and trade unions, and the economic, technological and societal changes, and (ii) the competitive environment concerning the availability of finance, plant, labour and management, the relationships with suppliers, subcontractors, consultants and clients, and the degree of rivalry among competitors.

Betts and Ofori (1994) observed that the environment in which construction firms operate is increasingly influenced by: (i) economic factors; (ii) technological factors; (iii) social factors; and (iv) the industry’s development towards the information age. This observation is supported by Hillebrandt et al. (1995), who identified five environmental factors shaping the competitiveness of the construction industry. They are: (i) economic and industrial factors; (ii) government policies; (iii) social and technological changes; (iv) external influences; and (v) the industry’s evolution.

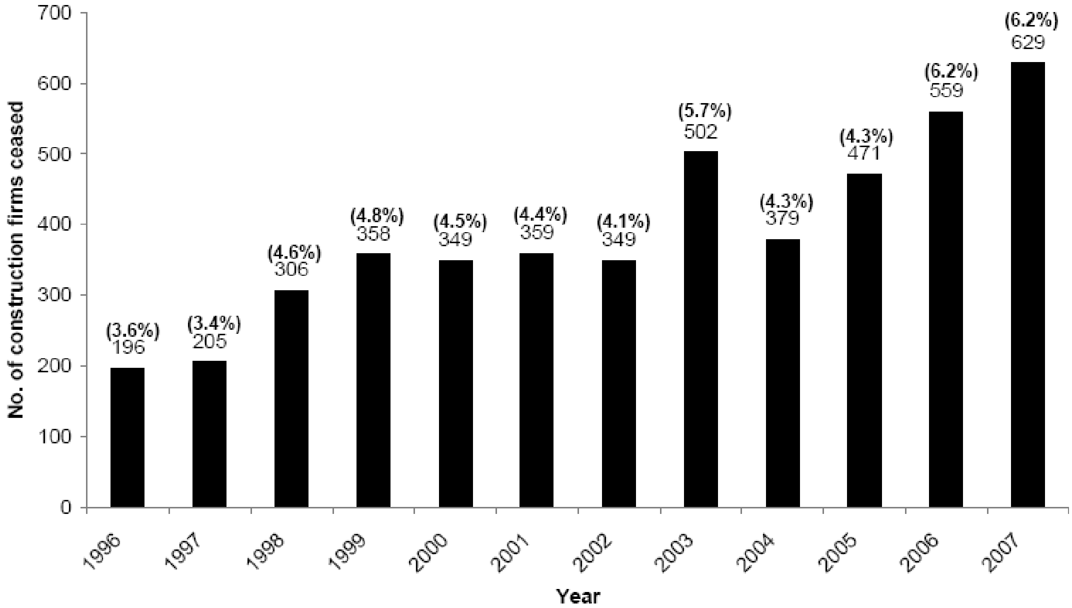
Duncan (1972), an organizational theorist, developed a model focusing on the prediction of the kinds of environments in which different levels of perceived uncertainty are expected to exist. Two environmental dimensions are identified and represented along the two continuums of simple-complex and static-dynamic. The simple-complex deals with the extent to which factors in the decision environments are few in number and similar in nature or are many and different, i.e., the degree of complexity in the environment. The static-dynamic refers to the extent to which factors in the decision environments remain basically the same over time or are in a continual process of change, i.e., the degree of stability in the environment. Based on this format, Duncan (1972) offered a four-way classification of organizational environments, which are arranged in an ascending order of perceived uncertainty in decision-making as follows: (i) simple-static; (ii) complex-static; (iii) simple-dynamic; and (iv) complex-dynamic.

In applying Duncan's (1972) model of organizational environment into the context of the construction industry, Shirazi et al. (1996) identified that the complex-dynamic environment, signifying the greatest amount of uncertainty in decision-making, is the most representative type of environment in the industry. This means that contractors are likely to deal with rapid changes and unanticipated decision situations in their business activities. This agrees with Hughes (1989), who noted that the ideal state of the environment, characterized as stable, certain, simple, and easy, is rare in down-to-earth situations based on his study on the Jamaican and UK construction industries.

In the case of the UK construction industry, the environmental dynamism and contractors' responses within different operating environments during the periods of 1960s to 1980s and 1986 to 1993 were investigated by Lansley (1987) and Hillebrandt et al. (1995), respectively. In this case, environmental dynamism refers to the rate of change, absence of pattern and unpredictability of the environment (Dess and Beard, 1984). Lansley (1987) found that UK construction firms implemented different corporate strategies in response to different level of environmental changes; shifting from the focus on internal efficiency and specialization in the 1960s to the emphasis on flexibility in the 1970s and subsequently, to restructuring and streamlining of business operations in the 1980s. Similarly, Hillebrandt et al. (1995) noted the following major changes in contractors' strategies from the periods 1986 to 1993: (i) greater concentration on core businesses; (ii) greater focus on balance sheets matters compared with profits and cash flow and greater financial sensitivity; (iii) greater attention to marketing strategies; (iv) greater focus on international markets; (v) tightening of organizational structure; and (vi) continued reduction of permanent employees.

In the context of the United States (US) construction industry, Kale and Arditi (2003) examined the relationship between a construction firm's performance and its environment, which is considerably fuelled by competitive and institutional forces. They found that the performance of US construction firms is significantly affected by the industry's competitive forces, but not the institutional forces, and added that construction firms need to differentiate themselves from their closest rivals in order to remain viable. Some suggested differentiation strategies include: (i) providing high quality in finished products; (ii) offering a high quality contracting service; (iii) minimizing operational costs and administrative overheads; and (iv) introducing innovative approaches to financing techniques, administrative procedures, construction processes and methods.

According to Betts and Ofori (1994:205), the environmental dynamism in construction "is growing at an increasing fast pace and is offering proportionately greater strategic opportunities with time, while posing significant threats". It appears that, if construction firms are not able to effectively deal with dynamism in their business environment, they could soon undergo difficulties that might jeopardize their continued existence. This phenomenon is attested in Singapore's construction industry, especially during the last decade, 1997 to 2007. Figure 1 shows the number of construction company cessations during 1996-2007. The term 'cessation' is defined as a company that had ceased operations, or been struck off, liquidated and dissolved during the reference year (Department of Statistics, 2007).



NB: (%) denotes the percentage of construction firm cessations with reference to the total population of construction firms for the respective year

Figure 2.1 Number of construction firm cessation
Source: Data were taken from the Department of Statistics (1998; 1999; 2001; 2007; 2008a)

Figure 2.1 shows that the number of construction firm cessations generally follows an increasing trend, ranging from 205 cases in 1997 to 629 cases in 2007, as compared to 1996. During the periods 1997 - 2007, many large-sized contractors (for example, Econ Corporation, Neo Corporation and Wan Soon Construction) had gone into liquidation (The Business Times, 2004; The Straits Times, 2006). The fluctuation in cessation cases can be explained in relation to the state of the Singapore construction industry discussed in Section 2.5.

The above reveals that the behaviour of construction firms is influenced by several environmental factors within a nation's construction industry and that, with the increasing level of environmental dynamism, construction firms are facing a fundamental management challenge in their endeavours to remain viable. They need to gain flexibility in their endeavours to be adaptive and responsive to changes within the business environment (see Section 2.6 for further discussion). Also, it appears that the business environment moderates the behaviour of construction firms as they attempt to achieve flexibility for their continued existence. As such, it is important for contractors to understand the types of change in their business environment and how these changes could affect their business operations.

2.4 Changes in the business environment of construction firms

In this section, the types of change taking place within the business environment of construction firms are discussed under the following headings: (i) construction demand; (ii) intensity of competition; (iii) procurement trend; (iv) clients' performance criteria of construction services; and (v) technological possibilities. Although each change or a combination of changes in the business environment of the construction industry may have different impacts on individual contractors, it is believed that contractors have to adequately respond to each relevant change in order to stay viable.

2.4.1 Construction demand

One of the market characteristics for construction services is the rapid changes in demand. According to Runeson (2000), changes in construction demand may, in some instances, exceed 10% per year for the industry as a whole. As for individual markets, the variation may be even more substantial, exceeding 50% per year. Gruneberg (2009) pointed out that rapid changes in construction demand of a nation could be due to major changes in its economic, political, demographic, technological and environmental conditions.

Fluctuation in construction demand is cyclical and a construction (or building) cycle is defined as “the period between two successive peaks or troughs in the total volume of construction” (Ofori, 1990; 49). Construction demand is subject to periods of contraction (i.e., recession) and expansion (i.e., boom), which are linking the wider economic activity of a nation (Ive and Gruneberg, 2000; Hillebrandt, 2000).

Studies demonstrated that building and economic cycles are closely interrelated. Bon (1989) related building cycles to economic cycles, discussing the effect of economic cycles on building cycles. He noted that individual building cycles could differ in terms of their pattern and intensity since influencing factors of each cycle may vary over time. This observation is shared by Ive and Gruneberg (2000), who pointed out that individual cycles could be of highly variable amplitude. According to them, sometimes the downward part of each cycle is dwarfed by the recovery comprising many fewer quarters of contraction than of expansion, whereas at times, the period of contraction may be longer than or similar in length to the period of recovery. They compared both the economic and construction cycles between the periods 1950 - 1973 and those since 1973, and found that: (i) the contraction and expansion amplitudes in the UK construction industry have increased; (ii) the size of contractions has been greater than the size of expansions; and (iii) the construction cycles have shown greater amplitude than the economic cycles. Also, Bon (1989) and Snyman (2009) noted that the amplitude of fluctuations in construction exceeds the fluctuations in the manufacturing and services industries of any economy.

According to Loosemore et al. (2003), the cycles of peaks and troughs in construction demand cause problems to contractors in their human resource management strategies. For example, the cyclical nature makes retaining their directly employed workforce and making long-term investment in their core professional staff difficult. Likewise, Ive and Gruneberg (2000) and Hillebrandt and Cannon (1990) recognized that the demand fluctuation in construction is one of the main difficulties facing contractors in their strategic planning for resource utilization and investment. Ive and Gruneberg (2000) pointed out that, if a firm cannot predict demand accurately, the firm needs to be flexible in response to any change in its business environment. It is because fluctuations in demand will directly affect a firm’s cost inputs and tender prices for construction projects, and in turn, influence its project profitability (Snyman, 2009).

Male (1991a) noted that there can be significant problems associated with forecasting construction demand, on account of the influences of government as a major client of the industry. Finkel (1997) and Hillebrandt (2000) highlighted that every aspect of the construction industry is, to some extent, influenced by the government. For example, safety, training and employment are each entangled with the public sector expenditures on the construction industry services, and also, government financial regulations, such as its fiscal aspects of housing and capital spending, building grants and loans, will significantly influence construction demand. According to Finkel (1997), the government building programs and budgets are often designed as a means to jump start a sluggish economy. This agrees with Ofori (1988) and Hillebrandt et al. (1995) that governments regulate public expenditures in their attempts to even out the cyclical nature of the construction industry. On the other hand, governments may limit the extent of construction activities through implementing building quotas or limiting sales of land in response to an overheated economy.

Briscoe (2009) noted that governments have to make constant adjustments to different policies (for example, fiscal, monetary and regulatory policies) in order to achieve their key macroeconomic objectives (for example, economic growth, control of inflation, stability in the balance of payments and protection of the environment), which are closely aligned with the world economy. He added that these constant changes in governmental policies will considerably influence the construction industry and its construction demand. For example, Gruneberg (2009) pointed out that, as climate change issues have become a prominent feature in current global politics, governments' initiative towards creating a more sustainable environment has also initiated changes in demand for construction; especially in developed nations. He explained that government legislation to reduce carbon emission means that greater pressures have been placed on contractors to produce environmentally friendly buildings. The changing trend in customers' preference, in both private and public sectors, will be discussed in Section 2.4.4.

Also, changes in the size of population and societal expectation do considerably affect the level of construction demand. Gruneberg (2009) suggested that, as economies grow, societal expectation changes; public and private demand for improved housing, non-residential buildings and infrastructure increase, in terms of comfort, convenience and appearance. Similarly, Hillebrandt (2000) explained that, as population increases, the demand for housing and educational facilities also increase. The increase in demand increases the price of accommodation and this in turn increases houses and land prices; all these eventually shape the demand of construction activity (Gruneberg, 2009).

The various environmental factors discussed above are some of the factors affecting construction demand. These are present to varying degrees in different countries. No one factor can be said to be the cause in shaping a nation's construction activity and demand. Fluctuations in construction demand are influenced by many interrelated factors, and are unavoidable and difficult to predict. Thus, it is not unusual for contractors to undertake a broad range of work of different nature in their endeavours to counteract the fluctuation in demand for a particular type of work. However, it is noted that the kind of management skills required varies from project to project, and that it is very difficult for firms to accurately predict their next project since a considerable portion of the industry's workload is let by competitive tendering (Ball, 1988; Ive and Gruneberg, 2000). This further places greater emphasis for contractors on the need to be flexible in response to specific requirements of each project, instead of focusing only on efficient delivery of the kind of projects currently on hand, in their endeavour to obtain sufficient turnover (sales volume) within an environment which is subject to cyclical demand fluctuation (Ball, 1998).

2.4.2 Intensity of competition

Cox and Thompson (1997) and Cheng et al. (2000) noted that the fragmented nature of the construction industry is one of the key causes sparking off intense competition within the industry. In measuring the degree of competition in the construction industry, three measurement items were operationalized by Runeson (2000): (i) the number of firms in the industry; (ii) the concentration ratio; and (iii) the profit level. His study showed that: (i) the construction industry is a very competitive industry; (ii) the industry is fragmented into several different markets; and (iii) individual contractors have no influence over prices and output.

In fact, the intensity of competition has been intensified with the increased participation of more foreign contractors in domestic construction markets, especially in less developed countries due to governments' economic and infrastructure development initiatives (Raftery et al., 1998). Sillars and Kangari (1997) noted that the traditionally geographically dependent construction industry has transformed into one in which borders between competitors are virtually removed. The wide availability of economical transportation and effective telecommunication systems have virtually removed the barriers to access of information and markets, which were previously not possible (Sillars and Kangari, 1997).

According to Raftery et al. (1998), as more countries participate in the globalization process with more trade barriers lifted, the world will be entering an era of increasing competition. They added that the globalization trend in construction poses both opportunities and concerns for less developed construction markets. In terms of opportunities, the expansion of international trade in construction would drive firms to comply with international standards, a process which could help to increase their competitiveness, in terms of cost, quality and project delivery. On the other hand, Raftery et al. (1998) are concerned that the increased competition arising from the inflow of foreign contractors could edge out local construction firms, if no proper governmental control is implemented. In fact, the increasing trend of foreign competition in domestic construction markets is not only evident in less developed countries, but also in developed nations, such as Hong Kong and Singapore, which have always been open markets for foreign investment and competition.

Russell and Stouffer (2000) pointed out that the globalization trend, fuelled by economic and technological forces, will affect any construction firms. Large-sized contractors must compete with the world’s largest; medium-sized contractors must constantly take advantage of opportunities and manage change effectively; small-sized firms must strive to retain loyal clients since they can potentially contract similar construction services for less money.

Recognizing the change and intensity of competition in construction, Kale and Arditi (2002) examined the competitive positioning of 107 US construction companies along two dimensions: (i) the mode of competition and (ii) the scope of competition. The former refers to firms' decision to compete on the basis of quality, innovation, time and cost, while the latter refers to firms' decision to adopt either a narrow or a broad operational approach in terms of geographical locations, market segments of operation, project delivery systems offered and group of clients served. They found that the construction firms can be grouped into four approximately equal clusters of different competitive positioning as shown below:

(i) Cluster 1: adopts a neutral approach to scope of competition (i.e., falls between a narrow and a broad approach) and places strong emphasis on all modes of competition.

(ii) Cluster 2: adopts a neutral approach to scope of competition and only places strong emphasis on competing on the basis of innovation and quality.

(iii) Cluster 3: adopts a neutral approach to scope of competition, but no emphasis on any modes of competition.

(iv) Cluster 4: adopts a very broad approach in terms of scope of competition and is primarily concerned with time and cost modes of competition.

The above clustering is an attempt to shed light concerning contractors' competitive positioning through categorization into relatively homogeneous groups. The finding showing that the neutral approach to scope of competition in three out of the four clusters of firms is striking. This suggests that construction firms do recognize the needs and possibilities for flexibility in delivering construction services by: (i) offering an adequate range of project delivery systems; (ii) targeting and serving a few groups of clients; and (iii) operating in several geographical locations and market segments of operation.

The review above shows the increasing trend of global competition in construction. It follows that contractors have to engage in a continuous process of developing and managing their resources and capabilities, improving their business efficiency and upgrading their products and services in order to respond flexibly to challenges imposed on them by their business environment.

2.4.3 Procurement trend

Cartlidge (2004) studied the procurement trends in the UK construction industry, and found that the industry does not appear to recognize the necessity to challenge long held industry practices. He noted that trends in procurement have been brought about as a result of clients' pressure or economic conditions or a combination of both, moving from the traditional approach of Bills of Quantities (BQ) and competitive tendering (1983 – 1969) to the methods of management contracting and construction management (1970 – 1989). Thereafter, following the economic milestone of globalization, three predominant procurement methods (i.e., design and build (D&B); prime contracting; public private partnership (PPP)) and three contracting methods (i.e., partnering; alliancing; and joint ventures) emerged. Cartlidge (2004) considered this transition as "the remodelling of the UK construction industry" and perceived that the industry is progressively moving towards a more integrated and relationship based contracting approach. This agrees with Winch (2000) who, in his study on the evolution of contractual relations and the construction process in the UK construction industry, noted that: (i) the industry aims to improve the performance of the construction process by introducing concession contracting under the PPP arrangement, and (ii) public sector clients are progressively developing strategic partnerships with the private sector for delivery of public infrastructure facilities to the community.

A longitudinal study, conducted on a three-year interval between 1985 and 2004, also demonstrated that the UK construction industry has shifted from the traditional lump sum-fixed price bill of quantities method to a more integrated and relationship-based approach (Royal Institution of Chartered Surveyors, 2004). The study recorded that the use of D&B method has increased progressively from 8.0% in 1985 to 43.2% in 2004 based on the percentage of the value of contracts awarded. Beside this, there was a gradual increase in the use of partnering agreements, from 1.7% in 2001 to 6.6% in 2004. On the other hand, the use of lump sum-fixed price BQ method plunged from 59.3% in 1985 to 23.6% in 2004. Correspondingly, changes in clients' procurement strategies are noticeable in the Singapore construction industry and will be subsequently discussed in Section 2.5.

Also, Runeson and de Valence (2009) found that there is a radial change, in terms of how contractors function, within the current "new" Australian construction industry compared to the "old" industry in the last 15 years (the terms "new" and "old" were used in their study). They noted that the use of PPP and other innovative procurement methods has accelerated considerably, and that the competition in construction is far beyond the basis of price. Rather than providing a fairly simplistic construction management service based on a competitive price, as had been traditionally done by contractors, the contractors are expected to offer a more sophisticated and differentiated range of services in order to satisfy changing clients' needs (Runeson and de Valence, 2009). They have to compete on design, technology and value for money and at times, their scope of competition may further include financing, constructing and operating a facility for anything up to 30 years, if projects are tendered under the PPP procurement method (Runeson and de Valence, 2009). According to Bevan (2008), there is an increase in the number of PPP projects, including construction of court houses, schools, prisons and hospitals, within the Australian construction industry.

Likewise, Raftery et al. (1998) examined the major trends in construction industries across Asia (for example, Philippines and Malaysia), and found that there is an increase in both PPP infrastructure projects and vertical integration of construction projects. He pointed out that the "construction only" contracting service is becoming less preferable except in small-to-medium scale projects, and that many construction projects are becoming more complex and requiring more sophisticated technologies (see Section 2.4.5) and financing devices. In response to this increasing complexity, they found that the more usual arrangement for large scale projects is for contractors, developers and financiers to form consortia in order to build individuals' expertise, in addition to reducing project risks. They added that formations of strategic alliances and partnering agreements are seen as necessary because contractors cannot be expected to have all resources and capabilities that are required to be effectively competitive. This agrees with Tiong and Yeo (1993) and Li and Tiong (1999), who suggested that forming global partnership relationships is a common approach for international contractors to strengthen their competitiveness in both international and domestic markets.

From the above discussion, it appears that the procurement trend has, to a great extent, influenced the ways in which contractors compete and function. The extent to which how the procurement trend in construction, over the past decades, influences construction business is further substantiated in the series of studies published by: (i) the International Council for Research and Innovation in Building (CIB) Working Commission W92 on procurement; and (ii) the IF research group (GRIF) at the University of Montreal, Canada. Admittedly, it is no longer sufficient for contractors to simply offer management services based on a competitive price, but rather they have to offer a broader range of products and services in order to remain competitive. Apart from developing firms' resources and capabilities, in their endeavours to offer improved products and services, contractors further need to build cooperative relationship with external parties in configuring and formulating business packages and strategies, which are difficult to realize single-handedly, in response to clients' changing requirements.

2.4.4 Clients' performance criteria of construction services

Most buildings have been conceived and built on the basis of simple criteria - fitness for purpose corresponding to the lowest possible construction cost in traditional procurement (Yisa et al., 1996). Besides the cost element, construction project performance has traditionally been measured in terms of time and quality (Walker, 1990; Ofori, 1992).

In the UK, Yisa et al. (1996) noted a change in public sector clients' project performance criteria; where emphasis has been placed on the elements of speed and value-based services, in addition to the traditional time-cost-quality performance of a project. Likewise, Cartlidge (2004) found that UK clients have changed their emphasis regarding project performance criteria. In descending order of importance, they are: (i) the contractor's ability to innovate and provide bespoke value-added solutions to construction-related problems combined with minimum exposure to risk; (ii) the assurance of cost, service and quality; and (iii) the assurance of supply. This changing trend of project performance criteria can partly be explained in relation to the increase in PPP projects and vertical integration of projects where clients are seeking more integrated value-added (or value for money) services from design and construction to operation and maintenance of built facilities (see section 2.4.3). Manseau (2005a) pointed out that this contracting trend has influenced the way clients define project performance and values of construction services.

Apart from the above performance criteria, Winch (2000) detected that UK public sector clients are more inclined towards total building performance, focusing on the total life cycle cost of owning and operating a building. Spencer and Winch (2002) suggested four aspects of total building performance that are increasingly becoming the focus of UK clients: (i) spatial quality that encourages interaction between staff; (ii) indoor environmental quality and its impact on the efficiency and the effectiveness of people who are in the built facility; (iii) symbolism of the facility that conveys the identity and the values of its owners; and (iv) financial value of the facility for exploitation or trade.

Lutzkendorf and Lorenze (2005) pointed out that total building life cycle cost and sustainable construction and development are the two emerging trends within international construction markets, especially in most developed countries. They noted that a variety of private and governmental initiatives and programmes are being implemented to provide sustainable development within planning, construction, management, refurbishment and demolition of buildings. They suggested that private and public sector clients are becoming more demanding and environmentally conscious, integrating environmental, social and economic dimensions of into building performance assessment. Lately, Gangolells et al. (2009) found that the environment has been consistently considered as the fourth major dimension in evaluating project performance – a theme put forth by Ofori (1992), urging that clients should make the environment as their fourth construction project objective. This phenomenon can partly be explained in relation to the increasing pressure of climate change and environmental issues.

The review above shows the changes in clients' performance criteria, from the traditional cost-time-quality performance model to the value-added services performance approach and then, to the emerging trends of total building performance and sustainable development. All these imply that contractors have to be flexible in their design and delivery of construction services in response to clients' changing requirements, for better competitiveness and continued existence.

2.4.5 Technological possibilities

According to Gann (1994), the design and delivery of construction services have been influenced by some major technological changes and possibilities: (i) the use of information and communication technologies (ICT) in both construction process and building operation and maintenance; (ii) the mechanization of construction activities; (iii) the prefabrication technique; and (iv) the use of new construction materials. Hillebrandt et al. (1995) and Gruneberg (2009) found that changes in technology affect construction demand (see Section 2.4.1) in turn, influence the share and type of work being undertaken by main contractors and specialist subcontractors; especially with the development of new sophisticated buildings such as offices, hospitals and commercial facilities. Hassan et al. (1998) pointed out that industrial and other commercial facilities will be increasingly complex owing to advancing technology that will influence the nature and internal environment of productive facilities.

The European Construction Technology Platform (ECTP, 2005) found that the collective effect of industrialization and improved efficiencies in both the construction process and the performance of construction materials, fuelled by rapid technological advancement, have brought about recent changes in the design and construction of built facilities in European countries. For example, (i) skyscrapers could be built reaching 500 metres or more; (ii) bridges could span more than 1400 metres; (iii) underground tunnels could reach 56 kilometres in length; and (iv) deep foundations could reach 120 metres. However, these changes do not only occur in European countries, but also in other regions. Examples of some skyscraper buildings under construction in other countries include: (i) the Burj Dubai Tower in United Arab Emirates; (ii) the Lotte World II in South Korea; and (iii) the International Commerce Centre in HK.

The other emerging global trend, characterized by the rapid technological advancement, is the design and construction of energy-efficient buildings. Many studies have been done in different industry settings (for example, US (Andrews and Krogmann, 2009); Greece (Papadopoulos et al., 2008); Spain (Orosa and Olivera, 2009); China (Hong, 2009); and HK (Chung and Hui, 2009)) focusing on the development of different energy-efficient technologies in building projects such as heating, venting and air-conditioning (HVAC) systems, lighting and window systems. Brochner (2009) suggested that the emerging global trend towards indoor comfort and effective energy consumption will trigger major changes and possibilities in traditional construction methods.

In HK, other impacts of technological change for the construction industry are evident in the increased use of prefabrication techniques in private sector residential building projects and the increased demand of intelligent buildings. Jaillon and Poon (2009) found that although prefabrication was introduced in public sector residential building projects since the mid 1980s, there has been a recent push in the private sector to adopt prefabrication techniques following the introduction of several regulations and incentive schemes (for example, the Joint Practice Notes 1 and 2 that promote the use of green building technologies and prefabrication). Under the Joint Practice Note schemes, Gross Floor Area exemption is granted for buildings constructed with green features such as prefabricated non-structural external walls and balconies (see HK Buildings Department, 2004 for further details). Jaillon and Poon (2009) further noted that, with the constant introduction of governmental policies that emphasize reducing construction waste and improving quality control and working conditions, more prefabricated building components have been progressively used in both public and private sectors projects (for example, the use of precast facades, semi-precast slabs, beams, lift and stair core walls, bathrooms, kitchens and refuse chutes).

Furthermore in HK, Cho and Fellows (2000) and Chan (2007) found that there is an increasing and constantly changing need for high rise intelligent office buildings, integrating high-tech ICT and building management systems. Cho and Fellows (2000) and Chan (2007) explained that this growing phenomenon is attributable to the merits of intelligent buildings in: (i) helping building owners and occupiers to reduce operating and occupancy costs while providing an environment which is more flexible, convenient and comfortable; (ii) offering advanced technological facilities together with reduced maintenance; and (iii) offering users with improved operational effectiveness and efficiency, and providing owners with better marketability.

Manseau (2005a) suggested that, as building owners, clients and end-users continuously demand high-tech, complex and highly customized built facilities, together with the constant adjustment of governmental policies, the impact of technological changes on contractors is expected to grow. This is especially true in the current business environment where contractors can consider offering a more integrated range of construction services, from design and construction to operation and maintenance of built facilities, in fulfilling their clients' needs and preferences (see Sections 2.4.3 and 2.4.4). For example, in concession contracting, contractors would need to be equipped with necessary know-how in designing and constructing specialized facilities incorporating improved building controls and automation to reduce operating costs since the commitment made for delivery of services usually lasts for 30 years. Likewise, the growing investment in intelligent or energy-efficient buildings requires contractors to continuously upgrade their capabilities and innovate in terms of the types of designs, technologies, materials or construction methods deployed in a project. All these imply possible business opportunities and threats to contractors' operations. Therefore, construction firms should seek to improve their organizational flexibility, i.e., to achieve improved responsiveness to changes, in their attempts to fulfil the changing expectancies and needs of clients, end-users or building owners (see Section 3.4 for the definition of organizational flexibility adopted in this study).

2.5 Changes in the Singapore construction industry

This section focuses on the marketplace changes in the business environment of Singapore contractors, corresponding to the afore-discussed headings.

The Singapore construction industry is based on the British model in which the traditional design-bid-build procurement system predominates. During the periods 1993 to 1998, the industry was listed as one of the top 15 most attractive construction markets by city in the world (Bon and Crosthwaite, 2000). This attractiveness ranking was evaluated based on three criteria: (i) the fastest growing market; (ii) the most profitable market; and (iii) the most open market. Nonetheless, the construction industry is subjected to cyclical fluctuation in demand, which is sensitive to the wider economic activity. The industry grew strongly in the early 1980s, posting construction demands measured by contract value which ranged from S$6.6 billion to S$6.9 billion, and then experienced a deep economic downturn in 1985 to 1988 with construction demands valued between S$3.4 billion and S$4.8 billion (BCA, 2002). Growth resumed during the late 1980s, but subsequently slowed down following the Asian financial crisis in 1997 (BCA, 2002; BCA, 2009a).

This study concentrates on the period 1997 – 2007 (see Section 1.3). Figure 2.2 shows the construction demand (contracts awarded) of both the public and private sectors in the Singapore construction industry from 1996 to 2007. It can be seen that the local construction demand is subjected to cyclical fluctuation. In 1998, there was a 36% drop in construction demand following the Asian financial turmoil in the mid 1997 - 1998. The overall construction demand continued to slump in 1999 with a further drop of 21% from 1998. This drop was mainly due to the contraction (approximately 40%) in the value of contracts awarded by the public sector (BCA, 2000). A sign of recovery for the industry was reflected in 2000 when the construction demand rebounded by 54% to reach S$20.1 billion from S$13 billion in 1999 owing to a two-fold increase in the value of public sector contracts awarded on infrastructure projects in preparation of future economic and social developments (Department of Statistics, 2001). However, a slump of 29% in the construction demand was again registered in 2001 due to the softening of private developments and the cutback of public housing (Department of Statistics, 2002). Although there was a marginal growth of 1% in 2002, the construction demand yet again plunged by 31% in 2003 to reach S$10 billion owing to the acute decline in the public sector contracts awarded and the sluggish performance of the private sector (Department of Statistics, 2004). The industry turned around from 2005 onwards. The total contracts awarded increased from S$10.2 billion in 2004 to S$21.8 billion in 2007. This growth was underpinned largely by the brisk private sector activity in residential, commercial and industrial developments (Department of Statistics, 2006; 2007a).

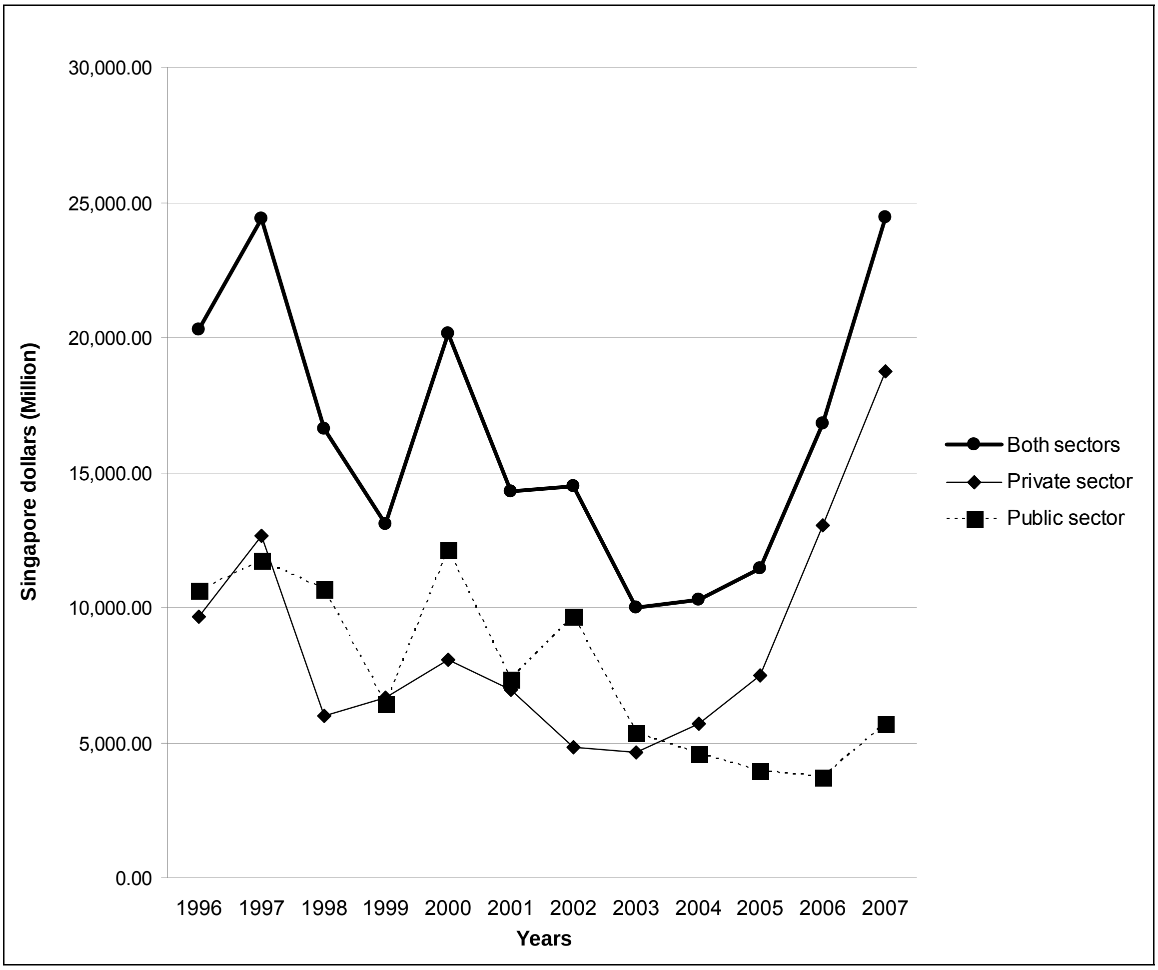
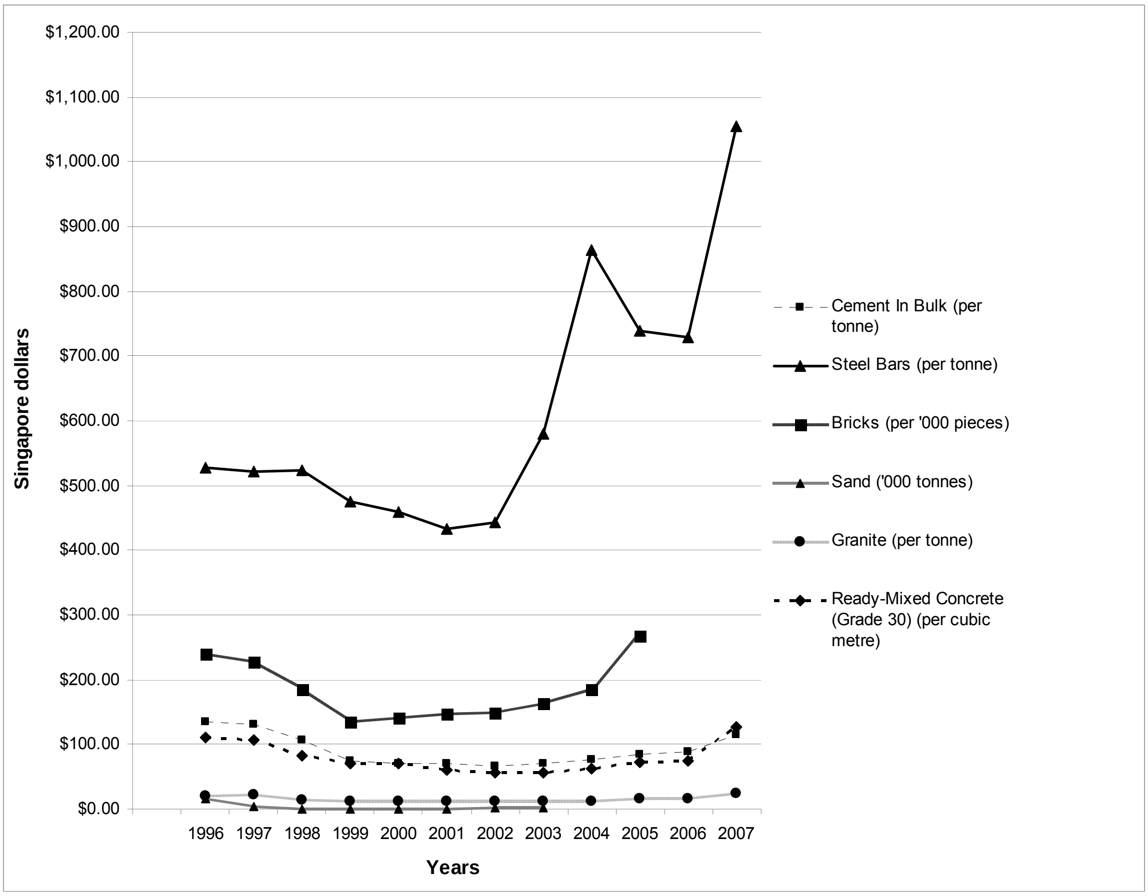


Figure 2.2 Value of contracts awarded in the Singapore construction industry
Source: Dataset were taken from BCA (2009a)

However, the industry demand valued at S$34.6 billion in 2008 is expected to fall as the global financial crisis makes its impact on the real economy; with a 2009 forecasted construction demand valued between S$22 billion and S$28 billion (Joyce, 2008a; BCA, 2009a). In response to the murkier outlook in construction, calls have been made by the industry for the government to bring forward those public sector projects deferred in the end of 2007 due to the high rise in construction costs triggered by the soaring construction demand (Joyce, 2008b). Here, the influences of government as a major client of the industry (i.e., political factor) do play a role to cushion an anticipated fall in demand. According to Kok (2008) and Shankari (2008), the increasing price of raw materials may have led to the liquidation of many

Singapore contractors, who worked on low profit margins without considering the escalation of material prices. Figure 2.3 shows the market price of some basic construction materials in Singapore. It can be seen that there was an increase in price for most construction materials; especially for steel bars where the price increased two-fold over the period 2001 to 2007. It appears that, besides facing an increased competition due to the shortfall of construction demand during the 1997-2005 economic downturn, contractors were faced with the problem of soaring raw materials prices.



Note: the prices for sand and bricks are not published from the periods 2004-2007 and 2006-2007, respectively.

Figure 2.3 Market prices of construction material

Source: Dataset were taken from BCA (2009b)

There have been a few studies on how Singapore contractors responded to economic downturn in the 1997-2005 period. Some actions frequently adopted by

Singapore contractors are to: (i) concentrate on their core skills and limit their business scope; (ii) retrench, downsize and streamline in order to keep a foothold in their business; (iii) form joint ventures; and (iv) submit a low tender price to secure projects (The Contractor, 1998). Other identified actions which are less common among Singapore contractors include: (i) diversifying into other related business; (ii) merging and forming strategic alliances; and (iii) exiting the industry (The Contractor, 1998). In a survey of 46 Singapore contractors, Low and Lim (1999; 2000) categorized the contractors' responses to the economic downturn into five major headings, namely: (i) company restructuring; (ii) business repositioning; (iii) business marketing; (iv) cost cutting; and (v) long-term planning. The identified top ranked responses among their respondents include: (i) cutting suppliers' costs; (ii) adopting competitive bidding among suppliers; (iii) encouraging individual participation through quality circles; (iv) introducing new methods of managerial control; and (v) explaining current difficulties to staff. These studies indicate that contractors have to respond flexibly, via a variety of strategies, in striving for their continued existence in the face of declining construction demand. However, their findings could only reflect the initial responses of Singapore contractors to the beginning of the 1997 - 2005 economic downturn. They did not consider the strategies adopted by Singapore contractors in response to the prolonged 1997- 2005 downturn that lasted eight years; particularly when the deep downturn occurred in 2003 and the local construction demand plunged to its lowest point ever since 1991 (Department of Statistics, 2004). Nevertheless, it is acknowledged that their findings could be used to map the reformulation of Singapore contractors' responses throughout the long downturn.

Considering a modern city like Singapore, one of the fundamental demographic changes taking place is the aging population associated with the low birth rates. For example, the median age of Singapore resident population rose from 30 years old in 1990 to 37 years old in 2008, and correspondingly, elderly persons (age above 64) increased to 8.7% of the resident population of 3.64 million in 2008, from 6.8% of the resident population of 3.18 million in 1998 (Department of Statistics, 2008b). Besides this, the number of persons aged below 15 years plunged from 22.29% of the resident population in 1998 to 18.43% of the resident population in 2008 (Department of Statistics, 2008b). This attested to the declining trend of the nation's birth-rate. In effect, all these changes in the demographics influence construction demand in several ways: (i) more housing for single persons; (ii) more special housing for the elderly and for those in need of care; and (iii) more healthcare facilities.

Next, looking at the population size, there was a slight increase of resident population of 460,000 from 1998 to 2008. Despite the growth in resident population, a high percentage of the national home ownership was reported, indicating that about 91% of the resident population own their homes in Singapore; one of the highest in the world (Mah, 2007; Department of Statistics, 2008b). Also, several social development and support schemes have been implemented to meet the changing social housing expectation in Singapore (see Mah, 2007 and MCYS, 2008). Examples of such schemes include: (i) the self-contained towns scheme; (ii) the ageing population programme; (iii) the public housing upgrading scheme; (iii) the design, build and sell scheme; (iv) the Comcare scheme; and (v) the work support programme. These measures help Singapore to achieve social stability.

Furthermore, an International Monetary Fund (IMF) report by Annet (2001) found that Singapore is one of few countries, which are politically stable with a calculated political instability index of 0. Considering the current status of Singapore, a developed country underpinned by its political and social stability, the influence of political and social factors on construction demand is not considered in this study.

The next issue to look at is the procurement and competition trends in the Singapore construction industry. Singapore is a signatory to the Agreement on Government Procurement under the World Trade Organization (WTO). Under this agreement, all public sector construction contracts above S$70,000 are obliged to follow a set of tendering procedures to ensure open and fair competition among all foreign and domestic construction services providers (Ministry of Finance, 2005). Like all public sector projects, most of the private sector projects are formally tendered, but the respective tendering process is more flexible where contracts could be awarded either through competition or negotiation or a combination of both (Davis Langdon and Seah, 2000). On the other hand, construction firms must be registered with the BCA Singapore before they are eligible to tender and compete for public sector projects (BCA, 2009c).

Also, the study by Davis Langdon and Seah (2000) showed that competitive tendering is used extensively in the Singapore construction industry as a mechanism for awarding construction contracts, with preference for the traditional form of contracts (for example, lump sum contract 'with' and 'without' bills of quantities). However, changes in the local clients' procurement strategies are noticeable. Although the D&B procurement method has yet to gain much popularity in Singapore, which is probably due to some inherent problems that clients face in their D&B projects (Ling and Poh, 2008), the percentage of D&B building projects (for public sector contracts) has increased progressively from 1.7% in 1992 (BCA, 2002) to 9.8% in 2008 (BCA, 2008b). Within these periods, the highest percentage of D&B building projects recorded was 22.7% in 2004 (BCA, 2008b). In view of this fluctuation, Ling and Chong (2005) pointed out that the use of D&B procurement method is expected to rise only if contractors are capable of meeting clients' expectations in their service delivery of D&B projects. The prevailing wave is the privatization of public sector infrastructure projects in Singapore. Hitherto, five infrastructure projects were awarded based on the PPP arrangement since 2003 (Ministry of Finance, 2008). All these show the shifting tendency in clients' procurement strategies, signifying that Singapore contractors have to be flexible in their design and delivery of construction services. They should adopt an open-minded approach in exploring different procurement strategies and offering a more integrated range of services.

In terms of degree of competition, there is a large number of firms in the Singapore construction industry in proportion to its small physical size (see Section 2.3). This observation is supported by Oo (2007), who affirmed that the Singapore construction industry is highly competitive, especially for the public sector work, considering the large number of tenders received per project, the low level of profit, and the seemingly low success rate in contractors' bidding attempts.

Changes in the intensity of competition are noticeable in Singapore's construction industry. Betts and Brown (1992) studied the construction tender bid variability over the period 1989-1990, and found that there was an average of eight tenderers competed in each contract based on a total of 1256 Singapore public sector contracts, comprising small maintenance jobs to very large infrastructure contracts. Looking at the period 2002-2004, Oo (2007) studied 46 building projects with contract values ranging from S$ 10 to S$ 30 million, and found that the number of tenderers per project ranges from 6 to 31, with an average of 15.72. Indeed, recent tender results for public sector work showing number of tenderers above 20 are well documented (CPG, 2005), indicating the increasing intensity of competition in Singapore construction market. One example is a D&B public infrastructure project which attracted 28 tenderers (The Straits Times, 2004).

The increase in the intensity of competition can be partly explained in relation to the increasing trend towards globalization and the expansion of Singapore's free trade agreement network (see International Enterprise Singapore, 2008), which have virtually shifted the traditional dimensions of competition. As more trade barriers are lifted, Singapore is connected to more major economies and new markets, and hence is entering into an era of increasing global competition. As a result, Singapore contractors are urged to develop their export capability to compete for overseas projects through the formation of consortia and setting up co-operative business arrangements with overseas counterparts in the Construction 21 (C21) report (C21, 1999).

The review above attests to the increasing intensity of competition in the Singapore construction industry, where Singapore contractors need to compete among each other and with foreign contractors for local construction projects, although Singapore construction demand is relatively small. In addition, the increasing trend in globalization has influenced the way Singapore contractors compete and function. All these suggest that Singapore contractors have to be flexible, via developing strategic options and strategies, in response to their changing competitive environment.

The last two dimensions of change in the industry are the client's performance criteria of construction services and technological development. The traditional time-cost-quality model was mainly used to define the performance criteria of Singapore contractors' services. However, changes are noticeable in the way both public and private sectors clients define the value of construction services, especially with the introduction of the PPP procurement arrangement and the gradual increase in D&B projects. These phenomena demonstrate that clients are seeking more integrated value-added services from design and construction to operation and maintenance of built facilities.

Also, with the introduction of construction site safety legislation and environmental sustainability schemes, further changes are noted in clients' performance criteria of construction services. A report by BCA (2003) mentioned that Singapore contractors are expected not only to deliver quality workmanship within the stipulated cost and time, but also need to proactively manage the environmental and occupational health and safety aspects of their projects.

Lately, reports by Ministry of Environment (2006, 2007) highlighted that the Singapore construction industry has increasingly become aware and committed towards environmental sustainability. This phenomenon is supported by the relatively high recycling rates of 94% and 98% achieved in 2005 and 2006, respectively. Also, it is reported that 13 public sector agencies (for example, Land Transport Authority, Singapore Land Authority and Housing and Development Board) have incorporated the Earth Control Measures requirement in their construction services procurement contracts (Ministry of Environment, 2006). Similarly, much emphasis is placed on personal health of construction workers on issues such as dengue and the breeding of rats in construction sites, and smoke emissions of construction machineries.

In January 2005, the Singapore BCA launched the Green Mark Scheme (GMS) in an attempt to promote environmental awareness in the construction and real estate sectors. According to BCA (2007), the GMS aims to: (i) provide a yardstick to rate a building's environmental friendliness, and (ii) encourage developers and building owners to adopt green building technologies in achieving a sustainable built environment via improving resource efficiencies. To further encourage the adoption of green building practices and technologies, the Singapore government launched the Green Mark Incentive Scheme in late 2006. It consisted of a $20 million cash incentive for developers and building owners who achieve the targeted benchmark in the design and construction of new buildings or refurbishment of existing buildings during 2006 to 2008 (BCA, 2007). Lately, the Singapore BCA (2009) launched two incentive schemes, i.e., Green Mark Gross Floor Area (GM GFA) and Green Mark Incentive Scheme for Existing Buildings (GMIS-EB), to further encourage developers and building owners to strive towards a more sustainable built environment. Since 2008, 129 building projects, comprising a mix of private and public sectors projects, have been awarded the Green Mark Certificates (BCA, 2008d).

Next, considering the current status of Singapore as a developed nation, a growing investment on intelligent and highly customized buildings is noticeable, especially in industrial and infrastructure building projects (for example, Singapore Changi Airport Terminal 3, and pharmaceutical industrial projects at Tuas Biomedical Park). Building owners, clients and end-users demand more high-tech and complex built facilities with sophisticated technologies for their routine operation. In fact, more highly customized building projects are anticipated to be built in Singapore, since the nation's vision is to become the hubs of both clean energy and pharmaceutical and biotechnology industries in the Asian region (EDB, 2009). All these trends and changes indicate the challenges lie in Singapore contractors' ability to respond flexibly to the changing trend in clients' value of construction services and technological needs.

2.6 Need for organizational flexibility

There is radical change in how contractors function and compete in response to all major and interrelated changes discussed in Sections 2.4 and 2.5. These changes have induced a complex process of responses, requiring a new kind of management that focuses on the need to manage organizational flexibility. McGregor (2000) pointed out that organizations cannot afford to wait until consequence of the changes become apparent but need to move from reactive tactics to anticipatory strategic planning in order to maintain their competitiveness.

Runeson and de Valence (2009) pointed out that enhancing technological capabilities and formal and informal training of employees are progressively becoming important for construction firms to achieve and develop organizational flexibility in a changing business environment. Manseau (2005b) added that firms should design and adopt a flexible organizational structure, which fosters an interactive learning environment, thus helping the firms to develop new professional specialities in response to clients' evolving needs. Likewise, Lenard (1999) suggested that development and management of responsive behaviour in supply chain relationships is important for firms to achieve improved flexibility in response to any unforeseen events. According to Yisa et al. (1996), firms have to restructure their operations in different ways and styles, building and developing their resources and capabilities, in order to flexibly respond to changes within the business environment. All these indicate the need for organizational flexibility in the face of the challenges faced by construction firms in developing their flexibility.

2.6.1 Flexibility management in construction

Studies done on flexibility in construction are now discussed.

2.6.1.1 Flexibility within corporate-level management

Focusing on the UK construction industry, Lansley et al. (1979) pointed out that, flexibility and diversity are needed to provide favourable conditions during initial stages of the creative process required for exploring new areas in organizational problem-solving skills. They found that one of the prime requirements for developing a wide range of reasoning and problem-solving skills is to be able to realign limited physical, technical and human resources to meet rapid changes in the construction markets and the preferred procurement methods of clients. Also, they found that flexible contractors, who were successful in adapting to changing demands of the environment, exhibited a different set of characteristics compared with their less successful counterparts. These include: (i) having clearly defined and stated objectives supported by strong management commitment; (ii) considering employees' welfare; (iii) emphasizing high levels of employees' morale and job satisfaction; (iv) promoting effective corporate planning strategies; and (v) having an effective market sensing mechanism in place and making full use of employee knowledge and potential in every aspect of decision making. Subsequently, Lansley (1983) found that organizational flexibility is influenced by firms' scope of operation, which could be defined in terms of the group of clients served and range of market segments involved. Lansley (1987) further examined the influences of organizational structure, management style and problem-solving skills on organizational flexibility, and found that an organic structure, a high level of organizational problem-solving skills and a management style that emphasizes employee development are the keys towards achieving flexibility.

Handa and Adas (1996) included the flexibility dimension, as one of their measures, in predicting effectiveness of Canadian construction firms, and operationalized flexibility into two aspects: structural context, and rule and regulation. The former contains measurement items such as the level of joint venturing, subcontracting and information flow. The latter comprises measurement items such as the degree of organizational process control and attitude towards change. Of these measurement items, Handa and Adas (1996) found that only firms' attitude towards change is significant in predicting organizational effectiveness. Similarly, Dikmen et al. (2005) included the flexibility trait as an independent variable to evaluate the effectiveness of Turkish construction firms, and found that organizational effectiveness is significantly correlated with firms' flexibility (i.e., as the level of flexibility increases, organizational effectiveness also increases).

Debrah and Ofori (1997) and Ofori and Debrah (1998) explored the flexibility management of workers in the Singapore construction industry, discussing the labour market, employment structure and core-peripheral flexibility model (which is also known as the 'flexible firm' model). Ofori and Debrah (1998) pointed out that product-related organizations tend to adopt the core-peripheral flexibility model, retaining minimum number of core employees and varying the number of peripheral workers (for example, part-timers and temporary workers) in order to achieve functional and numerical flexibility in response to fluctuation in production demand. Debrah and Ofori (1997) and Ofori and Debrah (1998) recognized that the extensive use of labour subcontracting does provide construction firms with a certain degree of flexibility in response to abrupt changes in demand for their resources. However, Ofori and Debrah (1998) explained that the intensification in the use of labour subcontracting is not a conscious effort on the part of construction firms to adopt the 'flexible firm' model for improved strategic flexibility, but rather is a response to the problem of labour shortage.

2.6.1.2 Flexibility within project-level management

In addressing the need for greater flexibility in project information flow in the UK construction industry, Betts (1991) pointed out that the use of relational database technology and integrated database design methodology would improve the flexibility of information retrieval. In the context of the Australian construction industry, Walker and Shen (2002) studied the influence of the planning and flexibility components towards achieving good construction time performance, based on a conceptual framework of project understanding and knowledge transfer. They found that competence and commitment, of both individual organizations and the project team, in seeking and exploring alternative options are the key to achieving good construction time performance. Subsequently, Walker and Loosemore (2003) added that promoting a learning culture within a project environment, via a systematic problem solving approach, could enhance participants' flexibility potential in response to any unanticipated challenge that arise during the course of a project.

Gil et al. (2005) investigated challenges involved in semi-conductor fabrication facility projects in Portland, Oregon (for example, technical complexity of product design and unexpected project changes), and developed a framework to overcome the identified challenges based on two principles, i.e. the product and process flexibilities. Based on their interview findings, several managerial strategies embodying product and process flexibility were identified. These include: (i) overdesigning products to accommodate future needs for extra capacity; (ii) differentiating project activities for better workflow control; (iii) adopting off-site fabrication; (iv) using the four-dimensional computer-based modelling technique; (v) adopting the modular design concept; and (vi) increasing communication between project stakeholders.

Olsson (2006), in his study of the flexibility management of 18 Norwegian projects, found that the importance of flexibility is well-appreciated by the majority of project stakeholders including project owners, users, project management consultants and contractors. He noted however that stakeholders' opinions on flexibility are somehow related to their individual roles and incentives in the respective projects; it can be considered as either a value by stakeholders who benefit from changes or a cost for those who respond to the changes involved. Therefore, he pointed out that it is important for stakeholders to strategically identify critical parts of projects (i.e., undefined and unclear activities) that require flexibility in their endeavours to achieve effective project flexibility management.

In the context of the US construction industry, Ford et al. (2002) adopted the structured real options approach to ascertain how strategic flexibility is proactively exploited to recognize inherent values hidden in dynamic uncertainties. According to them, dynamic uncertainties are described as "project conditions that cannot be resolved adequately through improved description or planning for pre-project strategy selection" (p.343). Despite the argument that a structured approach is necessary for successful project delivery, they found that existing usage of flexibility, i.e., strategic options, in project management is not structured adequately to provide firms with a useful strategic design and valuation tool. Recognizing this inadequacy, Ford and Bhargav (2006) pointed out that managers should structure their flexible project strategies in their endeavours to improve their evaluation, development and use of flexibility. They explained that the availability of flexible project strategies, in the form of options, can considerably increase project value if uncertain conditions cannot be adequately predicted before actual construction activities take place. To develop their firms' flexible project options, manager should implement and continuously review their project risk management protocol comprising risk planning, identification, analysis, response planning, and monitoring and controlling (PMI, 2004)

2.6.2 Flexibility as a challenge in construction

Although the above studies on flexibility management were conducted within the context of the construction industry, it appears that the concept of flexibility in construction is not well-understood. Many studies considered flexibility as a uni-dimensional rather than an integrative multi-dimensional concept, as was the case in manufacturing-related studies (see Section 3.6), comprising different dimensions and ranges of flexibility types. Of these studies, some (for example, Handas and Adas, 1996; Dikmen et al., 2005) applied flexibility as an independent variable to predict organizational effectiveness, rather than examining and identifying the type of organizational attributes that contribute to the attainment of flexibility. In the latter case, flexibility is considered as a dependent variable.

As for studies that considered flexibility as a dependent variable or desired outcome, they have specifically examined the influence of individual organizational attributes on flexibility. As revealed above, the organizational attributes may comprise: (i) human resource; (ii) organizational structure and management style; (iii) information and process technologies; and (iv) organizational learning culture. Also, many studies were conducted using a qualitative approach. It appears that little has been done to empirically investigate the collective effect of individual organizational attributes towards achieving organizational flexibility. According to Pugh and Hickson (2007:12&13),

> Organizations and their members are changing and complex […] thus their attributes should be studied together and as matters of degree, not as 'either/or' phenomena – a multivariate approach to a changing world of greys, rather than blacks and whites [...] there will no single reason for the way in which an organization is set up and run, but many possible influences (that is, multivariate causal explanations). What happens cannot be due to an organization's size alone, nor for that matter to its technology alone, but must in some degree be due to a number of these and other factors all acting together...

Furthermore, the majority of studies used project(s) as the subject matter, but did not consider construction organizations as the unit of analysis. This study agrees with Pugh and Hickson's (2007) argument, and maintains that the emphasis should be placed on a construction organization itself since the ability of being flexible may involve the interdependency of various key organizational attributes, and these may in turn affect the performance of individual organizations in a project setting.

Hitherto, little is known about the management and development of organizational flexibility in construction, for example, (i) “what kinds of organizational attributes (also known as determinants in this study) that contractors should focus in their efforts to achieve superiority in different dimensions of organizational flexibility such as strategic flexibility and tactical flexibility” and (ii) “how different organizational attributes collectively and interactively influence different dimensions of organizational flexibility”. These issues would offer useful insight for construction firms into the functioning of resources, capabilities and strategies in attaining organizational flexibility; but these have not yet been addressed in the construction management literature. This contributes to the challenge faced by contractors in developing and managing their flexibility potential.

2.7 Summary

There is a convergence of the related changes in the construction industry that leads to the growing need for organizational flexibility. A review of the literature shows that changes have taken place in: (i) construction demand; (ii) intensity of competition; (iii) procurement methods; (iv) clients’ performance criteria of construction services; (v) technological possibilities. Although each change or a combination of changes in the business environment of the construction industry may have different impacts on individual contractors, it appears that contractors have to be flexible in response to each relevant change in order to stay viable.

Although studies have been done to explore flexibility in construction, hitherto, the means for assessing and achieving organizational flexibility remain under researched. Some studies considered flexibility as an independent variable in predicting organizational effectiveness, while some have specifically examined the influence of individual organizational attributes on flexibility, thus a dependent variable. Also, many studies used project(s) as the subject matter, but did not consider construction organizations as the unit of analysis. Therefore, this study emphasizes the collective effect of individual organizational attributes on organizational flexibility, identifying the key determinants and dimensions of flexibility, and exploring how individual attributes interrelate and contribute to organizational flexibility. In line with this, the next chapter discusses the concept of flexibility.

CHAPTER 3

THEORETICAL FRAMEWORK OF FLEXIBILITY MANAGEMENT

3.1 Introduction

This chapter starts with the review of the concept (Section 3.2) and definitions (Section 3.3) of flexibility. Thereafter, a definition of organizational flexibility is formulated for this study (Section 3.4). This is followed by a description of various flexibility-related studies, exploring: (i) the other defining features of flexibility (Section 3.5); (ii) the multi-dimensional perspective of organizational flexibility (Section 3.6); and (iii) the determinants of organizational flexibility (Section 3.7).

A conceptual framework of organizational flexibility in the construction business was developed by integrating four perspectives of organizational studies (Sections 3.8 and 3.9). They are: (i) the dynamic contingency view of firms; (ii) the organizational learning perspective; (iii) the resource-based view of firms; and (iv) the complex adaptive system perspective. These theories focus on the organization-environment relations, positing that the environment plays an important role in influencing organizations' flexible behaviour in response to changes within the business environment towards their continued existence.

3.2 Concept of flexibility

The concept of flexibility has attracted much interest from many organizational researchers since 1960s (Ansoff, 1965; Oke, 2005), focusing on how companies within the manufacturing industry attain flexibility. Flexibility has been touted as the next strategic weapon in the battlefield of competition (Parker and Wirth, 1999; Oke, 2005); an attribute that contributes to firms' ability to survive and prosper in a turbulent and unpredictable environment (Dreyer and Gronhaug, 2004).

Flexibility is often regarded as one of the ‘competitive priorities’ that must complement other organizational priorities such as quality, cost and time (Lau et al., 1996; Boyle, 2006). This means that firms should not overlook the importance of other priorities in their endeavours to attain flexibility in order to remain competitive and viable in a changing business environment (Ahmed et al., 1996; Volberda, 1998). This is because flexibility is a ‘good thing’ (Adler, 1988; Aviso et al., 1995) but not a ‘free goods’ (Carlsson, 1989). For example, a production plant, that wishes to possess a greater ability to produce more than one product to cater for bigger markets, may become more competitive, while also incurring higher investment and operating costs, than a plant specializing in the production of one product (Stigler, 1939; Golden and Powell, 2000). Besides the associated cost of developing flexibility, Das and Elango (1995) related flexibility to other issues including the increased levels of stress among employees and lack of organizational focus.

Despite the above concerns on flexibility, Lambert and Peppard (1993) noted that firms still continue to seek for flexibility in order to increase their competitiveness. Carlsson (1989) argues that flexibility, particularly in the guise of adaptive manufacturing technologies, has become as vital a determinant of competitiveness as cost. Comparing the periods between 1970s and 1990s, Thompson (1993) found that there is an increased recognition of flexibility in firms’ strategic processes in their attempts to stay viable in a changing business environment. Avison et al. (1995) added that flexibility has become so vital to firms that it may take a central role as an organization’s critical success factor.

To attain flexibility, firms are expected to: (i) build excess and liquid reserves (Cyert and March, 1963); (ii) build a flexible resource pool and a diverse portfolio of strategic options (Quinn, 1980; Aaker and Mascarenhas, 1984); and (iii) induce agility and versatility (Fredericks, 2005) (The concepts of agility and versatility are discussed in

Section 3.5.4). Frederick (2005) added that the variety of strategic options available to firms should increase corresponding to marketplace uncertainty.

Frederick (2005) and Boyle (2006) shared that, through the process of integration, reconfiguration and development of organizational resources and competences, firms could become more flexible in response to marketplace uncertainties and complexities. This agrees with Sanchez's (1997: 76) assertion that a continuous cycle of competency building, "by creating the right kind and range of resources and coordination flexibilities together with competency leveraging", plays an important role in developing a firm's flexibility potential.

Boyle (2006) however expressed that it is not easy to understand, implement and manage organizational flexibility because flexibility is not general and cannot be simply purchased and plugged into any firm's operations. This is especially true since firms can be very flexible in some ways and less flexible in others (Suarez et al., 1995). Therefore, it is important for firms to recognize the nature and constitution of flexibility and the determinants of achieving flexibility, if the potential benefits of being flexible are to be fully realized (Koste and Malhotra, 1999).

Recognizing the importance of being flexible in a changing competitive environment, Slack (2005) emphasized that it would be an oversight to treat the concept of flexibility exclusively in the manufacturing sector given the importance of other sectors (including construction) as recorded in most government statistics. He further pointed out that regardless of "the importance of either manufacturing or service sectors as the economic drivers, or repositories of technical knowledge or as a protection against long term economic turbulence, the fact remains that more than 80% of economic activity and employment occurs in non-manufacturing enterprises" (p.1208).

3.3 Definitions of flexibility

The meaning of flexibility is not always clear (Evans, 1991; Golden and Powell, 2000). For example, the Longman Dictionary (2001: 536) broadly defined flexibility as "the ability to change or be changed easily to suit different situations". Collin's (2004:115) business dictionary defined flexibility as the ability of "being easily changed". Oxford Reference Online (2009) described flexibility as the ability to adapt an operating system to respond to changes in the environment.

Generally, it is understood what flexibility is, but its translation with respect to an organization is still indistinct. This is exemplified by the variety of definitions of flexibility in the existing body of literature relating to organizational studies. One possible explanation for the lack of consensus regarding the definition of flexibility is that proposed definitions, within the literature, are often coloured by particular managerial situations or problems (Upton, 1994).

Table 3.1 summarizes a list of definitions of flexibility found in previous studies. It is however recognized that this list of definitions is not exhaustive given the vast number of existing definitions of flexibility. As can be seen from Table 3.1, flexibility is widely but partially and briefly defined in terms of: (i) flexible manufacturing; (ii) flexible production automation; and (iii) flexible management styles. Along with these definitions, some studies defined and described organizational flexibility in a more comprehensive approach. These definitions are presented chronologically below.

Table 3.1 Definitions of flexibility

Classifications	Definitions	Authors
Flexible manufacturing	The ability to move with customer needs, respond to competitive pressure and be closer to the market.	Slack (1987:35)
	The ability to cope quickly with changing circumstances and environmental uncertainty.	Gupta and Goyal (1989)
	The capability to switch gears – from, for example, rapid product development to low cost – relatively quickly and with minimal resources.	Hayes and Pisano (1994:78)
	The ability to change or react with little penalty in time, effort, cost or performance	Upton (1995a:207)
	The ability of firms to respond to changes in their customers' needs, as well as to unanticipated changes stemming from competitive pressures.	Vokurka and O'Leary-Kelly (2000:485)
	The ability to meet an increasing variety of customer expectation without excessive costs, time, organization disruptions or performance losses.	Zhang et al. (2003: 173)
	The ability to react to customer demands without incurring excessive time and cost penalties.	Narasimhan et al. (2004:91)
	The ability to change levels of production rapidly, to develop new products more quickly and more frequently, and to respond more rapidly to competitive threats.	Oke (2005:973)
Flexible production automation system	The ability of a system to quickly adjust or adapt to any changes in relevant factors like product, process, loads and machine failure.	Nagarur (1992)
	The ability to shift or replicate core manufacturing technologies quickly and effectively between different facilitates, both domestically and internationally.	Galbraith (1990:56)
	The ability of a system or facility to adjust to changes in its internal or external environment.	Das and Patel (2002:266)
Flexible management style	The ability of firms to reposition themselves in a market, change their game plans, or dismantle their current strategies when the customers they serve are not longer as attractive as they once were.	Harrigan (1985:1)
	The ability to implement changes in the internal operating environment in a timely manner at a reasonable cost in response to changes in market condition.	Watt et al. (1993)
	The ability of a firm to respond to uncertainties by adjusting its objectives with the support of its superior knowledge and capabilities.	Lau (1996:11)

Classifications	Definitions	Authors
	The ability to modify the alliance and exit the alliance relationship when alliance is performing poorly.	Young-Ybarra and Wiersema (1999:440)
	The ability of an organization to respond to changes in the environment in a timely and appropriate manner with due regard to competitive forces in the environment.	Das and Elango (1995:62)
	The ability to reallocate resources quickly and smoothly in response to changes.	Buckley and Casson (1998:23)
	The ability to respond quickly to changing market conditions.	Matusik and Hill (1998:682)
	The capability of the firm to proact or respond quickly to changing competitive conditions and thereby develop and/or maintain competitive advantage.	Hitt et al. (1998:27)
	The ability to adapt.	Golden and Powell (2000:373)
	The ability to adapt, in a reversible manner, to an existing situation, as opposed to evolution, which is irreversible.	Bucki and Pesqueux (2000:62)
	A firm's capacity to adjust to change and/or exploit opportunities resulting from environmental changes and, in our view, can be considered a company-specific skill or a resource.	Dreyer and Gronhaug (2004:484).

Note: The underlined phrases or words are regarded as the keyword(s) of each definition.

Eppink (1978:42) defined flexibility as “a characteristic of an organization that makes it less vulnerable to unforeseen external changes or puts it in a better position to respond successfully to such a change”. He related flexibility and adaptability to the ability of an organization to respond to unforeseen and foreseen changes, respectively. This suggests that the responsiveness of an organization would consist of flexibility and adaptability.

According to Krijnen (1979:64), “a flexible firm has the ability to change itself in such a way that it remains viable”. He added that the change can occur in three ways: (i) adapting flexibly to circumstances and events in the environment which were unpredictable or unforeseeable; (ii) altering the organization by anticipating the external changes by means of planning; and (iii) developing activities in order to influence the environment so that the firm does not have to adapt itself.

As part of Quinn’s (1980) notion of incrementalism, flexibility refers to firms’ attitude to keep options open (i.e., free options) by specifying broad performance goals and allowing different technical methods to compete as long as possible. He highlighted that free options should be consciously developed, and stated that “logic dictated the managers purposely design needed flexibilities into their organizations and have reserve resources ready to deploy incrementally as event demanded” (p.122). In order to achieve designed flexibilities, Quinn (1980) recommended that firms should: (i) establish a horizon scanning activity to identify and analyze the opportunities and threats which an organization might encounter; (ii) create sufficient resource buffers to respond effectively as events occur; and (iii) develop and deploy activist with a psychological commitment to move opportunistically and flexibly at the appropriate moment.

Similarly, Aaker and Mascarenhas (1984) considered flexibility as a strategic option, and defined it as " the ability of the organization to adapt to substantial, uncertain, and fast occurring (relative to required reaction time) environmental changes that have a meaningful impact on the organization's performance" (p.74). According to them, firms can attain flexibility through: (i) adopting a diversification strategy, either defensive or offensive (for example, participating in multiple product markets and distribution channels); (ii) investing in less specialized and commonly used assets (for example, increasing the liquidity of assets and using multiple general purpose facilities and equipment); and (iii) reducing specialized commitments (for example, reducing specialized facilities, using multiple suppliers, subcontracting work or avoiding vertical integration in order to decrease exit and entry barriers).

Linking organizational flexibility to organizational capabilities, Volberda (1998:100) defined flexibility as "the degree to which an organization has a variety of managerial capabilities and the speed at which they can be activated, to increase the control capacity of management and improve the controllability of the organization". He elaborated that the controllability or changeability of an organization is dependent on the creation of appropriate conditions within its organizational structure and process regulation to foster flexibility.

More specifically, Johnson et al. (2003) related firms' flexibility to market-focused strategic flexibility, and defined it as "the firms' intent and capabilities to generate firm-specific real options for the configuration and reconfiguration of appreciably superior customer value propositions" (p.77). They went on to explain that market-focused strategic flexibility refers to how firms apply both their intent and capabilities to create option bundles for: (i) various value-creating configurations of products; (ii) their positioning; and (iii) their distribution in various markets. In their study, the term 'options' was described, based on Bowman and Hurry's (1993:762) definition, as the “preferential access to future opportunities (for example, opportunities for growth or opportunities to earn capital gain by divestiture) arising from the interplay of the organization’s existing investments, its knowledge and capacities, and its environmental opportunities”.

3.4 Formulating the definition of organizational flexibility

In this study, the definition of organizational flexibility is formulated based on the underlying features of flexibility extracted from previous studies. The six key features identified from the review in Section 3.3 are: (i) adaptability; (ii) changes (i.e., unforeseen or foreseen); (iii) responsiveness; (iv) reversibility; (v) continuous learning; and (vi) organizations’ resources and capabilities.

In general, nearly all definitions of flexibility place emphasis on the features of adaptability in terms of (i) organizational capabilities (Aaker and Mascarenhas, 1984; Bucki and Pesqueux, 2000) or (ii) free options to initiate or adapt to changes (Quinn, 1985). However, Stigler (1939) argued that flexibility is different from adaptability in that the latter implies a singular and permanent change, whereas the former enables successive, but temporary approximation to the current state of affairs. Evans (1991) suggested that, in dynamic environments, it is only a temporary relief to develop a permanent response to environmental changes because subsequent environmental states may possibly reverse or reshape the previous state or even reinforce it again. According to him, adaptability involves repositioning to address the imperatives of a new environment. Thus, he agreed with Lawrence and Dyer (1981) that the feature of re-adaptation is a better resemblance of flexibility, whereby organizations and their environments interact and evolve towards more mutually acceptable exchanges.

Similarly, most definitions indicate that the driving force behind organizational flexibility is closely related to environmental changes. It is recognized that organizational flexibility can be considered as a way to achieve some forms of control in a changing environment. The aspect of this control is demonstrated in the definitions of Eppink (1978), Krijnen (1979), Aaker and Mascarenhas (1984) and Volberda (1998) where the ability to be flexible facilitates a higher order of control in a changing business environment.

Another essential feature of organizational flexibility is responsiveness. Many definitions suggest that the response capacity and reaction time to changes are important aspects of flexibility (Aaker and Mascarenhas, 1984; Upton, 1995a; Volbera, 1998). This refers to the speed with which an organization can react and respond to changes without incurring high transaction cost and excessive time wastage, which may in turn lead to low productivity and poor performance.

Next, some studies revealed that reversibility is another feature of flexibility (Genus, 1995; Bucki and Pesqueux, 2000). In relating the feature of reversibility to the concept of flexibility, Genus (1995) expressed the view that mistakes or errors in strategic decision may first be detected and then remedied, and eventually completed actions are undone to allow other courses of action to be pursued. In practice, full reversibility may not be realistic, but rather firms would learn from their mistakes, and could avoid the same mistake when a similar event occurs.

The next feature of flexibility is firms' continuous learning process. This element of continuous learning is manifested in the definitions of Harrigan (1985), Buckley and Casson (1998), Hitt et al. (1998) and Oke (2005); where firms need to learn about their business environment, in terms of customers' preferences or threats from competitors, and change their game plans accordingly, in order to maintain their competitiveness. Especially in a changing business environment, firms should engage themselves in a continuous learning process of developing and coordinating their resources and capabilities in order to take advantage of business opportunities and overcome threats, fuelled by dynamics of environmental change (Bogner and Thomas, 1994; Salaman and Asch, 2003).

The last underlying feature of flexibility that has been identified is associated with organizations' resources and capabilities (Quinn, 1980; Volberda, 1998; Dreyer and Gronhaug, 2004). Evans (1991) highlighted that flexibility is widely used to denote a firm's capabilities to manoeuvre defensively or offensively. Sanchez (1995) suggested that firms' flexibility potential is mainly dependent on the inherent flexibilities of their resources and coordination capabilities in applying those resources to achieve strategic options. Also, Slack (1987) and Carlsson (1989) shared the view that organizational flexibility should be determined exclusively by the flexibilities of organizations' resources and processes.

Based on the above discussion, organizational flexibility is defined in this research as:

> The ability of an organization to effectively utilize its <u>resources and capabilities</u> to <u>respond</u> or <u>readapt</u>, in a <u>timely</u> and <u>reversible</u> manner to <u>environmental changes</u>, through a <u>continuous learning process</u>.

3.5 Other defining features of flexibility

Other than the variety of definitions of organizational flexibility, some studies (Evans, 1991; Genus, 1995; Swafford et al., 2006) have related organizational flexibility to other defining features. Some of these related features are now discussed.

3.5.1 Hedging

According to Genus (1995), hedging is related to flexibility in that the former, as a form of business strategies, is adopted to protect and insure things or firms against errors or risks. This view is shared by Lim and Wang (2007), who expressed that financial hedging allows an organization to be flexible with regard to its environment and thus reduces its risk exposures through financial instruments, for example, forward and future contracts, swaps and options.

Also, Allanyannis et al. (2001) found that the combined use of operational and financial hedging strategies could mitigate firms' exposure to risk and improve their business performance. The former hedging strategy refers to the geographic dispersion of firms' business operations. They further found that the more geographically dispersed a firm is, the more likely the firm will use financial instruments to mitigate the exchange-rate risk. Heimeriks et al. (2009) and Lyons (1991) suggested that operational hedging strategies could be in the form of various collaborative working agreements such as alliance, partnering and joint venture.

From the above discussion, it appears that hedging could be considered one of the business risk management strategies which provides firms with options to expand while minimizing their exposure to risk. Thus, this study argues that the feature of hedging could be seen as the defensive role of flexibility, which has been embodied in firms' responsive capabilities towards environmental changes.

3.5.2 Organizational slack

Like the feature of hedging, organizational slack represents the protective and proactive roles of firms' resources and capabilities. It concerns the use of slack resources to buffer the core of an organization from environmental variation, thereby minimizing the need to make substantial changes to the operating core of the organization (Pfeffer and Salancik, 1978). Likewise, Hambrick and Snow (1977) pointed out that the use of slack resources enable firms to more safely experiment with new strategies such as introducing new products and entering into emerging markets.

However, organizational slack does have its own disadvantages. For example, the possession of excessive resources (such as workers and unused productive capacity) could lead to inefficiency and reduced performance resulting from a firm's failure to optimize its available resources to their fullest capacity (Nohria and Gulati, 1997; Tan and Peng, 2003).

Thompson (1967) considered the merits and demerits of organizational slack, and argued that it is important for managers to exercise their discretion in determining, developing and managing an acceptable level of slack resources. In this study, the feature of organizational slack could be considered as the ability of firms to effectively utilize their resources and capabilities in response to environmental changes.

3.5.3 Liquidity

Evans (1991) related liquidity to flexibility from the perspective of organizational assets. An asset is described as 'liquid' when it can be readily converted into cash with minimal transaction costs and thus it can lead to financial flexibility. It follows that the feature of liquidity can be considered, in this study, as the characteristic of firms' resources that contributes to firms' ability to respond or readapt to environmental changes.

3.5.4 Versatility and agility

The concepts of versatility and agility are often used synonymously with the concept of flexibility. Versatility can be seen as firms' ability to respond to a wide range of scenarios in advance (Evans, 1991) by doing different things and applying methods and standards in different circumstances (Bahrami, 1998).

Evans (1991) and Sharifi and Zhang (1999) referred to agility as firms' ability to deal with adversities and threats, and subsequently move into an advantageous position. Baharami (1998) defined agility as firms' ability to respond, redefine, refocus, and take advantages of opportunities in a timely manner. According to him, both versatility and agility are the main ingredients of organizational flexibility. This disagrees with Golden et al. (1994), who argued that flexibility is a component of agility.

The discussion above suggests similarities among the concepts of flexibility, versatility and agility, although there is no consensus whether flexibility is a component of agility or vice versa. It can be seen that these three concepts emphasize the importance of firms' ability to utilize their resources and capabilities in configuring timely responses to environmental changes.

3.5.5 Strategic renewal

Genus (1995) pointed out that the dynamic character of 'strategic renewal' is relevant to understand flexibility because both concepts are used to express how firms react to changes in the face of crisis. According to Huff et al. (1992:55),

> …the need for renewal is never ending. The viable organization must have the capacity to frequently improve its alignment with internal and external demand…Renewal efforts are characterized as virtually continuous, but

pulsing in ways that depart more and less dramatically from the status quo or time.

The above suggests that the concepts of flexibility, strategic renewal and organizational learning are related. These concepts involve firms to effectively utilize their resources and capabilities to respond or readapt to environmental changes through a continuous learning process (see Section 3.9.2 for the discussion of the organizational learning theory).

3.6 Multi-dimensional perspective of organizational flexibility

Many studies highlighted the notion that flexibility is an integrative multi-dimensional concept rather than an independent variable that can be defined and measured in isolation (for example, Slack, 1987; Beach et al., 2000). Despite this recognition, it is noted that there is lack of a widely accepted and robust method to assess firms' flexibility (Koste and Malhotra, 1999; Das and Patel, 2002), as exemplified by the broad range of measures available. In manufacturing-related studies, these measures are considered either as flexibility dimensions and/or flexibility types. Corresponding to this, Vokurka and O'Leary-Kelly (2000) highlighted that there is a need to develop a generalized set of measures for empirical testing of hypotheses about the concept of flexibility.

The focus of this section is to identify and generate a list of different flexibility dimensions and flexibility types used for analyzing flexibility. This facilitates the development of a set of measures for empirical testing of hypotheses regarding organizational flexibility in subsequent phases of this study. An overview of the dimensionality and various types of flexibility is now presented.

3.6.1 Dimensionality of flexibility

This section discusses the dimensions of flexibility based on: (i) micro-perspective and (ii) macro-perspective of flexibility. This is followed by the categorization of dimensions into a simpler framework for empirical testing.

3.6.1.1 Micro-perspective of flexibility

Ansoff (1965) suggested that firms need to be internally and externally flexible in order to cope with unanticipated disturbances. According to him, internal flexibility is "as old as business itself…it seeks to provide a cushion for response to catastrophe" (p.57), while external flexibility "is best described by the maxim of not putting all of one's egg in a single basket" (p. 55). He added that firms can attain external flexibility via (i) a defensive approach pursuing a product-market diversification strategy to mitigate the effect of disturbances, and (ii) an offensive approach that involves business venturing into areas in which a firm can benefit from likely breakthroughs. Upton (1994) described external flexibility as firms' capabilities to accommodate a source of environmental variability, whereas internal flexibility is the operational strategy and set of capabilities which a firm nurtures in order to respond to its environment.

Eppink (1978) related his concept of active and passive flexibility to Ansoff's (1965) original notion of internal and external flexibility. He described active flexibility as the response capacity of an organization to its environment, and argued that his concept of active flexibility is much wider in scope than Ansoff's original notion of internal flexibility. Next, he described passive flexibility as "the possibility to limit the relative impact of a certain environmental change" (p.10).

Carlsson (1992) pointed out that organizational flexibility can be characterized into two dimensions, i.e., static and dynamic. He described static flexibility as the ability to deal with foreseeable changes (for example, fluctuations in demand), whereas dynamic flexibility as the ability to deal with uncertainty in the form of unpredictable events (for example, new products and new competitors). This notion by Carlsson (1992) suggested that flexibility can be used as a tool to deal with both foreseeable and unforeseeable changes.

Next, Gerwin (1993) suggested that organizational flexibility can be of either reactive or proactive in nature. The reactive nature of flexibility aims to improve organizational responsiveness in the face of unanticipated disturbances (Gerwin, 1993; Koste, 1999). Considering the rapid changes in the manufacturing industry, Koste (1999) suggested that the reactive ability of an organization is a key towards sustaining organizational competitiveness. On the other hand, the proactive nature of flexibility allows organizations to “redefine market uncertainties” (Gerwin, 1993:396) or “influence what customers have come to expect from a particular industry” (Gerwin, 1993:397). In fact, the proactive nature of flexibility can offer competitive advantages to an organization through creation of new competitive uncertainties for its rivals. This phenomenon is recorded in the ‘Honda and Yamaha motorcycle war’ reported in Gerwin’s (1993) study.

3.6.1.2 <u>Macro-perspective on flexibility</u>

Many studies considered flexibility along three dimensions (Carlsson, 1989; Hayes and Pisano, 1994; Buckley, 1997): (i) operational flexibility; (ii) tactical (or structural) flexibility; and (iii) strategic flexibility. Operational flexibility is often seen as a short-term flexibility potential pertaining to day-to-day operations (Galbraith, 1990; Suarez et al., 1995; Johnson et al., 2003), or a routine manoeuvring capacity comprising routines that are formulated based upon existing structures and goals of an organization (Volberda, 1997). This ability tends to be reactive in nature and enables firms to respond to changes that they are familiar with in a timely manner (Carlsson, 1989; Volberda, 1997). Such changes often lead to temporary, short-term fluctuation in firms' level of business activity (Carlsson, 1989; Suarez et al., 1995).

Volberda (1997) argued that though the variety in the environment may be high, the sort of combinations is realistically predictable so that a firm, on the basis of its experience and extrapolation, is able to develop certain routines to reduce any short-term uncertainty. This suggests that a firm's learning process will determine its operational flexibility potential. Sethi and Sethi (1990) viewed that firms' operational flexibility is a determinant of speed and cost of response, reinvestment, and degree of interruption in their existing systems and processes. Consistent with these, Johnson et al. (2003) pointed out that a higher level of operational flexibility enables a firm to shorten the time between planning and implementation through quick adjustments, and thus enhances the firm's ability to improvise and respond to short-term fluctuation.

Turning to tactical flexibility, this dimension of flexibility potential is related to firms' decisions-making process concerning 'when' and 'how' to implement strategic options generated in the face of any moderate level of environmental changes (Carlsson, 1989; Frederick, 2005). This description of tactical flexibility is similar to that of Volberda's (1997; 1998) structural flexibility dimension. According to Volberda (1997; 1998), structural flexibility can be seen as a firm's adaptive manoeuvring capacity that allows its management to adapt its decision and communication processes within a given structure as well as the speed at which the desired outcome can be accomplished. He subsequently classified structural flexibility into internal and external aspects of an organization.

Volberda (1997) explained that, in a dynamic and vibrant business environment, a firm needs to possess a superior internal structural flexibility or intra-organizational flexibility to facilitate the renewal or transformation of its current processes. For external structural flexibility (also known as inter-organizational flexibility), he suggested that firms should foster relationship building with their supply chain parties in supporting and sheltering new technologies or developing new products or markets. He noted that a superior level of structural relations with external parties could enhance a firm's ability to engage in new developments.

In terms of strategic flexibility, many studies shared the view that this flexibility dimension involves the creation, maintenance, and realization of options for a firm's future (Buckley, 1997; Johnson et al., 2003). Extant definitions often suggest that strategic flexibility hinges on firms' ability to adopt measures or actions, which are of non-routine and unstructured in nature, in response to changes within the business environment (Evans, 1991; Volberda, 1997). This dimension becomes vital when firms face unfamiliar changes that exhibit far-reaching consequences and require rapid responses (Carlsson, 1989; Volberda, 1997).

On account of the unstructured and non-routine nature of occurrences, firms usually have no specific experience or routine solution to deal with the changes involved. In most cases, to respond to changes, firms may require to shift or replicate their resource portfolio, internally modify their strategies, and/or increase or decrease their range and mobility (Harrigan, 1985; Frederick, 2005). Here, 'range' refers to the number of options available and 'mobility' is the time, cost and effort involved in response to changes (Koste and Malhotram, 1999; D'Souza and Williams, 2000). From another perspective, firms' strategic response can be externally-oriented via: (i) influencing clients through marketing and promotions (Mascarenhas, 1982); (ii) creating new product market combinations (Krijnen, 1979); and (iii) using market power to deter entry and control competitors (Porter, 1980). Under such circumstance, new values and norms are vital, and past experience may not provide any upper hand since the creation of new activities in new situations become essential (Volberda, 1997). In comparison, Frederick (2005) noted that the associated costs, risks and coordination efforts in developing one's strategic flexibility are higher than those found under conditions of operational or tactical flexibility.

Meta-flexibility is the other flexibility dimension initiated by Volberda (1997), who defined it as a firm's monitoring or learning system. According to him, meta-flexibility involves "the processing of information to facilitate the continual adjustment of the composition of management's flexibility mix in line with changes in the environment". Volberda (1998) and Llorens et al. (2005) added that meta-flexibility involves a continual learning and unlearning process of creating new flexibility capabilities, integrating existing ones, and improving old ones or even unleashing inappropriate options in the flexibility mix. Thus, Llorens et al. (2005) pointed out that meta-flexibility is important for firms' business operation in that it supports and sustains their flexibility potential in a changing competitive environment. According to Volberda (1998), firms require higher-order learning capabilities in order to achieve meta-flexibility as compared to the other three flexibility dimensions.

3.6.1.3 <u>Flexibility dimensions</u>

Based on the above review, it appears that flexibility could be studied by its dimensions for empirical testing in subsequent stages of this study. Table 3.2 shows flexibility dimensions: (i) operational flexibility; (ii) tactical or structural flexibility; (iii) strategic flexibility; and (iv) meta-flexibility.

Table 3.2 Flexibility dimensions

Operational flexibility	**Tactical/ structural flexibility**	**Strategic flexibility**	**Meta-flexibility**
Internal and external	Internal and external	Internal and external	Internal and external
Reactive	Reactive/proactive	Proactive	Reactive/proactive
Static	Static/dynamic	Dynamic	Static/dynamic
Active	Active/ passive	Active	Active/ passive

It can be seen that individual dimensions have taken into consideration several notions of flexibility suggested by various studies. The review attests that Ansoff's (1965) notions of internal and external flexibilities can occur in all four categories, whereby firms can achieve different dimensions of flexibility by means of their internal processes and external business activities. Besides this, it appears that operational flexibility comprises the characteristics of Gerwin's (1993) reactive flexibility, Carlsson's (1992) static flexibility, and Eppink's (1978) active flexibility. All these flexibility dimensions emphasize firms' response capability to improvise and reconfigure their existing systems and processes in response to environmental changes, which are of a short-term fluctuation nature.

In terms of tactical flexibility, it appears that this dimension can be considered in term of the four pairs of flexibility dimensions suggested by Ansoff (1965), Eppink (1978), Carlsson (1992) and Gerwin (1993). It is because tactical flexibility emphasizes firms' adaptive manoeuvring capacity (i.e., how and when to implement strategic options) in response to environmental changes, which could be of predictable or unpredictable nature. For example, tactical flexibility could be dynamic and proactive, while static and reactive, in that firms build partnership relationships with external organizations to develop new products or venture into new markets, and at the same time, cultivate responsive behaviour within their supply chain relationships that may help to improve the firms' response capabilities. Likewise, the strategic flexibility dimension could be of proactive and dynamic nature since it involves firms' endeavour to create, maintain and build new options that enable them to implement measures or actions, which are non-routine and unstructured in nature, in response to marketplace changes.

As for meta-flexibility, it can be seen as firms' learning processes whereby the firms encode inferences from history into routines that guide their behaviour in developing and managing different dimensions of flexibility, which may include operational, tactical and strategic flexibility. It follows that meta-flexibility is not considered in this study as a dimension of organizational flexibility, but rather as part of an organization's learning culture, because this dimension is likely to influence the other three dimensions.

Based on the above review, the first hypothesis is set out as follows:

H_1: Organizational flexibility (Y) can be characterized by three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}).

3.6.2 Types of flexibility

This section examines the types of flexibility potential, which could be grouped into their respective dimensions, for evaluating a firm's flexibility. It is recognized that the dominant contribution of previous studies was the development of various flexibility types for assessing firms' flexibility (Sethi and Sethi, 1990; Upton, 1994; Beach et al., 2000). According to Parker and Wirth (1999), the taxonomy of flexibility types developed by Browne et al. (1984) formed the foundation for many subsequent studies, which attempted to measure flexibility. Sethi and Sethi (1990) however found that at least 50 different terms were adopted by previous studies to define various types of flexibility, which are of similar nature, and criticized the lack that their definitions are not always specific and at times, even similar terms are inconsistent with one another. Following this, they refined Browne et al.'s (1984) original taxonomy of nine flexibility types into a 12-item instrument, i.e., including three new flexibility types.

However, Beach et al. (2000) highlighted that the development of a generic taxonomy remains underachieved due to the multi-dimensionality concept of flexibility. They expressed the view that many studies underestimated the significance of understanding the implications of acquiring and implementing flexibility from both operational and strategic dimensions. According to them, the exact constructs, representing different flexibility dimensions, are less important than the ability of the firm's management to articulate and contextualize the need for it, i.e., flexibility types, under different scenarios. This is especially true since different organizations may exhibit different types of flexibility (Slack, 1983).

In line with the above, Oke (2005) recognized that there is no general consensus on the nature and definitions of individual flexibility types, despite the previous efforts in developing a generic taxonomy of flexibility types. He added that the endeavours in developing a generic taxonomy have created at least two problems: (i) different terms have been used to define the same type of flexibility, and (ii) failure to differentiate between how flexibility can be delivered by the external and internal aspects of an organization.

Recognizing the complications in developing a generic taxonomy for assessing firms' flexibility, a four-stage development process was adopted in this study (see Figure 3.1). This process is consistent with Green et al.'s (2004) framework for learning across different business sectors, i.e., aerospace and construction sectors. They pointed out that the principles of understanding, contextualization and re-contextualization are important elements within a learning procedure.

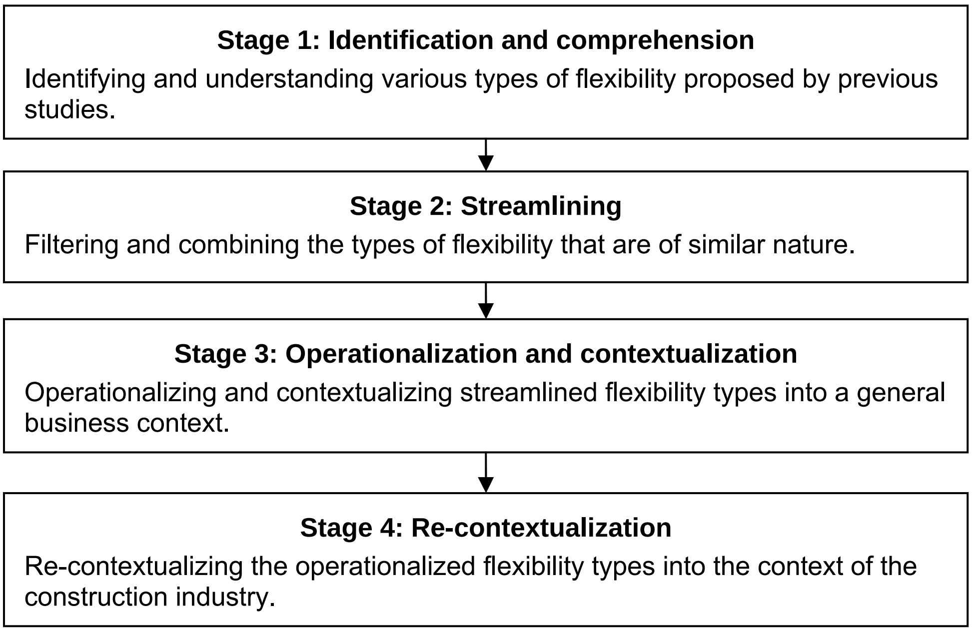


Figure 3.1 Four-stage process for developing a generic taxonomy for assessing firms' flexibility

Corresponding to Stage 1 of the development process, Table 3.3 summarizes the various types of flexibility extracted from previous studies. Overall, 22 terms, representing various types of flexibility, were identified. It can be seen that most of the flexibility types identified have been widely defined among several studies, but no consensus was obtained. Also, several terms were used by previous studies to characterize flexibility types that are of similar nature. For example, two different terms, i.e., 'modification' and 'changeover', were used to characterize a similar type of flexibility potential, i.e., 'the ability of a manufacturing system to effectively implement changes to firms' products'. To deal with the overlapping concern, efforts were made to filter and combine similar flexibility types into a single term based on their proposed meanings, i.e., Stage 2 – the streamlining process in Figure 3.1.

As shown in Table 3.4, a total of 15 terms, characterizing individual flexibility types, were identified following the streamlining process. This indicates that the concept of flexibility can be operationalized into 15 flexibility types, and in turn, these items could be used for subsequent assessment of firms' flexibility. As can be seen from Figure 3.1, these items were subjected to a contextualization-then-re-contextualization procedure in an attempt to generate a more meaningful and applicable definition for individual items within the context of the Singapore construction industry. This step is considered necessary since these items were originally defined based on the context of the manufacturing industry. It follows that the operationalized items were first contextualized into a general business context to allow an easier interpretation of definitions of individual items. Then, these contextualized items were re-contextualized and refined based on expert opinions in the exploratory phase of this study using a face-to-face interview approach (see Section 5.3).

The interviews revealed that most of the identified flexibility types are applicable to the Singapore construction industry. Of the 15 flexibility types, all interviewees (see Section 5.3.2 for the profile of interviewees) highlighted that program flexibility (F13) is less applicable in the context of the Singapore construction industry and should be eliminated from the list (appended as Appendix B). Also, the interviews revealed that labour flexibility (F3) should be re-classified and re-defined into two flexibility types, which were subsequently labelled as numerical flexibility (F3) and functional flexibility (F4) (see Section 5.3.3.3 for further discussions).

Table 3.3 Definitions of flexibility types

No.	Flexibility types	Definitions	Authors
1	Changeover	The ability of a manufacturing system to effectively handle additions and subtraction to the products mix over time	Pagell and Krause (2004)
2	Delivery	The ability to effectively respond to changes in planned delivery dates	Pagell and Krause (2004)
3	Expansion	The capabilities of building a system and expanding it as needed, easily and modularly	Browne et al. (1984)
		The ease with which the manufacturing system capacity and capability can be increased when needed.	Sethi and Sethi (1990) Wainwright and Bateman (1998)
		The number and heterogeneity (variety) of expansion which can be accommodated w/o incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999)
		The ability to easily add capacity or capabilities to the existing system	Parker and Wirth (1999)
		The ability to handle long-term increases in demand. It is related to handling variation of demand, or rather uncertainty of demand	Kara and Kayis (2004)
4	Financial	It enables organization to have the ability to integrate, construct and re-shape those financial resource in the face of environmental changes	Llorens et al. (2005)
5	Labour	The number and heterogeneity (variety) of tasks/operations a worker can execute without incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999;2000)
		The ability to change number of workers, task performed by workers and other worker responsibilities	Yadav et al. (2000)
		The ability of the workforce to perform a broad range of manufacturing tasks effectively	Wainwright and Bateman (1998)
6	Logistic	The availability of a range of options and the ability to effectively exploit them so as to adapt the process of controlling the flow and storage of materials, finished goods, services, and related information from origin to destination in response to changing marketplace condition. It enables an organization to adapt its delivery schedule to unpredictable or rapidly changing customer requirement	Swafford et al. (2006)
		The ability to ensure that smooth flow of material, which facilities the production and deliveries of high-quality value added products	Porter and Miller (1985)
7	Machine	The ease of making changes required to produce a given set of part types	Browne et al. (1984)

No.	Flexibility types	Definitions	Authors
		The various types of operations that the machine can perform without requiring a prohibitive effort in switching from operation to another	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
		The number and heterogeneity (variety) of operation a machine can execute without incurring high transition penalties or large charges in performance outcomes	Koste and Malhotra (1999)
		The ability to perform a variety of operations on a single machine	Parker and Wirth (1999)
8	Market	The ease of which the manufacturing system can adapt to a changing market environment	Sethi and Sethi (1990) Wainwright and Bateman (1998)
9	Material	The ability to make parts with alternative composition and dimension of raw material	Yadav et al. (2000)
10	Material handling	The ability to move different part types efficiently for proper positioning and processing through the manufacturing facility in serves	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. 2000
		The number of existing paths between processing centers and the heterogeneity (variety) of material which can be transported along those paths w/o incurring penalties or large changes in performance outcomes	Koste and Malhotra (1999)
11	Mix	The ability of a manufacturing system to effectively produce a wide range of different products	Pagell and Krause (2004)
		The number and heterogeneity (variety) of products which can be produced w/o incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999;2000)
		The ability of the system to respond quickly and economically to different product mix changes in the market	Wainwright and Bateman (1998)
12	Modification	The ability of a manufacturing system to effectively implement minor changes in current products that result from corrective actions or changing customer requirement	Pagell and Krause (2004)
		The number and heterogeneity (variety) of product modification which are accomplished w/o incurring high transition penalties or large changes in performance outcomes.	Koste and Malhotra (1999, 2000)
		The ease of producing minor alternations in product design to meet customization or differentiation requests	Narasimhan et al. (2004)

No.	Flexibility types	Definitions	Authors
13	New product	The number and heterogeneity (variety) of new products which are introduced into production w/o incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999;2000)
		The ability of the system to introduce and make new parts and products, using existing facilities	Narasimhan et al.(2004)
14	Operation	The ability to interchange the ordering of several operations for each part type	Browne et al. (1984)
		The ability to produce a part using alternative operations or sequence of operation	Sethi and Sethi (1990)
		The number of products which have alternate sequencing plans and the heterogeneity (variety) of the plan used w/o incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999;2000)
		The ability to be produced in different ways with alternative process plans by either an interchange or a substitution of certain operations	Yadav et al. (2000)
		The ability to be produced in different way	Wainwright and Bateman (1998)
15	Process	The ability to produce a given set of part types, each possibly using different materials, in several ways	Browne et al. (1984)
		The set of part types that the system can produce without major setups	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
		The ability to change between the production of different products with minimal delay	Parker and Wirth (1999)
		The costs associated to the plant capability of producing different items usually grow with the number of item	Garavelli (2003)
16	Procurement	The availability of a range of options and the ability of the purchasing process to effectively exploit a range of options so as to respond to changing requirements related to the supply of purchase component	Swafford et al. (2006)
17	Product	The ability to changeover to produce a new product very economically and quickly	Browne et al. (1984)
		The ease with which new parts can be added or substituted for existing parts	Sethi and Sethi (1990) Wainwright and Bateman (1998)
		The ability to change the mix of products in current production	Parker and Wirth (1999)
		The ease with which the part mix currently being produced can be changed inexpensively and rapidly	Yadav et al. (2000)
18	Production	The universe of part types that the flexibility management system can produce	Browne et al. (1984)

No.	Flexibility types	Definitions	Authors
		The universe of part types that the manufacturing system can produce without adding major capital equipment	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
19	Program	The ability of the system to run virtually untended for a long enough period	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
20	Routing	The ability to handle breakdown and to continue producing the given set of part types	Browne et al. (1984)
		The ability to produce a part of alternative routes through the system	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
		The number of products which have alternate routes and the extent of variation among the routes used w/o incurring high transition penalties or large changes in performance outcomes	Koste and Malhotra (1999)
		The ability to take a variety of alternative paths through the system, visiting various machines during its manufacture, and this accommodating changes in machine availability	Parker and Wirth (1999)
21	Spanning	The ability to ensure that different department or groups can coordinate product design, production and delivery in ways that add value to customers	Zhang et al. (2003)
22	Volume	The ability to operate a flexibility manufacturing system profitably at different production volume	Browne et al. (1984)
		The ability of the manufacturing system to be operated profitability at different levels of overall output	Sethi and Sethi (1990) Wainwright and Bateman (1998) Yadav et al. (2000)
		The ability to change the volume of output of a manufacturing process	Gerwin (1987)
		The ability to effectively increase or decrease aggregate production in response to customer	Pagell and Krause (2004)
		The ability to operate efficiently, effectively and profitably over a range of volume	Parker and Wirth (1999)
		The ability of plant to operate economically over a range of production volumes	Narasimhan et al. (2004)

Table 3.4 Streamlining and contextualization of flexibility types

Code	Terms	Proposed definitions
F1	Modification/changeover flexibility	The ability to modify its operational structure without major restructuring in the face of environmental changes.
F2	Financial flexibility	The ability to integrate, construct and re-shape those financial resources in the face of environmental changes.
F3	Labour flexibility	The ability to change number of workers, tasks and responsibilities performed by workers.
F4	Expansion flexibility	The ability to add and expand business capacity as and when it is needed without incurring high transition costs or major investment.
F5	Market flexibility	The ability to operate in different market conditions.
F6	Operation/Routing/ Production flexibility	The ability to adopt a range of alternative routes or options in response to environmental changes and clients' needs.
F7	Volume flexibility	The ability to operate efficiently, effectively and profitability in response to current market demand.
F8	Machine flexibility	The ability of equipments or machines to perform or modify to suit variety of operations without incurring high transaction penalties or large charges in performance outcomes.
F9	Material flexibility	The ability to make or produce products using alternative compositions and dimensions of raw materials.
F10	Process flexibility	The ability to change procedures and technologies in response to changes in clients' need or the business environment.
F11	Procurement flexibility	The ability to effectively exploit a range of purchasing processes or options in response to changes in clients' need and/or the business environment.
F12	Product /mix/new product flexibility	The ability to effectively provide a range of products and services aligned with changes in clients' needs or the business environment.
F13	Program flexibility	The ability of an organization to upgrade its technological system without incurring high transaction penalties.
F14	Spanning flexibility	The ability to integrate different business units (i.e., internal functions and external firms) in producing and delivering value added products and services for clients.
F15	Logistic/ Delivery/Material handling flexibility	The ability to effectively respond to changes in the delivery schedule due to unpredictable changes in clients' requirements or the business environment.

3.7 Determinants of organizational flexibility

The determinants of organizational flexibility are now considered. Despite much work done regarding flexibility in manufacturing, Beach et al. (2000) recognized that little attention has been given to the method of acquiring various flexibility types, as identified in the earlier discussion. According to them, firms' flexibility potential is, to a large extent, influenced by six determinants. They are: (i) organizational culture; (ii) management structure; (iii) facility layout; (iv) information technology; (v) process technology; and (vi) human resource. Some of these determinants have also been identified by Kara and Kayis (2004) and Volberda (1998). The former considered firms' employees, organizational structure, information and process technologies as the important channels for delivering flexibility. The latter highlighted organizational culture, structure and technology are the important aspects of a flexible firm.

Vokurka and O'Leary-Kelly (2000) pointed out that it is vital for firms to understand their business conditions, and then integrate various key resources and capabilities in order to achieve required flexibility dimensions and types in response to changes within the business environment. They identified six determinants of organizational flexibility: (i) business strategy; (ii) technology; (iii) supplier involvement; (iv) firm size; (v) organizational structure; and (vi) human resource.

Likewise, many studies have collectively highlighted a similar list of determinants of organizational flexibility. Of these, some studies focus specifically on how individual determinants (for example, information technologies or human resources) contribute to firms' flexibility potential (see Section 2.6 for the review of construction-related studies done on flexibility management). Table 3.5 summarizes the various determinants of organizational flexibility identified in previous studies. These identified determinants will be discussed and operationalized in Chapter 4. Overall, it can be seen that seven determinants of organizational flexibility were identified across different fields of research, including construction.

Table 3.5 Determinants of organizational flexibility

Determinants	Authors
Organizational culture/ organizational learning culture	**Lansley et al. (1979);** Volberda (1992, 1998); **Walker and Loosemore (2003);** Yukl and Lepsinger (2004); Wang and Li (2007).
Organizational structure	**Lansley et al. (1974; 1975);** Mintzberg (1979); Carlsson (1989); **Male (1991b); Flanagan (1994)**; **Lansley (1994);** Volberda (1992, 1998); **Handa and Adas (1996)**; Beach et al. (2000); Englehardt and Simmons (2002); **Ofori (2003)**.
Labour/human resource/workforce/ Employees' skills and behaviour	**Lansley et al. (1979)**; **Lansley (1987);** Wright et al. (1994); **Ofori and Debrah (1998)**; Koste and Malhorta (1999); Beach et al. (2000); Kalleberg (2001); **Loosemore et al. (2003)**; **Raiden et al. (2004)**; Kara and Kayis (2004); Bhattacharya et al. (2005).
Information and process technologies /Technological capabilities	**Betts (1991)**; Volberda (1992, 1998); Golden and Powell (2000); Beach et al. (2000); Vokurka and O'Leary-Kelly (2000); **Gil et al. (2005)**; **Ekstrom and Bjornsson (2005)**.
Supply chain capabilities	**Hillebrandt and Cannon (1990)**; Genus (1995); Suarez et al. (1995; 1996); Vickery et al. (1999); **Langford and Male (2001)**; Duclos et al. (2003); Sanchez and Perez (2005); Chang et al. (2006).
Business strategies	Ansoff (1965); **Hillebrandt et al. (1995)**; Quinn and Hilmer (1998); Young-Ybarra and Wiersema (1999); Vokurka and O'Leary-Kelly (2000); Starkey et al. (2001).
Size	Neilsen (1974); Mintzberg (1979); Fiegenbaum and Karnani (1991); Chen and Hambrick (1995).

Note: **Names** in bold denote studies done in construction

This study focused only on large and medium sized firms (see Sections 1.7 and 5.5.4). The sampling frame of the study was subjected to a filtering process with the intention to enhance the validity of results. Only a total of 91 large and medium-sized contractors who have ingrained a considerable degree of flexibility capacity in response to changes within the industry, exemplified by their capability to tide over the unprecedented 1997 – 2005 economic downturn in the construction industry, were selected for this study. Taking into consideration the low response rate that characterizes most studies involving construction practitioners in Singapore (Tan, 1995), it appears impractical to consider firm size in the model development (i.e., medium vs. large) since the sample of 91 contractors is made up of only 38 medium-and 53 large-sized contractors. Even with 100% response rate for the medium-sized group, a data sample of 38 sets is still considered to be small for modelling purposes.

Therefore, this study focused on the following determinants of organizational flexibility: (i) organizational learning culture (X1); (ii) organizational structure (X2); (iii) employees' skills and behaviour (X3); (iv) technological capabilities (X4); (v) supply chain capabilities (X5); and (vi) business strategies (X6). The inclusion of these six determinants into the conceptual framework for organizational flexibility was substantiated by the interview findings obtained in the exploratory phase (see Section 5.3.3.2).

3.8 Conceptual framework for organizational flexibility

Figure 3.2 shows the conceptual framework for organizational flexibility in construction businesses. It can be seen that organizational flexibility may comprise three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}) (see Section 3.6.1.3), which could be operationalized into 15 flexibility types: (i) modification flexibility (F1); (ii) financial flexibility (F2); (iii) numerical flexibility (F3); (iv) functional flexibility (F4); (v) expansion flexibility (F5); (vi) market flexibility (F6); (vii) operation flexibility (F7); (viii) volume flexibility (F8); (ix) machine flexibility (F9); (x) material flexibility (F10); (xi) process flexibility (F11); (xii) procurement flexibility (F12); (xiii) product flexibility (F13); (xiv) spanning flexibility (F14); and (xv) logistic flexibility (F15) (see Section 3.6.2). However, it is recognized that some of the flexibility types may not be applicable in the context of the construction industry. The relevance and practicality of the flexibility dimensions and their respective flexibility types are tested in the subsequent fieldwork (see Section 5.5), which in turn, determine the appropriateness of the flexibility dimensions and types used to evaluate a contractor's flexibility potential.

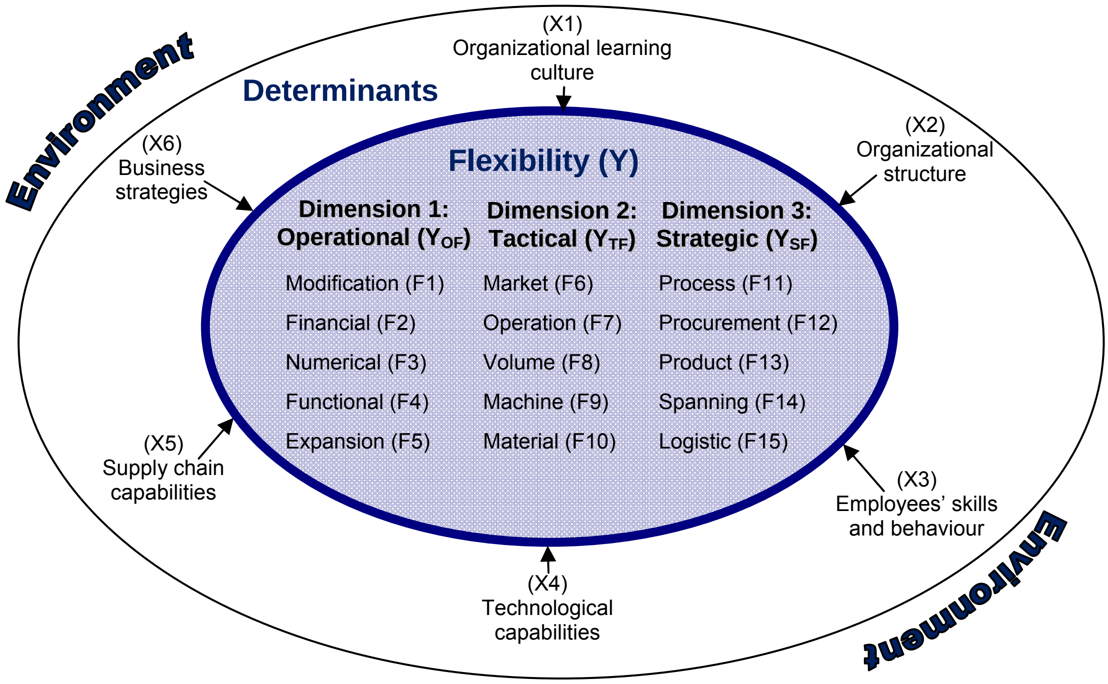


Figure 3.2 Conceptual framework for organizational flexibility

The conceptual framework also shows six possible determinants (see Section 3.7) that may help firms to attain organizational flexibility. These determinants are discussed in Chapter 4.

Figure 3.2 also shows the element of 'environment'. It is hypothesized that the environment, within which firms operate, plays an important role in influencing the firms' behaviour towards attaining flexibility, in their attempts to respond to marketplace changes for their continued existence. Environment factors are discussed in Section 4.8.

Theories underpinning the relationship between organizations and their environment are discussed next.

3.9 Theories to underpin the conceptual framework

In this study, efforts were made to integrate four vital perspectives of organizational studies. These are: (i) the dynamic contingency view of firms (Child, 1972); (ii) the organizational learning perspective (Cyert and March, 1963); (iii) the resource-based view of firms (Penrose, 1995); and (iv) the complex adaptive system perspective (Prigogine and Stengers, 1984). These theories focus on the organization-environment relations, positing that the environment plays an important role in influencing organizations' behaviour to attain flexibility in their attempts to respond to changes within the business environment for their continued existence. This is consistent with the views of Hillebrandt et al. (1995) and Kale and Arditi (1998; 2003) that the behaviour of construction firms is closely linked to the environment within which they operate.

3.9.1 Contingency theories

In studying the contingency view of firms, three predominant theories are often discussed. They are: (i) static contingency; (ii) population ecology; and (iii) dynamic contingency. The static contingency theory was pioneered by Burns and Stalks (1961), Woodward (1965) and Lawrence and Lorsch (1967), who conceptualized the 'goodness of fit' between organizational forms and contingencies. This theory postulates that: (i) organizational viability is dependent upon a fit between an organization and its context (Pennings, 1987), and (ii) an organization reacts, in a predictable way, to different business conditions via adjusting its organizational purpose and shaping its structure (Miles and Snow, 1978).

The population ecology theory was initiated by several organizational theorists (for example, Campbell, 1969; Aldrich and Pfeffer, 1976; Hannan and Freeman, 1977) who examined the effect of social, economic and political conditions on the relative abundance and diversity of organizations within a ‘population’. Hannan and Freeman (1977) defined ‘population’ as a group of organizations operating within a similar environment. This theory postulates that the environment is the sole determinant of organizational survival (Hannan and Freeman, 1989). Organizations that best fit with their environment will be selected and retained and will survive, whereas obsolete organizations will be weeded out by environmental dynamism (Perrows, 1986; Hannan and Freeman, 1989).

However, it is noted that the theories of static contingency and population ecology have being criticised by many organizational theorists due to their strong deterministic and biased nature. Both theories incorporated the assumption that ‘organization’ and ‘environment’ are real, material and separate just as they appear to be in a biological world (Smircich and Stubbart, 1985). According to Volberda (1998), what individuals consider as their environment is created not only by their imperfect perceptions of the material objective environment but also by their actions and accompanying intellectual efforts to make sense out of them. This means that organizations and their environments are interrelated, and can be seen as a socially construed phenomenon.

Consonant with the above view, Morgan (1986:74) pointed out that it is a mistake to assume that “organizations need to adapt to their environment, as static contingency theorists suggest, or that environments select the organizations that are to survive, as the population ecologists assert”. Notwithstanding the opposing standpoints of these two theories, they mutually considered organizations as inert agents that are largely dependent upon external environmental forces, rather than recognizing them as active agents that interact closely with the dynamisms of their environment. This stereotyped and deterministic conception of the organization-environment relationship largely ignores the role of managerial choice in the adjustment process.

As a result, the dynamic contingency view of firms, focusing on the importance of managerial choice or strategic choice, has gained its popularity among organizational theorists. In some cases, it is known as neo-contingency theory (Donaldson, 2001).

Thompson (1967) is among one of the pioneers who recognized the dynamic contingency mode of organizations. In his work 'Organizations in Action', Thompson (1967) presented an integrated contingency design model that combines the rational, natural and open system perspectives of organizations, suggesting how dynamic organizations, through the actions of their decision-makers or dominant coalition, integrate both environmental and technological aspects into their organizational structure and process designs. Following the three organizational levels (i.e., the technical, managerial and institutional levels) proposed by Parsons (1960), Thompson (1967) argued that these three levels within any organizational structure are differentially open to environmental influences.

Next, Child (1972) argued that organizations are not as tightly coupled to the environment as attested in both static contingency and population ecology theories, and called for more dynamic approaches in studying the interchanging relationship between organizations and their environments. He noted that, due to imperfections in market conditions, decision-makers exercise their discretion in pursuing other courses of action, which often requires them to constantly review and readjust their standards of performance and appropriateness of structural designs. This view is shared by Pfeffer (1982; 1997) and Perrow (1986), who pointed out that the fundamental activity of decision-makers within any organization is to control, coordinate and employ resources in the way that is most beneficial to the organization. In this process, the standard of performance sought and the trade-off between performance and other managerial objectives are both elements of strategic choice relating to the environment concerned (Child, 1972). According to Miles et al.

(1974:250), "...in enacting [sic] to its environment, the organization has, in part, defined its domain. An organization's domain consists of those activities it intends to pursue, and in choosing a domain of activity, the organization simultaneously determines its pattern of interdependence with elements of the environment..."

In supporting their arguments on organizational strategic choice, Child (1972) and Miles et al. (1974) mutually maintained that the effects of the environment on organizations are largely mediated through the filter of managerial perceptions and organizations' choice of domains. Therefore, Pfeffer (1982) noted that, under the sphere of the dynamic contingency view, organizations are becoming more autonomous in selecting their: (i) business domains; (ii) strategic responses within those chosen domains to produce equal standards of performance; and (iii) target standards of performance for those chosen domains within a broad limit. This puts organizations in a more active role to determine their continued existence.

The view, that organizations are not always passive recipients of environmental influence but also active agents that could reshape and influence the environment of their chosen business domains, has been progressively accepted by many organizational researchers. Among them, Weick (1979) has been one of the most active supporters of the view that organizations can reshape their environment, instead of passively waiting for the natural selection process of their environment to select them into or out of the environment. Instead of adopting the three-stage 'variation-selection-retention' cyclical model, as portrayed in the population ecology theory, he substituted the process of 'variation' with 'enactment' in the first stage of the model so as to emphasize the more active role of decision-makers in defining the environment which they would deal with.

Following that, many neo-contingency advocates (Donaldson, 2001; Miles and Snow, 1978) maintained that adaptation is a dynamic process that integrates both managerial actions and environmental forces, striving towards an optimal choice for the organization concerned. In this case, this runs to the extreme opposite end of the static contingency and population ecology theories which focused on the concept of 'fits' rather than on the process by which they were achieved. To a large extent, as suggested by Volberda (1998), too much emphasis on the optimal fit between an organization and its environment will cause organizational inertia, which could eventually lead to business failure since "too much fit breeds complacency" (p.51).

Many studies have recognized the possible destructive effects of organizational complacency, and suggested that it could be one of the main causes that lead to the failure of good companies (Sull, 1999; Sheth, 2007). According to Sull (1999) and Jayachandran and Varadajan (2006), when successful companies face dramatic environmental shifts, they often fail to respond effectively because they tend to persist in their established patterns of behaviour and procedures, and neglecting the need to identify and analyze opportunities and threats which their organizations might encounter in a changing competitive environment. Sull (1999) referred to this persistence or rigid devotion as active inertia, and exemplified its detrimental impact in relation to the business failures of two companies that were once the leading player of their industries: They are: Firestone Tire and Rubber and Laura Ashley. It was reported that both companies were trapped in the mode of thinking and working based on their past successes and status quo. Decision-makers simply accelerated all their 'tried-and-proven' activities in response to changes within their business environment, and ignored the need to reorient and reshape their business focuses. Instead of pulling themselves out of the depression, both companies just deepened their situation (Sull, 1999; Graetz et al., 2002).

Besides the above example, it is noted that there is an increase in companies that have gone from good to bad, for example, Compaq, Daewoo, Lego, NatWest, Sainsbury and Xerox (Sull, 2005; Sheth, 2007). Among these companies, many were once being labelled as ’excellent’ companies in the book ‘*In Search of Excellence’* by Peters and Waterman (1982). Some studies take the view that the main reason why many of these ‘excellent’ companies were no longer successful, was mainly due to their ‘static’ business approaches (Sull, 2005; Sheth, 2007). Companies become successful because they have clear and devoted commitments, but as time goes by, there is a great tendency that these commitments might harden and ultimately constrain companies’ ability to adapt and respond when their competitive environment shifts (Sull, 1999; 2005; Jayachandran and Varadajan, 2006). In order to avoid active inertia, Sull (2005) pointed out that decision-makers should regularly review their companies’ strategic frame, processes, relationships, routines and values so as to identify hardened commitment and facilitate their adaptation to market changes. He went on to conclude that “success often breeds complacency and arrogance…but success need not breed failure if executives actively manage the organization’s various commitments” (p.12). Again, this implies that organizations should emphasize a dynamic process of self-assessment and self-organization in order to survive and prosper within a dynamic business environment.

In general, the dynamic contingency theory can be characterized as follows (following Miles and Snow, 1978): (i) managerial or strategic choice is the fundamental linkage between an organization and its environment; (ii) managerial competency in creating, filtering and reshaping environmental influences is vital towards organizational survival; and (iii) mutual adaptation between organizations and their environments can happen in multiple ways depending on organizations’ choice of domains. Under the dynamic contingency perspective, organizational flexibility can be viewed as the proactive and reactive capacity of an organization in response to unanticipated shocks (Volberda, 1998).

In this study, the dynamic contingency theory underpins the conceptual framework (see Figure 3.2) in the way that the environment, within which construction firms operate, may moderate the firms' endeavour in developing their resources and capabilities, and subsequently, in implementing appropriate strategies, towards achieving organizational flexibility (see Section 3.10). Hitherto, little has been done to empirically test the moderating role of environmental conditions on the relationships among firms' resources, capabilities, strategies and their flexibility potential.

3.9.2 Organizational learning theory

Many studies highlighted that, to align themselves with their environments or to reshape environmental influences, organizations must possess some unique skills to learn, unlearn and then relearn on the basis of their past behaviour (for example: Day, 1991; Wang and Li, 2007). This indicates that the process of organizational learning becomes an important component in attaining organizational flexibility.

The theory of organizational learning was coined by Cyert and March (1963), and subsequently kindled by many other organizational analysts like Peters and Waterman (1982), Kanter (1989) and Senge (1990), who studied the effect of learning on organizational structures and systems. Since then, the concept of learning has been increasingly appreciated as a key towards competitiveness (Dodgson, 1993). In a turbulent environment, characterized by rapid technological changes in products and processes, organizations would need to learn faster and respond faster to the rapid changes within their environment; otherwise they simply will not survive (Hannan and Freeman, 1984; Barlow and Jashapara, 1998; Kenny, 2006).

According to Cyert and March (1963), organizational learning is a process whereby organizations collectively learn through the interaction with their environments. In this process, members within an organization share information and create organizational memory in the form of shared beliefs and assumptions, and subsequently, this knowledge base will guide the actions of its members and the organization as a whole (Cyert and March, 1963; Hanvanich et al., 2006). This view is shared by Fiol and Lyles (1985), who considered organization learning as "the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions" (p.811).

Hedberg (1981) took the view that the learning process may occur in different situations since organizations continually interact with their environment, and enhance their knowledge of reality by observing the results of their organizational action. According to him, this process is both "adaptive and manipulative in the sense that organizations adjust defensively to reality and use the resulting knowledge offensively to improve the fits between organizations and their environment" (Hedberg, 1981:3). Likewise, Levitt and March (1988) considered learning as processes whereby organizations encode inferences from their history into routines that guide behaviour. According to them, "routines" is a multi-dimensional construct comprising organizational rules, procedures, strategies, technologies, cultures, knowledge, etc. These routines are often recorded in a collective memory that is coherent and enduring, but are also subjected to changes due to social influence from other learning organizations (Levitt and March, 1988).

According to Pedler et al. (1989; 1991), learning organizations are organizations that facilitate the learning of all their members and continually transform themselves with their environment. They ascribed 11 characteristics (for example, internal exchange, inter-company learning and participative policy making) to a learning organization, and further elaborated the desirable outputs and preconditions of each characteristic towards becoming learning organizations. Similarly, in Senge's (1990) work *'The Fifth Discipline'*, learning organizations are defined as "organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together" (p.3). During this process, organizations would continuously need to "discover how to tap people's commitment and capacity to learn at all levels" (Senge, 1990: 4). In fact, Senge's (1990) philosophy of learning organizations shares many features with Quinn's (1992) 'intelligent enterprise' and Nonaka and Takeuchi's (1995) 'knowledge-creating company'.

In practice, every organization may have its own unique style and ability to learn, and makes use of different ways of learning. Of these, adaptive (single loop) learning and generative (double loop) learning are the most commonly discussed forms (see Senge, 1990; Volberda, 1998; Wang and Li, 2007). The former occurs when there is a repetitive association between input and output factors, for example, whenever an operational error or problem is detected, it is often remedied without questioning or altering the underlying values and objectives of the process (Argyris and Schon, 1978; Slack and Lewis, 2002). This form of learning facilitates implementation of tactical adjustments to operations, production and planning, and hinges on organizations' core competence (Wang and Li, 2007). This, to some extent, resembles the passive mode of firms' operational and tactical flexibilities.

However, Miles and Snow (1978) and Pascale (1990) took the view that, owing to its system-specific nature, an adaptive learning mechanism hampers organizational search and ignores significant amounts of relevant uncertainty, diversity and change signals. As a result, this form of learning may unintentionally develop structural inertia that threatens organizational survival (Metcalfe, 1981; Slack and Lewis, 2002).

Unlike the passive nature of adaptive learning, the generative learning approach challenges existing operating assumptions in fundamental ways, seeks to re-frame competitive questions and remains open to changes occurring in the competitive environment (Volberda, 1998; Slack and Lewis, 2002). Incompatible organizational norms are often resolved through the process of (i) setting new priorities and weighting norms, or (ii) restructuring the norms themselves (Argyris and Schon, 1978). Accordingly, organizations must increasingly "develop their capability to redefine the problems they seek to resolve, redesign their relations with their environments, and discard established structures in the process" (Metcalfe, 1981: 526). In this way, it is clear that organizations' ability to learn and unlearn are the keys toward effective generative learning (Hedberg, 1981; Fiol and Lyles, 1985; Pascale, 1990). The ability to learn promotes organizational search and self-questioning values, while the ability to unlearn mitigates possibilities of organizational inertia. All these amalgamate to place generative learning as a prerequisite to organizational survival since this mechanism emphasizes organizations' capacity to unlearn obsolete perspectives and procedures, and simultaneously replace them (through learning) with new appropriate approaches in creating and maintaining their competitiveness (Day, 1991; Dickson, 1996; Wang and Li, 2007).

However, the generative learning approach does have its dysfunctional effects on organizations if it has been improperly or excessively implemented. These include: (i) promoting redundant resources and conflicting working environments where people work around and even defy their superiors (Stewart and Warner, 1996); (ii) igniting low trust or defensive behaviours among employees when incompatible organizational norms cannot be resolved (Argyris and Schon, 1978; Van de Ven, 1986); and (iii) destroying an organization's identify, especially in a chronic double-loop learning process that may further induce other problems such as conflict of authority, unclear responsibilities and inadequate controls (Volberda and Cheah, 1993; Volberda, 1998).

In view of the two learning mechanisms, Hedberg et al. (1976) pointed out that firms should emphasize the learning process of self-experimentation or self-organization in their attempts to facilitate the evolution of their internal structures, processes, systems and domains in line with changes within the business environment. They noted however that, during this self-organization learning process, organizations often engage, paradoxically, in hesitating whether to (i) focus and develop their core competence, or (ii) to redefine, restructure and redesign their underlying processes, objectives and policies, in order to meet challenges from both internal and external environments. Corresponding to this, Argyris and Schon (1978) and Hedberg and Jonsson (1978) shared the view that firms need to maintain a balance between the two mechanisms if learning is to be effective. According to Argyris and Schon (1978), this 'balancing' form of learning process is known as deutero-learning. They went on to say that:

> When an organization engages in deutero-learning, its members learn about previous context for learning. They reflect on and inquire into previous episodes of organizational learning, or failure to learn. They discover what they did that facilitated or inhibited learning, they invent new strategies for learning, they produce these strategies, and they evaluate and generalize what they have produced (p.4).

From another perspective, Prahalad and Hamel (1990) and Wang and Li (2007) pointed out that organizational learning does not simply improve firms' competitiveness. In order to maintain their competitive position, firms must learn at a rate at least equal to (i) the rate of environmental changes, and (ii) the learning rate of their closest competitors (Sinkula et al., 1997). A firm that can learn, adapt and respond to changes within its environment promptly is able to surpass its closest competitors who rarely learn from their past behaviour (Blaszevic and Lievens, 2004). In this case, an effective learning process helps firms to develop their core competences and attain a higher degree of flexibility, thus improving their responsiveness to changes within their business environment. This ultimately leads to better firm competitiveness.

In this study, the organizational learning theory underpins the conceptual framework (see Figure 3.2) in the way that contractors have to engage in the continuous processes of learning, unlearning and re-learning, in their efforts to develop the right kind and range of flexibilities concerning resources and responses, for their continued existence in a changing business environment. Further discussions on how this theory complements other theories to underpin the theoretical framework are provided in Section 3.10.

3.9.3 Resource-based theories

The resource-based theory of firms (RBT) advocates that the extent to which an organization can learn and adapt is strongly rooted to its resources and capabilities, explaining how the organization grows and competes in dynamic business environments, through strategy implementation. This theory was developed in the 1950s by Edith Penrose, who originally named it as '*the theory of the growth of the firm'* (Penrose, 1959). Subsequently, conceptual and empirical studies that built on this theory have widely termed it as ‘the resource based view of firms’ (RBV), following Wernerfelt (1984).

According to Penrose (1959), a firm is an administrative organization and a collection of productive resources, which can only exist if it grows continuously. She pointed out that the administrative organization structure of a firm is the creation of the men who run it; where the structure may have either been developed rather haphazardly in response to immediate needs as they arose in the past, or it may have been shaped largely by conscious attempts to achieve a ‘rational’ organization. Thus, a firm is an entity that possesses unique collections of resources and capabilities bounded together in its administrative framework, and that ‘ownerships’ of these collections of resources and capabilities provide the basis for its strategy formulation (Penrose, 1959; 1995). In general, this uniqueness determines the performance differential between one firm and another within the same arena (Grant, 1991; Peteraf and Barney, 2003).

Theorizing on the fact that organizational resources and capabilities are unique, RBT assumes that: (i) firms are fundamentally heterogeneous in terms of their unique resources and internal capabilities underlying the production, and (ii) resources may not be perfectly mobile across firms, and thus the resources differences persist over time (Wernerfelt, 1984; Peteraf, 1993). According to Barney (1991) and Peteraf (1993), an organization can achieve competitive advantages over its closest competitors if its resources and capabilities are scarce and superior in use. Superior resources and capabilities are more ‘efficient’ in that they enable a firm to produce more economically (at lower cost) and/or better satisfy customers’ needs. This partly explains why some firms outperform others (Barney, 1991; 2001).

Bounded by the above assumptions, the RBT provides a theoretical framework focusing on an efficiency-based explanation at firm level of performance differences, explaining how competitive advantages within firms are achieved and sustained over time (Prahalad and Hamel, 1990; Nelson, 1991; Peteraf and Barney, 2003). In particular, it examines how management of organizational resources, capabilities, productive opportunities, and strategies can lead to competitive advantages, thus resulting in economic profits and profitable firm growth (Grant, 1991; Barney, 1991; 2001; Kor and Mahoney, 2004). Kimball (1998) defined economic profits as the amount of profits in excess of the cost of capital and the opportunity cost involved should the capital have been invested elsewhere. In brief, this theory integrates both management and economic perspectives of an organization (Peteraf and Barney, 2003).

Heterogeneity of organizational resources and capabilities is the most fundamental assumption within the RBT (Penrose, 1995; Helfat and Peteraf, 2003). In order to generate and sustain competitiveness, organizational resources and capabilities must be: (i) rare (ii) valuable; (iii) inimitable; and (iv) immobile (see Barney, 1991; Hoopes et al., 2003; Barratt and Oke, 2007). Of these, the characteristics of being valuable, inimitable and immobile are of paramount importance in sustaining firm competitiveness. The attribute of rareness is important only if a resource is valuable, and exists only if the resource cannot be imitated and replicated by competitors (Hoopes et al., 2003). Further discussions on what constitute organizational resources and capabilities are now presented.

3.9.3.1 <u>Resources</u>

Organizational resources can be defined as “anything which could be thought of as strengths or weaknesses of a given firm” (Wernerfelt, 1984:172), and those assets or inputs to the production process, both tangible and intangible, that the firm owns, controls and has access to on a semi-permanent (i.e., long-term but temporal) basis (Wernerfelt, 1984; Grant, 1991). These may include: (i) brand names; (ii) in-house technological knowledge; (iii) skilled personnel; (iv) machinery; and (v) finance. Barney (1991) summarized firms' resources into: (i) physical capital resources; (ii) human capital resources; and (iii) organizational capital resources. According to him, physical capital resources refer to a firm's physical technologies, plants and equipment, geographical location, and access to raw materials. Human capital resources include training, experience, judgement, relationship and insight of individual employees within each firm. Lastly, organizational capital resources relate to a firm's formal reporting structure, both formal and informal planning, controlling and coordinating systems, and its informal relations among groups within themselves and between them and others within the same sector.

Grant (1991) however pointed out that resources, in general, are not productive when standalone. Productive activity requires the cooperation and coordination of teams of resources. Consonant with this, Collis and Montgomery (1999) pointed out that an organization's resources cannot be evaluated in isolation because their value is determined by the interaction of individual resources, generating forms of capabilities, in response to marketplace influences.

3.9.3.2 Capabilities

Grant (1991) described capabilities as the abilities of an organization resulting from a team of resources working together. However, he highlighted the fact that the efforts to create or develop capabilities is not simply a matter of assembling a team of resources, but rather it involves a complex pattern of coordination and interaction between people, and between people and other resources. He went on to express that “while resources are the source of a firm’s capabilities, capabilities are the main source of its competitive advantage” (p.119). Firms’ capabilities (for example, the knowledge and skills of firms’ employees) have been found to be one key determinant of a firm’s success (Teece et al., 1997; Galbreath, 2005; Jayachandran and Varadajan, 2006).

Amit and Schoemaker (1993) related capabilities to how firms develop their strategic flexibility potential against marketplace influences. They defined capabilities as:

> A firm’s capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end. They are information-based, tangible or intangible processes that are firm-specific and are developed over time through complex interactions among the firm’s resources. They can abstractly be thought of as ‘intermediate goods’ generated by the firm to provide enhanced productivity of its resource, as well as strategic flexibility and protection for its final product or services (p.35).

Consonant with the above definitions, Salaman and Asch (2003) pointed out that ‘teams’ or ‘combinations’ of resources are not just human teams, but also include buildings, systems, people, equipment, finance, technologies, etc. According to them, capabilities are things that must be developed and built over time, and more importantly, they must be cherished and deployed. This means that the extent to which firms are able to develop and nurture their capabilities is dependent on their ability to learn, plan and manage changes effectively and coherently. This is consistent with Teece et al.’s (1997) notion of dynamic capabilities where organizational resources and capabilities need to be dynamic and adaptive, evolving and changing over time in order to sustain firm competitiveness. They defined dynamic capabilities as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environment” (p.516). It follows that Tecce et al.'s (1997) dynamic capabilities framework emphasizes on the effect of managerial and organizational processes (which could also be referred to as routine, or patterns of practice and learning) on firms' 'positions' and 'paths'. Firms' positions are defined as organizational assets, which could be further categorized into: (i) technological assets; (ii) financial assets; (iii) reputational assets; (iv) structural assets; (v) institutional assets; (vi) market assets; and (vii) organizational boundaries. As for firms' paths, they refer to the firms' routines and strategic alternatives.

Eisenhardt and Martin (2000) adapted Teece et al.'s (1997) definition of dynamic capabilities and described them as:

> The firm's processes that use resources – specifically the processes to integrate, configure, gain and release resources – to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve and die (p.1107).

Eisenhardt and Martin (2000) added that firms' organizational and strategic routines can be operationalized into practices such as product development, alliancing and other strategic decision making that create value for firms through manipulating existing resources into new value-creating strategies. According to them, this development process can be deemed to be the 'best practices' adopted by firms in response to changes within their business environment. These practices influence organizational structures, established routines and some other organizational attributes, and collectively, they determine how members within a firm behave and how their behaviour produce desired outcomes from readily available resources (Salaman and Asch, 2003). Under such circumstance, managers play an important role to integrate, build, and reconfigure firms' internal and external resources and capabilities into different strategies that enable firms to adapt and respond flexibly to changes within their business environment (Teece et al., 1997; Salaman and Asch, 2003). This explains why Grant (1991) argued that organizational resources and capabilities form a better basis to determine firms' strategies, and thus define their business focus in a changing business environment.

From another perspective, the notion of dynamic capabilities is related to Prahalad and Hamel's (1990) notion of core competences concerning how firms gain their competitiveness. Prahalad and Hamel (1990) observed that, in the short run, firms gain their competitiveness from the price/performance attributes of current products, but in the long run, their competitiveness will derive from firms' ability to build core competences that lead to unanticipated products. In their study, core competences refer to a complex collection of constituent skills and technologies, collective learning, and both tacit and explicit knowledge of individual firms that contributes to firm competitiveness through superior coordination of functional activities within its organizational processes. According to Bogner and Thomas (1994), a firm should continuously develop and improve its core competences in order to maintain its competitiveness.

In relating core competences to flexibility, Wang and Li (2007) noted that a manufacturer who possesses a superior level of competences tends to exhibit a higher level of strategic flexibility. In their study, firms' core competences are categorized into: (i) technological competences; (ii) market competences; and (iii) integrative competences. According to them, technological competences refer to firms' abilities to integrate knowledge into the development and designing of new products and processes. Next, market competences relate to processes designed to apply the collective knowledge, skills and resources of a firm to the market-related needs of its business, adding value to its goods and services so as to meet the competitive demands of customers. The last category, i.e., integrative competences, refers to firms' abilities to integrate and achieve positive interaction among elements of dynamic competence building and leveraging process.

The review above shows the importance of firms' resources and capabilities towards achieving competitiveness, which subsequently affect their continued existence in a changing business environment. In this study, the RBT and the notion of dynamic capabilities underpin the need to examine how contractors learn, develop and manage their resources and capabilities, and subsequently integrate and reconfigure these resources and capabilities into different strategies towards achieving organizational flexibility in response to environmental changes (see Section 3.10 for further discussion). Hitherto, little has been done in the construction industry to empirically test the effect of learning (see Section 3.9.2) on organizational resources and capabilities towards achieving flexibility. Fieldwork was carried out to ascertain the importance of organizational learning towards the development of dynamic capabilities.

3.9.4 Complexity theory

The complexity theory was developed in the 1960s by Ilya Prigogine, a Russian-born physical chemist, who studied how living organisms or systems are able to survive in highly unstable, or far from equilibrium conditions. In explaining this phenomenon, he developed the theory of 'dissipative structures' that was the first description of what is now being known as 'self-organizing systems' (Prigogine and Stengers, 1984). Subsequently, self-organization and self-organizing systems became the key concepts in the complexity theory.

The complexity theory is a broad theory that has been studied across many disciplines, for example, chemistry, physics, mathematics and biology. This deals with the study of complex systems that comprise many interactive elements linking in complex ways (Simon, 1996). Frenken (2006) referred to a complex system as a graph represented by nodes (i.e., elements) and edges (i.e., interactions), and complexities are defined by the number of interactions between elements. It is this structure of interactions between elements within an entire system that is of main interest to researchers who studied complexity theory (Carroll and Burton, 2000; Frenken, 2006). According to Carroll and Burton (2000), a loss of understanding of the whole system under study will occur if the problem concerned is simply dissected into several smaller parts.

In organizational science, many studies highlighted that organizations can be seen as a systemized whole comprising many interdependent and coordinating elements (Englehardt and Simmons, 2002; Eijnatten and Putnik, 2004), which interact, relate and evolve within their environments (Moffat, 2003; Cunha and Cunha, 2006). Waldrop (1992) characterized a complex system as the system that: (i) comprises a great many independent agents who are interacting with each other; (ii) depends on systemic interactions that lead the system to spontaneous self-organizations; and (iii) learns through feedback. These characteristics are shared by Stacey (2001), who further added that (i) the systemic interactions are iterative, recursive, and self-referential and non-linear, i.e., individual agent adapt to each other, and (ii) the rules for interactions are subject to random mutation and cross-over replication.

Bounded by the above characteristics, firms are treated as complex adaptive systems (Boisot and Child, 1999; Cunha and Cunha, 2006) or chaordic organizations (Eijnatten and Putnik, 2004) that match and adapt themselves closely with changes within their environments. They behave as a self-organizing entity, and learn, adapt, and evolve during the states of uncontrollability, uncertainty and complexity in their efforts to remain viable (Eijnatten and Putnik, 2004; Eijnatten, 2004). In this way, one may infer that the complexity theory is related to organizational learning theory discussed in Section 3.9.2.

According to Anderson (1999), the element of complexity can be treated as a structural variable that characterizes both organizations and their environments. Daft (1992) operationalized the element of complexity into the number of activities or subsystems within an organization that can be measured along three dimensions. These include: (i) vertical complexity, i.e., the number of levels in an organizational hierarchy; (ii) horizontal complexity, i.e., the number of job titles or department across an organization; and (iii) spatial complexity, i.e., the number of geographical locations. Also, organizations must match the complexity of their organizational structure against the complexity of their environments and technologies in their attempt to improve firm responsiveness and adaptation (Galbrath, 1973). Two modes of adaptation to complexity were discussed by Boisot and Child (1999). First, in a complexity reduction mode, firms seek to understand environmental complexity and deal with them in a timely manner. The other mode is complexity absorption where firms create options and formulate risk-hedging strategies, for example, entering into partnership relationships and forming alliances, in response to marketplace influences.

Tetenbaum (1998) noted that firms are increasingly exposed to marketplace uncertainty, i.e., a state of mixture between stability and instability, owing to six key challenges: (i) technology; (ii) globalization; (iii) competition; (iv) change; (v) speed; and (vi) complexity and paradox. In order to overcome these challenges, she suggested that it is important for firms' management to: (i) manage their employee transition; (ii); destabilize their organizational system in order to respond swiftly; (iii) manage order and disorder in the present and future; (iv) create and maintain a learning organization; and (v) build a certain degree of organizational flexibility in response to changes.

In general, the complexity theory characterized organizations as complex adaptive systems that are: (i) vital and creative when they are at the edge of chaos, i.e., in states of both order and disorder (Prigogine and Stengers, 1984); (ii) sensitive to their environments, and thus responding to marketplace influences and co-evolving with them (Church, 1999); and (iii) self organizing, to a large extent, in which self organization is the outcome of interdependences among individual elements following their own set of rules (Crozier and Thoening, 1976). According to Tetenbaum (1998), the complexity theory assumes that an organization comprises a complex linkage of elements that behave in line with its environment, and if the organization manages to self-organize and respond effectively and in a timely manner to environmental changes, it will ultimately turn into a higher performance entity.

In this study, the complexity theory underpins the conceptual framework (see Figure 3.2) in the way that construction firms can be seen as complex adaptive systems, comprising a complex linkage of elements, which inevitably interact and evolve with their environment, in order to remain viable. The contractors have to self-organize themselves in order to achieve organizational flexibility to address environmental changes. This is consistent with Kale and Arditi (1998; 2003), who pointed out that construction firms could be seen as open systems that inevitably interact with the environment within which they operate. Further details on how this theory complements the other three theories to underpin the proposed theoretical framework are discussed below.

3.10 Integration of four theories into the proposed conceptual framework

In this study, the four theories were used to collectively explain how contractors behave, learn, adapt, compete and evolve in response to changes in the business environment within which they operate for the study period from 1997 – 2007. It should be noted, however, that the main focus of this study is not on mapping the changes of contractors over these periods, but rather on the characteristics of contractors' resources and capabilities, and the adopted practices in developing their resources and capabilities in response to marketplace influences.

From the complex adaptive system perspective (see Section 3.9.4), a contractor is seen as a self-organizing system that consists of many interrelated agents evolving and adapting to its environment; especially since the Singapore construction industry underwent eight years of unprecedented economic downturn from 1997 to 2005. It is believed that contractors who survived through this economic downturn have ultimately emerged into a higher performance entity. From the resource-based perspective (see Section 3.9.3), the interrelated agents, within the self-organizing system, refer to contractors' resources and capabilities that provide the basis for their strategies and the primary source of competitiveness. Managers integrate, build and reconfigure their firms' resources and capabilities into different strategies that enable them to adapt and respond flexibly to changes within their business environment. This involves the selection of a business domain and decision making within the chosen domain in responses to changes in the business environment. This forms the dynamic contingency view of firms (see Section 3.9.1).

In the above selection procedure, contractors undergo the processes of learning, unlearning and re-learning in their efforts to develop insights and knowledge about the associations between past actions, and to understand the effectiveness of those actions. They seek to learn and understand the implications from their past actions and surroundings, for example, the success or failure of their competitors, in order to respond to changes effectively or to avoid any mistake that could be detrimental to their business. Ultimately, this forms a loop where contractors engage in a continuous process of competence-building by developing the right kind and range of resources and coordination flexibilities, coupled with competence leveraging that is effective in utilizing the current resource and coordination flexibilities. This provides contractors with a higher level of organizational flexibility potential and thus enables them to engage in a more active role in determining their continued existence.

In summarizing the above discussion, Figure 3.3 shows the hypothetical example of how construction firms behave and react in the face of marketplace influences. Diagram A denotes the complex adaptive system of a contractor, linking with many agents (nodes) that are determined, to a great extent, by its resources and capabilities. In this case, the smaller nodes represent the key determinants of organizational flexibility, and the linkages between nodes denote the influence or relationships between individual resource-based determinants. The large central node represents firms' flexibility potential.

Next, Diagram B shows the exertion of external forces (i.e., marketplace influences) on the organizational system. Contractors are expected to consolidate their resources and capabilities, and formulate appropriate strategies in response to different business conditions. As a result, the external forces reshape the structure of the organization system (Diagram C), which shows the resultant system where individual determinants react adaptively, thus reshaping the relationship between one another. These effects could influence the firm's flexibility potential in one of the following ways: (i) direct impact; or (ii) indirect impact; or (iii) both direct and indirect impacts.

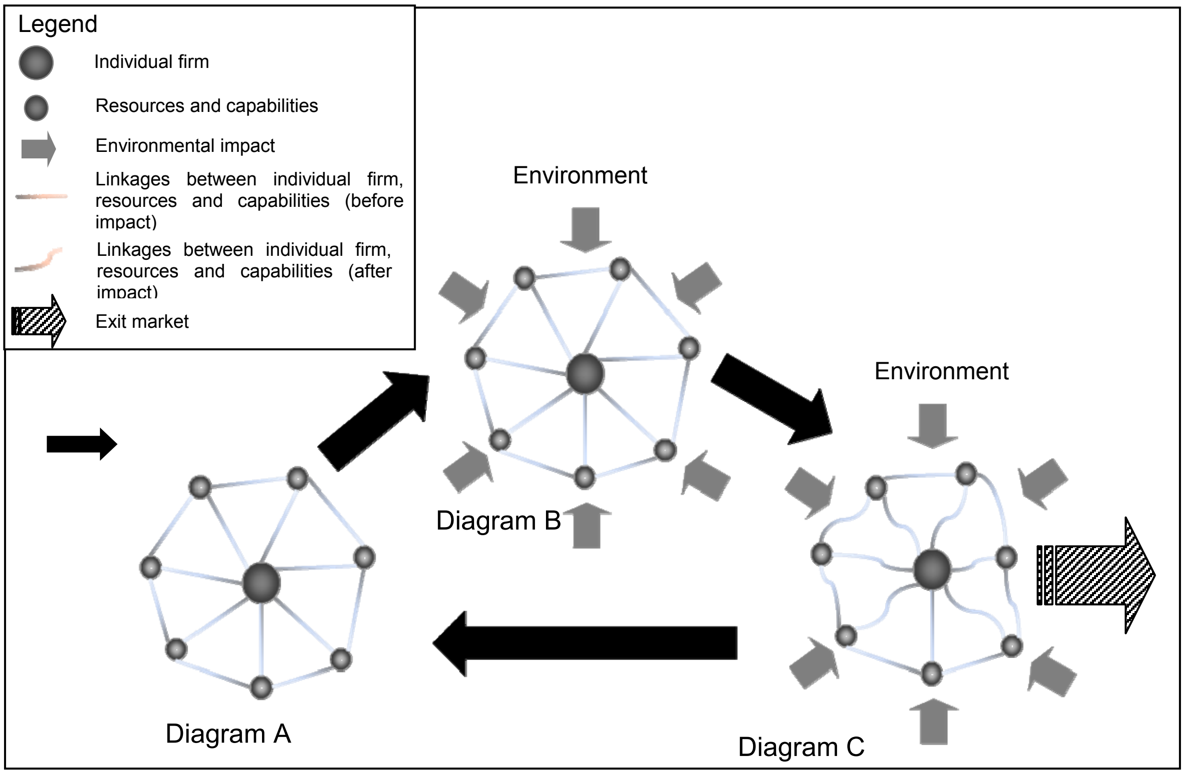


Figure 3.3 Hypothetical example of how contractors behave and react in the face of marketplace influences

In this study, it is believed that contractors, who fail to respond to changes, may experience financial hardship or difficulties, and eventually be compelled to exit the market. This scenario is captured by the chequered arrow, marked on the right side of Diagram C of Figure 3.3. On the other hand, if contractors succeed, a learning loop is formed, representing by the arrows directing from Diagrams C → A → B → C. This forms a learning organization. Contractors learn from their past knowledge and use them to deal with unexpected disturbance of similar nature.

3.11 Summary

Flexibility is increasingly appreciated as a key for firms to survive and prosper in a turbulent and unpredictable environment. As a result, it is necessary for firms to recognize the nature and constitution of flexibility, and the means for achieving flexibility, if the potential benefits of being flexible are to be fully realized. In this study, organizational flexibility is defined as “the ability of an organization to effectively utilize its resources and capabilities to respond or readapt, in a timely and reversible manner to environmental changes, through a continuous learning process”.

The review of literature shows that flexibility is a multi-dimensional concept rather than an independent variable that can be defined and measured in isolation. The flexibility dimensions identified are: (i) operational flexibility; (ii) tactical flexibility; (iii) strategic flexibility; and (iv) meta-flexibility. Of these, meta-flexibility is not considered separately in this study but rather as part of an organization’s learning culture, because this dimension could influence the development of the other three dimensions due to its learning and unlearning characteristics. Based on this, the first hypothesis was formulated (i.e., organizational flexibility can be characterized by three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF})).

This study adopted a four-stage process for developing a generic taxonomy of flexibility types for assessing organizational flexibility based on a multi-dimensional perspective. Fifteen flexibility types were identified, following the identification and reorganization processes, based on an initial list of 22 flexibility types. The15 flexibility types were subjected to a contextualization-then-re-contextualization procedure in an attempt to generate a more meaningful and applicable definition for individual items within the context of the Singapore construction industry. Six determinants that affect organizational flexibility are also identified from the literature.

A conceptual framework for organizational flexibility in construction business was developed. The framework shows the multi-dimensional concept of organization flexibility (Y) comprising: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}). These are further operationalized into: (i) modification flexibility (F1); (ii) financial flexibility (F2); (iii) numerical flexibility (F3); (iv) functional flexibility (F4); (v) expansion flexibility (F5); (vi) market flexibility (F6); (vii) operation flexibility (F7); (viii) volume flexibility (F8); (ix) machine flexibility (F9); (x) material flexibility (F10); (xi) process flexibility (F11); (xii) procurement flexibility (F12); (xiii) product flexibility (F13); (xiv) spanning flexibility (F14); and (xv) logistic flexibility (F15).

The conceptual framework further proposes that organizational flexibility may be influenced, to varying degrees, by six determinants: (1) organizational learning culture (X1); (2) organizational structure (X2); (3) employees' skills and behaviour (X3); (4) technological capabilities (X4); (5) supply chain capabilities (X5); and (6) business strategies (X6). This framework is underpinned by four theories: (i) contingency theory; (ii) organizational learning theory; (iii) resource-based theories; and (iv) complexity theory. These theories collectively explain how contractors behave, learn, adapt, compete and evolve in response to changes in the business environment within which they operate so that their organizations remain flexible.

The next chapter presents a review of the identified key determinants of organizational flexibility including: (i) specifying the domain of individual determinants and (ii) operationalizing individual determinants into their respective measurement items.

CHAPTER 4

DETERMINANTS OF ORGANIZATIONAL FLEXIBILITY

4.1 Introduction

In this chapter, the focus is on the operationalization of the determinants (independent variables) of organizational flexibility (dependent variable) in the conceptual framework (Sections 4.2 to 4.7). For each determinant, the corresponding section presents a review of the literature on its concept and a specification of its domain and measurement items.

This chapter also operationalizes two environmental components, namely: (i) economic conditions, and (ii) technological conditions. These are used in the fieldwork to investigate the extent to which environment conditions moderate the relationships between the determinants and organizational flexibility (Section 4.8).

4.2 Organizational learning culture (X1)

Figure 3.2 shows that organizational learning culture (X1) is one of the possible determinants of organizational flexibility. Compared to other organizational features, organizational culture is both specific (Barley, 1983; Smircich, 1983) and relatively constant to an organization (Hofstede et al., 1990; Beugelsdijk, et al., 2006). Under the light of the resource-based theory, organizational culture is seen as a resource that is rare, durable, non-tradable and non-imitable (Barney, 1986; 1995).

More often than not, organizational culture is an overused concept that is employed to explain different aspects of organizations which cannot otherwise be explained (Salaman and Asch, 2003). Therefore, it is difficult to find a general accepted definition on what organizational culture is. Hofstede et al. (1990) characterized organizational culture as a construct that is: (i) holistic; (ii) historically determined; (iii) related to anthropological concepts; (iv) socially constructed; (v) soft; and (vi) difficult to change.

4.2.1 Definition

Volberda (1992:112) considered organizational culture as “the shared interpretation about the kind and usefulness of work and cooperation…which is contained in the minds of the organization members…that cannot be observed directly, it can only be felt”. Likewise, Katz and Kahn (1978:43) expressed that the behaviour of organization members is largely driven by “the norms prescribing and sanctioning these behaviours and the values in which the norms are embedded”.

Next, Brown (1998:9) defined organizational culture as “the patterns of beliefs, values, learned ways of coping with experience that have developed during the course of an organization’s history, and which tend to be manifested in its material arrangement and in the behaviours of its members”. This is shared by Crocitto and Youssef (2003), who perceived organizational culture as a collective history of an organization’s decision, actions, symbols and philosophies that reflects the organization’s learning process over a period of time. Senge (1990) pointed out that a properly managed learning process will enhance a firm’s flexibility potential. All these relate organizational culture to the theory of organizational learning discussed in Section 3.9.2.

Salaman and Asch (2003) observed the trend where more emphasis is now placed to explore organizational culture systematically and cross-culturally towards how organizational learning culture shapes firms’ strategy and capabilities, which in turn, influence firm performance. They went on to define organizational culture as the value placed (i) on open learning and (ii) on challenges relating to the review and critique by the dominant organizational culture. According to them, culture norms that are relevant to organizational learning would include, for example, norms concerning attitudes towards authority, or towards risk taking. If organizational culture encourages deference and respects towards authority but discourages risk (for example, by publicly vilifying and punishing failure or performance mistake) then radical forms of learning will be discouraged.

In this study, the focus is on how organizational learning *culture* affects organizational resources and capabilities, and thus shaping firms' flexibility potential. This is in line with the view of many studies (Ireland and Hitt, 1999; Thornhill et al., 2000; Llorens et al., 2005) that organizational learning is one of the key determinants affecting businesses' continued existence. As a result, organizations need to be learning-oriented in order to stay viable and responsive to changes within their business environments.

4.2.2 Possible dimensions

Learning orientation can be seen as organizational values or actions to create and use knowledge to enhance a firm's competitiveness (Sinkula et al., 1997; Calantone et al., 2002). This comprises: (i) obtaining and sharing information about customer needs, market changes, and competitors' actions; (ii) improving employees' skills; and (iii) developing new technologies to create new products that are superior to those of competitors (Dodgson, 1991; Mone et al., 1998; Calantone et al., 2002). Therefore, firms' learning orientation influences the type of information being gathered, and how the information is interpreted, evaluated, and eventually shared within firms (Aryris and Schon, 1978; Dixon, 1992; Sinkula et al., 1997).

According to Sinkula et al. (1997), a firm's learning orientation can be characterized along three dimensions: (i) commitment to learning; (ii) shared vision; and (iii) open-mindedness. They argued that shared vision is different from commitment to learning and open-mindedness, in that it influences the direction of learning, whereas commitment to learning and open-mindedness affect the intensity of learning. As a result, they pointed out that it is vital to include these three dimensions in an attempt to build a more comprehensive learning orientation of an organization that is in congruence with extant theories and practices. These three dimensions are adopted by many studies (for example, Calantone et al., 2002; Morgan and Turnell, 2003; Wang and Li, 2007) in studying the effect of learning orientation on a firm's performance. In addition to these three dimensions, Calantone et al. (2002) included a new fourth dimension, i.e. intra-organizational knowledge-sharing, into their conceptual framework linking learning orientation, a firm's innovation capabilities and its performance. The above four dimensions are now discussed and their respective measurement items are summarized in Table 4.1.

4.2.2.1 Commitment to learning

This dimension seeks to determine the extent to which an organization appreciates and promotes a learning culture (Sinkula et al., 1997) by evaluating whether individual firms consider learning as a vital investment that is crucial for their continued survival. According to Sinkula et al. (1997) and Calantone et al. (2002), the more a firm values learning, the more likely the firm will learn from its environment.

4.2.2.2 Shared vision

This dimension seeks to determine the extent to which an organization focuses on learning, i.e., sharing mutual learning direction. Sinkula et al. (1997) and Day (1994) mutually maintained that the concept of having a shared vision is crucial for proactive learning in that it provides directions, i.e., a focus for learning, that foster commitment and mutual purpose among organization members. Brown and Eisenhardt (1995) pointed out that a shared vision coordinates the focus of various departments and enhances the quality of learning.

Hult (1998) and Calantone et al. (2002), however, recognized that a widespread problem in many organizations is that many creative ideas often fail to translate into best practices due to the lack of mutual interests and directions. Without commitment and agreement with the direction an organization is heading, employees are often less motivated to learn (Norman, 1985; Senge, 1990; Veron, 1999). This is because employees are not likely to know what organizational expectations are, what outcomes to measure, or what procedures are in operation (Sinkula et al., 1997). In such an ambiguous environment, even if one is motivated to learn, it is difficult to know what to learn. Therefore, Calantone et al. (2002) urged that it is important for management to establish their organizational direction and focus in order to create a positive learning climate for their organizational strength or core competence development.

4.2.2.3 Open-mindedness

This dimension seeks to determine the extent to which an organization is willing to critically evaluate its operational routine and to accept new ideas (Sinkula et al., 1997). This is especially important for firms operating in a dynamic marketplace when the rate of knowledge obsolescence is high (Calantone et al., 2002). In this case, successes and failures of the past organizational actions and behaviour provide insight on how their marketplace works. As times passes, the information may no longer be accurate but may still be informative only if organizations have an open-mindedness to question it (Sinkula, 1994; Sinkula et al., 1997). Organizations should proactively and constantly question their established routines, assumptions and beliefs, and subsequently unlearn, relearn and learn from their business environments. This is in line with Sull's (1999) concept of organizational active inertia and Argyris and Schon's (1978) notion of deutero-learning discussed in Sections 3.9.1 and 3.9.2, respectively. According to Sinkula et al. (1997), the process of unlearning is at the heart of organizational change, and open-mindedness is an organizational value that may be necessary for unlearning efforts to transpire.

4.2.2.4 Intra-organizational knowledge sharing

This dimension seeks to determine the extent to which firms develop collective beliefs or behavioural routines related to the spread of learning among different departments or units within an organization (Calantone et al., 2002). This attitude towards creating a knowledge sharing platform keeps alive the knowledge and information gathered from various sources (for example, different departments or individuals), and subsequently, provides informative reference for future organizational actions (Lukas et al., 1996; Calantone et al., 2002). In this way, organizational learning can be seen as an accumulated effect of individual learning within an organization. Considering the employee turnover and transfer, Lukas et al. (1996) pointed out that it becomes necessary for firms to develop and maintain a knowledge sharing platform to prevent any loss of information.

Next, Calantone et al. (2002) and Moorman and Miner (1998) shared the view that it is important for firms to establish an effective and efficient system for sharing and re-examining information in order to foster an intra-organizational knowledge sharing environment. Calantone et al. (2002) however pointed out that intra-organizational knowledge sharing does not simply refer to obtaining information from various sources. Rather, it depends on firms' ability and commitment to systemically reexamine and re-organize the information gathered, and then assure that this processed information should be stored into organizational memory and shared across departments. This agrees with Raiden and Dainty (2006), who pointed out that new ideas and practices emerging from individuals and project teams should undergo a formal evaluation process in order to facilitate efficient transfer of good practices within an organization.

4.2.3 Domain

The effects of organizational learning culture on determinants that may affect organizational flexibility are now discussed.

4.2.3.1 <u>Organizational learning culture (X1) and organizational structure (X2)</u>

Sinkula et al. (1997) found that a more positive learning orientation (i.e., a value-based construct) will directly result in increased market information generation and dissemination (a knowledge-based construct), which in turn, directly influence the degree to which a firm responds to changes in the business environment (a behavioural construct). This is shared by Teare (1997), who pointed out that an organization should promote a learning environment that enables members of the organization to effectively communicate and disseminate information for responsive decision making. Styhre et al. (2004) studied the effect of organizational learning in relation to information- and knowledge- sharing within network organizations in construction projects. They found that learning often takes place within a construction project through personal contacts, face-to-face interactions, communities of practices and learning by doing rather than being formalized or embodied in a computer-based solution.

The review above suggests that learning-oriented organizations are likely to have a flexible structure (see Section 4.3.3 for further explanation on the design of organizational structure), allowing them to effectively communicate, disseminate and share information, for responsive decision making in response to environmental changes. Accordingly, this study hypothesized that:

> *H_2: Organizational learning culture (X1) has a significant direct impact on organizational structure (X2).*

4.2.3.2 Organizational learning culture (X1) and employees' skills and behaviour (X3)

Flamholtz and Randle (2008) pointed out that organizational learning culture (X1) is a determinant of employees' skills and behaviour, in the way that it influences their willingness to change, innovate and learn new things. This agrees with Kanter (1983), who suggested that an organization should create an interactive learning environment that encourages employees' participation in decision making, and updates the employees on their company's future direction. He explained that, under such environment, employees feel more self-assured, knowing their fitness with the company's vision, and consequently, they become more motivated to change and learn new skills in accordance with the firm's business direction (see Section 4.2.2.2). Griego et al. (2000) explored the effect of learning culture on human resource development, and found the positive relationships among organizational learning, human resource development, firm productivity and performance. They identified that appropriate rewards and recognition, and training and education are key practices to achieving higher employees' motivation to learn new skills and adopt an adaptive behaviour, supporting firms' response to changes in the business environment.

Based on the above discussion, this study hypothesized that:

> *H_3: Organizational learning culture (X1) has a significant direct impact on employees' skills and behaviour (X3).*

4.2.3.3 Organizational learning culture (X1) and technological capabilities (X4)

Figueiredo (2002) examined the relationship between organizational learning orientation and technological capabilities, and found that firms' learning orientation influences the extent to which they accumulate their technological capabilities. This agrees with Malerba (1992), who found that organizational learning orientation is related to various trajectories of incremental technical change through the accumulated stock of knowledge of firms. This finding is supported by Dodgson (1993), who explained that organizational learning orientation has become a key factor towards achieving competitiveness, in the way that it shapes firms' endeavour in developing and managing their technological capabilities in an environment characterized by rapid technological change. He added that the turbulence, engendered by technological change in products and processes, increases the uncertainties faced by firms and the conflicts within the firms. For example: (i) the complexity of new product development processes, and shortening of product life-cycles (Rothwell, 1992; Dodgson, 1993); (ii) the evolution of new production processes (such as lean production and mechanization of production) (Womack et al., 1990); (iii) the growing use of computer-assisted organizational modernization such as Just-in-Time delivery and material requirement (Dodgson, 1993); and (iv) the greater emphasis on the use of information and communication technologies in acquiring, storing, processing and disseminating information within a firm or between firms (Shrivastava, 1983). All these technological complications require firms to learn to perform things and tasks in new ways, which are often radically different.

Wang and Li (2007) related organizational learning orientation to firms' core competence (i.e., integrative, marketing and technological competences), and found that individual dimensions of learning orientation influence the specified dimensions of core competences in different degrees. Of these, shared vision is found to positively influence the three core competences specified. This is followed by commitment to learning that positively influences firms' technological and integrative competences. Lastly, open-mindedness is found to have a positive impact on firms' marketing and integrative competences. All these indicate that organization learning orientation helps to enhance firms' core-competences, to a certain extent.

Based on the above review, this study hypothesized that:

> *H_4: Organizational learning culture (X1) has a significant direct impact on technological capabilities (X4).*

4.2.3.4 <u>Organizational learning culture (X1) and business strategies (X6)</u>

Szulanski and Amin (2001) highlighted that companies have to learn to formulate new strategies, and subsequently migrating to them in order to remain viable in a changing competitive environment where the value of new strategies erodes rapidly. This is, to some extent, similar to Quinn's (1980) notion of incrementalism (see Section 3.3), whereby firms have to incrementally develop strategic options in their efforts to improve their flexibility potential in a changing business environment. According to Szulanski and Amin (2001), a firm's learning culture is important for effective strategy-making in that it creates an interactive environment that promotes: (i) implementation of regular scanning activities to identify and analyze opportunities and threats arising from the business environment, and (ii) participation of employees in contributing to new business ideas.

Calantone et al. (2002) found that learning-oriented firms possess greater chances to enhance their innovation capabilities because of: (i) the firms' positive attitude towards building and marketing a technological breakthrough; (ii) the firms' commitment in monitoring competitors' actions in the market, understanding their strengths and weaknesses, and learning not only from their successes but also from their failures; and (iii) the firms' enthusiasm to learn from changes within their market conditions, and subsequently using the knowledge to understand and anticipate customers' needs. They maintained that a positive learning climate is beneficial for firms that seek to pursue a product development strategy, based on their findings that learning orientation has a direct influence on firms' performance (for example, market share, new product success and overall performance). This is consistent with Baker and Sinkula's (1999) findings that there is a positive relationship between firms' performance and learning orientation. According to Calantone et al. (2002), learning orientation facilitates the development of organizational resources and capabilities essential for a firm's performance, which in turn, enhances the organization's performance, both directly and indirectly, through its influence on competitive advantage. Similarly, Sinkula et al. (1997) found that learning-oriented firms are more likely to be more flexible and nimble, changing their marketing strategies in a rapid and fluid manner to anticipate, neutralize or possibly prosper from any external shock.

Theoharakis and Hooley (2003) examined the influence of commitment to learning on firms' planning flexibility in relation to their performance, and found that it enhances planning flexibility (in terms of resources utilization), which in turn influences their service responsiveness, by developing and implementing timely responses. From this, it follows that firms' responsiveness is found to have direct impact on clients' satisfaction and their overall performance.

Based on the above, this study hypothesized that:

> *H_5: Organizational learning culture (X1) has a significant direct impact on business strategies (X6)*

4.2.4 Measurement items

This section focuses on the operationalization of the organizational learning culture (X1) construct. Table 4.1 shows the measurement items operationalized by other studies in evaluating a firm's learning culture (see 3rd column), and the items incorporated in the data collection instrument of this study (see 4th column).

Table 4.1 Measurements items for organizational learning culture (X1)

Possible dimensions (1)	**Authors** (2)	**Possible measurement items** (3)	**Remark (see legend for symbol connotation)** (4)
Commitment to learning	Sinkula et al. (1997); Calantone et al. (2002); Theoharakis and Hooley (2003); Morgan and Turnell, (2003); Wang and Li (2007)	The sense around here is that employee learning is an investment, not an expense	Δ: refer to item CL1 in Appendix C, Q3.1
		The basic values of this organization include learning as key to improvement	Δ: refer to item CL2 in Appendix C, Q3.1
		Managers basically agree that our organization's ability to learn is the key to our competitive advantage	Δ: refer to item CL3 in Appendix C, Q3.1
		Learning in my organization is seen as a key commodity necessary to guarantee organizational survival	
Shared vision	Sinkula et al. (1997); Calantone et al. (2002); Morgan and Turnell, (2003); Wang and Li (2007)	There is total agreement on our organizational vision across all levels, functions, and divisions	Δ: refer to item SV1 in Appendix C, Q3.1
		All employees are committed to the goals of this organization	Δ: refer to item SV2 in Appendix C, Q3.1
		There is a commonality of purpose in my organization	Δ: refer to item SV3 in Appendix C, Q3.1
		Employees view themselves as partners in charting the direction of the organization	@: refer to item SV4 in Appendix C, Q3.1
	Griego et al. (2000)	The vision and strategy are continually updated, based on changes in the business environment and customers' needs	#
		We have a vision of ourselves as an organization in which learning and purposeful changes are expected	#
Open-mindedness	Sinkula et al. (1997); Calantone et al. (2002); Morgan and Turnell, (2003) Wang and Li (2007)	We are not afraid to reflect critically on the shared assumptions we have made about our customers	Δ: refer to item O1 in Appendix C, Q3.1
		Personnel in this enterprise realize that the very way they perceive the marketplace must be continually questioned	#
		We rarely collectively question our own biases about the way we interpret customer information	#

Possible dimensions (1)	Authors (2)	Possible measurement items (3)	Remark (see legend for symbol connotation) (4)
Intra-organizational knowledge-sharing	Calantone et al. (2002)	There is a good deal of organizational conversation that keeps alive the lessons learn from history. We always analyze unsuccessful organizational endeavours and communicate the lessons learned widely We have specific mechanism for sharing lesson learned in organizational activities Top management repeatedly emphasizes the importance of knowledge sharing in our company	Ξ Ξ Ξ Ξ
		We put little effort in sharing lessons and experiences	Ξ
Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork # - omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study @ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork			
Note: Sinkula et al. (1997), Griego et al. (2000), Calantone et al. (2002), and Theoharakis and Hooley (2003) adopted a five-point Likert scale. Morgan and Turnell (2003) and Wang and Li (2007) adopted a seven-point Likert scale.			

In this study, eight out of the 18 items identified in the literature review were retained following the preliminary interviews (see Section 5.3) and pilot study (see Section 5.4.4) in the exploratory and reflective phases, respectively. Of these eight retained items, many were modified to suit the research context before being incorporated into the data collection instrument. Also, two items were identified during the preliminary interviews and subsequently labelled as items O2 and O3 in the instrument. In this study, the measurement items of intra-organizational knowledge sharing were found to be not applicable because these items overlapped with other items in the ‘organizational structure’ construct (see Section 4.3.5) and the ‘shared value’ dimension. In fact, this exclusion was, to some extent, supported by many interviewees, who pointed out that these items symbolize some characteristics of a firm’s shared values and organizational structure. They suggested that these characteristics should be integrated into relevant items of the ‘shared value’ dimension and ‘organizational structure’ construct, and added that it is more feasible to adopt the term ‘shared value and vision’ instead of ‘shared value’. They explained that the former provides a more integrated meaning than the latter since a company's vision and value are interrelated.

In total, 10 measurement items were used to evaluate firms' organizational learning culture (X1). The dimensionality of firms' organizational learning culture is examined in Section 7.3.2.1.

4.3 Organizational structure (X2)

The second possible determinant of organizational flexibility is a firm's structure (see Figure 3.2). Definitions of organizational structure are now discussed.

4.3.1 Definition

Many studies have defined organizational structure (for example, Khandwalla, 1977; Robbins, 1983; Scott and Davis, 2007). Of these, one commonly adopted definition is that organizational structure is the internal pattern of relationship, authority, and communication among positions in an organization and among members of the organization (Thompson, 1967; Tomer, 1996). In explaining this internal network, Blau (1974:12) referred to organizational structure as "the distributions, along various lines, of people among social positions that influence the role relations among these people". This definition was subsequently adopted by Hall (1987), who inferred that organizations comprise two important structural components. They are: (i) the division of labour where individuals are given different tasks or jobs to fulfil, and (ii) the hierarchy defining positions of individuals and specifying sets of rules and regulations.

Similarly, Volberda (1998:136) described an organization's structure as the actual distribution of responsibilities and authority among the organization's members.

According to him, this distribution network results in the construction of a basic organizational form, comprising various elements such as functions, units and divisions. He went on to point out that these elements have to be flexible so that they can be easily modified into other mutual relationships; when necessary, at low cost and little resistance, and without losing their efficiency and effectiveness.

From a different perspective, Ranson et al. (1980) considered organizational structure as “a complex medium of control which is continually produced and recreated in interaction and yet shapes that interaction – therefore, structures are constituted and constitutive” (p.3). This perspective indicates that organizational structure is neither fixed nor static, but rather shaped by environmental influences within and outside an organization, and subsequently influences interactions within the organization. This is consistent with Penrose’s (1995) view of the ‘administrative organization structure’ under her theory of the growth of the firm, discussed in Section 3.8.3. According to her, an organization’s structure is: (i) developed to respond to immediate needs, and (ii) shaped largely by conscious attempts to achieve a ‘rational organization’.

Chandler (1997) described organizational structure as the design of an organization through which it is administered, based on two organizational attributes. They are: (i) the line of authority and communication channels, and (ii) the flow of information through these lines of authority and communication channels. According to Chandler (1997), these lines of authority and communication are vital to ensure the effective coordination process and planning of resources in accomplishing an organization’s goals. Thus, organizational structure serves as a functioning framework that governs organizational transformation processes (Van de Ven, 1976; Robbins and Coulter, 1996) or “an arena for organizational actions” (Hall, 1987:99).

In this study, organizational structure is defined as the actual distribution of lines of authority and lines of communication channels that facilitate the decision-making and communication procedure in a construction firm (following Chandler, 1997). This emphasizes the communication flow, work procedure and decision-making process within a firm. The next section focuses on the dimensions of organizational structure that influence a firm's decision-making and communication process.

4.3.2 Possible dimensions

According to Montarini (1979) and Kale (1999), an organizational structure may be characterized by a variety of dimensions. Of these, some varieties are attributable to: (i) the multi-dimensional nature of organizational structure; (ii) the different conceptualizations depending upon researchers' interest; and (iii) the usage of different classification schemes. Some commonly discussed structural dimensions in organizational studies are now reviewed.

It was Pugh et al. (1968) and Inkson et al. (1970), who first identified the four major dimensions of organizational structure in their Aston studies. The four dimensions are: (i) structuring of activities; (ii) line control of work; (iii) relative size of support component; and (iv) concentration of authority. Of these, the first three dimensions were reconfirmed by Child (1972), who replicated the Aston studies, as the major dimensions of organizational structure. This group of dimensions evolved into the following structural dimensions of: (i) complexity; (ii) integration; (iii) formalization; and (iv) centralization, which are now discussed.

4.3.2.1 <u>Complexity</u>

This dimension refers to the extent of diversity or differentiation within a given organizational system in terms of four components (Hall, 1987; Robbins and Coulter, 1996). These are: (i) horizontal differentiation of tasks among different positions within an organization; (ii) vertical differentiation of distinct hierarchical levels; (iii) spatial dispersion of subunits or members of an organization; (iv) degree of personal expertise (Ford and Slocum, 1977; Hall, 1987; Kale, 1999).

According to Robbins and Coulter (1996), the more division of labour in an organization, the more vertical levels in the hierarchy, and the more geographically dispersed the organization's units, the more difficult it is to coordinate people and their activities within the organization. This is consistent with Hall (1987), who noted that organizations tend to become more complex as their own activities and environments become more complex. According to him, if organizations are unable to design and adopt an appropriate structure that suits their business environments, and if they cannot avoid the trap of increasing complexity, they may soon be in trouble.

4.3.2.2 Integration

This dimension refers to the extent to which an organization coordinates its various departments or sub-units as a systemized whole towards meeting its overall objectives (Lawrence and Lorsch, 1967; Lansley, 1994). More often than not, this integration process could be facilitated by: (i) forming project groups and teams; (ii) establishing effective formal channels of communication; and (iii) sharing information among staff about their jobs and the firm (Lawrence and Lorsch, 1967; Khandwalla, 1977; Mintzberg, 1979). However, it should be noted that an increase in complexity, for example, when firms grow in size, can often lead to greater problems of integration and control (Hall, 1987; Burton and Obel, 2004). This implies the positive correlation between the level of complexity within a firm and the efforts required to integrate functional departments within the firm.

4.3.2.3 Formalization

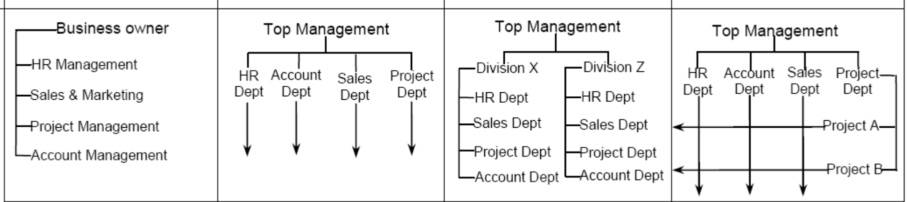
This dimension refers to the extent to which an organization relies on a set of rules and regulations to direct and control employees' behaviour (Hall, 1987; Robbins and Coulter, 1996). The set of rules and regulations can be formalized either in writing or unwritten norms and standards (Hall, 1987; Kale, 1999), directly influenced by organizational culture (Volberda, 1998). Hall (1987) suggested that the degree to which an organization is formalized can run along a continuum - one end indicating maximal formalization and the other end representing minimal formalization - which is influenced by the extent to which various mechanisms are implemented. These mechanisms may include: (i) functional specializations; (ii) close supervision; (iii) formal training; and (iv) well-defined systems, procedures and performance standards (Burns and Stalker, 1961; Khandwalla, 1977; Lansley, 1994). According to Robbins and Coulter (1996), the more rules and regulations in an organization, the more formalized the organization's structure is. These suggest that the dimensions of formalization and integration are positively correlated, i.e., the higher the formalization, the greater will be the integration and control.

4.3.2.4 Centralization

This dimension refers to the extent of employees' participation in the decision-making process (Aiken and Hage, 1968; Robbins and Coulter, 1996). According to Marsh (1992), the locus of decision-making authority can be considered along a continuum of maximum degree of centralization (i.e., low decentralization) to a minimum degree of centralization (i.e., high decentralization). If most decision-making occur at the top management level, it suggests that the organization favours centralization. On the other hand, if there is greater level of employees' participation in decision-making, it implies that the organization is orientated towards delegative decision-making process (i.e., decentralization).

4.3.3. Design of organizational structure

Child (1984) pointed out that it is crucial for firms to put emphasis on the above-discussed dimensions when designing a structure that matches their organizational goals. However, many studies highlighted that there is no single way of designing and organizing a structure as there is no guarantee that an organization would find an appropriate single form in dealing with its environment (for example, Burns and Stalker, 1961; Woodward, 1965; Galbraith, 1973). According to some studies, the best way of organizing or designing a structure is contingent upon the kinds of task or environment to which an organization relates (for example, Scott, 1992; Volberda, 1998). As a result, different structural configurations can be formulated by placing different levels of emphasis on the aforementioned structural dimensions (Burton and Obel, 2004). Descriptions of some commonly discussed structural configurations are summarized in Figure 4.1, showing the inherent potential of flexibility in respective configurations.

Descriptions	**Simple configuration**	**Functional configuration**	**Divisional configuration**	**Matrix configuration**
Types of structural configuration				
	See Section 4.3.3.1	See Section 4.3.3.2	See Section 4.3.3.3	See Section 4.3.3.4
Flexibility potential	Moderate	Low	⟷	High
Burn and Stalker's (1961) organizational model	Not included	Mechanistic structure	⟷	Organic structure
	See Section 4.3.3.5			

Note: There may be other functional departments and divisions within an organization. The aforementioned departments and divisions are just a hypothetical example illustrating the difference in departmental structures and division between the four structural configurations

Figure 4.1 Classification of structural configurations concerning the potential for flexibility

Adapted from Burn and Stalker (1961), Volberda (1998), Burton and Obel (2004) and PMI (2004)

4.3.3.1 Simple configuration

The simple configuration comprises a flat hierarchy with a single point of coordination, communications, control and decision-making (Newcombe, 1990a; Burton and Obel, 2004). There is little functional specialization and no well-defined departmental structure with departmental heads (Burton and Obel, 2004), and thus it possesses a moderate degree of flexibility potential since decisions are often made by a single person. According to Newcombe (1990a), this configuration is also known as an integrated structure, and is only appropriate for smaller-sized companies.

4.3.3.2 Functional configuration

The functional configuration comprises a series of specialized functions, for example, production, marketing, finance and human resources departments (Newcombe, 1990a). In comparison, Burton and Obel (2004) pointed out that the functional configuration comprises more vertical levels and more horizontal specialization than a simple configuration. It is appropriate for achieving internal efficiency goals, using task specialization and a strict chain of command to gain efficient use of scare organizational resources (Daft and Marcic, 2007). However, owing to the high interdependence between departments, the functional configuration tends to possess a low level of flexibility (Volberda, 1998; Burton and Obel, 2004). In the face of unforeseen contingencies, coordination between interfacing units becomes urgent and complex (Khandwalla, 1977). According to Volberda (1998), as the number of interdependent functional department increases, the response time to changes also increases.

4.3.3.3 Divisional configuration

The divisional configuration is characterized by organizational subunits based on a grouping of products, markets or customers (Burton and Obel, 2004). Unlike the functional form, this configuration minimizes the interdependence of subunits. Subunits within a divisional configuration are relatively self-sufficient, and as a result, they can do more tasks and change tasks more easily (Mintzberg, 1979; Volberda, 1998). This is consistent with Khandwalla (1977), who noted that the self-containment of units shortens lines of communications between interdependent personnel, makes planning and coordination easier, and thus facilitating quicker adaptation to marketplace changes. In this way, it appears that a divisional form exhibits a higher flexibility potential than a functional form.

4.3.3.4 Matrix configuration

The matrix configuration, also known as project-centred arrangement, introduces a dual hierarchy of authority (Burton and Obel, 2004). It incorporates the essence of both functional and divisional configurations into an organization’s structure, and focuses on grouping by customers or markets (Volberda, 1998; Burton and Obel, 2004). Compared with the functional and divisional forms, Volberda (1998) highlighted that the matrix configuration encourages the greatest flexibility potential within an organization. He explained that the increased self-containment of targeted market units, together with the direct client contacts and boundary-spanning activities, enable quicker adaptation to changes in specific customers’ demands or to fluctuations in market demand. This agrees with Eppink (1978) and Krijnen (1979), who found that a matrix configuration exhibits a high degree of flexibility potential, characterized by its structural arrangement in promoting effective communication and swift decision-making, and thus improving organizations’ responsiveness to changes within the business environment.

4.3.3.5 Mechanistic versus Organic structures

The above structural configurations can be further classified according to Burns and Stalker's (1961) model of mechanistic and organic organizations, corresponding to the opportunities for adaptive capabilities (following Volberda, 1998). The mechanistic structure is more suitable for routine stable conditions (Burns and Stalker, 1961), which is characterized by a high level of control and centralization, and a low level of adaptation (Chakravarthy, 1982), and thus leading to a low level of organizational flexibility. Volberda (1998) suggested that a functional form with many hierarchical levels is a close resemblance of the mechanistic structure. He added that, in this arrangement, processes may be highly regulated through elaborate planning and control systems, specialization of tasks, and high degrees of standardization and formalization. As a result, the levels of employees' participation and delegation are low,

On the other hand, the organic structure is best suited to cope with or adapt to a dynamic business environment (Burns and Stalker, 1961; Lawrence and Dyer, 1983; Lansley, 1994), owing to: (i) its high degree of information sharing and integration, and (ii) low degree of formality and centralization (Mintzberg, 1979; Volberda, 1998). As a result, it promotes a high level of adaptation (Chakravarthy, 1982), and in turn, improving a firm's flexibility potential. Volberda (1998) suggested that an organic structure can exist as a divisional or matrix form that comprises few hierarchical levels. He explained that the essence of both divisional and matrix forms are planning and control systems that are predominantly "performance-oriented", instead of being "means-oriented", thus allowing room for ambiguous information and necessary experimentation and intuition.

In this study, the four structural configurations were included in the questionnaire to identify the types of structure adopted by Singapore contractors (see Appendix C, Q4.3). The purpose is to find out which is the organizational structure that provides flexibility to Singapore contractors.

4.3.4 Domain

This section discusses the influence of organizational structure (X2) on business strategies (X6) and organizational flexibility (Y).

4.3.4.1 Organizational structure (X2) and business strategies (X6)

The next issue is to address the questions of whether 'structure follows strategy' or 'strategy follows structure'. Of these, the former is the predominant proposition, initiated by Chandler (1962), which has been advocated by many organizational researchers such as Miles and Snow (1978), Miller (1988) and Daft and Marcic (2007). It emphasizes that companies' internal structure must fit with the adopted corporate strategy, conceptualizing that firms select their domain of strategy before designing their structures (Burton and Obel, 2004). Taking Miles and Snow's (1978) generic strategies as an example, each of the four categories of strategy identified (i.e., prospectors, defenders, analyzers and reactors) necessitates particular organizational structures. If a firm favours a prospector positioning, it should adopt an organic structure, whereas if it chooses to be a defender, a mechanistic structure (see section 4.3.3.5) will be more applicable. Further discussions on Miles and Snow's (1978) generic strategies are provided in Section 4.7.2.1.

Turning to the second school of thought, i.e., 'strategy follows structure', this proposition emphasizes that an organizational structure could influence the choice of firms' business strategy (Burton and Obel, 2004). Hall and Saias (1983) and

Frederickson (1984) are some of the many supporters of this hypothesis. In Frederickson's (1984) study, three interesting trends on the effects of structure on strategy were established. These are: (i) an increase in complexity makes strategic actions more political and more incremental; (ii) an increase in formalization results in incremental strategic actions; and (iii) an increase in centralization gives rise to strategies that are major departures from existing ones.

In this study, it appears that the latter proposition, i.e., 'strategy follows structure', is more appropriate. This is because most of the targeted Singapore general contracting firms (see Section 5.5.4) are expected to be family-controlled businesses, which are conservative in their decision-making process. Besides this, the contractors are considered as relatively small in size compared to transnational corporations. As a result, it is expected – indeed very likely – that the contractors are constrained by their structures in pursuing their strategic actions. In most instances, contractors would make slight modification on the lines of authority and communication rather than reorganize their structures. Even if contractors venture overseas, it is unlikely for them to establish a branch, but rather a satellite office manned by one or two personnel who will report directly to top management in the Singapore office. Based on this argument, it is hypothesized that:

> *H_6: Organizational structure (X2) has a significant direct impact on business strategies (X6).*

4.3.4.2 <u>Organizational structure (X2) and organizational flexibility (Y)</u>

In the prevailing business environment, characterized by global competition and environmental dynamism, the need for an organizational structure design that promotes responsiveness, flexibility and control is increasing (Carlsson, 1989; Male, 1991b; Englehardt and Simmons, 2002). According to Denton (1998), firms should eliminate “rigid job description, strict hierarchy and excessive bureaucracy” (p.92) in their endeavours to foster a cross-functional teamwork environment for improved communication and information-sharing among departments within their organizations as they move towards achieving flexibility.

Also, Volberda (1998) and Englehardt and Simmons (2002) pointed out that a flexible firm should promote: (i) a loose planning control procedure; (ii) a high decentralization process; (iii) a low specialization process; and (iv) a flat hierarchical structure. Of these, a flat hierarchical structure has been considered as the most appropriate form for contractors who venture overseas (Construction Industry Institute, 1993; Flanagan, 1994; Ofori, 2003). Also, Lansley (1987; 1994) advised that contractors should focus on ‘right control rather than tight control’ when designing their organizational structure for improved flexibility and responsiveness to changing business environments.

Based on the above, this study hypothesized that:

> *H_7: Organizational structure (X2) has a significant direct impact on organizational flexibility(Y)*

4.3.5 Measurement items

This section focuses on the operationalization of the organizational structure construct (X2). Table 4.2 shows the measurement items operationalized by various studies in evaluating organizational structure (see 3rd column), and the items incorporated in the data collection instrument of this study (see 4th column).

Table 4.2 Measurement items for organizational structure (X2)

Possible dimensions (1)	Authors (2)	Possible measurement items (3)	Remark (see legend for symbol connotation) (4)
Complexity	Daft (1992) Kale (1999)	The number of hierarchical levels	Δ: refer to Q4.1 in Appendix C
		The number of geographical locations	Δ: refer to Q6.3 in Appendix C
		The number of function, department and jobs	#
Formalization	Kale (1999)	Formal training programs for project managers	Ξ
		Written manual of procedures and work rules	#
		Safety management program for the prevention of accidents	#
		Cost reporting system for evaluating actual vs. budgeted cost, cost record, updates	Ξ
		Quality control system for QA/QC reports, testing and inspections, trend analysis, etc	#
		Schedule/progress control system for tracking progress, variances, etc	#
		A comprehensive management control and information system.	Ξ
		A regular performance appraisal for managers including foreman	Ξ
		An integrated project control information system	Ξ
	Khandwalla (1977)	Greater emphasis on getting things done even if methods used disregard the formal procedure	@: refer to item OS1 in Appendix C, Q4.4
		Greater emphasis on loose, informal control, which heavy dependence on informal relationships and norms of cooperation for getting work done	@: refer to item OS4 in Appendix C, Q4.4
Centralization	Khandwalla (1977)	Greater emphasis on decentralization with most operating decisions made at lower management levels	@: refer to item OS2 in Appendix C, Q4.4
Integration	Kale (1999)	Temporary teams or task forces consisting managers from different departments	#
	Khandwalla (1977)	Greater emphasis on open communication channel with flexible access to important information for decision making	@: refer to item OS3 in Appendix C, Q4.4

Legend: Δ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork
- omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study
Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study
@ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork

Note: Khandwalla (1977) adopted a seven-point Likert scale. Kale (1999) adopted a five-point Likert scale

It can be seen from Table 4.2 that only six out of the 17 items identified in the literature were retained and incorporated into the data collection data following the preliminary interviews (see Section 5.3) and pilot study (see Section 5.4.4) in the exploratory and reflective phases, respectively. It appears that some of the items identified were unsuitable because of the nature and scope of this study, while some were found to overlap with the measurement items of the 'technological capabilities' construct (see Section 4.5.3) and the human resource management practices (see Section 4.4.3). It follows that organizational structure may appear as a single-dimensional rather than a multi-dimensional construct in this study (see Section 5.4.1, where it is stated that individual constructs should comprise at least three measurement items). The dimensionality of this construct is further examined in Section 7.3.

4.4 Employees' skills and behaviour (X3)

The third possible determinant of organizational flexibility is employees' skills and behaviour (see Figure 3.2). The importance of employees' skills and behaviour, in enabling firms to respond to changes within marketplaces and thus contributing to firm competitiveness, has been highlighted in many studies (for example, Kalleberg, 2001; Kara and Kayis, 2004). According to Barney and Wright (1998) and Lopez-Cabrales et al., (2006), employees' skills and behaviour are considered as a firm's valuable asset that cannot be easily imitated by other organizations. This valuable asset subsequently helps to develop organizational capabilities that are firm-specific and generate tactical organizational knowledge (Reed and DeFilippi, 1990; Barney, 1991). In this study, the term 'employees' refers to the pool of human capital under the firm's control in a direct employment relationship (following Wright et al., 1994), holding a permanent supervisory position or above in a construction firm.

4.4.1 Domain

This section focuses on the influence of employees' skills and behaviour on other organizational capabilities and strategies, in addition to a firm's flexibility potential.

4.4.1.1 Employees' skills and behaviour (X3) and technological capabilities (X4)

With reference to Sections 2.4.5 and 4.5, firms are increasingly expected to produce more technically complicated products, as clients' expectations increase, and to operate in a more effective way, as competition rises. All these suggest that firms have to improve their technological capabilities, in response to environmental changes, through changing the way their employees work (see Section 4.5.1 for definition of technological capabilities adopted in this study). According to Johnson and Clayton (1998), the advance in technology has altered the nature of employees' work; where employees are not only required to communicate and collaborate with people using information technologies (such as electronic email and videoconferencing), but also to analyze and produce complex products using advanced process technological tools.

The foregoing discussion suggests that firms may need to consider employees' skills and behaviour in their attempts to improve or manage their technological capabilities, such as whether their employees possess an acceptable level and type of skills in fulfilling the firm's technical need and their employees will resist to the changes made in accordance with the firm's technical need. According to Cameron and Green (2004), employees' willingness to learn new skills and change is at the heart of everything that is achievable within an organization. This is because when employees are unwilling to learn or adapt, their resistance may considerably affect a firm's endeavours to improve its responsive capabilities (Bhattacharya et al., 2005). Also, Senge (1990) pointed out that people do not resist change but they resist being changed to meet unfamiliar and uncomfortable organizational requirements.

Based on the review above, this study hypothesized that:

> *H_8: Employees' skills and behaviour (X3) have a significant direct impact on technological capabilities (X4).*

4.4.1.2 <u>Employees' skills and behaviour (X3) and supply chain capabilities (X5)</u>

Employees are the main linkage among firms, connecting a firm with its subcontractors, suppliers and customers, and collaborating across teams of people (Athey, 2008). As a result, their skill and behaviour in building relationships and working in a team environment influence a firm's supply chain capabilities (Gold et al., 2001) (see Section 4.6.1 for the definition of supply chain capabilities adopted in this study). Based on this, this study hypothesized that:

> *H_9: Employees' skills and behaviour (X3) have a significant direct impact on supply chain capabilities (X5).*

4.4.1.3 <u>Employees' skills and behaviour (X3) and business strategies (X6)</u>

Many studies suggested that employees' skills and behaviour should complement a firm's strategy for improved performance (for example, Kanter, 1983; Lawrence, 2002). According to Schuler and Jackson (1978), employees' role behaviour is instrumental in the implementation of competitive strategies because different competitive strategies necessitate different sets of employees' behaviour. For example, firms pursuing a competitive strategy of innovation require employees to possess: (i) a high degree of creative behaviour; (ii) a relatively high level of cooperative and interdependent behaviour; (iii) a moderate degree of concern for quality; (iv) an equal degree of concern for process and results; and (v) a greater degree of risk-taking (Schuler and Jackson, 1978). As a result, Wright and Snell (1998) suggested that it is important for firms to recruit employees who possess a broader range of skills and behaviour for facilitating the implementation of different competitive strategies in different business conditions.

Wright et al. (1994) explained that the superior skills of employees can enhance a firm's ability to sense marketplace influences that require changes in the firm's activities, and subsequently devise effective strategies in response to the relevant changes within its business environment. Once responsive strategies have been devised, they need to be implemented quickly and efficiently. In this transition process, the flexibility and adaptability of employees' behaviour are the keys towards effective strategies implementation; they have to learn fast, apply new skills, implement new technologies and re-organize work processes in response to changes within the business environment (Snow and Snell, 1992; Wright et al., 1994). It is especially true that, in an environment characterized by fast changing technologies and products, and cyclical fluctuations in demand, the employees' ability to learn and adapt to different marketplace conditions, through constantly acquiring knowledge from the environment, has become an important determinant of organizational flexibility, in firms' endeavours to remain viable (Schmidt and Hunter, 1992).

Based on the above, it is hypothesized that:

> *H_{10}: Employees' skills and behaviour (X3) have a significant direct impact on business strategies (X6).*

4.4.1.4 Employees' skills and behaviour (X3) and organizational flexibility (Y)

Wright and Snell (1998) studied the relationship between employees' skills and behaviour and flexibility, and found that employees' skills and behaviour may, both directly and indirectly, influence a firm's flexibility. They explained that, when a firm's employees possess a broad repertoire of adaptive behaviours and are encouraged to apply them in appropriate situations, rather than always follow standard operational procedures, the firm is usually flexible in response to changes in the business environment. This is shared by Bhattacharya et al. (2005), who pointed out that the intrinsic behavioural motivation of employees towards changes within the marketplace is important in that it enables firms to flexibly deal with a variety of situations and facilitates the implementation of change.

Likewise, if a firm's employees possess a variety of skills, which could be applied and deployed in different market environments, the firm's flexibility increases (Wright and Snell, 1998; Bhattacharya et al., 2005). This is because the broad-based skills of employees not only help the firm to fulfil its current needs but also enable it to explore new businesses, i.e., influencing the firms' strategic choices (Lengnick-Hall and Lengnick-Hall, 1988; Bhattacharya et al., 2005). This phenomenon can be explained in relation to the dynamic contingency view of firms (see Section 3.9.1); where employees' skills can be seen as an important element in supporting different choices of business domain by individual firms during different market conditions.

MacDuffie (1995) considered the importance of employees' skills and behaviour towards achieving flexibility, and pointed out that employees may possess broad-based skills but lack the behavioural motivation to change, or they may be highly motivated but lack the essential skills to devise and implement responsive strategies to marketplace influences. As a result, firms are faced with the challenges to manage their employees' skills and behaviour (Details of human resource management are discussed in section 4.4.3).

Based on the above review, this study hypothesized that:

> *H_{11}: Employees' skills and behaviour (X3) have a significant direct impact on organizational flexibility (Y).*

4.4.2 Human resource management practices

Many studies suggested that human resource management practices may be considered under four categories (Raiden and Dainty, 2006; Major et al., 2007): (i) competence development; (ii) stress management; (iii) performance management; (iv) intra-organizational relationship management. Table 4.3 summarizes the human resource management practices found in previous studies (see 3rd column), and the practices incorporated in the data collection instrument (see 4th column).

Table 4.3 Human resource management practices

Categories **(1)**	**Authors** **(2)**	**Possible practices** **(3)**	**Remark (see legend for symbol connotation)** **(4)**
Competence development	Wang and Li (2007); Major et al. (2007);	Offering on the job training	@: refer to item C6 in Appendix C, Q2.2
	Volberda (1998)	Offering job rotation programme	@: refer to item C7 in Appendix C, Q2.2
	Volberda (1998)	Offering job enrichment programme	@: refer to item C8 in Appendix C, Q2.2
	Raiden and Dainty (2006)	Offering day-release scheme to attend part-time course	@: refer to item C9 in Appendix C, Q2.2
		Allowing employees to attend formal trainings relating to their continuous professional development and professional qualification course	∆: refer to item C10 in Appendix C, Q2.2
		Providing monitoring and coaching scheme	∆: refer to item C11 in Appendix C, Q2.2
		Collaborating with a leading management college to provide training for employees	@: refer to item C12 in Appendix C, Q2.2
Stress management	Major et al. (2007)	Giving employees time off	∆: refer to item SM1 in Appendix C, Q2.3
		Facilitating use of company sponsored programs (e.g. vacation time)	∆: refer to item SM2 in Appendix C, Q2.3
		Encouraging co-worker support	∆: refer to item SM3 in Appendix C, Q2.3
		Offering psychosocial support	∆: refer to item SM4 in Appendix C, Q2.3
Performance management	Major et al. (2007)	Organizing informal gathering to recognize employees' achievement to foster team building	@: refer to item PM1 in Appendix C, Q2.4
	Volberda (1998)	Providing flexible compensation plans	@: refer to item PM2 in Appendix C, Q2.4
	Raiden and Dainty (2006); Major et al. (2007)	Conducting company annual appraisal process to collect formal means of discussing, identifying and recording employees' training needs	@: refer to item PM4 in Appendix C, Q2.4
	Volberda (1998); Raiden and Dainty (2006); Major et al. (2007)	Offering career development and promotion opportunities	@: refer to item PM5 Appendix C, Q2.4
Intra-organizational	Major et al. (2007)	Encouraging regular face-to-face interaction and open communication among employees	∆: refer to item RM1 in Appendix C, Q.25

Categories (1)	Authors (2)	Possible practices (3)	Remark (see legend for symbol connotation) (4)
relationship management	Raiden and Dainty (2006)	Conducting regular meetings among subordinates and superiors	@: refer to item RM2 in Appendix C, Q.25
	Wright and Snell (1998); Raiden and Dainty (2006); Subramony (2006)	Implementing survey feedback programme to track the well-being of employees	@: refer to item RM3 in Appendix C, Q.25
	Raiden and Dainty (2006)	Organizing induction programmes to support all new recruits	@: refer to item RM4 in Appendix C, Q.25
Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork # - omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study @ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork			
Note: All measurement items, found in previous studies, were not administered by any measurement scale			

It can be seen from Table 4.3 that all the practices identified by previous studies were incorporated into the data collection instrument; where description of some practices were modified, based on the exploratory interview and pilot study findings, to suit the research context of this study. Three new practices were identified in the exploratory interviews and included in the instrument as items C13, PM3, and RM5 in Appendix C. These 22 practices were used to examine the relationships between human resource management practices and employees' skills and behaviour.

4.4.3 Measurement items

This section focuses on the operationalization of the employees' skills and behaviour (X3) construct. Table 4.4 shows the measurement items operationalized by various studies in evaluating employees' skills and behaviour (see 2nd column), and the items incorporated in the data collection instrument of this study (see 3rd column) following the preliminary interviews (see Section 5.3) and pilot study (see Section 5.4.4) in the exploratory and reflective phases, respectively.

Table 4.4 Measurement items for employees' skills and behaviour (X3)

Authors (1)	Possible measurement items (2)	Remark (see legend for symbol connotation) (3)
Desarbo et al. (2005)	Ability to identify trends and then developed new markets and services using their analytic skills	∆: refer to item ESB1 in Appendix C, Q2.6
	Ability to be flexible and creating responsive changes based on their broad and entrepreneurial skills	
Correa (1994); Lientz and Rea (2003)	Ability to work in team environment	∆: refer to item ESB2 in Appendix C, Q2.6
	Ability to communicate well within each other	
Correa (1994); Lientz and Rea (2003);	Ability to be self-motivated and willing to travel overseas for an extended period of time	∆: refer to item ESB3 in Appendix C, Q2.6
Snow and Snell (1992); Wright et al. (1994); Correa (1994); Lientz and Rea (2003); Bhattacharya et al. (2005)	Ability to adapt to new situations	∆: refer to item ESB4 in Appendix C, Q2.6
	ability to adjust to changing work requirements within a short period	
	Ability to change their work habits in response to changes in the competitive environment	
	Ability to learn and deploy new skills within a short period and in a continuous manner	
	Ability to switch to new jobs in our company within a short time	
Lengnick-Hall and Lengnick-Hall (1988); Bhattacharya et al. (2005)	Ability to work in various jobs	∆: refer to item ESB5 in Appendix C, Q2.6
Correa (1994);Lientz and Rea (2003)	Ability to deploy certain degree of knowledge of methods and skills in any project	∆: refer to item ESB7 in Appendix C, Q2.6
	Ability to specialize on one or a few highly sophisticated tasks	
Correa (1994); Lientz and Rea (2003); Desarbo et al. (2005)	Ability to make decisions or solve problem independently	∆: refer to item ESB8 in Appendix C, Q2.6

Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork
- omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study
@ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork

Note: Lengnick-Hall and Lengnick-Hall (1988), Snow and Snell (1992), Wright et al., (1994), Correa (1994) and Lientz and Rea (2003) described the characteristics of employees' skills and behaviour without adopting any measurement scale; Desarbo et al. (2005) adopted a nominal scale. Bhattacharya et al. (2005) adopted a seven-point Likert scale.

It can be seen from Table 4.4 that all measurement items were retained, but modified, before their inclusion into the data collection instrument. The interviews revealed that many items identified were interrelated and overlapped, and redefinition and restructuring were necessary for clearer explanation. Also, one additional item was identified during the interviews, and subsequently labelled as ESB6 in the instrument (see Appendix C). In total, eight measurement items were used to evaluate employees' skills and behaviour.

4.5 Technological capabilities (X4)

Figure 3.2 shows that technological capability is a possible determinant of organizational flexibility. In construction, technology is increasingly appreciated as a key towards achieving firms' competitiveness (see Sections 2.4.5 and 2.5). According to Tatum (1988) and Mitropoulos and Tatum (2000), the basis of competition in construction is shifting beyond managerial to technological issues. Contractors' ability to manage their suppliers and subcontractors as a key element for competitive pricing is no longer enough in prevailing business conditions, characterized by the changes in customer and social demand, the increase in international competition and technical complexity of built facilities (Hassan et al., 1998; Mitropoulos and Tatum, 2000) (see Sections 2.4 and 2.5). For example, construction projects (such as industrial, commercial and residential buildings) are becoming more technically complicated in terms of the design, nature and internal environment of built facilities (Hassan et al., 1998). In such a context, the ability of construction firms to implement advanced and appropriate technologies, for better efficiency and productivity of construction activities, has become the main source for creating and sustaining firms' competitive advantages (Bennett, 1991; Ho and Liu, 2003).

4.5.1 Definition

Although the concept of technology has been explored by many studies since 1960s, it is noted that, hitherto, no widespread consensus is obtained as to the single best definition of technology. This could be due to the diverseness of technology-related research in terms of the level of analysis and the study fields (for example, information, communication and process) at which the concept is being studied. Some definitions of technology are now presented.

Perrow (1967) related technology to individuals' direct actions on raw materials in an attempt to transform them into desired outputs. He pointed out that, in order to operate effectively, technology should integrate certain organizational requirements that will be reflected in the pattern of sequences used to perform specific tasks and the characteristics of the knowledge used in the work flow. According to Khandwalla (1977), workflow is "the way programs, activities, and events in the input-process-output cycle of the organization are sequenced" (p. 446).

Likewise, Hulin and Roznowski (1985:47) defined technology as "the physical combined with the intellectual or knowledge processes by which materials in some forms are transformed into outputs". In a more specific way, technology can be seen as (i) "a systematic body of knowledge about how natural and artificial things function and interact" and (ii) "a body of knowledge embodied in human brains and muscles, machines, and also in software and standard operating procedures of the organization" (Itami and Numagami, 1992:119). In view of its importance, Itami and Numagami (1992) argued that technology is the most fundamental of firms' core competences.

According to Dosi (1984), technological competences can be defined as a set of knowledge comprising both practical and theoretical know-how, techniques, procedures, experiences, physical devices and equipment. This definition is subsequently amplified by Wang and Li (2007), who considered technological competences as "the ability to develop and design new products and processes and combining knowledge about the physical world in unique ways, transforming this knowledge into designs and instructions for the creation of desired outcomes" (p. 65). They added that technological competences symbolize the superior and heterogeneous technical assets of a firm that are linked to its products, designs, processes and information technologies.

In construction, technology can be defined in relation to Tatum's (1987) 'construction technology' and Goulding and Alshawi's (2002) 'process management'. Tatum (1987) described construction technology as the integration of construction practices and resources, work tasks and project influences that define the manner of performing a construction operation. Goulding and Alshawi (2002) defined process management as a capability to integrate the process with technologies, systems and procedures, organizations, organizational structures, change initiatives and organizational learning towards achieving targeted objectives. These two definitions shared a common characteristic; that is technology can be seen as a firm's competence to integrate and transform its resources, processes and knowledge into desired outcomes.

In this study, technology is defined as organizational capabilities or competences, whereby mechanical and intellectual efforts are employed to transform resources, knowledge and processes into final goods and services. This is consistent with Shirazi et al. (1996) and Scott and Davis (2007), who pointed out that technology is an important mechanism, both mechanical and intellectual processes, facilitating a firm's input-transform-output process. Technology includes not only the hardware used in performing work, but also the skills and knowledge of employees, and the characteristics of the objects on which work is performed (Scott, 1992; Scott and Davis, 2007).

4.5.2 Possible dimensions

In this study, technological capability comprises two dimensions: (i) information technology capabilities and (ii) process technology capabilities. Descriptions of these two dimensions are now presented, and their respective measurement items are summarized in Table 4.5.

4.5.2.1 Information technology capabilities

Desarbo et al. (2005) defined information technology capabilities as the relative capabilities that help a firm to create technical and market knowledge and facilitate intra-organizational communication flow. According to Johnson and Clayton (1998), a firm's information technology capabilities could refer to the relative capabilities that help to (i) improve collaboration and effectiveness of individuals within intra-organizational and inter-organizational environments, and (ii) create new services and markets by facilitating the acquisition and conversion of information into knowledge that creates distinctive value for customers. All these suggest that a firm's technological capabilities can be defined as the relative capabilities that facilitate information flow and communication within the firm and between firms, thereby improving their response capability and competitiveness.

4.5.2.2 Process technology capabilities

Desarbo et al. (2005) defined process technology capabilities as the relative capabilities that help a firm to improve production process efficiency and achieve greater consistency in product delivery, thus leading to improved competitiveness. Johnson and Clayton (1998) referred to the process technologies capabilities as a form of process improvement through the use of information technology. They explained that energy and lighting simulation tools are some examples of process technologies software, and that the use of such software may not only speed up, by orders of magnitude, difficult design tasks but also make possible design explorations that would be impractical with traditional methods. As a result, they suggested that a firm's process technological capabilities can be defined as the relative capabilities to facilitate and improve a firm's production processes through the use of computer-aided software. Besides this, Tatum (1989) defined process technological capabilities, in a more mechanical sense, as a firm's ability to achieve process improvement in construction methods designed to accomplish usual construction operations or to improve the efficiency of a standard operation.

4.5.3 Domain

This section focuses on the influence of a firm's technological capabilities on determinants that may affect organizational flexibility are now discussed.

4.5.3.1 <u>Technological capabilities (X4) and organizational structure (X2)</u>

Woodward (1965) found that several critical structural variables are directly related to the nature of technology employed by firms. In particular, her findings attested that the nature of the technology fundamentally influences a firm's management structure. According to her, the number of levels in the management hierarchy, the span of control of supervisors, and the ratio of managers and supervisors (in terms of direct supervision) to other personnel could all be affected by a firm's technology. Similarly, Thompson (1967) established the relationship between technology and organizations, explaining that it is rational to find the significant relationship between technology and organizational structure owing to the interdependence among work units within an organization and across organizations, and the way tasks are coupled together. He added that firms need to implement technology in order to minimize coordination costs.

On the other hand, Pugh et al. (1968) and Inkson et al. (1970), in their Aston studies, challenged the technology imperative on organizational structure, and argued that firm size, rather than technology, exerts a greater influence on organizational structure. This is supported by Blau and Schroenheer (1971), who pointed out that firm size is the most important contextual determinant of organizational structure when technology and environmental conditions were employed as control variables. However, these assertions were subsequently challenged by other Aston researchers (for example, Aldrich, 1972; Child and Mansfield, 1972), who supported Woodward's (1965) findings that technology is a major determinant of organizational structure.

Ford and Slocum (1977) noted that there is no consensus that the relationship between technology and structure does exist based on three observations: (i) some studies found a strong relationship between technology and structure; (ii) some studies showed no statistically significant relationship between technology and structure; and (iii) some studies argued that different dimensions of organizational structure vary independently on size and technology. For example, Marsh and Mannari (1981) noted that both dimensions of organizational structure (i.e., complexity and formalization) are seen more as a variable of size instead of technology, while technology appears to exert greater influence than size on the dimension of 'span of control'.

In this study, it is hypothesized that:

> *H_{12}: Technological capabilities (X4) have a significant direct impact on organizational structure (X2).*

4.5.3.2 <u>Technological capabilities (X4) and supply chain capabilities (X5)</u>

Many studies pointed out that organizations are increasingly relying on information technology to improve their supply chain processes (Yusuf et al., 2004; Wu et al., 2006). According to Radjous (2003), the use of information technology can benefit a firm's supply chain process by: (i) reducing cycle and response time; (ii) achieving higher production efficiency and consistency; and (iii) delivering products to customers in a timely manner. Yusuf et al. (2004) explained that the impact of firms' information technological capability on their supply chain capabilities is increasingly greater in the global business environment where companies grow through vertical integration and search for new overseas markets for improved competitiveness. As a result, the use of information technology to facilitate information flow among spatially distributed entities becomes necessary. For example, in a situation where a local project company collaborates with an overseas designer firm, the need to process and transfer large volumes of data in the form of designs, plans, budgets and reports across several administrative and operation units is necessary.

Wu et al. (2006) found that effective use of information technology improves a firm's supply chain capabilities, by means of improved information exchange, activity integration and coordination with supply chain partners, thus leading to superior supply chain responsiveness to marketplace changes. They added that the improvement in supply chain capabilities through information technology allows a firm to learn and respond to market changes better and quicker than its closest competitors. This agrees with Lin et al. (2002) and Vakharia (2002), who argued that effective information sharing across the supply chain network can help firms to forecast market demand better, reduce inventory costs, and respond flexibly to customers' changing requirements.

Similarly, individual construction projects are heavily dependent on a wide range of professions that often operate independently but progressing collectively towards mutual accepted objectives of any project (Love et al., 1999; Cox and Ireland, 2002). Hence, this inevitably places a weighty importance on the use of information technology to improve coordination and communication between various professions at different stages of any construction project (Cheng et al., 2001), in an attempt to achieve improved project performance for greater clients' satisfaction.

Based on the above, this study hypothesized that:

> *H_{13}: Technological capabilities (X4) have a significant direct impact on supply chain capabilities (X5)*.

4.5.3.3 <u>Technological capabilities (X4) and business strategies (X6)</u>

Porter and Miller (1985) argued that the evolution of technology has changed business competition in three ways. They are: (i) it changes the industry structure and thus alters the rule of competition; (ii) it creates competitive advantages by giving a firm new ways to outperform its competitors; and (iii) it spawns new businesses often from within a firm's existing operations. All these collectively affect the way a firm operates, designs and strategizes its products and services for improved competitiveness. As a result, Itami and Numagami (1992) asserted that technology is one of the central factors in deciding a firm's strategy.

Zahara and Covin (1993) pointed out that firms should formulate technology policies that 'closely fit' their strategy for better deployment of resources and capabilities in their pursuit of goals based on the chosen business strategy. According to Porter (1985), an effective deployment of technological resources facilitates firms' endeavour towards achieving sustainable competitive advantage and improved financial performance. He added that technology plays an important role in determining a firm's cost position or differentiation strategy (see Section 4.7.2.2), in that it can raise or lower economies of scale, create the opportunity for advantage in timing, and influence many of the other drivers of cost or uniqueness. As such, he suggested that a firm can use its technological capabilities to alter drivers in a way that favour it, or to be the first and only firm to exploit a particular driver.

Based on the above, this study hypothesized that:

> *H_{14}: Technological capabilities (X4) have a significant direct impact on business strategies (X6)*

4.5.3.4 Technological capabilities (X4) and organizational flexibility (Y)

Lucas and Olson (1993) considered the effect of information technology on business performance, and found that information technology contributes to organizational flexibility in three ways. These are: (i) changing the nature of a firm's boundaries and the time when work occurs; (ii) altering the nature and pace of work; and (iii) helping firms to respond to a changing business environment. Through appropriate use of information technology, information processing improves, and thus firms are in a better position to make timely decision and take advantage of new opportunities in their business activities (Lucas and Olson, 1993). As a result, Johnson and Clayton (1998) suggested that information technology is no longer just a tool that incrementally improves 'back office' productivity but also is a strategic necessity for firms to develop and configure their flexible responses, via creating new product designs and new range of services, and improving inter-organizational relations.

Similarly, Crocitto and Youssef (2003) highlighted that information technology improves firm competitiveness because it establishes an effective communication network among employers, employees, customers, subcontractors and suppliers (also see Section 4.5.3.2). This communication network provides critical linkages to real-time market information that is valuable for timely decision making, and thus improves firms' flexibility potential in response to changes within the business environment (Lucas and Olson, 1993; Golden and Powell, 2000). According to Galbraith (1973), as the level of marketplace uncertainty or complexity increases, the information processing necessary to accomplish a task also increases.

Correa (1994) pointed out that process technologies are increasingly recognized as an important aspect of manufacturing flexibility, and found that process technologies are associated with the flexibility of systems and equipment in terms of the set-up or changeover time requires for a process to change from producing one product to another. He discussed two different types of process technology in improving flexibility: (i) flexible automation that involves the use of computer controlled machines to control or modify processes to changes, and (ii) methodology based approach that emphasizes the interaction of an organization, human resource and conventional equipment in response to marketplace changes. Yadav et al. (2000) highlighted that process technology cannot itself contribute to different types of flexibility (see Section 3.6.2), and argued that it should be accompanied by other determinants, including: (i) human resources; (ii) supplier relationships; and (iii) information technologies, to achieving organizational flexibility.

Based on the above, this study hypothesized that:

> *H_{15}: Technological capabilities (X4) have a significant direct impact on organizational flexibility (Y).*

4.5.4 Measurement items

Table 4.5 summarizes the measurement items found in previous studies for evaluating a firm's technological capabilities (see 3rd column), and the items incorporated in the data collection instrument of this study (see 4th column). It can be seen that only eight out of the 20 items identified in the literature were retained following the preliminary interviews (see Section 5.3) and pilot study (see Section

5.4.4) in the exploratory and reflective phases, respectively. Of these eight items, three were restructured into two items and subsequently labelled as IT1 and IT2 in the instrument (see Appendix C), while the other five items were redefined based on interviewees' suggestions. In total, seven items were used to assess firms' technological capabilities. Also, it was found that the majority of the interviewees recognized technological capabilities as a single-dimensional rather than a multi-dimensional construct. The dimensionality of firms' technological capabilities is examined in Section 7.3.

Table 4.5 Measurement items for technological capabilities (X4)

Possible dimension **(1)**	**Authors** **(2)**	**Possible measurement items** **(3)**	**Remark (see legend for symbol connotation)** **(4)**
Information technologies capabilities	Volberda (1998); Desarbo et al. (2005)	Facilitating external communication and information sharing (for example suppliers, customers and channel members)	Δ: refer to item IT1 in Appendix C, Q7.5
	Volberda (1998); Griego et al., (2000); Desarbo et al. (2005); Wang and Li (2007)	Facilitating internal communication and information sharing (for example across different departments and across different levels of the organization)	Δ: refer to item IT2 in Appendix C, Q7.5
	Wang and Li (2007)	Obtaining real time information	Δ: refer to item IT1 and IT2 in Appendix C, Q7.5
		Sharing and leveraging information about competing strategies of major competitors in a timely manner	Δ: refer to item IT4 in Appendix C, Q7.5
	Stewart et al., (2002)	Facilitating international access to project information	Δ: refer to item IT3 in Appendix C, Q7.5
		Facilitating the electronic storage and retrieval of project information (past or existing) to form a knowledge base	
		Attracting and facilitating more local and international works	#
		Improving the document control process which reduces administration costs	#
		Facilitating international strategic alliances	#
	Volberda (1998)	Reducing response time	#
	Desarbo et al. (2005)	Creating new product development projects	#
		Facilitating creation of market knowledge	#
		Facilitating cross functional integration	#
		Facilitating creation of technical knowledge	#
Process technologies capabilities	Tatum (1989)	Adopting different construction process technologies, such as different methods and materials to satisfy clients' requirement	Δ: refer to item PT1 in Appendix C, Q8.4
	Johnson and Clayton (1998)	Applying computer-aided process technologies such as product designing, estimating and purchasing software	Δ: refer to item PT2 in Appendix C, Q8.4

Possible dimension (1)	Authors (2)	Possible measurement items (3)	Remark (see legend for symbol connotation) (4)
	Wang and Li (2007)	Leading technology innovation in the company's chosen business domain	∆: refer to item PT3 in Appendix C, Q8.4
		Applying new technology to problem solving process in a timely manner	#
	Desarbo et al. (2005)	Applying new product development and manufacturing process	Ξ
		Having advanced production facilities	Ξ
Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork # - omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study @ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork			
Note: Volberda (1998) and Griego et al. (2000) adopted a five-point Likert scale. Stewart et al (2002) adopted a five-point AHP scale. Wang and Li (2007) adopted a seven-point Likert scale. Desarbo et al. (2005) adopted a 10-point Likert scale.			

4.6 Supply chain capabilities (X5)

Competitive advantage no longer inhabits within an organization's own internal capabilities but rather within the network of relationships and linkages that the organization can create with external organizations (for example, Underhill, 1996; Spekmann et al., 1999). According to Christopher (1992), companies increasingly see themselves as part of a supply chain that has to compete against other supply chains, rather than as a single firm competing against other individual firms. As a result, a firm's supply chain capability is increasingly appreciated as an essential determinant of business competitiveness and performance (Akintoye et al., 2000; Langford and Male, 2001; Chang et al., 2006).

4.6.1 Definition

Recognizing its importance, the theme concerning supply chain relationship building and its management has not only attracted interest from mainstream organizational researchers (Eccles, 1981; Jones et al., 1997; Tan, 2001), but also in the construction management literature (Hinze and Tracey, 1994; Shash, 1998; Dainty et al., 2001). These studies provided valuable insights on how an effective supply chain relationship and its management contribute to firm performance. Hitherto, little or no study has clearly defined a firm's supply chain capabilities.

In this study, efforts were made to derive an appropriate definition of supply chain capabilities by examining definitions concerning a firm's supply chains and its supply chain management (SCM). Some of the definitions are now presented.

According to Christopher (1992), a supply chain is defined as "the network of organizations that are involved through upstream and downstream linkages, in different process and activities that produce value in the form of products and services in the hands of the ultimate customer" (p.12). Next, Handfield and Nicholas (1999) considered an organization's supply chains as "related processes, suppliers and customers that offer the greatest potential for achieving a competitive advantage, and that, therefore, hold the greatest promise for the ongoing success of the organization" (p.42). Following this, they classified a firm's supply chains into internal and external supply chains. The former refers to the multiple links among different functional departments or divisions and employees of an organization, focusing on intra-organizational relationship building and communication. The focus of external supply chains is on a firm's external business linkages, i.e., inter-organizational relationship. Handfield and Nicholas (1999) pointed out that it is important for a firm to identify key supply chain member organizations (i.e., suppliers and customers) that are vital to the firm's SCM endeavour, considering the efforts required to nurture and maintain an effective supply chain relationship.

A general definition of SCM in the literature is that it is an approach considering how a firm manages and links its supply chain activities elements across several organizational boundaries, from the manufacturing and supply process of raw materials through to end users (Scott and Westbrook, 1991; New and Payne, 1995).

Subsequently, La Londe (1998) described SCM as the delivery of improved customer and economic value through coordinated management of the workflow of physical goods and associated information, from sourcing through consumption. This is shared by Van de Vorst and Beulens (2002), who defined SCM as “the integrated planning, co-ordination and control of all business processes and activities in the supply chain to deliver superior consumer value at minimum cost to the end-consumer while satisfying requirements of other stakeholders” (p.410). In brief, the underlying principle is on how a firm: (i) utilizes its suppliers’ processes, technologies, and capabilities to enhance competitive advantage (Houlihan, 1985; Cooper et al., 1997), and (ii) coordinates its manufacturing, logistics, materials, distribution, and transportation functions within its own structure (Lee and Billington, 1992; Tan, 2002a; Duclos et al., 2003).

In construction, Akintoye et al. (2000) adapted Christopher’s (1992) definition of supply chain in their attempt to define construction SCM. According to them, it is a “process of strategic management of information flow, activities, tasks and processes, involving various networks of organizations and linkages (upstream and downstream) involved in the delivery of quality construction products and services through the firms, and to the customer, in an efficient manner” (p.161). Besides looking at the upstream and downstream linkages of firms’ supply chains, Voordijk et al. (2000) pointed out that supply chains in the building industry consist of three major subsystems. They are: (i) the manufacturing of building materials and components; (ii) the construction activities or procurement processes; and (iii) the design of products, involving descriptions of the appearance, layout, drawings and specifications of every part. It appears that these three perspectives were included in Love et al.’s (2004) definition, stating that construction SCM is the “network of facilities and activities that provide customer and economic value to the functions of design development, contract management, service and material procurement, materials manufacture and delivery, and facilities management" (p.44).

Based on the above definitions, it appears that the focus of SCM is on how a firm integrates its supply chain member organizations, i.e., from material manufacturers and suppliers to end users, as a single entity, for better stakeholders' performance and value through relationship building and management. Along these lines, supply chain capability is defined in this study as the extent to which a contractor is able to realize various desired outcomes through its SCM endeavour. Various desired outcomes may include: (i) improved products and services offered to clients; (ii) greater accessibility to strategic options; (iii) improved responsiveness to changes within the marketplace; and (iv) improved competitiveness.

4.6.2 Inter-organizational relationship management practices

Many studies highlighted that the degree of a firm's supply chain capabilities is determined by the way partnership relationships among supply chain parties contribute to the flexibility components of the firm's supply chain (Duclos et al., 2003; Garavelli, 2003). It follows that effective relationship management is a key determinant of firms' supply chain capabilities towards achieving improved firm responsiveness and increased customers' satisfaction (Krause, 1997; Narasimhan et al., 2001; Swafford et al., 2006). Table 4.6 summarizes the intra-organizational relationship management practices found in previous studies (see 2nd column), and shows the practices incorporated in the data collection instrument of this study (see 3rd column).

Table 4.6 Inter-organizational relationship management practices

Authors (1)	Practices (2)	Remark (Refer to Legend for symbol connotation) (3)
Zou and Lim (2006)	Providing subcontractors/suppliers the flexibility to plan their delivery schedule	@: refer to item RM6 in Appendix C, Q2.5
	Offering incentive scheme to suppliers and subcontractors (e.g. early payment)	@: refer to item RM7 in Appendix C, Q2.5
	Organizing trainings for other supply chain parties	@: refer to item RM9 in Appendix C, Q2.5
Tan (2002a); Zou and Lim (2006)	Keeping constant contact with end users to get feedback and keep track of their business need	∆: refer to item RM10 in Appendix C, Q2.5
	Establishing frequent contact with supply chain parties by means of organizing informal gatherings	∆: refer to item RM11 in Appendix C, Q2.5
Elmuti (2002); Duclos et al. (2003)	Sharing information across supply chain parties	∆: refer to item RM11 in Appendix C, Q2.5
Tan (2002a)	Participating in the marketing efforts of customer	∆: refer to item RM8 in Appendix C, Q2.5
	Locating closers to the clients	Ξ
	Requiring suppliers to locate closer to your firm	Ξ
	Creating a compatible information system	#
Tan (2002a); Elmuti (2002)	Creating a greater level of trust among supply chain parties via risk- and reward-sharing	#
Elmuti (2002)	Stating clear objectives and expectation by supply chain parties	#

Legend: ∆ - modified based on the exploratory interview and pilot study findings and tested in subsequent fieldwork
- omitted from subsequent fieldwork based on the preliminary interviews and pilot study findings
Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study
@ - incorporated into the questionnaire without modification, based on the preliminary interviews and pilot study findings, and tested in subsequent fieldwork

In this study, only seven out of the 12 practices identified in the literature were retained following the preliminary interviews and pilot study. Of these seven practices, two were combined into a single practice due to their close similarities. In total, six practices were tested in subsequent fieldwork to investigate the relationships between the intra-organizational relationship management practices and firms' supply chain capabilities.

4.6.3 Domain

This section focuses on how firms' supply chain capabilities influence their business strategies and flexibility potential.

4.6.3.1 Supply chain capabilities (X5) and business strategies (X6)

As the business trend is shifting towards a platform of cooperative partnerships and vertical integration (see Section 2.4.3) and product development processes are becoming more complex (see Sections 2.4.4 and 2.4.5), firms with high quality relationships will soon able to derive benefits, which are difficult to realize single-handedly (Pelton et al., 1997; Kale and Arditi, 2001). For example, firms' improved capacity allows them to pursue new development in technologies, products and services, and to penetrate into new markets (Volberda, 1996; Young-Ybarra and Wiersema, 1999). According to Young-Ybarra and Wiersema (1999), a cooperative working arrangement could provide firms with speedy and efficient channels to achieve competitive positioning more readily than through internal development since it is less capital intensive and more flexible than a merger and acquisition strategy. These, to some extent, indicate the influence of supply chain capabilities on a firm's business strategy. Details of firms' business strategies are discussed in Section 4.7.

Other benefits of having good supply chain partnership relationships may include: (i) reducing operational cost and material wastage through just-in-time purchasing and delivery; (ii) reducing lead time; (iii) increasing productivity; (iv) improving product and service quality through effective communications among supply chain parties; (v) improving firms' ability to introduce new products; and (vi) improving a firm's ability to offer a wide range of products and services (Krause, 1997; Spekman et al., 1998; Yusuf et al., 2004). Of these benefits, (i), (ii) and (iii) could be linked to either Porter's (1980) cost leadership strategy (see Section 4.7.2.2) or Treacy and Wiersema's (1993) operational excellence initiative (see Section 4.7.2.3). As for (iv), (v) and (vi), these benefits could be related to Treacy and Wiersema's (1993) product leadership initiative.

In construction, various benefits of having good supply chain partnership relationships are similar to those aforementioned. For example, Langford and Male (2001) pointed out that having high synergetic relationships with subcontractors and suppliers can provide contractors with preferential or advanced access to cost effective inputs over and above other firms (i.e. longer credit term, lower cost, better services and faster response). This is shared by Pearson (1999), who found that some clients and contractors implemented SCM as part of their business strategy in an attempt to derive greater price discounts from their downstream counterparts. This, to some extent, reflects firms' cost leadership strategy.

Based on the above, this study hypothesized that:

> *H_{16}: Supply chain capabilities (X5) have a significant direct impact on business strategies (X6)*

4.6.3.2 <u>Supply chain capabilities (X5) and organizational flexibility (Y)</u>

According to Handfield and Nichols (1999), via good partnership relationships with key suppliers and customers, firms could derive superior capabilities that enable them to deal effectively with marketplace uncertainties and complexities. This can partly be explained in relation to firms' ability to utilize different supply chain channels according to the level and types of changes within the business environment. For example, the use of different logistics channels allows firms to deal with unexpected events such as demand peak, urgent need of particular raw materials or operational expertise, and sudden change in clients' delivery requirements. As a result, many studies found that a firm's supply chain capabilities have a direct impact on its organizational flexibility.

In manufacturing, many studies found positive relationships between a manufacturer's supply chain capabilities and various flexibility types comprising: (i) volume flexibility; (ii) production flexibility; (iii) market flexibility; (iv) procurement flexibility; and (v) delivery flexibility (Vickery et al., 1999; Duclos et al., 2003; Sanchez and Perez, 2005). Similarly, in construction, Usdiken et al. (1988) pointed out that availability of subcontracting enables general contractors to retain flexibility in addressing the 'balancing of components' problem under uncertain demand conditions. This is shared by Hillebrandt and Cannon (1990), who pointed out that, if subcontracting is managed effectively, it will improve contractors' flexibility in operating across different geographical location.

Based on the above, this study hypothesized that:

> *H_{17}: Supply chain capabilities (X5) have a significant direct impact on organizational flexibility (Y)*

4.6.4 Measurement items

Table 4.7 summarizes the list of measurement items operationalized by previous studies in evaluating a firm's supply chain capabilities (see 2nd column), and shows the items incorporated in the data collection instrument of this study (see 3rd column). It can be seen that only nine out of the 19 items identified in the literature were retained following the preliminary interviews (see Section 5.3) and pilot study (see Section 5.4.4) in the exploratory and reflective phases, respectively. Of these nine items, two were combined into a single item (which was labelled as item SC1) due to their close similarities as suggested by interviewees, while one item was restructured into Q5.2 (see Appendix C). In total, seven items were developed to assess firms' supply chain capabilities.

Table 4.7 Measurement items for supply chain capabilities (X5)

Authors (1)	Possible measurement items (2)	Remark (Refer to Legend for symbol connotation) (3)
Akintoye et al. (2000); Langford and Male (2001); Love et al. (2004)	Improve cost benefits (i.e. longer credit term, lower cost)	∆: refer to item SC1 in Appendix C, Q5.1
National research council (2000); Akintyoe et al. (2000); Elmuti (2002)	Improve competitiveness and profitability	
Sethi and Sethi (1990); Swafford et al. (2006)	Improve ability to source materials, products and services globally	∆: refer to item SC2 in Appendix C, Q5.1
Goldman et al. (1994); Krause (1997); Sharifi and Zhang (1999); Akintoye et al. (2000); Langford and Male (2001); Yusuf et al. (2004)	Improve the quality of products and services in terms of delivery and reliability	∆: refer to item SC3 in Appendix C, Q5.1
Akintoye et al. (2000)	Simplify construction, tendering, and design process with clients	∆: refer to item SC4 in Appendix C, Q5.1
Goldman et al. (1994); Sharifi and Zhang (1999); Swafford et al. (2006)	Reduce delivery lead time (or change delivery times of order placed with suppliers)	∆: refer to item SC5 in Appendix C, Q5.1
Slack (1983); Sethi and Sethi (1990); Swafford et al. (2006)	Adjust to different distribution delivery requirements to meet customers' need	∆: refer to item SC6 in Appendix C, Q5.1
Elmuti (2002); Arditi and Chotibhongs (2005); Ng and Tang (2008)	Improve access to new technology (or improve firms' accessibility to specialized expertise, machineries and equipment)	∆: refer to item SC7 in Appendix C, Q5.1
Jones et al. (1997); National research council (2000); Tan (2002a); Swafford et al. (2006); Dainty et al. (2001); Kale and Arditi (2001)	Improve responsiveness to changing market needs/demand (or Improve firms' organizational capacity to manoeuvre in an unstable market condition)	∆: refer to Q 5.2 in Appendix C
Sethi and Sethi (1990); Goldman et al. (1994); Swafford et al. (2006)	Alter delivery schedule or worldwide delivery capacity to meet changing customer requirement	#
Goldman et al. (1994); Krause (1997); Swafford et al. (2006)	Increase production capacity and frequency of new product introductions	Ξ
Hillebrandt and Cannon (1990); Elmuti (2002)	Increase the firm's presence in a new market and/or increase market share (or a higher flexibility in companies' operation across different geographical locations)	#
Hillebrandt and Cannon (1990); Akintoye et al. (2000); Elmuti (2002); Yusuf et al. (2004); Arditi and Chotibhongs (2005); Ng and Tang (2008)	Improve use of human resource, and thus reduce operational cost	#
Goldman et al. (1994); Sharifi and Zhang (1999); National research council (2000); Elmuti (2002); Swafford et al. (2006)	Reduce product realization cycles and lower product development cost for new product development (or increase in productivity)	#
National research council (2000); Elmuti (2002)	Reduce capital investment in excess operational capacity (or make capital fund available for more profitable operation)	#
Akintoye et al. (2000)	Simplify construction and order processes with suppliers	#

Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork
- omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study
Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study
@ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork

Note: The majority of the measurement items were not administered by any measurement scale, except for measurement items used in few studies. For example, Akintoye et al. (2000) adopted a five-point Likert scale.

4.7 Business strategies (X6)

Business strategy is hypothesized as one possible determinant of organizational flexibility (see Figure 3.2). According to Barney (1996) and Kale (1999), strategy is a broad concept that may cover different perspectives (i.e., the linear, interpretative [or eclectic] and adaptive perspectives) and different aspects (for example, means, strategy-making process, and hierarchical levels). Therefore, the following section focuses on the definitions of various key aspects of business strategy adopted in this study.

4.7.1 Definition

The perspective and aspect of strategy of this study are now discussed.

4.7.1.1 Perspectives of strategy

Considering the research focus on the contractor's flexible behaviour, the definition of strategy adopted in this study is orientated towards the adaptive perspective of strategy; a perspective that is closely related to the theories of dynamic contingency, resource-based, and complexity (see Sections 3.9.1, 3.9.3 and 3.9.4). Following Barney's (1996) definition, strategy is defined in this study as a pattern of resources allocation and capabilities reconfiguration that enables a firm to maintain or improve its performance, via: (i) neutralizing threats; (ii) exploiting opportunities; (iii) capitalizing on strengths; and (iv) avoiding weaknesses, in keeping with changes within the business environment.

In comparison, Chaffee (1985) noted that the adaptive perspective does not deal as emphatically as the linear perspective with decisions about goal, but rather the former focuses the manager's attention on adaptive strategies in response to the firm’s environment. As for the linear perspective, the focus is on the rigidities of strategic planning emphasizing the methodical, directed, sequential action involved in planning an organization’s long-term goals (Ansoff, 1965; Chaffee, 1985). According to Volberda (1998), this perspective tends to emphasize planning “what to do” rather than “what the organization might be capable of doing in the future” and as a result, it underestimated or oversimplified the influence of the environment on firms’ strategy. That is to say, it assumes that everything remains constant after the implementation of strategy (Volberda, 1998), and thus ignores the importance of strategic flexibility (Bourgeois and Brodwin, 1984).

Also, rather than emphasizing changes with the business environment, as in the case of the adaptive strategy perspective, the interpretative perspective considered strategy as symbolic actions and communication within an organization (Chaffee, 1985). Under this perspective, in an attempt to maintain its flexibility, a firm needs to create strategic schemas or frames of reference that are broad enough to encourage strategic initiative and narrow enough to suppress counterproductive actions by the members of the organization (Chaffee, 1985; Volberda, 1998). The emphasis is to create an ‘ideological’ and ‘creative’ environment within an organization, and so, flexibility becomes the firm’s imaginative capacity.

4.7.1.2 Aspects of strategy

The focus of this study is on the ‘means’ aspect of business strategy, which is also known as strategy content (see Fahey and Christensen, 1986), emphasizing the way a contractor operates in its operating business environment. Under this aspect, three levels of strategy can be identified: (i) corporate level strategy; (ii) business level strategy; and (iii) functional level strategy. The corporate level strategy refers to a firm’s mission and objectives, and is primarily concerned with answering the question of ‘what set of business should we be in’ (Hofer and Schendel, 1978; Hambrick, 1980). As for the business-level strategy, it refers to the specific strategies adopted by a firm to achieve its mission and objectives, and is primarily concerned with answering the question of “how we compete in a given line of business” (Hambrick, 1980; Kale, 1999). Next, the functional-level strategy refers to tactics or policies regarding specific areas of business operation, such as marketing, human resource, and finance, to facilitate the implementation of a firm’s business-level strategies (Kale, 1999).

In view of the above discussion, it appears that the business-level strategy is in line with the research direction of this study, addressing the question of how a contractor competes, for continued existence, in the Singapore construction industry rather than the question of what business should the contractor engages. Similarly, the functional-level strategy appears to be less relevant in this section, but rather it is more applicable to the previous sections (for example, Sections 4.4, 4.5 and 4.6); since the functional-level strategy is concerned with a contractor’s tactics and policies on specific operational issues such as human resources and technologies.

4.7.2 Business strategy models

In the business strategy literature, three predominant business strategy models can be identified. They are: (i) Miles and Snow’s (1978) generic strategies; (ii) Porter’s (1980) generic strategies; and (iii) Treacy and Wiersema’s (1993) value disciplines. These strategy models have received considerable research interest, and have been applied in different industry settings, including the manufacturing, petrochemical and construction industries. These three strategy models are presented in Figure 4.2 and are reviewed below. It should be noted that efforts were made to combine various strategies, proposed by the models, into possible dimensions which could be used in this study to categorize different means of business strategies adopted by a contractor.

<table>
<tr><th></th><th colspan="4">Possible dimensions of strategy (see Section 4.7.3)</th></tr>
<tr><th>Models/Groupings</th><th>Group 1
Cost leadership</th><th>Group2
Product leadership</th><th>Group 3
Customer intimacy</th><th>Group 4
Risk leadership</th></tr>
<tr><td rowspan="2">Porter's (1980) generic typology
(see Section 4.7.2.1)</td><td>Cost leadership</td><td>Differentiation</td><td rowspan="2">Mixture of low-cost and differentiation (i.e., best cost)</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Focus</td></tr>
<tr><td>Miles and Snow's (1978) generic typology
(see Section 4.7.2.2)</td><td>Defender</td><td>Prospector</td><td>Analyzer</td><td>Reactor</td></tr>
<tr><td>Treacy and Wiersema's (1993) value disciplines
(see Section 4.7.2.3)</td><td>Operational excellence</td><td>Product leadership</td><td>Customer intimacy</td><td></td></tr>
</table>

Figure 4.2 Groupings of various strategies into possible dimensions

4.7.2.1 <u>Miles and Snow's (1978) generic typology</u>

This model is largely oriented towards firms' products or services and market development, and proposed four categories of strategy. They are: (i) prospectors; (ii) defenders; (iii) analyzers (with or without innovation); and (iv) reactors. Descriptions of respective strategies are provided as follows.

(i) The prospector's strategic orientation is characterized by firms' behaviour to constantly experiment with new things (i.e., ideas, technology and process) in search of new opportunities, and thus initiating changes in a given product or service and market domain (Miles and Snow, 1978). It concerns the way a firm competes through its propensity for seizing new opportunities rather than exploits its situation or develops efficiencies in its input-output transformation process. In sum, a prospector is the initiator of change, seeking new products and services, and leads the market in innovation. As a result, many other firms need to adjust to the prospector's action (Burton et al., 2006).

(ii) The defender's strategic orientation is characterized by firms' behaviour to concentrate on a narrow product or service and market domain, and defend their territory by emphasizing efficient transformation of inputs into outputs (Miles and Snow, 1978). It concerns the way a firm exploits its resources and situation, emphasizing the cost and quality of products or services, rather than explores anything new or being innovative. In sum, a defender maintains its position by efficient utilization of its resources, and develops its core competence in offering particular products and services.

(iii) The analyzer's strategic orientation shares the characteristics of both the prospector and defender (Miles and Snow, 1978). As a result, an analyzer can be either with or without innovation. The latter is similar to the role of a defender except that it does possess a passive innovative strategy, i.e., following the market trend and imitating similar products and services to satisfy customer needs. As for the analyzer with innovation, it is a dual strategy combining both aspects of the defender and prospector, emphasizing the exploitation of a firm's current market position and its utilization of resources as well as the development of new products, services and delivery processes (Burton et al., 2006). Accordingly, an analyzer (with or without innovation) maintains its balance by selecting and pursuing new opportunities while also establishing its core competence on a particular product or service.

(iv) The reactor's strategic orientation refers to a firm that does not have a well-defined strategy and is unwilling to assume risks (Miles and Snow, 1978). It follows that a reactor is neither an explorer nor exploiter, but rather a firm that pursues a "wait-and-see" approach, placing great emphasis on risk management in its business ventures.

4.7.2.2 Porter's (1980) generic typology

Porter (1980) highlighted that the path towards sustainable competitive advantage is the successful development of an internally consistent strategy, and proposed three generic strategies for creating a defensible position and outperforming competitors in a particular industry. They are: (i) cost leadership strategy; (ii) differentiation strategy; and (iii) focus strategy. According to Porter (1980), firms must follow only one of the three inherently incompatible strategies in order to succeed. For firms that pursue a balanced strategy of cost leadership and differentiation, they will be 'stuck-in-the middle' and may not fully realize the desired benefits of each distinctive strategy (Porter, 1980; 1985). This is because the firms will experience difficulties in deploying their organizational resources since the ways to "achieving cost leadership and differentiation are usually inconsistent" (Porter, 1985:18).

However, in the face of the increasing global competition, many studies argued that it is no longer effective to simply focus on one of the generic strategies, and that firms should combine strategies according to their strategic intent (for example, Harrison and John, 1998; Yamin et al., 1999; Srivannaboon and Milosevic, 2006). Miller (1992) argued that there are dangers associated with the exclusive pursuit of a single generic strategy proposed by Porter (1980, 1985). He explained that firms which pursue a strategic product specialization strategy may face serious gaps and weaknesses in product offerings, as they are likely to ignore the changing needs of their customers, and as a result, the firms may become inflexible, failing to seize opportunities and overcome competitive threats triggered by the changing business environment. This is shared by Wright et al. (1990), who found that US companies pursuing multiple strategies (for example, low-cost and differentiation) outperform their counterparts that mainly compete with one strategy. Similarly, Ling et al. (2005) found that the more effective business strategies for international construction firms that undertake projects in China is the adoption of both the differentiation and low-cost strategies. This combination is often known as the ‘Best-Cost’ strategy.

Having considered the subsequent development of Porter’s (1980, 1985) generic strategy, descriptions of the four strategies are now presented.

(i) The cost leadership strategy necessitates firms to emphasize low cost advantages relative to their competitors but not totally neglecting the quality of their products or services (Porter, 1980). According to Porter (1980), this form of strategy seeks all sources of cost advantages that derive from the characteristics and structure of the industry such as economies of scale and scope, and preferential access to raw materials. Approaches to the cost leadership initiative may include: (a) adopting a tight control and overhead cost; (b) minimizing coordination cost across functional departments; (b) conducting business operations and activities in an efficient manner.

(ii) The differentiation strategy necessitates firms to offer something unique and unrivalled, distinct from its competitors, which are widely valued by the industry, thus achieving competitive advantage (Porter, 1980). It usually involves having a core competence that competitors cannot easily match or imitate (Hamel and Prahalad, 1994). In general, the differentiation strategy enables a firm to demand a premium price over the industry average, which can be achieved by differentiating different aspects of the firm’s business depending on the industry’s characteristics (Porter, 1980). Some aspects may include: (a) the range of products or services offered; (b) the type of technology used; (c) the type of delivery system offered; and (d) the type of marketing approach adopted.

(iii) The focus strategy necessitates firms to pursue a lowest cost strategy or deliver differentiated products to a specific niche domain (Porter, 1980; 1985). Similar to those mentioned in Section 2.3.1 concerning contractors' specialization, firms may concentrate on a particular market, group of clients and geographical location, and offer a narrow range of products and services.

(iv) The best-cost strategy necessitates firms to combine strategies in creating a sustainable competitive advantage. According to Hill (1988) and Srivannaboon and Milosevic (2006), it becomes necessary for firms to combine both low-cost and differentiation strategies owing to the maturity of industries where many firms possess similar minimum cost structures. As a result, there is no unique low-cost position. Under such situations, firms that successfully emphasize both differentiation and low cost, in their attempt to address customer values (for example, fast time-to-market and superior product quality) and provide low-cost products, will be rewarded by superior economic performance (Hill, 1988; Srivannaboon and Milosevic, 2006).

4.7.2.3 <u>Treacy and Wiersema's (1993) value disciplines model</u>

Treacy and Wiersema's (1993) 'value disciplines' model was developed on the basis that firms need to deliver superior customer value in order to remain competitive. The model identified three inherently incompatible value disciplines: (i) operational excellence; (ii) customer intimacy; and (iii) product leadership. These disciplines are now discussed.

(i) The operational excellence initiative implies providing customers with reliable products or services at a very competitive price, and delivering what is required with minimum difficulty or inconvenience (Treacy and Wiersema, 1993). Firms pursuing an operational excellence are actively seeking ways to: (a) minimize overhead costs; (b) eliminate redundant steps; (c) reduce transactions and other coordination costs; and (d) optimize business processes across functional and organizational boundaries (Treacy and Wiersema, 1993).

(ii) The customer intimacy initiative implies “segmenting and targeting markets precisely and then tailoring offerings to match exactly the demands of those niches” (Treacy and Wiersema, 1993:84). According to Treacy and Wiersema (1993), firms that excel in customer intimacy are often found to share a common characteristic, i.e., they are capable of integrating detailed customer knowledge with operational flexibility in effectively addressing customers’ requests. As a result, this leads to tremendous customer loyalty and in turn, improves the firms’ profitability.

(iii) The product leadership initiative implies offering customers a continuous stream of state-of-the-art products and services that seek to consistently improve the customers’ use or application of the products (Treacy and Wiersema, 1993). Also, this helps a firm to disrupt its competitors’ business strategies. To excel in product leadership, firms should challenge themselves in three ways (Treacy and Wiersema, 1993): (a) recognizing and embracing creative ideas; (b) commercializing their new ideas promptly; and (c) engaging in a continuous process to upgrade their products or services and pursue new opportunities.

4.7.3 Possible dimensions

The review above suggests that the 11 generic business strategies share some common characteristics. Figure 4.2 shows that four groups of dimensions can be identified. Group 1, the cost leadership initiative, focuses on cost effectiveness and efficient utilization of organizational resources. As for Group 2, the product leadership initiative focuses on products and services in gaining competitive advantage over a firm's closest competitors. As mentioned earlier in Section 4.7.2.2, the focus strategy focuses on either a low cost advantage or differentiation advantage within a niche market; hence it is placed across Groups 1 and 2 in Figure 4.2. Following this, Group 3 is the customer intimacy initiative that emphasizes offering best customer values. The last grouping is referred to the risk leadership initiative, focusing on the risk minimization behaviour of firms (see Section 4.7.2.1, part iv). All these suggest that business strategies may comprise four dimensions, i.e., (i) cost leadership; (ii) product leadership; (iii) customer intimacy; and (iv) risk leadership.

4.7.4 Business strategies (X6) and organizational flexibility (Y)

Many manufacturing-related studies highlighted that business strategies are strongly related to a firm's flexibility potential (for example, Upton, 1995b; Chang et al., 2003). In view of the importance of business strategy, Suarez et al. (1996) pointed out that it is important for manufacturers to consider several strategic factors before planning and implementing flexibility. In studying the relationships between business strategies, manufacturing flexibility and firm performance, Gupta and Somers (1996) found that business strategy has direct effects on the adoption of manufacturing flexibility, which in turn, indirectly affects business performance. This finding is subsequently substantiated by Chang et al. (2003), who found that compatibility of manufacturing flexibility and business strategy is necessary for a firm to achieve better performance. They examined how the three business strategy categories, i.e., (i) pre-emptive/first mover; (ii) low cost/follower; and (iii) differentiation/follower, affect the development of a firm's flexibility, which in turn, shapes the firm's performance.

Similarly, Wernerfelt and Karnani (1987) took the view that the choice of business strategies does influence a firm's flexibility potential, to some extent, by exemplifying two scenarios. First, a firm, focusing its resources on one technology, could become a strong competitor only if the selected technology turns out to be the right choice. On the other hand, the firm can spread its investment over several technologies in order to maintain its flexibility for lower risk exposure. They opined that the latter is an important strategy to deal with uncertainty. According to them, a firm could lessen the impact of marketplace changes by: (i) investing in flexible assets that can be used under several scenarios or in multiple-purpose assets that can be sold to other organizations, and (ii) entering into cooperative working arrangements such as joint ventures or alliances. This view is shared by Starkey et al. (1991), who noted that the business trend in achieving flexibility is shifting towards: (i) cooperative working arrangements; (ii) vertical disintegration; (iii) networking; (iv) subcontracting (see Section 4.6.3 for further details); and (v) outsourcing. This agrees with Harrigan (1985) that the 'contracting out' strategy is particularly valuable in cruising a firm through fast-paced changes in technology, by outsourcing new production while avoiding committing the firm to a major investment in making products that change rapidly.

From the financial management perspective, Volberda (1998) pointed out that a firm could gain flexibility through various means. These include: (i) increasing the availability of financial resources that have not yet been allocated; (ii) restricting long-term contracts that cannot be terminated prematurely; (iii) investing in liquid assets; and (iv) leasing certain industrial equipments. Besides this, he identified various strategies that could help to improve a firm's flexibility potential, for example, adopting a product and service diversification strategy and entering into collaborative working relationship. Other strategies identified are summarized in Section 4.7.5.

In construction, Langford and Male (2001) pointed out that contractors could improve their liquidity via: (i) downsizing construction operations to reduce overheads; (ii) reducing debts; and (iii) investing cash in the money markets to earn interest. They added that contractors should adopt a diversification strategy to mitigate the impact of cyclical fluctuation in the domestic construction output. Contractors were encouraged to diversify into: (i) overseas markets; (ii) construction-related services (for example, landscaping and supply of building material); and (iii) non construction-related activities (for example, maintenance of airport and health care facilities) (Hillebrandt and Cannon, 1990; Langford and Male, 2001). In fact, studies concerning the flexible behaviour of contractors in response to economic downturns, could offer deeper insights into the adopted strategies. In this study, practices identified by various studies such as Hillebrandt et al. (1995), Boon (1996) and Low and Lim (1999; 2000) are summarized in Table 4.8.

Apart from the above, Raftery et al. (1998) pointed out that it is necessary for contractors to adopt a differentiation strategy, providing integrated services such as project financing, construction, operation and maintenance of built facilities, in their attempts to seek more work and sustain turnover. This agrees with Yates (1994) that greater equity participation by contractors in project financing is one of the means to secure projects. Although these practices do not directly indicate the influence of strategy on flexibility, it should be noted that, through these practices, contractors are able to establish closer relationships with their clients, which in turn, will improve their competitiveness (Hawk, 2006; Green et al., 2008). This indirectly enhances a firm's flexibility; especially in bad times, these established relationships might present contractors the privileged access to some private sectors projects.

Based on the above review, this study hypothesized that:

H_{18}: Business strategies (X6) have significant a direct impact on organizational flexibility (Y).

4.7.5 Measurement items

The heterogeneity of firms, as highlighted in the resource-based theory (see Section 3.9.3), which makes firms conduct their business differently, may partly explain the lack of a well-accepted way to assess firms' business strategies. In this study, instead of focusing on the ways how firms advance in their business (for example, by establishing a subsidiary in a foreign country to support an overseas venture), an effort was made to understand and identify the common strategies adopted by Singapore contractors in managing their business. Table 4.8 shows the business strategies found in previous studies (see 2nd column) and the items incorporated in the data collection instrument of this study (see 3rd column).

Table 4.8 Measurement items for business strategies (X6)

Authors (1)	**Possible measurement items** (2)	**Remark (Refer to Legend for symbol connotation)** (3)
Volberda (1998)	Adopting horizontal mergers and acquisition strategy to control competitive uncertainties through adjusting industry structure	∆: refer to item B1 in Appendix C, Q6.1
Wernerfelt and Karnani (1987); Volberda (1998); The Contractor (1998)	Entering into collaborative working relationship e.g., alliance, partnering and joint venture	∆: refer to item B2 in Appendix C, Q6.1
Volberda (1998)	Adopting a vertical integration to control input or demand uncertainties	∆: refer to item B3 in Appendix C, Q6.1
Volberda (1998); Langford and Male (2001)	Adopting product and service diversification strategy	∆: refer to item B4 in Appendix C, Q6.1
Hillebrandt et al. (1995)	Bidding for more projects that are within the firm's capabilities	@: refer to item B5 in Appendix C, Q6.1
Hillebrandt et al. (1995); The Contractor (1998)	Submitting a low tender price to secure projects	∆: refer to item B6 in Appendix C, Q6.1
Wernerfelt and Karnani (1987); Volberda (1998)	Investing into assets of high liquidity characteristic such as using general purpose facilitate and equipment	∆: refer to item B7 in Appendix C, Q6.1
Volberda (1998)	Creating uncommitted resources such as instant reserve	@: refer to item B8 in Appendix C, Q6.1
Hillebrandt et al. (1995); Boon (1996); Volberda (1998)	Implementing stricter financial management	@: refer to item B9 in Appendix C, Q6.1

Authors (1)	Possible measurement items (2)	Remark (Refer to Legend for symbol connotation) (3)
Hillebrandt et al. (1995)	Setting limitation to the size of project undertaken so that any failure of one project would not endanger the firm's operation	@: refer to item B10 in Appendix C, Q6.1
	Entering into forward contracts or fixed term agreements with certain suppliers to protect themselves for cost escalation when market upturn	∆: refer to item B11 in Appendix C, Q6.1
Wang and Li (2007)	Investing into R&D to further explore business opportunities	@: refer to item B12 in Appendix C, Q6.1
Hillebrandt and Cannon (1990); Hillebrandt et al. (1995); Volberda (1998); Langford and Male (2001)	Seeking opportunities in overseas markets	∆: refer to item B13 in Appendix C, Q6.1
Boon (1996); Volberda (1998); Low and Lim (1999; 2000)	Keeping constant contact with our customer to keep track of their existing and future needs	
Volberda (1998)	Reducing specialized commitment.	#
Raftery et al. (1998)	Adopting a differentiation strategy	#
Yates (1994); Hillebrandt et al. (1995); Langford and Male (2001)	Offering financial packages	#
Low and Lim (1999; 2000)	Sourcing directly from material suppliers	#
Legend: ∆ - modified based on the preliminary interview and pilot study findings and tested in subsequent fieldwork # - omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study @ - incorporated into the questionnaire without modification, on the basis of the preliminary interview and pilot study findings, and tested in subsequent fieldwork		
Note: The majority of the measurement items were not administered by any measurement scale, except for measurement items used in few studies. For example, Volberda (1998) adopted a five-point Likert scale.		

It can be seen that 14 out of the 18 strategies identified in the literature were retained following the preliminary interviews and pilot study in the exploratory and reflective phases, respectively. Of these 14 items retained, two were combined into a single item (labelled as item B13) based on interviewees' suggestions that their overseas ventures are usually led by clients. Also, three additional items (i.e., practices) were identified during the preliminary interviews (see Section 5.3) and subsequently labelled as B14, B15 and B16 in the instrument (see Appendix C). In total, 16 items were used to assess firms' business strategies. The dimensionality of firms' business strategy is examined in Section 7.3.2.2.

4.8 The role of environments on firms' resources and capabilities, and flexibility

This section focuses on the external environment of an organization in an effort to establish the interdependence between organizations and environments. To establish the interdependence, a revisit to the theoretical framework of this study is necessary (see Section 3.9). First, from the dynamic contingency perspective (see Section 3.9.1), managers' perceptions of the environments together with their choice of actions result in enacted environments that are resultants of both environmental influences and organizational decisions. As highlighted in Section 3.9.1, this process is largely dependent on managerial competency in creating, filtering and reshaping environmental influences towards organizational survival.

Also, environments directly influence organizational outcomes, which will, in turn, shape subsequent managerial perceptions and decisions (Scott, 1992). In light of resource-based perspective (see Section 3.9.3), the comparative advantages of organizational resources and capabilities could be dissipated by environmental influences if they are not constantly developed in line with changes within the environment (Barney, 1991; Peteraf, 1993). For their continued existence, managers need to learn, unlearn and relearn about the marketplace changes and build on their existing resources and capabilities, and subsequently reconfigure internal and external resources and capabilities into different strategies that enable them to adapt and respond flexibly to changes within their business environment.

Based on the above description, it appears logical to measure the external environment of firms based on participants' perception. This is because managers' perceptions of the environment become the reality, and subsequently this perceived ‘reality’ forms the basis of judgments for organizational actions (Dill, 1958; Lawrence and Lorsch, 1967; Duncan, 1972).

In this study, the environmental component was included to examine how environment conditions moderate the interactive relationship between the key determinants and organizational flexibility. How environment conditions influence firms’ endeavours to develop and nurture their resources and capabilities towards achieving organizational flexibility was investigated in the fieldwork. Hitherto, it is noted that few studies were done to examine the influence of environmental conditions on the interactive relationships between resource-based determinants and organizational flexibility in the construction management literature. Besides this, the endeavour to develop and enhance a firm’s resources and capabilities towards achieving organizational flexibility, for better responsiveness to marketplace changes, always means a cost commitment. Based on the moderated relationships, firms can seek the appropriate level of organizational resources and capabilities required corresponding to the level of environmental turbulence.

4.8.1 Possible dimensions

Studies suggested that environmental turbulence can exist in various forms (Duncan, 1972; Jauch and Kraft, 1986; Milliken, 1987). These include: (i) technological turbulence; (ii) market turbulence; and (iii) competitive turbulence. Descriptions of these dimensions are now provided.

Milliken (1987) considered technological turbulence as the degree of difficulty faced by firms to accurately predict or completely understand some aspects of the technological environment. This view is shared by Desarbo et al. (2005), who considered this dimension as the difficulty of technological forecasting, the assessment of technological changes, the extent of technical opportunity and other aspects of technology. As highlighted in Section 4.5, the technological advancement has caused changes in business competition, creating new imperatives on how firms operate. For example, new knowledge can be applied and communicated at a faster pace, greater numbers of new products and services can be introduced over time, more real-time information can be collected, analyzed and shared among parties, and there is a greater emphasis of technologically advanced buildings.

Turning to market turbulence, Kohli and Jaworski (1990) and Wang and Li (2007) considered it as changes in the composition of customers and their preferences, and also the intensity of competition with the industry. They included the 'competitive' element into the market turbulence dimension, based on the argument that the state of competition and market turbulence are closely related (Houston, 1986; Kohli and Jaworski, 1990). To exemplify this relationship, Kohli and Jaworski (1990) mentioned that, in the absence of competition, firms perform well even if they do not possess any core competence because clients have limited options on the types of products and services required; a circumstance which is contradictory to that which prevails within a competitive and dynamic environment. Operating in a competitive and dynamic environment, firms are expected to continually modify their strategies, products and services in order to meet clients' changing preference and cushion against competitors' actions (Wang and Li, 2007). Therefore, it appears reasonable to integrate market turbulence and competitive turbulence into a single dimension. Desarbo et al. (2005) described the former as changes in customer characteristics (for example, preferences and product needs) and ease of forecasting marketplace changes, and the latter as the extent of promotion and price wars, and the ability of firms to match competitors' offers.

The above suggests that the characteristics of the three environmental dimensions closely resemble the external environment of Singapore contractors discussed in Section 2.5. For example, the fluctuation in construction demand, and the increase in the intensity of competition and the demand for technically advanced building projects are corresponding examples of market, competitive and technological turbulences. Therefore, it is posited that these environmental turbulences do moderate the relationships between contractors' key resource-based determinants and their organizational flexibility. Following Kohli and Jaworski (1990) and Wang and Li (2007), this study considered market and competitive turbulences as a single dimension that is known as 'market conditions'. Likewise, the term 'technological conditions' was used to describe technological turbulence. In these ways, it is hypothesized that:

> *H_{19}: Market and technological conditions moderate the relationships between the key determinants and organizational flexibility.*

4.8.2 Measurement items

Table 4.9 summarizes the measurement items for the dimensions of market and technological conditions (see 3rd column), and shows the items incorporated in the data collection instrument of this study (see 4th column). It can be seen that only 10 out of the 20 items identified in the literature were tested in the fieldwork following the preliminary interviews and pilot study in the exploratory (see Section 5.3) and reflective phases (see Section 5.4.4), respectively. The interviews revealed that restructuring and redefining the 10 items were necessary for clarity, given that some items overlapped with one another. Also, two new items were identified in the interviews (see Section 5.3.3.1) and subsequently labelled as MC6 and TCn3 in the instrument (see Appendix C). In total, nine items were used to assess firms' environmental conditions. The dimensionality of the environmental conditions construct is examined in Section 7.3.2.3.

Table 4.9 Measurement items for environmental conditions (Z)

Possible dimensions	Authors	Possible measurement items	Remark (Refer to Legend for symbol connotation)
Market conditions	Desarbo et al. (2005)	It is very difficult to predict any changes in this marketplace	Δ: refer to item MC1 in Appendix C, Q9.1
	Miller (1987); Slater and Narver (1994); Cadogan et al. (2003); Desarbo et al. (2005); Wang and Li (2007)	In our kind of business, customers' product	Δ: refer to item MC2 in Appendix C, Q9.1
		Demand and consumer tastes are almost unpredictable	
		Actions of competitors are unpredictable	Δ: refer to item MC3 in Appendix C, Q9.1
	Desarbo et al. (2005)	Price competition is a hallmark of our industry	Δ: refer to item MC4 in Appendix C, Q9.1
		Sometimes our customers are very price-sensitive, but on other occasions, price is relatively unimportant	
	Miller (1987); Slater and Narver (1994); Cadogan et al. (2003); Desarbo et al. (2005); Wang and Li (2007)	Competition is very intense	Δ: refer to item MC5 in Appendix C, Q9.1
	Desarbo et al. (2005)	Our customers tend to look for new products all the time	#
		New customers tend to have product-related needs that are different from those of our existing customers	#
		We cater to many of the same customers that we used to in the past	Ξ
		Our competitors are relatively weak	#
	Cadogan et al.(2003); Desarbo et al. (2005)	There are many 'promotion wars' in our industry	#
	Miller (1987); Slater and Narver (1994); Cadogan et al. (2003); Desarbo et al. (2005); Wang and Li (2007)	Our firm must change our business practices (offering different products and services) frequently to keep up with the market and competitors	#
Technological conditions	Miller (1987); Slater and Narver (1994); Cadogan et al.(2003); Desarbo et al. (2005); Fynes et al. (2005); Wang and Li (2007	The rapid emerging of new technology always has fundamental impact on business activities, could be either opportunities or threats	Δ: refer to item TCn1 and TCn2 in Appendix C, Q9.1
		The technology in our industry is changing rapidly	
		The technological changes in the principle industry in which we operate are unpredictable	
	Slater and Narver (1994); Cadogan et al.(2003); Desarbo et al. (2005); Fynes et al. (2005)	A large number of new product ideas have been made possible through technological breakthroughs in our industry	#
	Desarbo et al. (2005)	Technological developments in our industry are rather minor	#
		The technological changes in this industry are frequent	#
	Wang and Li (2007)	Speed and pace of the changes of technologies in our principle industry is very fast	Ξ

Legend: Δ - modified based on the exploratory interview and pilot study findings and tested in subsequent fieldwork
- omitted from subsequent fieldwork based on findings from preliminary interviews and pilot study

Possible dimensions	Authors	Possible measurement items	Remark (Refer to Legend for symbol connotation)
Ξ - not considered because the proposed item overlapped with others/ is not applicable to this study @ - incorporated into the questionnaire without modification, on the basis of the exploratory interview and pilot study findings, and tested in subsequent fieldwork			
Note: Fynes et al. (2005) adopted a five-point Likert-scale. Miller (1987), Cadogan et al. (2003) and Wang and Li (2007) adopted a seven-point Likert-scale. Desarbo et al. (2005) adopted a 10-point Likert-scale.			

4.9 Summary

Eighteen hypotheses (i.e., H_2 to H_{19}) were developed in this chapter to examine: (i) the effects of inter-relationships among the six key determinants on organizational flexibility, and (ii) the extent to which the environment conditions moderate the relationships between the key determinants and organizational flexibility. The review of the literature suggests that some of the key determinants may be seen as multi-dimensional constructs, which comprise different dimensions of measurement items. Here, measurement items refer to items that are used to assess or measure the value of its respective constructs, which could be of single-dimensional or multi-dimensional nature.

The multi-dimensional constructs are: (i) organizational learning culture (X1); organizational structure (X2); (iii) technological capabilities (X4); (iv) business strategies (X6). First, the review shows the organizational learning culture (X1) construct comprises: (i) commitment to learning: (ii) shared value; (iii) open-mindedness; (iv) intra-organizational knowledge sharing. Ten measurement items were operationalized to assess organizational learning culture. Second, organizational structure (X2) is seen as a multi-dimensional construct comprising: (i) complexity; (ii) integration; (iii) formalization; (iv) centralization. Six measurement items were operationalized to assess a firm’s organization structure. This is followed by the technological capabilities (X4) construct, which comprises two dimensions: (i) information technological capabilities, and (ii) process technological capabilities. To evaluate technological capabilities, seven measurement items were operationalized.

The fourth multi-dimensional construct is business strategies (X6) that comprises: (i) cost leadership; (ii) risk leadership; (iii) customer intimacy; and (iv) product leadership. Sixteen measurement items were operationalized to assess construction firms' business strategies.

The literature reveals that employees' skills and behaviour (X3) and supply chain capabilities (X5) may be seen as single-dimensional constructs. In this study, eight and seven measurement items were applied to evaluate the former and latter, respectively.

Apart from the operationalization of key determinants, this chapter discusses the environmental conditions within which firms operate. Two environmental conditions were identified: (i) market conditions and (ii) technological conditions. These form the dimensions of a business environment, for which nine items were operationalized to evaluate the business environment of construction firms.

In this study, all measurement items of individual constructs identified in the literature were subjected to further scrutiny, by means of the preliminary interviews and pilot study in the corresponding exploratory and reflective phases of this study, before being incorporated into the data collection instrument as detailed in the next chapter. The next chapter also presents the research process along with the data collection techniques, using survey research design.

CHAPTER 5

RESEARCH DESIGN AND DATA COLLECTION METHODS

5.1 Introduction

This chapter presents the research process along with the data collection techniques, using a survey research design (Section 5.2). Justification for selecting a particular method over other methods is provided in the corresponding sections. This research was conducted in three phases, namely: (i) exploratory phase (Section 5.3); (ii) questionnaire development phase (Section 5.4); and (iii) data collection and analysis phase (Section 5.5), which combined both the qualitative and quantitative approaches. This combination capitalizes on the strengths and complements the weaknesses of each approach, and thus provides a synergistic research design. The methods of data analysis are addressed in Chapter 6.

5.2 Survey research design

In this research, a survey design was preferred over other research designs (i.e., archival research and historical research, experimental research, and case study research) for its abilities to provide a relatively quick and efficient method to (i) obtain information from the targeted sample (Tan, 2002b; Robson, 2002), and (ii) generalize the research findings based on the sample involved (Gill and Johnson, 1997). With reference to the research objectives stated in section 1.5, the unsuitability of the other research designs is outlined below:

(i) the limited study on flexibility management in the Singapore construction industry reduces the appropriateness of archival and historical research designs which require a considerably larger number of previous works in a similar research domain;

(ii) the focus of this research is not on the manipulation of variables via an experimental setting in measuring the effects of variables, but rather on the inter-relationships among variables (i.e., the organizational resources and capabilities) in achieving organizational flexibility. An experimental design is thus considered as inappropriate in this research; and

(iii) the research objective of identifying the common characteristics of the targeted sample of organizations (approximately 90 prospective respondents) in their attempts to stay adaptive and flexible has made a case study design unfeasible here. It is uneconomical and time-consuming to investigate in detail such a large sample population.

Nevertheless, it is recognized that the survey research design does have its major disadvantages of: (i) the low reliability and validity of survey data (Robson, 2002); and (ii) the possible biases that arise from sampling and individual responses (Tan, 2002b). Various methods suggested by Churchill (1979) and Dillman (2007) were taken in various phases of this research to deal with these shortcomings. The two major methods adopted here include: (i) the use of multiple techniques in generating measurement items (see Section 5.4), and (ii) the use of retrospective reporting and key informant approaches in the data collection process (see Section 5.5.5). These two methods sought to improve the reliability and validity of the survey data. Other methods such as multi-item approach and improvised sampling selection process were also adopted (see Section 5.5.3).

Within the survey research design, a three-phase research process (i.e., exploratory, questionnaire development, and data collection and analysis) was implemented in an attempt to combine both the qualitative and quantitative research approaches as shown in Figure 5.1. This combination capitalizes on the strengths and complements the weaknesses of each approach, and thus provides a synergistic research design.

Details of the respective phases, including the adopted data collection and sampling methods, are discussed next.

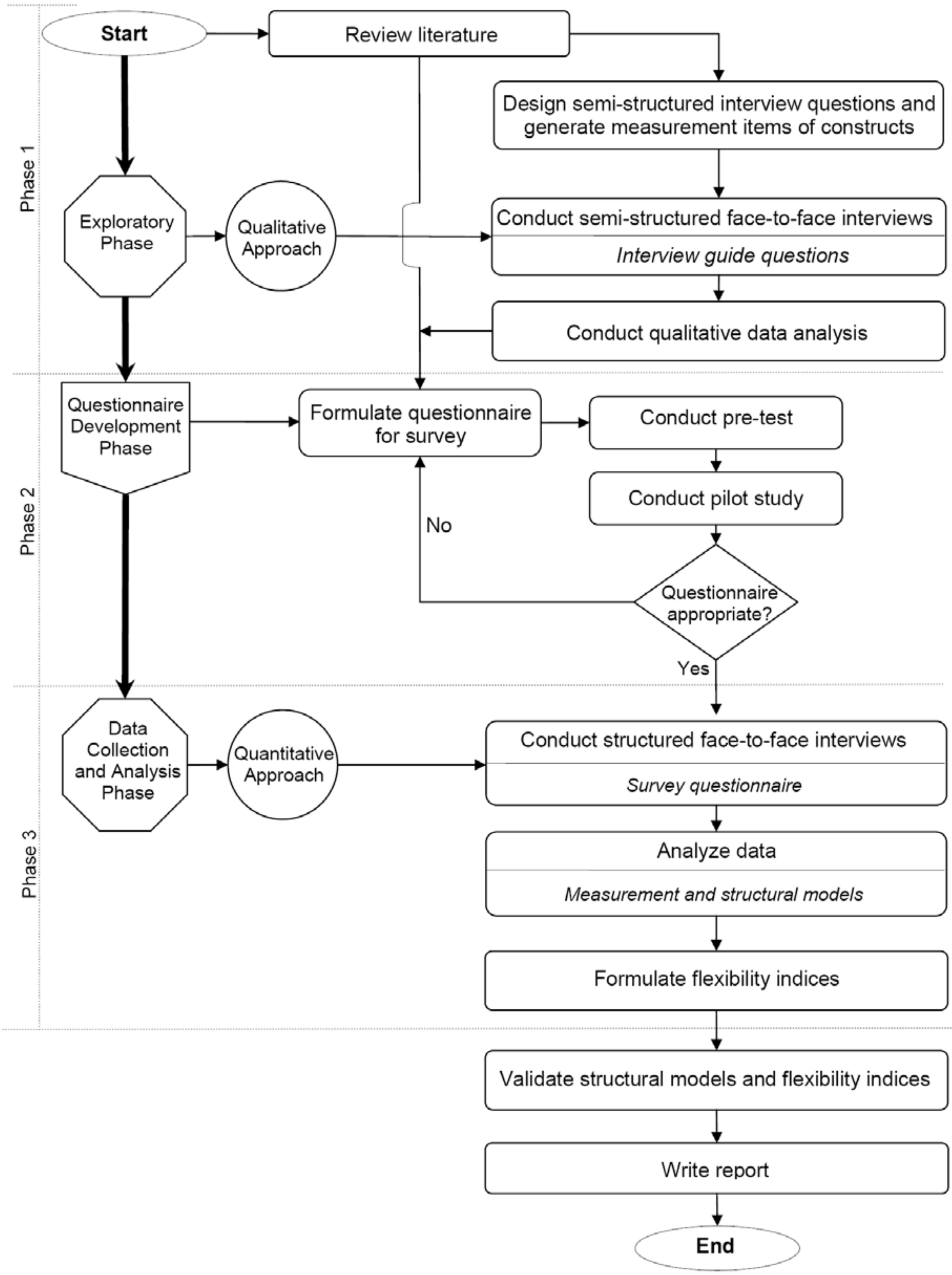


Figure 5.1 The three-phase research process

5.3 Exploratory phase

Corresponding to the first research objective of studying the appropriateness and importance of flexibility management in construction organizations, the exploratory phase is an important start-off phase in this research (see Phase 1 in Figure 5.1). It sought: (i) to uncover the major issues for the subsequent data collection and analysis phase; (ii) to identify the knowledge gap in previous studies concerning flexibility management of construction business and the key determinants of organizational flexibility; and (iii) to facilitate the exploration of how' and 'why' construction firms think and feel about the importance of being flexible in a dynamic business environment. The goal here was to clarify the key ideas concerning organizational flexibility for subsequent formulation of the structured survey questionnaire, which comprises the following tasks:

(i) identification of common 'industry' terms and language used to define flexibility;

(ii) identification of key determinants of organizational flexibility;

(iii) identification of key management practices adopted to attain organizational flexibility;

(iv) identification of main characteristics of the business environment within the Singapore construction industry; and

(v) contextualization and operationalization of different types of flexibility (as highlighted in Section 3.6) and individual determinants of organizational flexibility (see Sections 4.2 to 4.8).

5.3.1 Face-to-face interview approach

Face-to-face interviews were conducted to perform the above-mentioned tasks via subjective measurement of managerial opinion, perception or feeling. This is in line with Robson's (2002) assertion that interviews enable researchers to find out what people know, what they do, and what they think or feel. Burawoy (1991) took the view that a qualitative interviewing approach can reveal a dialectic interaction between interview findings and existing theories, and subsequently facilitate the 'reconstruction' of a theory. More often than not, an interview approach is considered as the initial step leading to a subsequent quantitative phase (Jaworski and Kohli, 1993; Robson, 2002) or the catalyst for development or refinement of a theoretical framework (Miles and Snow, 1978; Wang and Li, 2007).

The face-to-face interviews were conducted in a semi-structured setting whereby the entire questioning and answering process was guided by an interview guide, comprising a list of pre-determined questions (see Appendix A). The semi-structured interview setting helped to foster a greater deal of freedom to explore various areas and raise particular queries regarding flexibility management of a construction business, a condition which is difficult to achieve in both unstructured and structured interviews. The former is characterized by an entirely informal setting and the area of interest and concern is general, while the latter comprises a list of pre-determined questions with fixed wordings arranged in a pre-set sequence, usually it takes the form of a structured questionnaire (Bernard, 2000; Robson, 2002). Other advantages of the face-to-face semi-structured interview approach include:

(i) it is more flexible and practical to probe into the underlying motives of a particular phenomenon;
(ii) it allows direct contacts with interviewees and thereby enables direct observation of interviewees' behaviour and attitude towards certain issues;
(iii) it allows instant clarification of ambiguities and thus enhances the reliability of information obtained; and
(iv) it enables rapport-building with interviewees.

Also, it should be noted that various steps were implemented during the face-to-face semi-structured interviews to deal the major shortcoming associated with this interviewing technique. That is, the interviewers' bias since this interviewing technique is largely dependent on the quality and skill of the interviewers (Robson, 2002; Yin, 2003). These steps include (Robson, 2002):

(i) During open discussions, interviewees were encouraged to talk freely and openly without interruption. This aims to unearth much information about the specific issues concerning flexibility management from the interviewees' opinions and perceptions;

(ii) Interview guide questions were formulated in a straightforward and non-aggressive manner. This minimizes the possibilities that interviewees became confused and defensive, and allowed meaningful data to be obtained from the interviews; and

(iii) Interview guide questions were formulated in a neutral manner. This eliminates cues that might lead interviewees to respond in a particular way, and thus improves the reliability and validity of interview findings.

5.3.2 Development of the interview guide questions

In developing the interview guide questions, references were made to the studies by Das and Patel (2002) and Slack (1987) that focused on manufacturing firms. These studies were considered as the closest studies, having a similar research nature, to this research; especially since a comprehensive multi-dimensional flexibility-related study has yet to be presented in the construction management literature. Necessary rewordings and amendments were made to contextualize the relevant questions into the context of the construction industry. In addition, a list of definitions of various types of flexibility was presented to the interviewees (see Appendix B) and they were asked to comment on these definitions. This was done to obtain a consensus on the definitions that were used in the development of the structured survey questionnaire in the subsequent reflective phase.

A total of nine face-to-face semi-structured interviews were conducted with executives of Singapore construction firms in this exploratory phase. These interviewees were chosen based on the judgemental and snowball sampling methods. These two non-probability sampling approaches were considered as acceptable in this exploratory phase, given the high cost and time commitment involved in a probability sampling method in a quest for getting responses to the interview guide questions listed in Appendix A. Other reasons for selecting the judgemental and snowball methods in this study are provided as below (Holt, 1998; Tan, 2002b; Schutt, 2005).

(i) Both methods are easy to use and are able to obtain quick feedback from interviewees;

(ii) The judgemental method appears as the most appropriate way for the exploratory interviewing process, involving industry practitioners who are the key personnel of construction firms having the capacity to answer the interview guide questions. This appears as the pre-requisite for the subsequent industry-wide survey, which assumed the form of a 'key informant' survey. Reasons for using the key informant approach are discussed in Section 5.5.5; and

(iii) The snowball sampling method is useful for 'hard-to-reach' or 'hard-to-identify' key personnel of construction firms. This improves the response rate by asking interviewees to provide referrals for additional respondents.

In tandem with the above, Rubin and Rubin's (1995) guidelines on the application of the judgemental sampling method were adopted as follows.

(i) The interviewees were selected and invited on the basis that they are: (a) knowledgeable about or experienced in the situation being studied; (b) friendly and willing to talk; and (c) representative of the points of view.

(ii) The entire process of selecting and interviewing participants was governed by the following tests in determining the sufficiency of the study:

   a. The test for completeness is considered as satisfied only if the researcher grasps an overall sense of the concept of flexibility and flexibility-related issues in construction.

   b. The test of saturation is considered as satisfied only if the researcher gains confidence that little or no additional findings will be discovered from subsequent interviews.

In this study, all interviewees are from senior management levels including managing directors, directors, general managers, and senior managers who are key decision makers in their organizations. From the discussion, it is noted that they have extensive working experience in the Singapore construction industry, ranging from 17 years (min.) to 33 years (max.). An average working experience of 23.1 years was obtained, indicating that most interviewees have at least 20 years of working experience in the Singapore construction industry. Their views are thus deemed to be noteworthy and reliable. The interviews took an average of 90 minutes each. Each interview was recorded and transcribed, unless the interviewees requested otherwise.

5.3.3 Preliminary interview findings

The findings of the semi-structured interviews in the exploratory phase (see Figure 5.1) are summarized into three headings, namely: (i) business environment in the Singapore construction industry; (ii) industry practitioners' perspectives on organizational flexibility; and (iii) types of flexibility. These findings were used to inform the design of the data collection instrument (structured questionnaire) in the subsequent questionnaire development phase. Details of the interview findings are now summarized.

5.3.3.1 <u>Business environment in the Singapore construction industry</u>

Various challenges, fuelled by the dynamic business environment in the Singapore construction industry, were noted during the discussion. One of them, perhaps the most influential challenge, is the ever increasing rate of competition in the Singapore construction industry. This phenomenon can partly be explained in relation to the cyclical fluctuation of the limited domestic construction demand together with the continuous influx of foreign contractors.

Coupled with the competition intensity, the next challenge faced by interviewees is the gradual increase in the prices of materials. All interviewees admitted that it is increasingly difficult to hedge against any cost escalation in the prices of materials since 2003. Many of them explained that the increasing prices of raw materials have seriously affected and diluted their projected profit margins, and even in some instances, they ended up with losses in some projected ‘profitable’ projects. Many interviewees added that the fluctuation in the prices of materials aggravates the degree of uncertainty in the construction industry, and in turn, makes it difficult for them to predict and estimate the ‘acceptable and safe’ bid price for individual projects. This is in agreement with Shankari (2008), who reported that Singapore contractors are becoming more reluctant to tender for new projects owing to the soaring prices of materials, especially the prices of concrete and steel bars. Apart from these, other challenges identified include: (i) the severe price competition among contractors; (ii) the increasing clients’ expectation on contractors’ performance and services; and (iii) the increasing demand for advanced technological buildings.

In order to deal with the identified challenges, the interviewees adopted various practices. These include: (i) greater emphasis on procurement management; (ii) greater emphasis on site management in an attempt to reduce unnecessary material wastage; (iii) greater emphasis on cost control and management; (iv) greater emphasis on risk management; (v) increased focus on the development of employees' skills to deal with the rising client expectation; and (vi) greater emphasis to maintain a balanced business portfolio by investing in financial investment and property development.

5.3.3.2 Industry practitioners' perspectives on organizational flexibility

All interviewees noted that it is vital for contractors to develop and maintain flexibility in order to survive and prosper in a dynamic environment. The interviewees' definition of flexibility can be classified into these four: (i) ability to respond to changes immediately; (ii) ability to reallocate resources and capabilities in response to client needs; (iii) ability to mitigate risks and respond to changes; (iv) ability to learn from the business environment, to react and adapt, and to anticipate and adopt appropriate strategies to different situations.

Despite having different perspectives on what flexibility is, all the interviewees shared the view that the need for flexibility must complement the company's policies and principles. They pointed out that a firm cannot simply change without any principle or control because any misalignment between changes and business objectives could be detrimental to the firm's operation. In the case of misalignment, a firm may lose its core competence and organizational speciality, and its employees may become confused and disgruntled, and eventually their resistance to changes increases. Some interviewees went on to point out that the critical success factors towards changes are ‘flexibility in thinking’, ‘flexibility in commitment’ and ‘flexibility within unity’. This means that firms should not be inflexible and unwilling to change their guidelines and principles, and in the process of change, they should be pragmatic and open to all options, and more importantly, gain their employees’ commitment.

In order to achieve organizational flexibility, all the interviewees shared the view that (i) organizational learning culture; (ii) human resources capabilities; (iii) organizational structure; (iv) business strategies; (v) supply chain capabilities; and (vi) technological capabilities are the key determinants of organizational flexibility, and that they are interrelated. Of these, some can be considered as subsets of the other key determinants. Some interviewees added that it would be interesting to note the relationships among these determinants, observing how contractors develop and maintain their resources and capabilities towards achieving organizational flexibility.

5.3.3.3 <u>Types of flexibility</u>

The interviewees recognized that, in general, most of the identified flexibility types (shown in Appendix B) are applicable to the Singapore construction industry. Of the 15 flexibility types, program flexibility was particularly highlighted by all interviewees in that it is less applicable in the context of the Singapore construction industry. They explained that contractors are less likely to adopt advanced construction technologies unless they are requested to do so or it is specified in the contract. The example of the Singapore Housing Department Board (HDB) Hub project that involved construction of commercial office blocks and public transport interchange in 2003 was cited by some interviewees. In this particular project, the appointed contractor was required to adopt a proprietary construction system in constructing a building with a high amount of mechanized precast and prefabricated structural elements. Since then, this system has not been used in other projects in Singapore due to its high cost.

Also, some interviewees proposed that labour flexibility could be classified into two flexibility types. One involves the ability to change the number of employees within a firm's operation, while the other relates to the ability of the firm's employees to handle multiple responsibilities. This is consistent with Atkinson's (1984) 'core-periphery' model which operationalized labour practices into: (i) numerical flexibility, and (ii) functional flexibility.

Generally, all the interviewees suggested that the program flexibility could be eliminated from the list. Suggestions were also given on the definitions of various flexibility types.

5.4 Questionnaire development phase

The main purpose of this phase (see phase 2 in Figure 5.1) was to understand and accommodate, if necessary, the implications of the interview findings obtained from the exploratory phase for subsequent data collection process. These involved: (i) designing the structured questionnaire for the industry wide survey, and then (ii) pilot-testing the structured questionnaire in terms of its clarity and ability to test the proposed theoretical framework quantitatively.

According to Robson (2002) and Dillman (2007), one of the key criteria in developing a questionnaire is to standardize questions so that every prospective respondent will interpret them in the same way, be able to respond to and be willing to answer to every question accurately. Therefore, the emphasis here was on the content validity and the reliability of constructs and measurement items included in the structured questionnaire. Besides borrowing validated measurement items from previous studies of similar research nature, the questionnaire development process involved standardizing the meanings and perceptions on various flexibility types, constructs and measurement items (i.e., determinants for organizational flexibility) as revealed in the exploratory phase.

To develop a measurement instrument, an eight-step procedure is recommended by Churchill (1979): (a) to specify domain of constructs; (b) to generate samples of items; (c) to collect data; (d) to purify measures; (e) to re-collect data; (f) to assess reliability; (g) to assess validity; and (h) to develop norms. He however pointed out that it would be time-consuming to execute all the steps in practice, and suggested that researchers should at least execute steps (a) to (d) to ensure the reliability of their survey instruments.

Following Churchill's (1979) suggestion, only steps (a) to (d) were implemented in the questionnaire development process of this study. This option is more feasible after considering the attitude of Singapore construction practitioners on non-rewarding academic research. As noted by Tan (1995), a low response rate is typical of most studies involving construction practitioners in Singapore. Therefore, it is expected – indeed very unlikely – that the small pool of industry practitioners, who are willing to participate in non-rewarding academic research, are available for two rounds of discussion for data collection purposes. In this case, a pilot study was conducted as a measure to purify the structured questionnaire in an attempt to enhance its content validity and reliability before embarking on the industry wide survey.

5.4.1 Specify domain of constructs

The domain of constructs used in this study (for example, the definitions of various flexibility types and key constituents for organizational flexibility) is described in Chapter 4. The adopted definition of each construct dictates the operationalization of its measurement items, i.e., the use of either single- or multiple-item measures (Churchill, 1979; Bergkvist and Rossiter, 2007). It is found that the use of multiple items to measure the 'attributes' of a construct is popular not only among many marketing researchers (Theoharakis and Hooley, 2003; Dreyer and Gronhaug, 2004), but also in construction research using the structural equation modelling (SEM) technique (Leung et al., 2005; Jin et al., 2007).

According to Churchill (1979) and Peter (1979), the use of a multiple-item approach could diminish the inherent inadequacy of single-item measures in the following ways:

(i) Single-item measures often comprise a considerable uniqueness in that each item tends to have a lower correlation with the attribute being measured, and sometimes relates to other attributes. Therefore, combining relevant items can equalize the uniqueness of each item;

(ii) Single-item measures tend to classify respondents into a relatively small number of groups. By combining relevant items, a finer distinction among respondents can be made;

(iii) Single-item measures typically comprise considerable measurement error in the form of unreliable response whereby the same scale rating is unlikely to be detected in successive administration of an instrument. Through increasing the number of items in a combination, reliability tends to increase and thus reduces the measurement error; and

(iv) Single-item measures are often insufficient to capture the domain of an abstract construct adequately. The use of the multiple-item measures allows a more accurate prediction of the construct.

Based on the above comparison, a multiple-item approach was adopted in the development of the structured questionnaire. In this case, each of the identified constructs was measured by multiple items in an attempt to: (i) capture the domain of constructs adequately and accurately; (ii) reduce measurement error; and (iii) increase the reliability and validity of the measurement instrument. Following Schmitt and Stults (1985), all measurement items were developed in the way that they are concise and precise to overcome the major problem of non-responses bias due to the lengthy questionnaire involved.

However, it is noted that the inclusion of insufficient measurement items may reduce the reliability and validity of a measurement instrument (Churchill, 1979; Peter, 1979). Corresponding to this, some studies (Theoharakis and Hooley, 2003; Wang and Li, 2007) attested that a measure comprising three items is reasonably reliable. In this case, the guideline of at least three measurement items for each construct identified was adopted to govern the sample generation of measurement items.

5.4.2 Generation of sample of measurement items

The measurement items of constructs can be generated using various techniques including literature searches, experience surveys, critical incidents, focus groups and in-depth interviews (Churchill, 1979). Appropriate combination of these techniques, using two or more methods collectively, can often generate measurement items with a relatively high degree of content validity (Moore and Behasat, 1991; Wang and Li, 2007).

In this study, measurement items for individual identified constructs were generated via the review of literature (see Chapters 2 and 4) and in-depth interviews (see Section 5.3.3). First, validated measurement items measuring similar constructs were obtained from previous studies (see Chapter 4 for the lists of items in the literature). Next, these lists of items were subjected to a round of validation and streamlining process via the preliminary interviews conducted in the exploratory phase (see Section 5.3). To further enhance the content validity of the measurement instrument, an experienced academic and two industry practitioners were involved in assessing the structured questionnaire, particularly on issues involving the contents and wording of individual measurement items, prior to the pilot study (the ‘pre-testing’ activity shown in Figure 5.1).

5.4.3 Questionnaire design

In the questionnaire design, all questions were standardized in a way that they were presented exactly with the same wordings and order to all respondents. This was done to ensure that the datasets obtained are comparable for data analysis purposes. In this case, responses to most of the questions are fixed in a semantic differential scale administrated on a Likert design, unless otherwise stated.

Overall, the formulated questions can be broadly classified into the two main categories as shown below.

(i) Non time-phased questions - these refer to questions concerning organizational routines and behaviour, which are of a less fluctuating nature. Interviewees were requested to rate individual questions on a seven-point Likert scale, which are fixed in one of the following formats: (i) 1 = seldom - 7

= often; or (ii) 1= low – 7 = high; or (iii) 1 = strongly disagree – 7 = strongly agree.

(ii) Time-phased questions – these refer to questions concerning organizational business strategies and business environments, which are of a more dynamic nature. Interviewees were requested to rate individual questions on a four-point Likert scale in relation to the stated periods (i.e., year 1997-2000, 2001-2005 and 2006-2007). Two formats were used here, namely, ‘rarely practised – often practised’ and ‘minimal impact – high impact’. For the data analysis purposes, the four-point Likert scale was first converted into a seven-point Likert scale (for example, the corresponding scale for ‘rarely practised - sometimes practised - averagely practised - often practised’ is 1 – 3 – 5 –7), and the mean score of the three stated periods were calculated for the time-phased questions.

A semantic differential scale of a Likert design is preferred over other itemized rating scales (for example, Thurstone scale and constant-sum scale) because: (i) it is the easiest scale to construct and administer (Zikmund and Babin, 2007), and (ii) it is easy-to-understand and thus facilitates the respondents’ answering process (Bernard, 2000). Coupled with this, a seven-point, instead of a five or nine-point, Likert scale design was adopted in this study, following previous studies. As highlighted in Chapter 4, most validated measurement items in the literature, measuring similar constructs, were administered in the seven-point Likert scale design. According to Dawes (2007), a seven-point scale has a higher scale reliability and validity than those with fewer scale points, while more finely graded scales (for example, 9-point and 10-point scales) do not improve reliability and validity further.

5.4.4 Pilot study

Before embarking on the data collection and after the pre-testing, a pilot study was conducted to verify the structured questionnaire (see Figure 5.1). It involved a field test of the structured questionnaire involving face-to-face interviews with industry practitioners, which enabled instant feedback concerning the clarity and flow of the questionnaire.

In the pilot study, 12 face-to-face interviews were conducted with senior managers of local construction firms. Similarly, this group of interviewees was chosen based on judgemental and snowball sampling methods as discussed in Section 5.3.2. In this case, some of these interviewees had participated in the preliminary interviews. This process helped to ensure that the interviewees' suggestions obtained in the preliminary interviews were correctly interpreted and incorporated into the structured questionnaire.

It is noted that all interviewees have extensive working experience in the Singapore construction industry, ranging from 18 years (min.) to 26 years (max.). An average working experience of 21.3 years was obtained. In this process, interviewees were requested to give feedback on several issues, including: (i) the clarity of instructions, questions and measurable items, and (ii) the relevance of all measurement items to their organization.

In general, all the interviewees expressed that the questionnaire was comprehensive. Some interviewees commented that the questionnaire was relatively lengthy, and required at least 25 minutes to complete all the questions. They suggested that some overlapping items could be deleted, while some unclear statements and questions should be reworded into plain and 'industry' language. In response to the comments given, necessary rewordings and amendments were made before the industry-wide survey.

5.4.5 Organization of the questionnaire

The structured questionnaire comprises 11 parts (see Appendix C). In the first part, interviewees were required to provide general information about their firm (for example, year of establishment and types of ownership). The questionnaire ends with an optional section to determine demographic characteristics of the interviewees and their companies.

Apart from the opening and closing parts, different parts of the questionnaire were designated to measure the constructs specified and identify their corresponding management practices adopted. These parts are now discussed.

5.4.5.1 Part 2: Human resource

This part comprises five questions, which are related to a construction firm's human resources. The first question required interviewees to estimate the number of times in which each of the five identified training programmes has been offered to their firms' employees on an annual basis. Subsequently, they were requested to rate the extent to which the human resource management practices (see Section 4.4.3) have been adopted by them in nurturing their employees' skills and behaviour. Generally, these practices could be classified into: (i) competence development; (ii) stress management; (iii) performance management; and (iv) relationship management. In this study, it appears justifiable to integrate both the intra-organizational (see Section 4.4.3) and inter-organizational (see Section 4.6.2) relationship management practices into one category because of their similar nature.

Interviewees were also requested to rate and rank their employees' skills and behaviour according to the eight suggested items (see Section 4.4.4 and Appendix C, Q2.6). The purpose is to establish the consistency of information obtained. Subsequently, they were asked to indicate: (i) their firms' size, in terms of the number of employees (see Section 4.4 for the definition of employees adopted in this study), and (ii) the extent to which these employees are employed based on a contract basis.

5.4.5.2 Part 3: Organizational culture

This part comprises four questions relating to a firm's organizational learning culture. Interviewees were requested to rate the 10 statements (i.e., the measurement items of organizational learning culture), which best describe their firm's culture. In addition, they were asked to indicate, on a nominal scale, the statements that best describe their firm's planning approach and leadership style. A copy of their firm's mission and vision statement was requested so as to establish the consistency of information given.

5.4.5.3 Part 4: Organizational structure

This part comprises four questions concerning a firm's organizational structure. The first and second questions required interviewees to indicate the hierarchical level in their organizational structure and the number of changes made in their structure over the study period. Here, the hierarchical level refers to the line of authority of the interviewees' firms stemming from a line manager.

In addition, interviewees were requested to indicate the types of structural configuration (see Section 4.3.3), which have been commonly implemented by their firms over the study period. Subsequently, they were asked to rate the 4 pairs of statements, which best describe their organizations' decision making and communication procedures. Each pair of statements was designed in the way that interviewees had to rate their firms' decision making and communication procedures based on two extreme scenarios (following Khandwalla, 1977). This may help to improve the accuracy of information obtained.

5.4.5.4 Part 5: Organizational supply chain

This part comprises two questions, whereby interviewees were first requested to rate the seven items concerning their firms' supply chain capabilities and then, indicating the responsiveness of their subcontractors and suppliers, in terms of working days, in response to five scenarios given (see Appendix C, Q5.2). This provides a deeper insight and objective measurement of the firms' supply chain responsiveness.

5.4.5.5 Part 6: Business practices

This part comprises three questions, whereby interviewees were first requested to rate the extent to which the 16 business strategies have been adopted by their firms in response to changes within the industry over the study period. Subsequently, they were requested to indicate the average percentage of their work being subcontracted out and the number of countries where their firms have operated in during the study period.

5.4.5.6 Part 7: Information technology

This section comprises eight questions, where the first few questions required interviewees to indicate the average percentage of: (i) their firms' investment in their information technology development; (ii) their firms' employees who possess basic information technology knowledge; (iii) their firms' electronically stored documents; and (iv) their firms' employees who have direct access to the electronically stored documents. Subsequently, they were requested to rate the four measurement items concerning their information technology capabilities. All these help to explain a contractor's information technology capabilities in relation to its technological development endeavours.

5.4.5.7 Part 8: Process technology

This part comprises seven questions, whereby interviewees were requested to indicate: (i) the average percentage of their firms' investment in their process technology development, and the average percentage of their firms' employees who possess basic and advanced process technology knowledge. Subsequently, they were requested to rate the three items concerning their process technology capabilities. All these help to explain a contractor's process technology capabilities in relation to its technological development endeavours.

5.4.5.8 Part 9: Environmental condition

This part of the questionnaire required interviewees to rate the extent to which the nine aspects of the environmental condition have influenced their business operation and performance during the study period.

5.4.5.9 Part 10: Organizational flexibility

In this part of the questionnaire, interviewees were requested to rate their flexibility potential, corresponding to the 15 flexibility types (see Section 3.6.2), in response to the environmental conditions shown in Part 9.

5.5 Data collection and analysis phase

The third phase of this study was undertaken via a quantitative approach, focusing on an industry-wide survey (see Phase 3 in Figure 5.1). The objective here is to capture the relationships of largely unobserved constructs such as organizations' resources and capabilities, organizational flexibility and business environment. Through the application of appropriate statistical analytical tools, the results obtained enabled the testing of hypotheses in the study (see Chapter 4). Details of the data collection process are discussed next.

5.5.1 Data collection process

The data collection process was commenced in early October 2007. An invitation letter (see Appendix D for an example of the invitation letter) that explains the purpose of the survey (see Section 5.5) and the questionnaire were sent to all 91 construction firms (see Section 5.5.4) in requesting face-to-face interviews (see Section 5.5.2) with their key informants (see Section 5.5.5) to complete the questionnaire. For that reason, all invitation packages were directly addressed to the managing director of individual firms. They were requested to signify their acceptance, within two weeks after the receipt of the invitation package, through one of the following modes: (i) facsimile transmission; (ii) mail using the enclosed self-addressed and pre-paid postage envelope; (iii) telephone call; and (iv) email. Second reminder invitation packages were then sent to the firms after two weeks from the initial mailing exercise. By the end of October 2007, only 5% of the targeted firms had accepted the interview request.

In an effort to improve the response rate, follow-up telephone calls were made to the remaining firms, soliciting a conversation with their managing directors or general managers, for the following purposes:

(i) explaining the purpose of the survey interview and their important roles towards the successful completion of this study;

(ii) assuring them that all information provided will be treated in strictest confidentiality and that their names and organization's details will be kept anonymous (see Section 5.5.5) ; and

(iii) assuring them that a complimentary copy of the results, showing the calculated flexibility potential of their firm, will be provided to them upon the completion of this study.

In instances where directors and senior managers of respective firms were not available during the telephone calls, efforts were made to get hold of their names and email contacts. Emails were sent to them, emphasizing the three aforementioned purposes, and follow-up telephone calls were made to seek for their consent to participate in this study. Eventually, a total of 41 firms agreed to participate in this study, representing a response rate of 45% (see Section 7.2 for the profiles of interviewees).

5.5.2 Face-to-face interview approach

Besides the advantages stated in Section 5.3.1, the face-to-face interview approach was selected here as the main data collection method (see Phase 3 in Figure 5.1) because:

(i) it is an effective approach in collecting data, compared to the self-administered postal questionnaire and telephone interview methods, when a questionnaire is lengthy and complicated (Robson, 2002). In this study, the questionnaire comprises 9 pages of questions that were relatively complex (see Section 5.4.5); and

(ii) it may achieve a higher response rate than both the self-administered postal questionnaire and telephone interview methods. (Robson, 2002). This is one of the key considerations in this study due to the anticipated low response rate (see Sections 3.7 and 5.4).

Apart from the steps discussed in Section 5.3.1, the following procedures were implemented to overcome shortcomings of the face-to-face interviews:

(i) Each interview was tape recorded and transcribed, unless interviewees requested otherwise. This minimizes information loss and recall bias (Robson, 2002).

(ii) Each interview was conducted such a way that interviewees were requested to provide their response to questions following the interviewer's introduction of the individual parts of the questionnaire (see Section 5.4.5). This ensures that interviewees understood the questions before assessing them. In order to establish the accuracy of information obtained, interviewees were further requested to justify their responses to most questions.

5.5.3 Stratified sampling method

Having discussed the data collection instrument and method, the next issue to consider is the sampling method for this study. Among the two main sampling designs, i.e., non-probability and probability sampling, a probability sampling design was adopted in order to help in the generalization of the research findings through the use of appropriate statistical methods (Hair et al., 2003). This is a condition which is difficult to be fulfilled with the use of a non-probability sample design.

In this study, a probability sampling design based on the stratified sampling method was chosen whereby the interviewees were randomly selected from a strata of the population. The population comprised general contracting firms in the Singapore construction industry. This sampling method facilitates the stratification of the Singapore general contracting firms into their respective groups.

5.5.4 Sampling frame and selection process

The targeted groups of large and medium-sized general building contractors (i.e., Groups A1, A2 and B1) were selected from the BCA's 2007 Contractor Registry (as of 13th June 2007). These three groups of contractors are categorized in accordance to their financial grades where: A1 contractors have an unlimited tendering limit with a minimum paid up capital of $15 million (M); A2 contractors have a tendering limit capping at $65M with a minimum paid up capital of $6.5M; and B1 contractors have a tendering limit capping at $30M with a minimum paid up capital of $3M.

Through the pilot study and archival searches, other groupings (i.e., B2, C1 and C2) were found to be unsuitable for this study because: (i) they are made up of small firms that tend to work as subcontractors to large contractors and have small contract award values, and (ii) they tend to bid for small repair and maintenance works only. It could be expected that this group of contractors may not exhibit various flexibility management practices in a comprehensive scale. Likewise, it was found that some of these small firms are subsidiaries of large construction firms, which reside in the targeted sample. Therefore, these groups of small-sized contractors were excluded from this study.

In an attempt to enhance the validity of this study, the sampling frame was subjected to a filtering process. This involved a comparison of the list of contractors registered in the BCA's Contractors Registry between 1997 and 2007. In 1997, BCA was known as the Construction Industry Development Board (CIDB), where all registered contractors were classified into eight categories according to their financial grades, from G1 for the smallest to G8 for the largest category. In this study, the focus was on the top three categories in the CIDB's 1997 Contractor Registry: (i) G8 contractors (unlimited tendering limit); (ii) G7 (tendering limit capping at $50M); and (iii) G6 (tendering limit capping at $30M). It appears reasonable to compare these two lists of registered contractors since they share a similar range of tendering limits.

The 1997's and 2007's contractors registries contain 198 and 107 contractors in the retained categorizes, respectively. Of these, a total of 91 contractors who appeared in both lists were selected for this study. It is argued that these firms have ingrained a considerable degree of flexibility capacity in response to changes within the industry, exemplified by their capability to tide over the unprecedented 1997 – 2005 economic downturn following the Asian financial crisis in 1997 (see Section 1.3).

5.5.5 Key informant retrospective reporting approach

Before embarking on the data collection procedure, it is necessary to justify the use of the key informant retrospective reporting approach in an attempt to obtain both objective (for example, turnover figures) and subjective (for example, perception on strategic flexibility and environmental turbulence) data needed in this study. Key informant retrospective reports can often provide information (for example, account of facts, beliefs, activities and motives related to prior events) which is not available from other sources (Huber and Power, 1985; Golden, 1992).

According to Venkatraman and Ramanujam (1986), data from key informants exhibit less method variance than archival data. This is supported by many other strategic management studies (Miller, 1988; Zahra, 1996) that have provided substantial evidence of the high reliability and validity of self-reported measures by key informants of individual firms. Owing to its ability to acquire valuable data of both objective and subjective nature, the key informant retrospective reporting approach has gained its popularity not only in organizational studies (Bourgeois and Eisenhardt, 1988; Sinkula et al., 1997), but also in construction management studies (Kale and Arditi, 2001).

In this case, this selected approach facilitates the collection of subjective data with respect to different aspect of organizational flexibility and its key determinants. The use of subjective data was considered necessary here primarily because it is difficult: (i) to capture the essence of the values of the organizational flexibility and its key resource-based constructs, and (ii) to imitate idiosyncratic qualities from available sources (for example, the diversity of owners' compensation policies may make the financial report difficult to interpret). In particular, the key informants' perceptual measures of environmental turbulence are preferred in this study, as these measures are more relevant in examining a firm's choice of business strategies or strategic issues in response to changes within the business environment of the construction industry. As highlighted by Bourgeois (1980) and Keats and Hitt (1988), perceptual measures are thought to have the strongest association with strategic variables because managers' view of their firms' business environment shape their strategic choices. This is in line with the dynamic contingency view of organizations (see Section 3.9.1).

Given the exploratory nature of this study, the key informants would need to be the key personnel of the targeted firms who are knowledgeable about the issues being studied and have been working with their firm for many years (Seidler, 1974; Phillips, 1981). The goal here is to ensure and improve the reliability and validity of their retrospective reporting on past events. Accordingly, this group of key informants will be able to reply to the time-phased questions concerning their organization's past behaviour and performance, especially for the periods 1997 to 2007. The underlying assumption for the key informant approach is that by virtue of his/her position in a firm's hierarchy, he/she is able to give perceptions that are valid reflections of the perceptions of the other key decision makers in the firms (Phillips, 1981).

However, the use of the key informant retrospective reporting approach is not without problems of informant bias and random human reporting error (Huber and Power, 1985; Golden, 1992). To minimize these problems, various measures recommended by Golden (1992) and Miller et al. (1997) were adopted in this study. These include:

(i) designing a structured questionnaire that comprises straightforward questions concerning factual data rather than past opinions. In this study, various measures were adopted to reduce the ambiguity of measurement items throughout the exploratory and questionnaire development phases;

(ii) providing a detailed explanation of the nature and significance of the study to interviewees by the means of a cover (i.e., invitation) letter (see Appendix D). A detailed cover letter that explains the purpose of survey is critical to the success of a questionnaire approach (Tan, 2002b; Dillman, 2007). In this case, interviewees were assured that all information provided would be treated in strictest confidence; and that their names and organization details would be kept anonymous. The inclusion of this statement in the cover letter was aimed to seek for better response rate and encourage interviewees to provide accurate information; and

(iii) attaching an instructional page to the questionnaire to remind interviewees to answer individual questions based on their factual situations rather than the strategic intent of their organization (see Appendix C).

In this study, it appears reasonable to use a single key informant as the primary source of information; especially where the key informant is the managing director or senior manager of each construction firm (following Kale and Arditi, 2001). It is believed that these individuals are likely to possess the competence to assess their organizational resources and capabilities and flexibility potential, and more importantly, they have access to all information, which is necessary to complete the questionnaire.

5.6 Validation process for statistical results

After the statistical analysis was completed and models specified, a validation exercise was conducted (see Figure 5.1). The face-to-face interview was selected as the main validation method to examine the practicality and comprehensiveness of both PLS M1 and M2 (see Section 9.4). Besides the reasons highlighted in Sections 5.3.1 and 5.5.2, this approach was chosen because it is the most effective method to collect information, from subject matter experts, involving the application of proposed models (Robson, 2002). In this study, PLS M1 and M2 are models developed to illustrate the complex relationships between determinants themselves, and between individual determinants and organizational flexibility. Considering the complexity of questions involved in the validation process (see Appendix E), the interview approach which allowed instant clarification of ambiguities was the most appropriate for this study.

For the validation exercise, subject matter experts were selected from the remaining 50 firms (given that 41 out of the 91 targeted contractors had participated in the models development) that did not participate in the questionnaire survey stage (see Sections 5.5.1 and 7.2). Emails were first sent to these firms and then follow-up calls were made to seek their consent for a face-to-face interview (see Section 9.3.1 for further detail).

5.7 Summary

This chapter described the activities in the three-phase survey research design (i.e., exploratory, questionnaire development, and data collection and analysis phases) of this research. In the exploratory phase, nine face-to-face semi-structured interviews were conducted with key informants of Singapore construction firms with the main goal to studying the appropriateness and importance of flexibility management in construction organizations. The subsequent questionnaire development phase involved the design and pilot-testing of the structured questionnaire prior to the industry wide survey. Lastly, the focus of data collection and analysis phase was on the industry-wide survey via face-to-face interviews. A total of 91 contractors were targeted for this study after a filtering process. A key informant retrospective reporting approach was adopted in an attempt to obtain both objective and subjective data needed in this study. In this case, the interviewees would need to be the key personnel of the targeted firms who are knowledgeable about the issues being studied and have been working with their firm for many years. These interviewees' profiles would enable them to reply the time-phased questions concerning their organizational past behaviour and performance, especially for the periods 1997 to 2007.

The next chapter sets out the methods of data analysis using the structural equation modelling technique.

CHAPTER 6

METHODS OF ANALYSIS

6.1 Introduction

This chapter is devoted to the analytical methods used for analysing the survey data. It first presents the background of the chosen statistical modelling technique-structural equation modelling (Section 6.2), and its types along with the chosen type in this study (Section 6.3). This is followed by the details of the modelling process (Section 6.4). The last section presents the moderator analysis approach used to examine the moderating effects of environmental turbulence in the developed models (Section 6.5). Justification for selecting the relevant analytical approaches in different stages of the structural equation modelling approach is highlighted in the corresponding sections.

6.2 Review of statistical modelling techniques and structural equation modelling

There are a number of different statistical techniques that can be used to analyze the relationships among variables, both dependent and independent. The relationships can be classified into two categories, namely, (i) dependence and (ii) interdependence (Sharma, 1996).

6.2.1 First generation analysis techniques

The dependence statistical method refers to the cause-and-effect relationship in which the presence or absence of a relationship is assessed based on the extent to which a set of independent variables affects a set of dependent variables individually and/or jointly (Sharma, 1996). Statistical methods for analyzing this type of relationships are known as dependence statistical methods. Table 6.1 shows the types of dependence statistical methods classified along two axes, i.e., the number of variables involved and the type of measurement scales used. A metric scale consists of measurements that fall along a continuous scale, such as temperatures, or lengths, while non-metric scale refers to discrete or count data. Discrete data contain distinct values such as number of contractors or number of calls.

Table 6.1 Types of dependence statistical methods

	Dependent variable(s)			
	One		**More than one**	
	Metric	**Non-metric**	**Metric**	**Non-metric**
Independent variable(s) One				
Metric	• Simple regression	• Discriminant analysis • Logistic regression	• Canonical correlation	• Multiple-group discriminant analysis (MDA)
Non-metric	• t-test	• Discrete discriminant analysis	• MANOVA (multivariate analysis of variance)	• Discrete MDA
More than one				
Metric	• Multiple regression	• Discriminant analysis • Logistic regression	• Canonical correlation	• MDA
Non-metric	• Analysis of variance (ANOVA)	• Discrete discriminant analysis • Conjoint analysis (MONANOVA)	• MANOVA	• Discrete MDA

Source: Sharma (1996)

Among the dependence statistical methods listed in Table 6.1, the multiple regression modelling technique is one of the commonly adopted tools in construction research, assessing the strength of influence of multiple independent variables on a dependent variable (Sharma, 1996; Churchill and Iacobucci, 2005). In the case where there is only one independent variable, it is called the simple regression analysis. The next common dependence method is the ANOVA. It is a statistical extension of the *t*-test that enables: (i) the comparison of means of three or more groups of sample data simultaneously, and (ii) the use of two or more factors in defining the groups, and thus providing a better understanding of the dataset (Churchill and Iacobucci, 2005).

The multivariate interdependence statistical methods are used to understand or identify why and how the variables, regardless of their nature as independent or dependent, are correlated among themselves (Sharma, 1996). This is because it is very difficult or incorrect, in some cases, to delineate one set of variable as independent and another set as dependent. Some commonly used multivariate interdependence statistical methods include: (i) simple correlation analysis; (ii) principal components analysis; (iii) exploratory factor analysis; and (iv) cluster analysis.

A simple correlation analysis is a technique that involves measuring the closeness of the relationship or covariation between two variables at a time (Churchill and Iacobucci, 2005). Here, it is important to note that the mathematical functional relationship, obtained from the correlation analysis, cannot be used to establish causality. Next, the principal component analysis is a data reduction technique that helps to reduce a large number of variables into a few composites. It follows that each composite is formed by taking a weighted average of the variables involved (Sharma, 1996). In the Statistical Package for Social Sciences (SPSS) software, the principle component method is integrated into the exploratory factor analysis as an algorithm, facilitating extraction of the few underlying factors that are responsible for the correlation among a large number of variables (Norusis, 2007). As a result, the exploratory factor analysis is also considered as a data reduction technique that identifies clusters of variables such that correlations of the variables within individual cluster are higher than correlations of variable across other factors (Sharma, 1996).

Similar to the basic function of the exploratory factor analysis, the cluster analysis is a technique for grouping observations into clusters or groups. The observations within individual clusters are identical in terms of the variables used to form the clusters, while the observations across individual clusters are as different as possible with respect to the clustering variables (Sharma, 1996). However, the cluster analysis does differ from an exploratory factor analysis. In the former, observations are clustered in terms of particular characteristics of observations, whereas in the latter, variables are factorized (or grouped) based on the correlations between variables.

6.2.2 Second generation analysis techniques - SEM

Having discussed the above first-generation multivariate dependence and interdependence methods, the next issue to examine is the second-generation multivariate methods. One of these is the structural equation modelling.

Structural equation modelling (SEM) has been widely used in social and behavioural research for developing and testing theories through the use of survey data. These include studies in business marketing (Matzler et al., 2007; Jensen, 2008) and organization behavioural studies (Wang and Li, 2007). This modelling technique has also attracted interest among construction management researchers. The works by Dulaimi et al. (2005), Islam and Faniran (2005), Leung et al. (2005), Jin et al. (2007) and Aibinu et al. (2008) are among construction-related studies using SEM.

SEM has been seen as the second-generation multivariate technique that combines both econometric and psychometric perspectives in modelling attempts (Chin and Newstead, 1999; Wang and Li, 2007). Structural equation models are somewhat like multiple regression models in which numerous variables are used to predict another variable. However, the former are more complex than the latter in that they comprise many layers of variables (which may include latent variables) and their interrelationships (Churchill and Iacobucci, 2005). The general convention for latent variables that cannot be observed is ‘constructs’. For consistency, the term ‘construct’ is used in this study.

In structural equation models, there are predicted constructs and predictor constructs. Predicted constructs are unobserved dependent variables, for example, the constructs of organizational flexibility in this research context. Predictor constructs are unobserved independent variables that are used to predict other constructs, for example, the key determinants for organizational flexibility in terms of resources and capabilities.

Both predictor and predicted constructs are measured by their corresponding blocks of observed variables or measurement items. For consistency, this study uses measurement items. SEM focuses on prediction and modelling of constructs that are inferred from measurement items (Chin, 1998a; Chin and Newstead, 1999). Figure 6.1 illustrates the differences between structural equation and multiple regression models.

According to Chin and Newstead (1999), the SEM technique exhibits greater flexibility in modelling as compared to the first generation of multivariate techniques (for example, regression modelling and discriminant analysis). Chin (1998a; 1998b) pointed out that the first generation regression models always underestimate the accurate relationship between variables since they did not consider the existence of measurement errors of individual variables, as shown in Figure 6.1. On the contrary, structural equation models are characterized by their abilities (i) to predict multiple and interdependence relationships, and also (ii) to assess individual constructs in the presence of their interdependence relationships without being contaminated by measurement errors (Hair et al., 1998; Dilalla, 2000).

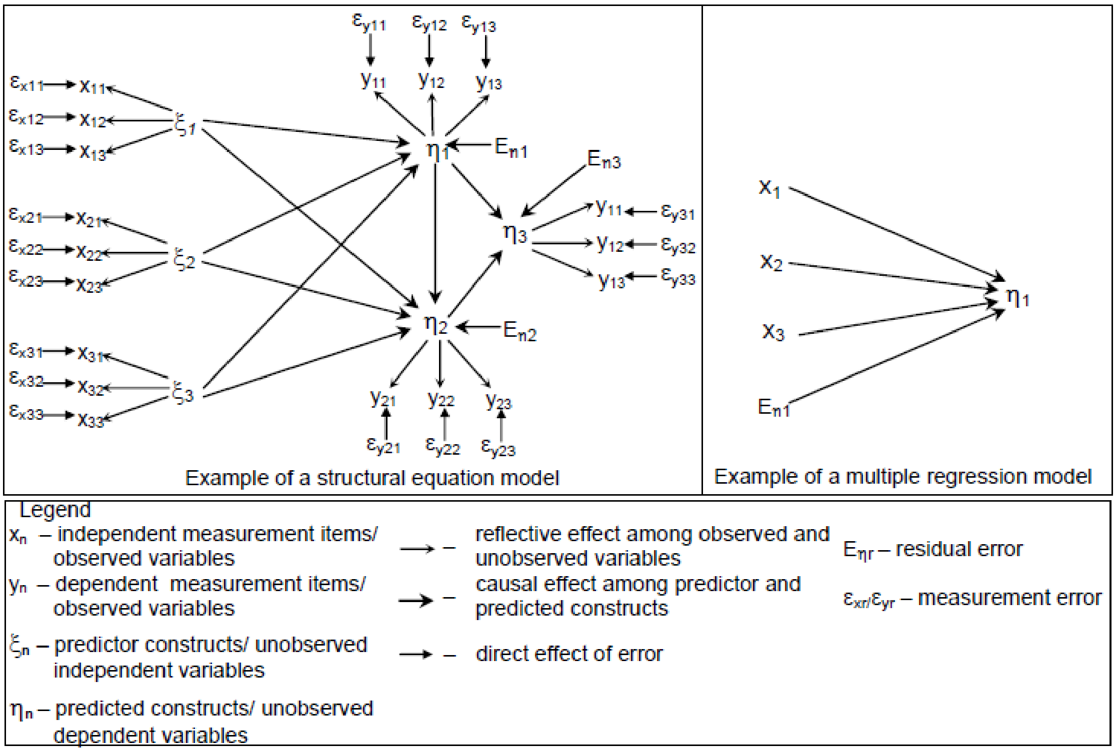


Figure 6.1 Comparison between structural equation and multiple regression models

Apart from its ability to allow for measurement errors in all observed variables (both dependent and independent variables, i.e., ε_{xn} and ε_{yn} in Figure 6.1), the SEM technique has incorporated extension statistical functions, i.e., confirmatory factor analysis and path analysis into its modelling framework to allow for comprehensive measurement models (Bollen and Lennox, 1991; Kline, 1998). Through this integration, maximally efficient fit between data and a structural model is likely to occur since both confirmatory factor analysis and path analysis are executed simultaneously in a single structural equation model (Amoroso and Cheney, 1991). This is one condition which cannot be fulfilled via the first generation multivariate analysis techniques, especially regression models.

According to Kline (1998) and Wang and Li (2007), confirmatory factor analysis is an extension of the exploratory factor analysis function, which contains inferential statistics that permit: (i) the testing of hypotheses regarding the uni-dimensionality of a set of measurement items of individual constructs, and (ii) the testing of significance of the factor loadings of measurement items using a statistical *t*-test analysis. For these reasons, confirmatory factor analysis leads to a stricter and more objective interpretation of uni-dimensionality (i.e., whether a set of empirical measurement items is related to an underlying construct), and a more comprehensive understanding of significance of measurement items as compared to exploratory factor analysis.

Likewise, through the path analysis function, SEM facilitates the specification and examination of multiple structural relationships between identified constructs based on a priori assumptions derived from the literature (Bollen and Lennox, 1991; Kline, 1998). Due to the complex structural relationships involved, this form of analysis cannot be conducted with a standard regression analysis (Kline, 1988; Dilalla, 2000). It should be noted that the concept of uni-dimensionality, and the exploratory factor analysis, confirmatory factor analysis and path analysis functions will be discussed in details in separate sections (see Sections 6.4.3 and 6.4.4).

In addition to the foregoing superiority of SEM over conventional multivariate techniques, the justification for using the SEM technique in this study is as follows. It allows (Chin, 1998a; 1998b; Dilalla, 2000):

(i) estimation of simultaneous relationships among measurement items of respective constructs, and between multiple predictor and predicted constructs;
(ii) construction of multiple constructs, a condition that is very difficult to achieve in multiple regression modelling. In this case, constructs like employees' skills

and behaviour, technological capabilities and organizational flexibility can be modelled to test the complex association among them; and

(iii) statistical test on a priori theoretical and measurement assumptions against empirical data via confirmatory analysis (i.e. confirmatory factor analysis and path analysis). Here, the survey data were used to test the hypotheses described in Chapter 4.

6.3 Types of SEM approach

There are two types SEM-based analytical approaches, namely covariance- and component-based SEM approaches. The covariance-based approach has been well-accepted in social science research, and is almost indistinguishable from the generic term SEM (Chin, 1998a). It should be noted that the covariance-based SEM approach has been attached to social science research since the 1970s when Joreskog (1973) developed the concept of maximum likelihood covariance structure analysis, and subsequently commercialized the concept into the computer software known as LISREL (Joreskog and Sorbom, 1978). Following the increasing popularity of the covariance-based SEM approach, other software packages have been commercialized over the last few decades. These include software packages such as AMOS, EQS, Mplus, SEPATH and RAMONA.

The component-based approach, which is also known as partial least square (PLS) method, is the other type of SEM-based analytical approach (Wold, 1975; Fornell and Bookstein, 1982). The PLS method is a variance-based causal modelling approach developed in the 1960s by Herman Wold who presented two iterative procedures using least square estimation for single- and multiple-component models and for canonical correlation (Wold, 1966; 1975). According to Wold (1975), PLS could be used to avoid some restrictive assumptions underlying the maximum likelihood estimation of LISREL. Nonetheless, Wold (1982) and Chin and Newstead (1999) take the view that PLS and LISREL are complementary rather than competitive in that they complement the weaknesses of one another. There are also commercial and academic software packages available to analyse PLS-based models. These include software packages such as LVPLS, PLS-GUI, VisualPLS, PLS-graph and SmartPLS.

6.3.1 Comparison between covariance-based SEM and component-based SEM

Having discussed the background of the two SEM approaches, it is noted that there are differences between covariance-based and component-based SEM approaches in terms of their objective, approach, assumptions, parameter estimation, latent variable (construct) score, sample size requirement, etc. Table 6.2 shows the detailed comparisons of these criteria between these two SEM approaches.

Table 6.2 Comparison of component-based and covariance-based SEM approaches

Criterion	Covariance-based	Component-based (PLS)
Objective	Parameter oriented	Prediction oriented
Approach	Covariance based	Variance based
Assumptions	Typically multivariate, normally distributed and independent observations (parametric)	Predictor specification/no specific requirements (non-parametric)
Parameter estimates	Consistent	Consistent as indictors and sample size increases (i.e. consistency at large)
Latent variable (construct) score	Indeterminate	Explicitly estimated
Epistemic relationship between a latent variable and its measures	Typically only with reflective indicator	Can be modelled in either formative or reflective mode
Implication	Optimal for parameter accuracy	Optimal for prediction accuracy
Model complexity	Small to moderate complexity (e.g., less than 100 indicators)	Large complexity (e.g., 100 constructs and 1000 indicators)
Sample size	Ideally based on power analysis of specific model – minimal recommendations range from 200 to 800 cases.	Power analysis based on the portion of the model with the largest number of predictors. Minimal recommendations range from 30 to 100 cases

Adapted from: Chin and Newstead (1999)

The main difference between these two SEM approaches lies in their objective. According to Joreskog and Wold (1982), the covariance-based SEM approach is best used for theory testing and development, while the component-based SEM approach is more oriented towards predictive applications. In term of estimation approach, the covariance-based SEM approach uses the maximum likelihood estimation and attempts to minimize the difference between the sample covariance and those predicted by the model. The component-based SEM approach, on the other hand, uses least square estimation and attempts to maximize the variance explained for constructs and parameter estimates by minimizing each residual variance separately for improved prediction of corresponding constructs (Fornell and Bookstein, 1982; Chin and Newstead; 1999).

The other difference is that the covariance-based SEM approach tends to be more restrictive and problematic to use than the component-based SEM approach (Fornell and Bookstein, 1982; Chin and Newstead, 1999). The former requires: (i) the observations to be normally distributed and independent of one another; and (ii) a large sample size (ranging from 200 to 800 sets of data). Furthermore, it tends to face problems with complex modelling in terms of fit indices and computation (see Chin, 1998a).

On the other hand, the component-based SEM approach is more exploratory (Chin, 1998a; Chin et al., 2003). First, it is not constrained by the normality assumption and does not require a large sample size. Second, it allows the use of non-interval scaled data (for example, ordinal-scaled data). Third, this approach tends to estimate constructs as linear combinations of observed variables using weight relations, and thereby it avoids the indeterminacy and provides an exact definition of constructs' scores (Fornell and Bookstein, 1982; Chin and Newstead, 1999). Since this approach operates on the relationships between observed variables and their corresponding constructs as a series of interdependent ordinary least square (OLS) regressions, there is no identification problems for recursive PLS (i.e., one way path) models nor any distributional requirements for observed variables (Fornell and Bookstein, 1982; Chin and Newstead, 1999).

According to Chin et al. (2003), the component-based SEM approach is a more comprehensive modelling technique since it comprises many other first generation multivariate analysis techniques. These include: (i) canonical correlation; (ii) redundancy analysis; (iii) multiple regression; (iv) MANOVA; (v) factor analysis; and (vi) principal components analysis. Therefore, it is more suitable for, and capable of explaining complex relationships among multiple predicted and predictor constructs (Fornell et al., 1990; Chin et al., 2003).

6.3.2 Justification for using PLS approach

Taking into consideration the characteristics of both SEM approaches in tandem with the exploratory nature of this research, the PLS approach (a component-based SEM) is considered as an appropriate tool for data analysis. The term 'PLS' is used hereinafter to facilitate the discussion.

Moreover, one of the major concerns in this study was the predictive power of the research model. As highlighted above, the PLS can handle a more complex model and it neither requires a large sample size (i.e., from 30 to 100 cases) nor rigorous restrictions on data distribution. In this case, it is clear that the use of the covariance-based SEM was inappropriate in that it was impossible to collect 200 to 800 dataset for this study since only 91 contractors were identified following the filtering process described in Section 5.5.4.

Also, the proposed conceptual framework for this study exhibits a high complexity with more than 10 constructs and approximately 70 measurement items, without mentioning the additional terms if one is to consider the interaction terms between variables in an attempt to test moderating effects in the proposed model. In this case, one of the research objectives is to test the moderating effects of two constructs, i.e., market and technological conditions on organizational flexibility, which made the PLS approach a more appropriate choice given its relative superiority over the covariance-based SEM approach. Indeed, the constructs' scores needed in this study to develop the flexibility index can only be obtained by using a PLS approach, the covariance-based SEM approach does not provide these results (Hsu et al., 2006).

However, the PLS approach does have its disadvantages that need to be mentioned here. First, the parameter estimates in PLS will be asymptotically correct only under the joint conditions of consistency (sample size becomes large) and consistency at large (the number of indicators or measurement items per construct becomes large). The consequence for failure to address this disadvantage is that the correlations between constructs will tend to be underestimated, whereas the correlations of the observed variables with their respective constructs will tend to be overestimated (Dijkstra, 1983). Nonetheless, Fornell and Cha (1994) noted that the prediction quality of the PLS remains unaffected since (i) these two effects approximately even out, and (ii) the order of effects and their relations to each other remain almost proportional. Second, the parameter estimates in PLS are not as efficient as full-information estimates (i.e., covariance-based SEM) at which jackknife or bootstrap procedures are required to obtain estimates of standard errors of the parameter estimates (Dijkstra, 1983).

The above two shortcomings of the PLS approach should not outweigh its suitability in this research. Here, the sample size of 40 cases is considered adequate for the modelling purposes (Wixom and Watson, 2001; Aibinu et al., 2008), and for each construct, at least three indicators or measurement items were taken into account in designing the structured questionnaire (see Section 5.4.1). To obtain the standard errors of the parameter estimate, bootstrapping method was adopted in this study and will be examined subsequently.

6.4 The PLS modelling process

Figure 6.2 presents the PLS modelling process in this study that consists of five major steps. Upon satisfying the PLS requirements of the data sample, the SmartPLS2.0 M3 (Ringle et al., 2005), a Java-based statistical software, was used to execute the iterative process on the PLS models specified in this study. This statistical software, which was developed by a project team at the Institute of Operations Management and Organizations (School of Business) from the University of Hamburg, has an in-built bootstrapping technique for estimating the standard errors of parameter estimates. Apart from its integrated statistical functions, justifications for choosing the SmartPLS2.0 M3 software are provided below.

(i) A web-based discussion forum is created for the SmartPLS community to discuss all software and PLS-related topics with users and experts. This forum is monitored by three professors, from the School of Business of the University of Hamburg, who provide advice to researchers across different disciplines. This provides the necessary support on the application of the PLS modelling technique in this study.

(ii) The SmartPLS software has been widely used by previous studies focusing on different areas, such as (i) business management research (Gudergan et al., 2008; Guenzi et al., 2008; Jenson, 2008), and (ii) information system research (Vance et al., 2008). This attests to the creditability of this software.

(iii) Compared with other PLS-related software, as discussed in Section 6.3, the SmartPLS is identified as one of the most user-friendly software (Temme et al., 2006). According to Vance et al. (2008), the SmartPLS software is comparable to the PLS-graph developed by Chin (1998a) from the University of Houston; where the former is based on the same method and offers similar features but with an improved graphical interface.

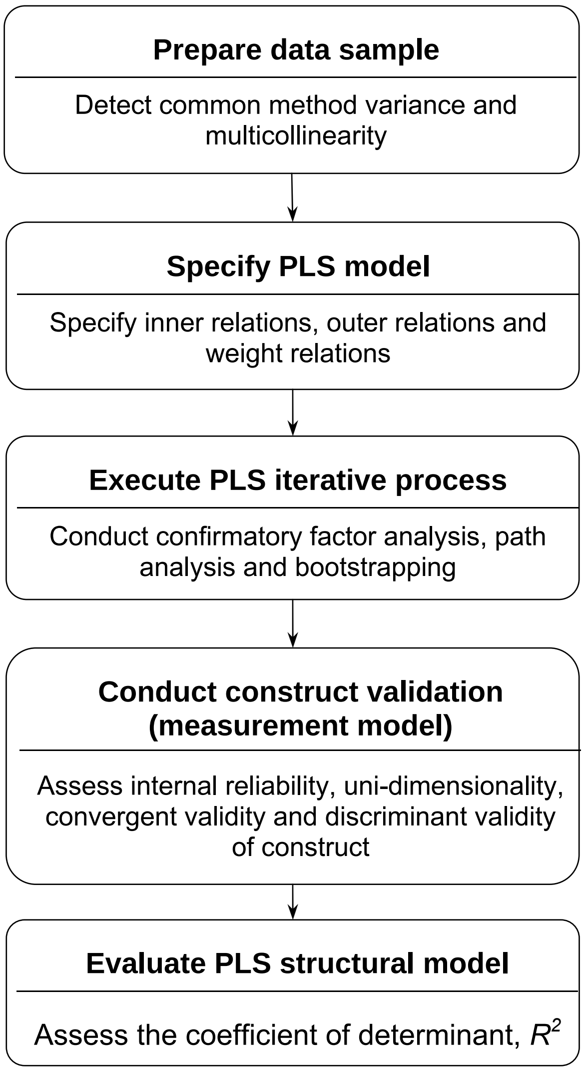


Figure 6.2 The PLS modelling process

6.4.1 Preparation of sample data

Before embarking on the data analysis, the two potential inherent problems (i.e., common method variance and multi-collinearity) in the sample data of this study were first addressed. The following provides an account of the methods adopted to detect the presence of these two potential problems.

6.4.1.1 Common method variance

Common method variance can be defined as the overlap in variance between two variables attributable to the type of measurement instrument used rather than due to the inherent relationships between the underlying constructs (Glick et al., 1986; Avolio and Bass, 1991). Although the use of self-report retrospective data is common in management research, it can, under certain conditions, either inflate or suppress the extent of relationships being investigated and cause common method variance problems (William et al., 1989; Strandholm et al., 2004).

Self-report data create the most variance problems in topics that evoke strong sentiments, such as stress and job satisfaction (Boyd and Fulk, 1996); or evoke socially desirable responses, leading to a compressed response range (Podsakoff and Organ, 1986). Hence, it is imperative to address the potential problems of common method variance in this study since the data obtained are primarily subjective and from a single key informant source. Various measures have been adopted during the data collection stage to minimize any possible distorted self-reports and socially desirable answers which, in turn, limiting the possibility of common method variance problems (see Section 5.5.5).

In addition, a formal test using the Harman's (1967) one-factor test was performed to address the issue of common method variance. This test involves entering all the independents and dependent variables into an exploratory factor analysis. Common method variance is a substantial problem if there is a single factor that accounts for a disproportionately large variance in the data sample. The results of this test show that a 23-factor solution emerged explaining 89.72% of the variance with no single factor accounting for more than 17% of the variance in the data sample. Thus, no corrective measure is required in this data preparation process.

6.4.1.2 Multicollinearity

Multicollinearity presents a problem of the presence of significant correlation among independent variables in a regression model. Such a problem is more likely to occur when moderating (or interaction) terms are employed because the multiplicative effect in creating cross-product terms may result in high levels of multicollinearity. However, Cronbach (1987) demonstrated that this is not a substantial problem, but can be a practical problem because high correlations between predictors can cause computational errors in standard computer programs.

In this study, the concern of multicollinearity needs to be addressed in two aspects: (i) the multicollinearity within individual blocks of measurement items used to represent respective underlying constructs, and (ii) the multicollinearity among predictor constructs in structural equation models. For the former, the coefficient of each measurement item in individual blocks under the reflective mode, is based on simple regression, and thus is not affected by multicollinearity (Fornell and Bookstein 1982). As for the test for the presence of multicollinearity among predictor constructs, a formal test suggested by Neter et al. (1990) was performed to obtain the variance inflation factors (VIF) values for all predictor constructs and the respective mean VIF values. The results of this test show that all VIF values and mean VIF values are below the suggested threshold level of 10 and 1, respectively. Thus, no corrective measure is required in the multicollinearity check.

Having satisfied the above checks, the sample data was entered in the required format specified in the SmartPLS2.0 M3 statistical software. As an inbuilt introductory function of the PLS software, the formatted sample data further underwent a validation check to ensure data consistency and compatibility before starting other modelling processes such as (i) confirmatory factor analysis; (ii) path analysis; and (iii) bootstrapping (see Section 6.4.3).

6.4.2 The PLS model specification

This section presents the two PLS model specifications of this study. Each of the specified PLS models consists of three types of relationships: (i) inner relation, which specifies the relationship between constructs; (ii) outer relation, which specifies the relationship between constructs and their respective observed variables; and (iii) weight relation upon which estimates for constructs' scores can be estimated.

Corresponding to the second objective of this research, i.e., to identify the key determinants of organizational flexibility, the PLS model one (PLS M1) is shown in Figure 6.3. PLS M1 consists of 11 predictor constructs (or independent constructs, ξ) in relation to a construction firm's resources, capabilities and strategies, which form the key determinants for the three-dimensional organizational flexibility construct, η (i.e., operational flexibility, tactical flexibility and strategic flexibility). The arrows represent the relationships between the three flexibility dimensions and 11 predictor constructs. The parameter estimates are imposed on the PLS M1 (for example, $\lambda_{1.1}$ $\lambda_{1.2}$, and $\lambda_{1.3}$) to facilitate the development of structural equations (inner relations) among constructs. Table 6.3 shows the three structural equations formed in PLS M1.

Table 6.4, on the other hand, shows the associated outer and weight relations between the constructs and their corresponding measurement items of the PLS M1. In this case, a total of 67 measurement equations are derived to represent the outer reflective relations between the constructs and their corresponding measurement items (i.e. measurement models), together with the 14 weight relations between the constructs and their corresponding measurement items.

A theoretical PLS model two (PLS M2) corresponding to the third objective of this study is considered next. Figure 6.4 shows the PLS M2 constructed to examine the effects of interrelationships among the key determinants on organizational flexibility. The overall conceptual linkages among the constructs start with three predictor constructs (or independent constructs, ξ) that are linked to 11 predicted constructs (or dependent constructs, η). Table 6.5 shows the eleven structural equations representing the inner relations among the constructs, using the imposed parameter estimates. Similarly, these inner relations are developed based on the propositions established in Chapter 4. Both the outer and weight relations between the constructs and their corresponding measurement items are shown next in Table 6.6.

It should be noted that, without any loss of generality, all observed variables are standardized to have zero means and unit variances so that constant terms can be eliminated in all proposed equations listed in Tables 6.3 to 6.6. This completes the PLS model specification process at which the SmartPLS2.0 M3 statistical software was used to execute both PLS M1 and M2.

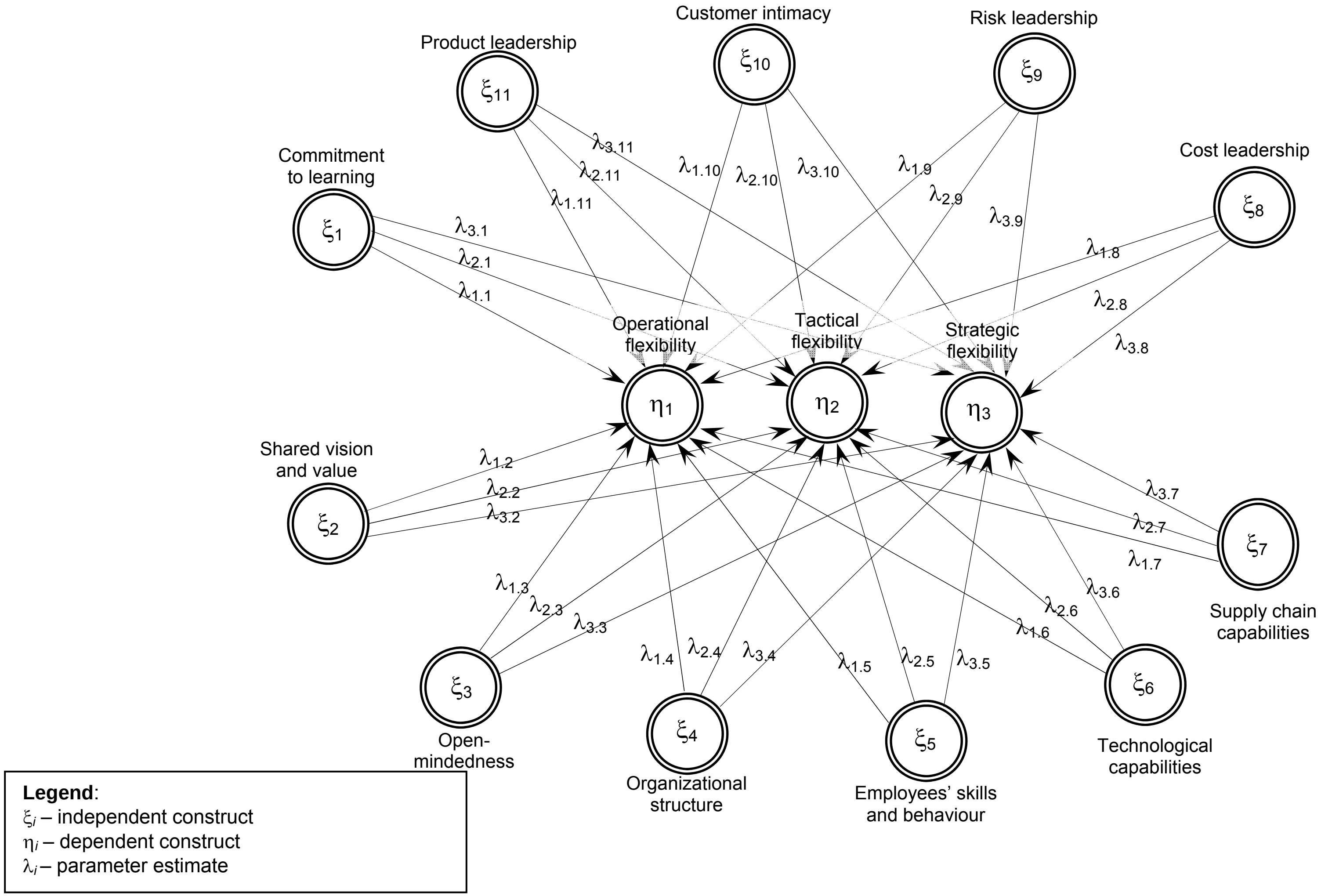


Figure 6.3 PLS M1 constructed to test significance of determinants of organizational flexibility

Table 6.3 Inner relations (structural relationships) among constructs for PLS M1

Inner relations - Latent structural equations ($\eta_i = \lambda_\gamma\xi_r + \Omega_i$)
$\eta_1 = \lambda_{1.1}\xi_1 + \lambda_{1.2}\xi_2 + \lambda_{1.3}\xi_3 + \lambda_{1.4}\xi_4 + \lambda_{1.5}\xi_5 + \lambda_{1.6}\xi_6 + \lambda_{1.7}\xi_7 + \lambda_{1.8}\xi_8 + \lambda_{1.9}\xi_9 + \phi_{1.10}\xi_{10} + \phi_{1.11}\xi_{11} + \Omega_1$
$\eta_2 = \lambda_{2.1}\xi_1 + \lambda_{2.2}\xi_2 + \lambda_{2.3}\xi_3 + \lambda_{2.4}\xi_4 + \lambda_{2.5}\xi_5 + \lambda_{2.6}\xi_6 + \lambda_{2.7}\xi_7 + \lambda_{2.8}\xi_8 + \lambda_{2.9}\xi_9 + \phi_{2.10}\xi_{10} + \phi_{2.11}\xi_{11} + \Omega_2$
$\eta_3 = \lambda_{3.1}\xi_1 + \lambda_{3.2}\xi_2 + \lambda_{3.3}\xi_3 + \lambda_{3.4}\xi_4 + \lambda_{3.5}\xi_5 + \lambda_{3.6}\xi_6 + \lambda_{3.7}\xi_7 + \lambda_{3.8}\xi_8 + \lambda_{3.9}\xi_9 + \phi_{3.10}\xi_{10} + \phi_{3.11}\xi_{11} + \Omega_3$

Table 6.4 Outer relations and weight relations between constructs and their corresponding observed variables for PLS M1

Construct	**Observed variables (measurement items) – Indicator code**	**Outer relation reflective measurement equations** ($x_s = \lambda_x\xi_r + \varepsilon_x$, $y_s = \lambda_y\eta_\beta + \varepsilon_y$)	**Weight relations** ($\xi_r = \omega_{\xi r}x_s$, $\eta_\beta = \omega_{\eta\beta}y_s$)
Commitment to Learning (ξ_1)	$x_{1.1}$ – CL1, $x_{1.2}$ – CL2, $x_{1.3}$ – CL3	$x_{1.1} = \lambda_{x1.1}\xi_1 + \varepsilon_{x1.1}$, $x_{1.2} = \lambda_{x1.2}\xi_1 + \varepsilon_{x1.2}$, $x_{1.3} = \lambda_{x1.3}\xi_1 + \varepsilon_{x1.3}$	$\omega_{\xi 1.1}x_{1.1} + \omega_{\xi 1.2}x_{1.2} + \omega_{\xi 1.3}x_{1.3}$
Shared vision and value (ξ_2)	$x_{2.1}$ – SV1, $x_{2.2}$ –SV2, $x_{2.3}$ – SV3, $x_{2.4}$ – SV4	$x_{2.1} = \lambda_{x2.1}\xi_2 + \varepsilon_{x2.1}$, $x_{2.2} = \lambda_{x2.2}\xi_2 + \varepsilon_{x2.2}$, $x_{2.3} = \lambda_{x2.3}\xi_2 + \varepsilon_{x2.3}$ $x_{2.4} = \lambda_{x2.4}\xi_2 + \varepsilon_{x2.4}$	$\omega_{\xi 2.1}x_{2.1} + \omega_{\xi 2.2}x_{2.2} + \omega_{\xi 2.3}x_{2.3} + \omega_{\xi 2.4}x_{2.4}$
Open-mindedness (ξ_3)	$x_{3.1}$ –O1, $x_{3.2}$ – O2, $x_{3.3}$ - O3	$x_{3.1} = \lambda_{x3.1}\xi_3 + \varepsilon_{x3.1}$, $x_{3.2} = \lambda_{x3.2}\xi_1 + \varepsilon_{x3.2}$, $x_{3.3} = \lambda_{x3.3}\xi_1 + \varepsilon_{x3.3}$	$\omega_{\xi 3.1}x_{3.1} + \omega_{\xi 3.2}x_{3.2} + \omega_{\xi 3.3}x_{3.3}$
Organizational structure (ξ_4)	$x_{4.1}$ –OS1, $x_{4.2}$ –OS2, $x_{4.3}$ –OS3, $x_{4.4}$ –OS4	$x_{4.1} = \lambda_{x4.1}\xi_4 + \varepsilon_{x4.1}$, $x_{4.2} = \lambda_{x4.2}\xi_4 + \varepsilon_{x4.2}$, $x_{4.3} = \lambda_{x4.3}\xi_4 + \varepsilon_{x4.3}$, $x_{4.4} = \lambda_{x4.4}\xi_4 + \varepsilon_{x4.4}$	$\omega_{\xi 4.1}x_{4.1} + \omega_{\xi 4.2}x_{4.2} + \omega_{\xi 4.3}x_{4.3} + \omega_{\xi 4.4}x_{4.4}$
Employees' skills and behaviour (ξ_5)	$x_{5.1}$ – ESB1, $x_{5.2}$ – ESB2, $x_{5.3}$ – ESB3, $x_{5.4}$ – ESB4, $x_{5.5}$ – ESB5, $x_{5.6}$ – ESB6, $x_{5.7}$ – ESB7, $x_{5.8}$ – ESB8	$x_{5.1} = \lambda_{x5.1}\xi_5 + \varepsilon_{x5.1}$, $x_{5.2} = \lambda_{x5.2}\xi_5 + \varepsilon_{x5.2}$, $x_{5.3} = \lambda_{x5.3}\xi_5 + \varepsilon_{x5.3}$, $x_{5.4} = \lambda_{x5.4}\xi_5 + \varepsilon_{x5.4}$, $x_{5.5} = \lambda_{x5.5}\xi_5 + \varepsilon_{y5.5}$, $x_{5.6} = \lambda_{x5.6}\xi_5 + \varepsilon_{x5.6}$, $x_{5.7} = \lambda_{x5.7}\xi_5 + \varepsilon_{x5.7}$, $x_{5.8} = \lambda_{x5.8}\xi_5 + \varepsilon_{x5.8}$	$\omega_{\xi 5.1}x_{5.1} + \omega_{\xi 5.2}x_{5.2} + \omega_{\xi 5.3}x_{5.3} +$ $\omega_{\xi 5.4}x_{5.4} + \omega_{\xi 5.5}x_{5.5} + \omega_{\xi 5.6}x_{5.6} +$ $\omega_{\xi 5.7}x_{5.7} + \omega_{\xi 5.8}x_{5.8}$
Technological capabilities (ξ_6)	$x_{6.1}$ –IT1, $x_{6.2}$ – IT2, $x_{6.3}$ – IT3, $x_{6.4}$ – IT4, $x_{6.5}$ – PT1, $x_{6.6}$ – PT2, $x_{6.7}$ – PT3	$x_{6.1} = \lambda_{x6.1}\xi_6 + \varepsilon_{x6.1}$, $x_{6.2} = \lambda_{x6.2}\xi_6 + \varepsilon_{x6.2}$, $x_{6.3} = \lambda_{x6.3}\xi_6 + \varepsilon_{x6.3}$, $x_{6.4} = \lambda_{x6.4}\xi_6 + \varepsilon_{x6.4}$, $x_{6.5} = \lambda_{x6.5}\xi_6 + \varepsilon_{x6.5}$, $x_{6.6} = \lambda_{x6.6}\xi_6 + \varepsilon_{x6.6}$, $x_{6.7} = \lambda_{x6.7}\xi_6 + \varepsilon_{x6.7}$	$\omega_{\xi 6.1}x_{6.1} + \omega_{\xi 6.2}x_{6.2} + \omega_{\xi 6.3}x_{6.3} + \omega_{\xi 6.4}x_{6.4}$ $+ \omega_{\xi 6.5}x_{6.5} + \omega_{\xi 6.6}x_{6.6} + \omega_{\xi 6.7}x_{6.7}$

Construct	**Observed variables (measurement items) – Indicator code**	**Outer relation reflective measurement equations** ($x_s = \lambda_x\xi_r + \varepsilon_x$, $y_s = \lambda_y\eta_\beta + \varepsilon_y$)	**Weight relations** ($\xi_r = \omega_{\xi r}x_s$, $\eta_\beta = \omega_{\eta\beta}y_s$)
Supply chain capabilities (ξ_7)	$x_{7.1}$ –SC1, $x_{7.2}$ – SC2, $x_{7.3}$ – SC3, $x_{7.4}$ – SC4, $x_{7.5}$ – SC5, $x_{7.6}$ – SC6, $x_{7.7}$ – SC7	$x_{7.1} = \lambda_{x7.1}\xi_7 + \varepsilon_{x7.1}$, $x_{7.2} = \lambda_{x7.2}\xi_7 + \varepsilon_{x7.2}$, $x_{7.3} = \lambda_{x7.3}\xi_7 + \varepsilon_{x7.3}$, $x_{7.4} = \lambda_{x7.4}\xi_7 + \varepsilon_{x7.4}$, $x_{7.5} = \lambda_{x7.5}\xi_7 + \varepsilon_{x7.5}$, $x_{7.6} = \lambda_{x7.6}\xi_7 + \varepsilon_{x7.6}$, $x_{7.7} = \lambda_{x7.7}\xi_7 + \varepsilon_{x7.7}$	$\omega_{\xi 7.1}x_{7.1} + \omega_{\xi 7.2}x_{7.2} + \omega_{\xi 7.3}x_{7.3} + \omega_{\xi 7.4}x_{7.4} + \omega_{\xi 7.5}x_{7.5} + \omega_{\xi 7.6}x_{7.6} + \omega_{\xi 7.7}x_{7.7}$
Cost leadership (ξ_8)	$x_{8.1}$ –B9, $x_{8.2}$ – B10, $x_{8.3}$ – B14, $x_{8.4}$ – B15	$x_{8.1} = \lambda_{x8.1}\xi_8 + \varepsilon_{x8.1}$, $x_{8.2} = \lambda_{x8.2}\xi_8 + \varepsilon_{x8.2}$, $x_{8.3} = \lambda_{x8.3}\xi_8 + \varepsilon_{x8.3}$, $x_{8.4} = \lambda_{x8.4}\xi_8 + \varepsilon_{x8.4}$	$\omega_{\xi 8.1}x_{8.1} + \omega_{\xi 8.2}x_{8.2} + \omega_{\xi 8.3}x_{8.3} + \omega_{\xi 8.4}x_{8.4}$
Risk leadership (ξ_9)	$X_{9.1}$ –B5, $x_{9.2}$ – B6, $x_{9.3}$ – B8, $x_{9.4}$ – B11	$x_{9.1} = \lambda_{x9.1}\xi_9 + \varepsilon_{x9.1}$, $x_{9.2} = \lambda_{x9.2}\xi_9 + \varepsilon_{x9.2}$, $x_{9.3} = \lambda_{x9.3}\xi_9 + \varepsilon_{x9.3}$, $x_{9.4} = \lambda_{x9.4}\xi_9 + \varepsilon_{x9.4}$	$\omega_{\xi 9.1}x_{9.1} + \omega_{\xi 9.2}x_{9.2} + \omega_{\xi 9.3}x_{9.3} + \omega_{\xi 9.4}x_{9.4}$
Customer intimacy (ξ_{10})	$X_{10.1}$ –B2, $x_{10.2}$ – B3, $x_{10.3}$ – B4, $x_{10.4}$ – B13	$x_{10.1} = \lambda_{x10.1}\xi_{10} + \varepsilon_{x10.1}$, $x_{10.2} = \lambda_{x10.2}\xi_{10} + \varepsilon_{x10.2}$, $x_{10.3} = \lambda_{x10.3}\xi_{10} + \varepsilon_{x10.3}$, $x_{10.4} = \lambda_{x10.4}\xi_{10} + \varepsilon_{x10.4}$	$\omega_{\xi 10.1}x_{10.1} + \omega_{\xi 10.2}x_{10.2} + \omega_{\xi 10.3}x_{10.3} + \omega_{\xi 10.4}x_{10.4}$
Product leadership (ξ_{11})	$X_{11.1}$ –B1, $x_{11.2}$ – B7, $x_{11.3}$ – B12, $x_{11.4}$ – BS16	$x_{11.1} = \lambda_{x11.1}\xi_{11} + \varepsilon_{x11.1}$, $x_{11.2} = \lambda_{x11.2}\xi_{11} + \varepsilon_{x11.2}$, $x_{11.3} = \lambda_{x11.3}\xi_{11} + \varepsilon_{x11.3}$, $x_{11.4} = \lambda_{x11.4}\xi_{11} + \varepsilon_{x11.4}$	$\omega_{\xi 11.1}x_{11.1} + \omega_{\xi 11.2}x_{11.2} + \omega_{\xi 11.3}x_{11.3} + \omega_{\xi 11.4}x_{11.4}$
Operational flexibility (η_1)	$y_{1.1}$ – F1, $y_{1.2}$ –F2, $y_{1.3}$ –F9, $y_{1.4}$ – F10, $y_{1.5}$ – F11, $y_{1.6}$ – F14	$y_{1.1} = \lambda_{y1.1}\eta_1 + \varepsilon_{y1.1}$, $y_{1.2} = \lambda_{y1.2}\eta_1 + \varepsilon_{y1.2}$, $y_{1.3} = \lambda_{y1.3}\eta_1 + \varepsilon_{y1.3}$, $y_{1.4} = \lambda_{y1.4}\eta_1 + \varepsilon_{y1.4}$, $y_{1.5} = \lambda_{y1.5}\eta_1 + \varepsilon_{y1.5}$, $y_{1.6} = \lambda_{y1.6}\eta_1 + \varepsilon_{y1.6}$	$\omega_{\eta 1.1}y_{1.1} + \omega_{\eta 1.2}y_{1.2} + \omega_{\eta 1.3}y_{1.3} + \omega_{\eta 1.4}y_{1.4} + \omega_{\eta 1.5}y_{1.5} + \omega_{\eta 1.6}y_{1.6}$
Tactical flexibility (η_2)	$y_{2.1}$ – F3, $y_{2.2}$ – F4, $y_{2.3}$ – F5, $y_{2.4}$ – F7	$y_{2.1} = \lambda_{y2.1}\eta_2 + \varepsilon_{y2.1}$, $y_{2.2} = \lambda_{y2.2}\eta_2 + \varepsilon_{y2.2}$, $y_{2.3} = \lambda_{y2.3}\eta_2 + \varepsilon_{y2.3}$, $y_{2.4} = \lambda_{y2.4}\eta_2 + \varepsilon_{y2.4}$	$\omega_{\eta 2.1}y_{2.1} + \omega_{\eta 2.2}y_{2.2} + \omega_{\eta 2.3}y_{2.3} + \omega_{\eta 2.4}y_{2.4}$
Strategic flexibility (η_3)	$y_{3.1}$ – F6, $y_{3.2}$ –F8, $y_{3.3}$ –F12, $y_{3.4}$ – F13, $y_{3.5}$ – F15	$y_{3.1} = \lambda_{y3.1}\eta_3 + \varepsilon_{y3.1}$, $y_{3.2} = \lambda_{y3.2}\eta_3 + \varepsilon_{y3.2}$, $y_{3.3} = \lambda_{y3.3}\eta_3 + \varepsilon_{y3.3}$, $y_{3.4} = \lambda_{y3.4}\eta_3 + \varepsilon_{y3.4}$, $y_{3.5} = \lambda_{y3.5}\eta_3 + \varepsilon_{y3.5}$	$\omega_{\eta 3.1}y_{3.1} + \omega_{\eta 3.2}y_{3.2} + \omega_{\eta 3.3}y_{3.3} + \omega_{\eta 3.4}y_{3.4} + \omega_{\eta 3.5}y_{3.5}$

Note: Measurement items of respective constructs were classified based on the test result of the exploratory factor analysis in Section 7.3

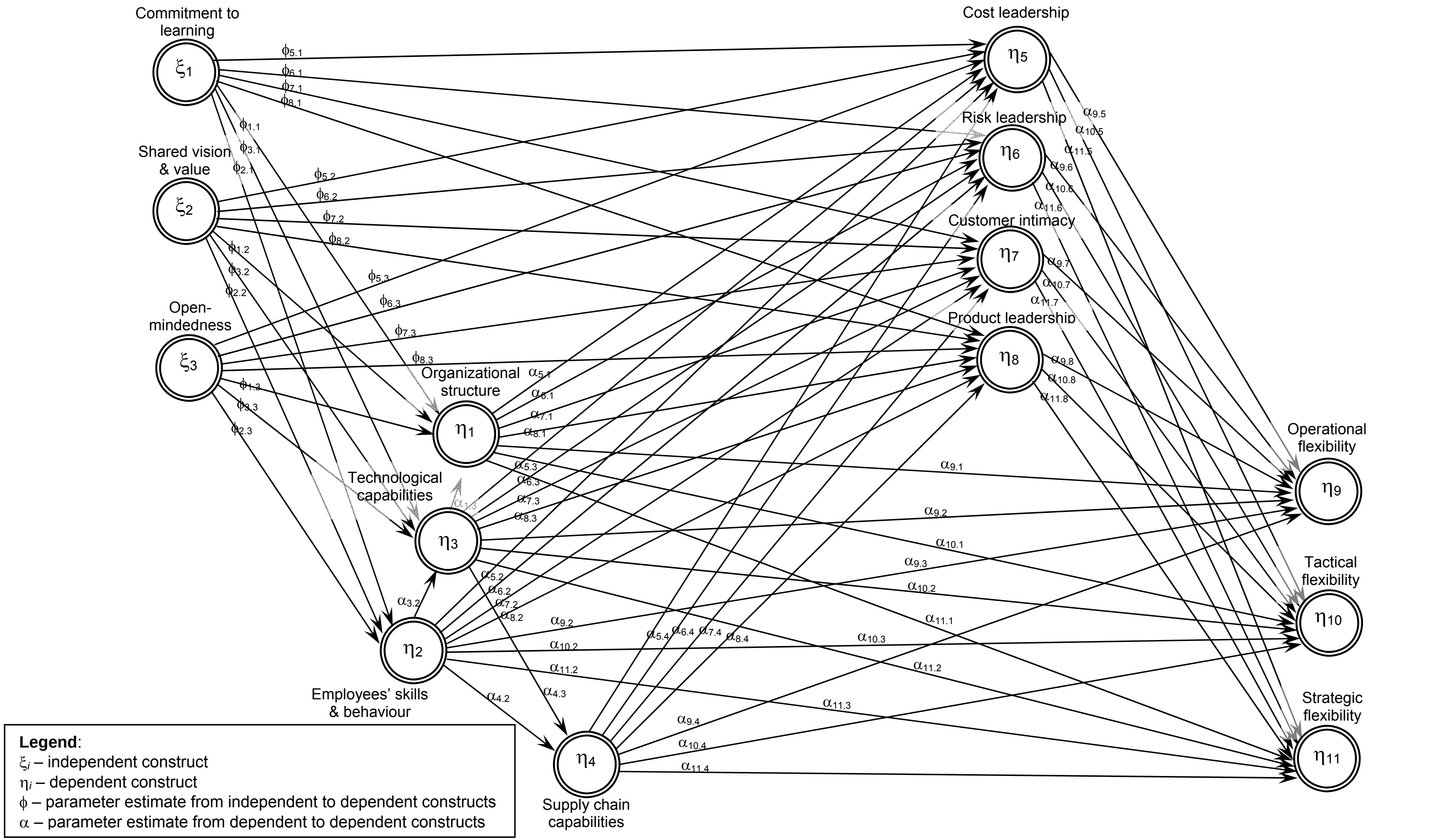


Figure 6.4 PLS M2 constructed to investigate interactions of determinants in influencing organizational flexibility

Table 6.5 Inner relations (structural relationships) among constructs for PLS M2

Inner relations - Latent structural equations ($\eta_i = \alpha_\mu\eta_\beta + \phi_\kappa\xi_r + \Omega_i$)
$\eta_1 = \alpha_{1.3}\eta_3 + \phi_{1.1}\xi_1 + \phi_{1.2}\xi_2 + \phi_{1.3}\xi_3 + \Omega_1$
$\eta_2 = \phi_{2.1}\xi_1 + \phi_{2.2}\xi_2 + \phi_{2.3}\xi_3 + \Omega_2$
$\eta_3 = \alpha_{3.2}\eta_2 + \phi_{3.1}\xi_1 + \phi_{3.2}\xi_2 + \phi_{3.3}\xi_3 + \Omega_3$
$\eta_4 = \alpha_{4.2}\eta_2 + \alpha_{4.3}\eta_3 + \Omega_4$
$\eta_5 = \alpha_{5.1}\eta_1 + \alpha_{5.2}\eta_2 + \alpha_{5.3}\eta_3 + \alpha_{5.4}\eta_4 + \phi_{5.1}\xi_1 + \phi_{5.2}\xi_2 + \phi_{5.3}\xi_3 + \Omega_5$
$\eta_6 = \alpha_{6.1}\eta_1 + \alpha_{6.2}\eta_2 + \alpha_{6.3}\eta_3 + \alpha_{6.4}\eta_4 + \phi_{6.1}\xi_1 + \phi_{6.2}\xi_2 + \phi_{6.3}\xi_3 + \Omega_6$
$\eta_7 = \alpha_{7.1}\eta_1 + \alpha_{7.2}\eta_2 + \alpha_{7.3}\eta_3 + \alpha_{7.4}\eta_4 + \phi_{7.1}\xi_1 + \phi_{7.2}\xi_2 + \phi_{7.3}\xi_3 + \Omega_7$
$\eta_8 = \alpha_{8.1}\eta_1 + \alpha_{8.2}\eta_2 + \alpha_{8.3}\eta_3 + \alpha_{8.4}\eta_4 + \phi_{8.1}\xi_1 + \phi_{8.2}\xi_2 + \phi_{8.3}\xi_3 + \Omega_8$
$\eta_9 = \alpha_{9.1}\eta_1 + \alpha_{9.2}\eta_2 + \alpha_{9.3}\eta_3 + \alpha_{9.4}\eta_4 + \alpha_{9.5}\eta_5 + \alpha_{9.6}\eta_6 + \alpha_{9.7}\eta_7 + \alpha_{9.8}\eta_8 + \Omega_9$
$\eta_{10} = \alpha_{10.1}\eta_1 + \alpha_{10.2}\eta_2 + \alpha_{10.3}\eta_3 + \alpha_{10.4}\eta_4 + \alpha_{10.5}\eta_5 + \alpha_{10.6}\eta_6 + \alpha_{10.7}\eta_7 + \alpha_{10.8}\eta_8 + \Omega_{10}$
$\eta_{11} = \alpha_{11.1}\eta_1 + \alpha_{11.2}\eta_2 + \alpha_{11.3}\eta_3 + \alpha_{11.4}\eta_4 + \alpha_{11.5}\eta_5 + \alpha_{11.6}\eta_6 + \alpha_{11.7}\eta_7 + \alpha_{11.8}\eta_8 + \Omega_{11}$

Table 6.6 Outer relations and weight relations between constructs and their corresponding observed variables for PLS M2

Construct	**Observed variables (measurement items) – Indicator code**	**Outer relation reflective measurement equations** ($x_s = \lambda_x\xi_r + \varepsilon_x$, $y_s = \lambda_y\eta_\beta + \varepsilon_y$)	**Weight relations** ($\xi_r = \omega_{\xi r}x_s$, $\eta_\beta = \omega_{\eta\beta}y_s$)
Commitment to Learning (ξ_1)	$x_{1.1}$ – CL1, $x_{1.2}$ – CL2, $x_{1.3}$ – CL3	$x_{1.1} = \lambda_{x1.1}\xi_1 + \varepsilon_{x1.1}$, $x_{1.2} = \lambda_{x1.2}\xi_1 + \varepsilon_{x1.2}$, $x_{1.3} = \lambda_{x1.3}\xi_1 + \varepsilon_{x1.3}$	$\omega_{\xi 1.1}x_{1.1} + \omega_{\xi 1.2}x_{1.2} + \omega_{\xi 1.3}x_{1.3}$
Shared vision and value (ξ_2)	$x_{2.1}$ –SV1, $x_{2.2}$ – SV2, $x_{2.3}$ - SV3, $x_{2.4}$ – SV4	$x_{2.1} = \lambda_{x2.1}\xi_2 + \varepsilon_{x2.1}$, $x_{2.2} = \lambda_{x2.2}\xi_2 + \varepsilon_{x2.2}$, $x_{2.3} = \lambda_{x2.3}\xi_2 + \varepsilon_{x2.3}$, $x_{2.4} = \lambda_{x2.4}\xi_2 + \varepsilon_{x2.4}$	$\omega_{\xi 2.1}x_{2.1} + \omega_{\xi 2.2}x_{2.2} + \omega_{\xi 2.3}x_{2.3} + \omega_{\xi 2.4}x_{2.4}$
Open-mindedness (ξ_3)	$x_{3.1}$ – O1, $x_{3.2}$ –O2, $x_{3.3}$ – O3	$x_{3.1} = \lambda_{x3.1}\xi_3 + \varepsilon_{x3.1}$, $x_{3.2} = \lambda_{x3.2}\xi_1 + \varepsilon_{x3.2}$, $x_{3.3} = \lambda_{x3.3}\xi_1 + \varepsilon_{x3.3}$	$\omega_{\xi 3.1}x_{3.1} + \omega_{\xi 3.2}x_{3.2} + \omega_{\xi 3.3}x_{3.3}$
Organizational structure (η_1)	$y_{1.1}$ –OS1, $y_{1.2}$ –OS2, $y_{1.3}$ –OS3, $y_{1.4}$ –OS4	$y_{1.1} = \lambda_{y1.1}\eta_1 + \varepsilon_{y1.1}$, $y_{1.2} = \lambda_{y1.2}\eta_1 + \varepsilon_{y1.2}$, $y_{1.3} = \lambda_{y1.3}\eta_1 + \varepsilon_{y1.3}$, $y_{1.4} = \lambda_{y1.4}\eta_1 + \varepsilon_{y1.4}$	$\omega_{\eta 1.1}y_{1.1} + \omega_{\eta 1.2}y_{1.2} + \omega_{\eta 1.3}y_{1.3} + \omega_{\eta 1.4}y_{1.4}$

Construct	Observed variables (measurement items) – Indicator code	Outer relation reflective measurement equations ($x_s = \lambda_x\xi_r + \varepsilon_x$, $y_s = \lambda_y\eta_\beta + \varepsilon_y$)	Weight relations ($\xi_r = \omega_{\xi r}x_s$, $\eta_\beta = \omega_{\eta\beta}y_s$)
Employees' skills and behaviour (η_2)	$y_{2.1}$ – ESB1, $y_{2.2}$ – ESB2, $y_{2.3}$ – ESB3, $y_{2.4}$ – ESB4, $y_{2.5}$ – ESB5, $y_{2.6}$ – ESB6, $y_{2.7}$ – ESB7, $y_{2.8}$ – ESB8	$y_{2.1} = \lambda_{y2.1}\eta_2 + \varepsilon_{y2.1}$, $y_{2.2} = \lambda_{y2.2}\eta_2 + \varepsilon_{y2.2}$, $y_{2.3} = \lambda_{y2.3}\eta_2 + \varepsilon_{y2.3}$, $y_{2.4} = \lambda_{y2.4}\eta_2 + \varepsilon_{y2.4}$, $y_{2.5} = \lambda_{y2.5}\eta_2 + \varepsilon_{y2.5}$, $y_{2.6} = \lambda_{y2.6}\eta_2 + \varepsilon_{y2.6}$, $y_{2.7} = \lambda_{y2.7}\eta_2 + \varepsilon_{y2.7}$, $y_{2.8} = \lambda_{y2.8}\eta_2 + \varepsilon_{y2.8}$	$\omega_{\eta2.1}y_{2.1} + \omega_{\eta2.2}y_{2.2} + \omega_{\eta2.3}y_{2.3} + \omega_{\eta2.4}y_{2.4} + \omega_{\eta2.5}y_{2.5} + \omega_{\eta2.6}y_{2.6} + \omega_{\eta2.7}y_{2.7} + \omega_{\eta2.8}y_{2.8}$
Technological capabilities (η_3)	$y_{3.1}$ –IT1, $y_{3.2}$ – IT2, $y_{3.3}$ – IT3, $y_{3.4}$ – IT4, $y_{3.5}$ – PT1, $y_{3.6}$ – PT2, $y_{3.7}$ – PT3	$y_{3.1} = \lambda_{y3.1}\eta_3 + \varepsilon_{y3.1}$, $y_{3.2} = \lambda_{y3.2}\eta_3 + \varepsilon_{y3.2}$, $y_{3.3} = \lambda_{y3.3}\eta_3 + \varepsilon_{y3.3}$, $y_{3.4} = \lambda_{y3.4}\eta_3 + \varepsilon_{y3.4}$, $y_{3.5} = \lambda_{y3.5}\eta_3 + \varepsilon_{y3.5}$, $y_{3.6} = \lambda_{y3.6}\eta_3 + \varepsilon_{y3.6}$, $y_{3.7} = \lambda_{y3.7}\eta_3 + \varepsilon_{y3.7}$	$\omega_{\eta3.1}y_{3.1} + \omega_{\eta3.2}y_{3.2} + \omega_{\eta3.3}y_{3.3} + \omega_{\eta3.4}y_{3.4} + \omega_{\eta3.5}y_{3.5} + \omega_{\eta3.6}y_{3.6} + \omega_{\eta3.7}y_{3.7}$
Supply chain capabilities (η_4)	$y_{4.1}$ –SC1,$y_{4.2}$ – SC2, $y_{4.3}$ – SC3, $y_{4.4}$ – SC4, $y_{4.5}$ – SC5, $y_{4.6}$ – SC6, $y_{4.7}$ – SC7	$y_{4.1} = \lambda_{y4.1}\eta_4 + \varepsilon_{y4.1}$, $y_{4.2} = \lambda_{y4.2}\eta_4 + \varepsilon_{y4.2}$, $y_{4.3} = \lambda_{y4.3}\eta_4 + \varepsilon_{y4.3}$, $y_{4.4} = \lambda_{y4.4}\eta_4 + \varepsilon_{y4.4}$, $y_{4.5} = \lambda_{y4.5}\eta_4 + \varepsilon_{y4.5}$, $y_{4.6} = \lambda_{y4.6}\eta_4 + \varepsilon_{y4.6}$, $y_{4.7} = \lambda_{y4.7}\eta_4 + \varepsilon_{y4.7}$	$\omega_{\eta4.1}y_{4.1} + \omega_{\eta4.2}y_{4.2} + \omega_{\eta4.3}y_{4.3} + \omega_{\eta4.4}y_{4.4} + \omega_{\eta4.5}y_{4.5} + \omega_{\eta4.6}y_{4.6} + \omega_{\eta4.7}y_{4.7}$
Cost leadership (η_5)	$y_{5.1}$ –B9, $y_{5.2}$ – B10, $y_{5.3}$ – B14, $y_{5.4}$ – B15	$y_{5.1} = \lambda_{y5.1}\eta_5 + \varepsilon_{y5.1}$, $y_{5.2} = \lambda_{y5.2}\eta_5 + \varepsilon_{y5.2}$, $y_{5.3} = \lambda_{y5.3}\eta_5 + \varepsilon_{y5.3}$, $y_{5.4} = \lambda_{y5.4}\eta_5 + \varepsilon_{y5.4}$	$\omega_{\eta5.1}y_{5.1} + \omega_{\eta5.2}y_{5.2} + \omega_{\eta5.3}y_{5.3} + \omega_{\eta5.4}y_{5.4}$
Risk leadership (η_6)	$y_{6.1}$ –B5, $y_{6.2}$ – B6, $y_{6.3}$ – B8, $y_{6.4}$ – B11	$y_{6.1} = \lambda_{y6.1}\eta_6 + \varepsilon_{y6.1}$, $y_{6.2} = \lambda_{y6.2}\eta_6 + \varepsilon_{y6.2}$, $y_{6.3} = \lambda_{y6.3}\eta_6 + \varepsilon_{y6.3}$, $y_{6.4} = \lambda_{y6.4}\eta_6 + \varepsilon_{y6.4}$	$\omega_{\eta6.1}y_{6.1} + \omega_{\eta6.2}y_{6.2} + \omega_{\eta6.3}y_{6.3} + \omega_{\eta6.4}y_{6.4}$
Customer intimacy (η_7)	$y_{7.1}$ –B2, $y_{7.2}$ – B3, $y_{7.3}$ – B4, $y_{7.4}$ – B13	$y_{7.1} = \lambda_{y7.1}\eta_7 + \varepsilon_{y7.1}$, $y_{7.2} = \lambda_{y7.2}\eta_7 + \varepsilon_{y7.2}$, $y_{7.3} = \lambda_{y7.3}\eta_7 + \varepsilon_{y7.3}$, $y_{7.4} = \lambda_{y7.4}\eta_7 + \varepsilon_{y7.4}$	$\omega_{\eta7.1}y_{7.1} + \omega_{\eta7.2}y_{7.2} + \omega_{\eta7.3}y_{7.3} + \omega_{\eta7.4}y_{7.4}$
Product leadership (η_8)	$y_{8.1}$ –B1, $y_{8.2}$ – B7, $y_{8.3}$ – B12, $y_{8.4}$ – B16	$y_{8.1} = \lambda_{y8.1}\eta_8 + \varepsilon_{y8.1}$, $y_{8.2} = \lambda_{y8.2}\eta_8 + \varepsilon_{y8.2}$, $y_{8.3} = \lambda_{y8.3}\eta_8 + \varepsilon_{y8.3}$, $y_{8.4} = \lambda_{y8.4}\eta_8 + \varepsilon_{y8.4}$	$\omega_{\eta8.1}y_{8.1} + \omega_{\eta8.2}y_{8.2} + \omega_{\eta8.3}y_{8.3} + \omega_{\eta8.4}y_{8.4}$
Operational flexibility (η_9)	$y_{9.1}$ – F1, $y_{9.2}$ –F2, $y_{9.3}$ –F9, $y_{9.4}$ – F10, $y_{9.5}$ – F11, $y_{9.6}$ – F14	$y_{9.1} = \lambda_{y9.1}\eta_9 + \varepsilon_{y9.1}$, $y_{9.2} = \lambda_{y9.2}\eta_9 + \varepsilon_{y9.2}$, $y_{9.3} = \lambda_{y9.3}\eta_9 + \varepsilon_{y9.3}$, $y_{9.4} = \lambda_{y9.4}\eta_9 + \varepsilon_{y9.4}$, $y_{9.5} = \lambda_{y9.5}\eta_9 + \varepsilon_{y9.5}$, $y_{9.6} = \lambda_{y9.6}\eta_9 + \varepsilon_{y9.6}$	$\omega_{\eta9.1}y_{9.1} + \omega_{\eta9.2}y_{1.2} + \omega_{\eta9.3}y_{9.3} + \omega_{\eta9.4}y_{9.4} + \omega_{\eta9.5}y_{9.5} + \omega_{\eta9.6}y_{9.6}$
Tactical flexibility (η_{10})	$y_{10.1}$ – F3, $y_{10.2}$ – F4, $y_{10.3}$ – F5, $y_{10.4}$ – F7	$y_{10.1} = \lambda_{y10.1}\eta_{10} + \varepsilon_{y10.1}$, $y_{10.2} = \lambda_{y10.2}\eta_{10} + \varepsilon_{y10.2}$, $y_{10.3} = \lambda_{y10.3}\eta_{10} + \varepsilon_{y10.3}$, $y_{10.4} = \lambda_{y10.4}\eta_{10} + \varepsilon_{y10.4}$	$\omega_{\eta10.1}y_{10.1} + \omega_{\eta10.2}y_{10.2} + \omega_{\eta10.3}y_{10.3} + \omega_{\eta10.4}y_{10.4}$
Strategic flexibility (η_{11})	$y_{11.1}$ – F6, $y_{11.2}$ –F8, $y_{11.3}$ –F12, $y_{11.4}$ – F13, $y_{11.5}$ – F15	$y_{11.1} = \lambda_{y11.1}\eta_{11} + \varepsilon_{y11.1}$, $y_{11.2} = \lambda_{y11.2}\eta_{11} + \varepsilon_{y11.2}$, $y_{11.3} = \lambda_{y11.3}\eta_{11} + \varepsilon_{y11.3}$, $y_{11.4} = \lambda_{y11.4}\eta_{11} + \varepsilon_{y11.4}$, $y_{11.5} = \lambda_{y11.5}\eta_{11} + \varepsilon_{y11.5}$	$\omega_{\eta11.1}y_{11.1} + \omega_{\eta11.2}y_{11.2} + \omega_{\eta11.3}y_{11.3} + \omega_{\eta11.4}y_{11.4} + \omega_{\eta11.5}y_{11.5}$

Note: Measurement items of respective constructs were classified based on the test result of the exploratory factor analysis in Section 7.3

6.4.3 PLS modelling approach and its parameter estimation process

Having specified the two PLS models in this study, an example of the PLS parameter estimate process adopted in this study is shown in Figure 6.5 to illustrate the execution of the PLS iterative process. The two constructs, i.e., employees' skills and behaviour (ξ) and supply chain capabilities (η), and their corresponding blocks of observed variables are selected here to illustrate the parameter estimation between constructs and their corresponding observed variables. It can be seen that a one-way causal relationship (i.e., path relation) is hypothesized between ξ and η. Insofar as ξ could only explain a portion of the variance in η, the residual variance at this structural level is assumed to reside in ε_η. Here, the structural relationship among ξ, η and ε_η forms the structural model, which is known as the inner relation (i.e., Eq. 6-1). The relationships between constructs and their corresponding observed variables form the measurement models; these relationships formed are also known as the outer relations (i.e., Eq. 6-2 and 6-3).

Both ξ and η are recognized as the constructs that cannot be measured directly. In effect, each of them is indirectly measured by a number of reflective observed variables, denoted by x_1, x_2, x_3,..., x_8 for ξ and y_1, y_2, y_3,..., y_7 for η. According to Bollen (1989), reflective observed variables are reflections of the extent a construct is being characterized, but they do not directly influence the construct. Therefore, they could be exchanged without a loss of validity if a better way is found to reflect a construct. The extent to which these observed variables reflects their respective constructs is determined, to a large extent, by the weight of their loadings using the factor analysis (i.e., λ_{X1}, λ_{X2}, λ_{X3},..., λ_{X8} for ξ and λ_{y1}, λ_{y2}, λ_{y3},..., λ_{y7} for η in Figure 6.5). Also, the predicted value of a construct allows for the measurement error of all of their corresponding observed variables, denoted by ε_{X1}, ε_{X2}, ε_{X3},..., ε_{X8} for ξ and ε_{y1}, ε_{y2}, ε_{y3},..., ε_{y7} for η.

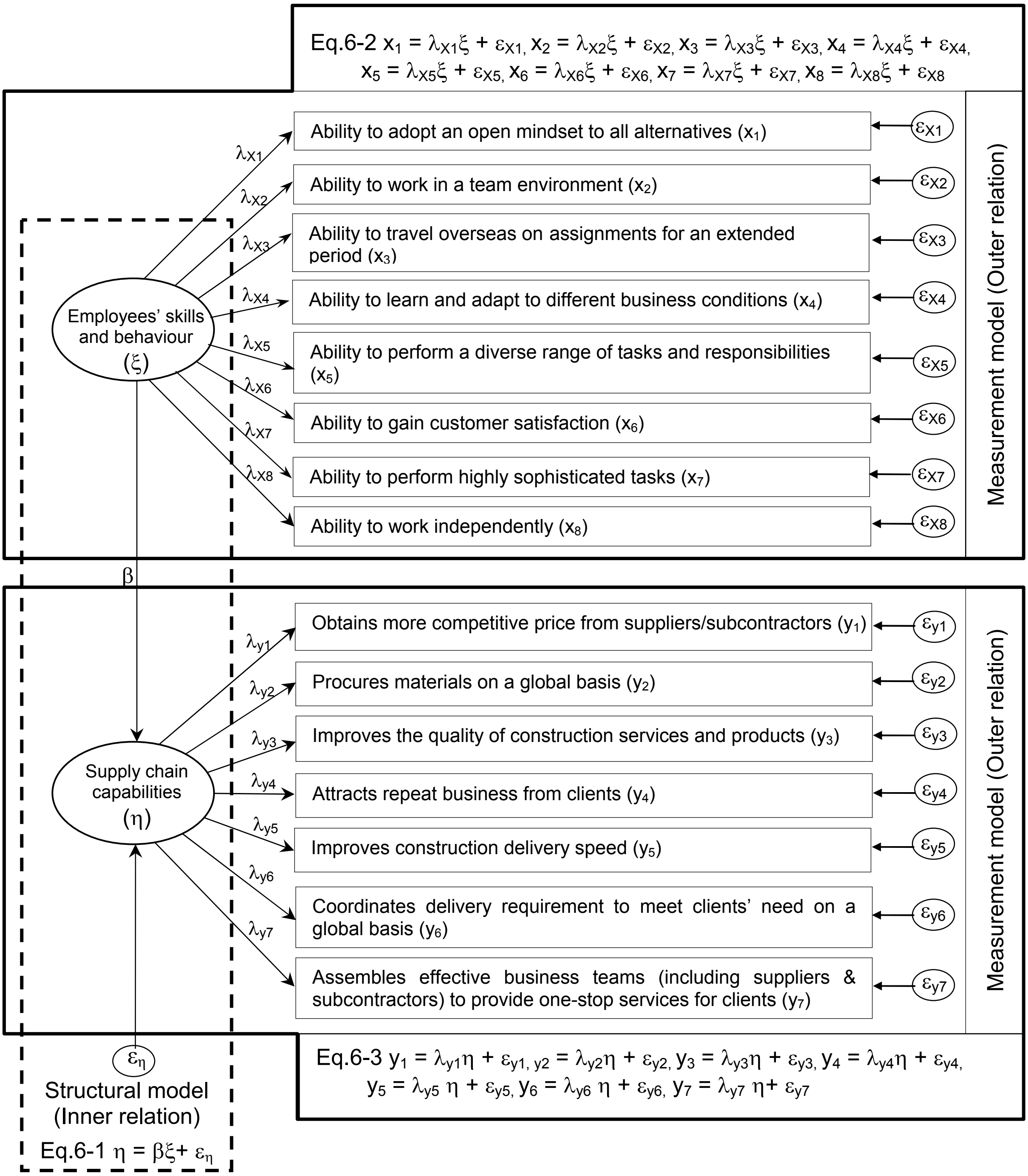


Figure 6.5 A PLS model with two blocks of reflective observed variables

Apart from its ability to model reflective epistemic relationship, it is noted that the PLS approach also permits the modelling of formative or casual relationships between constructs and their corresponding observed variables. Unlike reflective observed variables, formative observed variables have direct influence on the value of a construct (Fornell and Bookstein, 1982; Bollen, 1989). In this study, the relationship between constructs and their corresponding observed variables is modelled in a reflective mode.

In the PLS approach, the parameter estimation are based on the ability to minimize the residual variance of dependent variables through a three-stage iterative estimation algorithm (Wold, 1966; 1975). The three-stage iterative process is as follows (Lohmoller, 1989):

(i) Stage 1 consists of an iterative scheme of simple or multiple regressions that estimates weights and constructs' scores. Based on a random start matrix of initial outside approximation, first inner weights are estimated, followed by an inside approximation. Next, the outer weights are determined and followed by an outside approximation. This process continues until convergence is obtained as illustrated in Figure 6.6 (a) and (b) using the information from Figure 6.5.

(ii) In stage 2, factor loadings and path relations are estimated using OLS regression in which each dependent variable in the model (either constructs or observed variables in reflective mode) is regressed on its respective independent variables (i.e., other constructs).

(iii) In stage 3, the means and location parameters of the constructs and observed variables are estimated.

The new weights obtained in Stage 1 provide an exact linear combination of the observed variables for forming the construct score (i.e., outside relation) which is not only maximally correlated with its own set of indicators, but also correlated with other constructs (i.e., inner relation) in accordance with the proposed structural model (Chin and Newstead, 1999). Upon convergence being obtained, a least square criterion is used to estimate all parameters in the models in both Stages 2 and 3. This involves minimizing the residuals on all constructs and their respective observed variables.

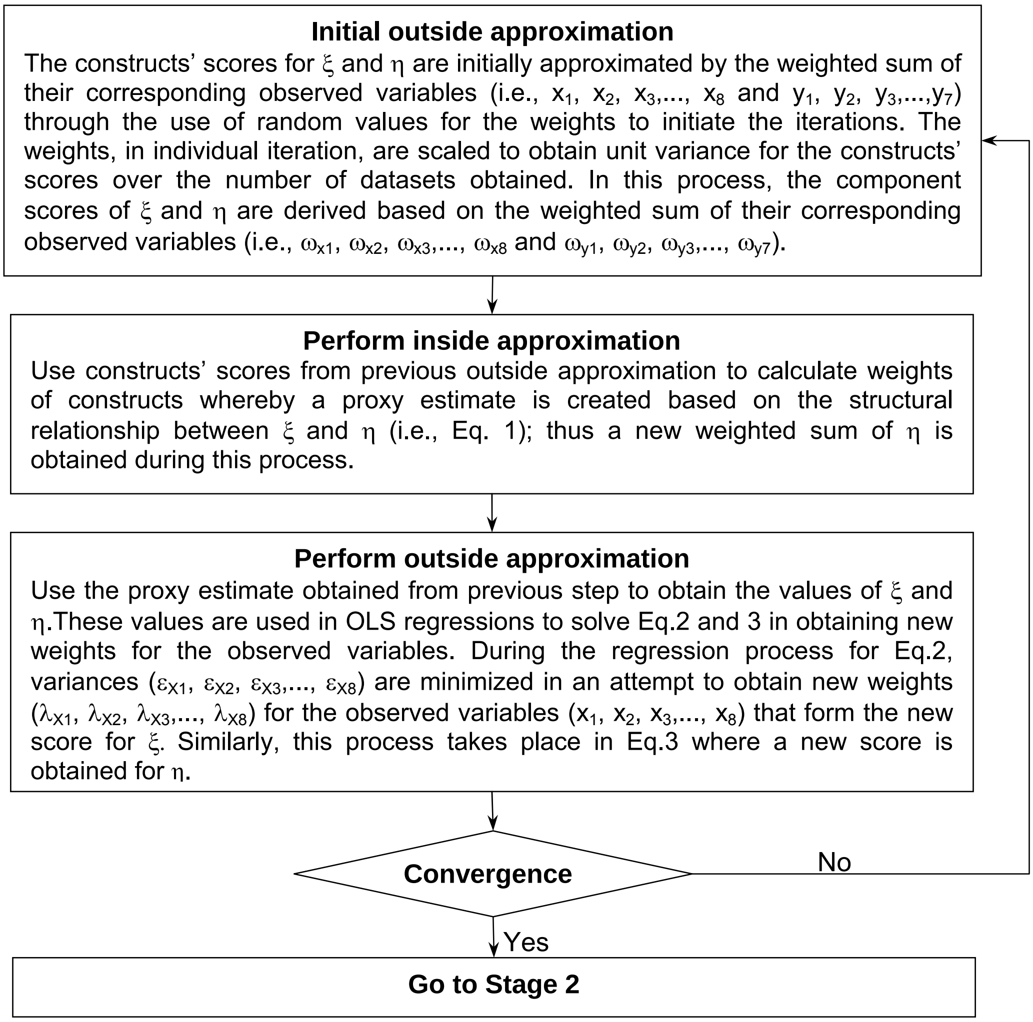


Figure 6.6 (a) Stage 1 estimation algorithm of PLS with description

Lohmoller (1989) however pointed out that, in the PLS algorithm, preference has always given to minimising the residuals on observed variables due to the governing assumption that theories are softer (less precise, less developed) than empirical observations. In this case, preference is given to the data and the measurement models (outer relations) by staying as close to data as possible while investigating the specified relationships between constructs (inner relations). This leads to optimizing the prediction of the constructs' score that necessarily requires deemphasizing parameter estimation between constructs since prediction and parameter accuracy cannot be optimized simultaneously (Wold, 1982).

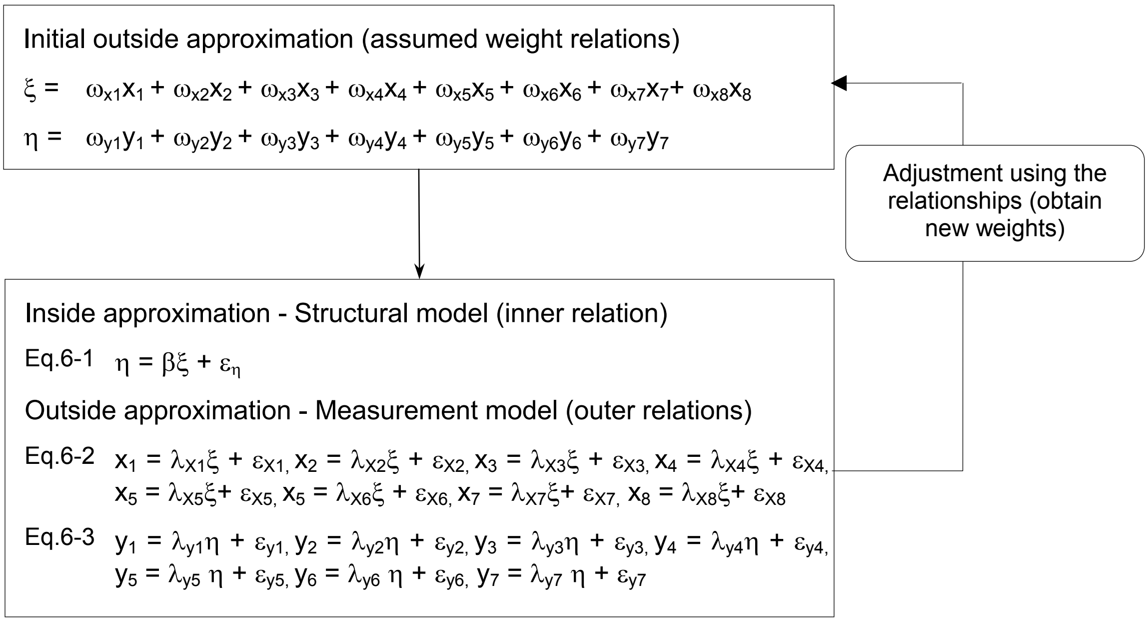


Figure 6.6 (b) Stage 1 estimation algorithm of PLS with equations

In sum, the statistical functions involved in the execution of the PLS algorithm are: (i) confirmatory factor analysis; (ii) path analysis; and (iii) bootstrapping. These functions will be examined in turn next.

6.4.3.1 <u>Confirmatory factor analysis</u>

Confirmatory factor analysis (CFA), or the measurement modelling technique, is typically used in a deductive mode to test hypotheses about the relations among a set of observed variables (Hoyle, 2000). As a result, the interrelations among variables within a CFA model (or measurement model) are specified upfront based on theoretical assumptions rather than revealed through an inductive or discover-oriented mode. Although CFA can be used as a sole statistical strategy, it is best understood as an instance of a SEM technique in which a useful distinction is made between the measurement model and the structural model (see Figure 6.5). The measurement model concerns the relations between individual constructs and their respective block of measurement items. It is known as the outer relation.

A part of the measurement model (i.e., Eq. 6-2) shown in Figure 6.5 is extracted here as Figure 6.7 to provide an overview of the CFA. The single-headed arrows suggest the causal or predictive relationships, and it can be seen that each measurement item is affected by two unmeasured influences. They are: (i) the causal influence that one shares with other measurement items, emanating from the construct (the large ellipse in Figure 6.5) and (ii) the distinct causal influence emanating from the measurement error of respective measurement items (the small ellipses in Figure 6.5).

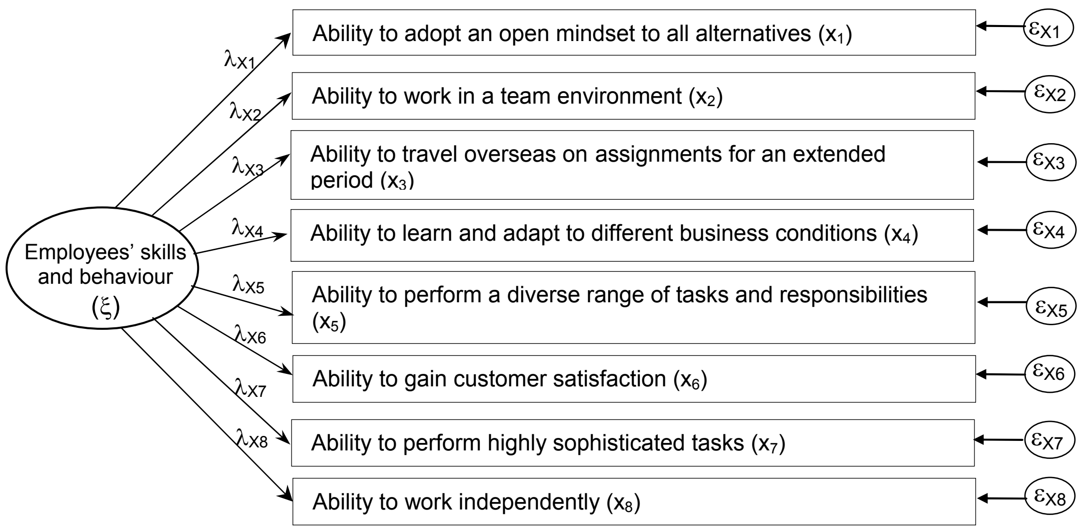


Figure 6.7 Path diagram of a single construct

Based on the above diagram, the causal relationships are translated directly into statistical form through a set of measurement equations given below:

$x_i = \lambda_{Xi}\xi + \varepsilon_{Xi}$ Eq. 6-2

$x_1 = \lambda_{X1}\xi + \varepsilon_{X1}$ Eq. 6-2a

$x_2 = \lambda_{X2}\xi + \varepsilon_{X2}$ Eq. 6-2b

$x_3 = \lambda_{X3}\xi + \varepsilon_{X3}$ Eq. 6-2c

$x_4 = \lambda_{X4}\xi + \varepsilon_{X4}$ Eq. 6-2d

$x_5 = \lambda_{X5}\xi + \varepsilon_{X5}$ Eq. 6-2e

$x_5 = \lambda_{X6}\xi + \varepsilon_{X6}$ Eq. 6-2f

$x_7 = \lambda_{X7}\xi + \varepsilon_{X7}$ Eq. 6-2g

$x_8 = \lambda_{X8}\xi + \varepsilon_{X8}$ Eq. 6-2h

For each measurement equation, the variability in the *i*th (i = 1,…,8) measurement item is an additive function of *i*th differentially weighted factor, $\lambda_{Xi}\xi$ (where ξ is the construct score), and *i*th unique factor (or measurement error), ε_{Xi}. Parameter estimates of these direct effects are called weights, and they are generally interpreted as regression coefficients that may be in unstandardized or standardized form.

Associated with the parameter estimate is a standard error, and the ratio of the unstandardized estimate to its standard error provides a test of whether the estimate significantly differs from zero, using the *t*-test analysis. In this way, the statistical power of each individual measurement items can be established based on the *t*-statistic evaluated against the standard one-tailed criterion (i.e., 1.68, 2.43 and 3.30 for $p < .05$, .01 and .001, respectively). These *t*-statistics corresponding to the *p*-values are based on 500 bootstrapping runs used to obtain estimates of standard errors of the parameter estimates. Nevertheless, any removal of insignificant or inconsistent measurement item is subjected to a set of rules-of-thumb that take into consideration the findings from other related analysis functions. These include the Cronbach's alpha reliability test and exploratory factor analysis, which will be examined in the construct validation process.

6.4.3.2 <u>Path analysis</u>

The structural model in SEM concerns the directional relations between constructs (i.e., inner relation). Path analysis (PA) is an extension of the multiple regression modelling technique. It is used in SEM to examine the depicted relationships between constructs. Streiner (2005) pointed out that, despite its previous name of 'causal modelling', PA cannot be used to establish causality or even to determine whether a specific model is correct; it can only determine whether the data are consistent with the model. Rather, it is the design of a study that establishes the causality, but not its analysis. This explains why Wilkinson and the Task Force on Statistical Inference (1999) emphasized that the use of SEM computer programs "rarely yield any results that have any interpretation as casual effects"(p.600).

Going beyond the traditional regression analysis, the PA allows for the analysis of more complicated models. In particular, it can examine situations in which there are several final dependent variables and those in which there are 'chains' of influence, for example, variable A influences variable B, which in turn affects variable C. However, the crucial aspect in specifying a PA model is the directionality of the presumed relationships between constructs. Streiner (2005) highlighted that the major criterion for having paths between constructs is the theoretical justification for their inclusion. He added that often changing the direction of an arrow, or even a series of arrows, may result in models that are statistically equivalent. However, it is beyond the scope of this study to test the specified PLS model by changing the directionality of presumed relationships between constructs.

In this study, the directional paths drawn between the identified constructs in the PLS model specification (see Figures 6.3 and 6.4) are based on the substantive literature review and preliminary interview findings with experienced experts in the Singapore construction industry. A total of 14 structural equations were formed in this study (see Tables 6.2 and 6.4), representing the inner relations among the constructs indentified. Using the Eq. 6-1 in Figure 6.5 as an example:

$$\eta = \beta\xi + \varepsilon_\eta \qquad \text{Eq. 6-1}$$

where β is the path coefficient linking the employees' skills and behaviour, ξ, to supply chain capabilities, η, and the residual variance at this structural level is assumed to reside in ε_{η}. Here, β is the standardized regression weight, identical to the β weight of a multiple regression model. Its sign should correspond to what the model predicts and be statistically significant. The issue now is how to determine the significance of the path coefficient, β. Similar to the CFA, an in-built bootstrapping technique in the SmartPLS2.0 M3 software was used to estimate the standard errors of the path coefficients, which, in turn, determine the *t*-statistics for proposition testing.

6.4.3.3 Bootstrapping technique

Like the jack-knifing technique, the bootstrapping technique primarily concerns the reliability of results across samples drawn from a population. This technique was originated in the late 1970s by Efron Bradley, a well-known statistician, who proposed a non-parametric bootstrap procedure that re-samples 'data with replacement' from an original sample. Due to its flexible characteristics, the Efron's (1979; 1982) bootstrap procedure can be used to estimate the sampling distribution of any statistics, following either a parametric or non-parametric procedure. For example, if the distribution of the sample data from which the bootstrap samples are drawn is unknown, then the procedure is considered as non-parametric. On the other hand, if it is known, then the procedure is considered as parametric.

Similar to many conventional parametric statistical procedures, the bootstrapping technique is also based on a sampling distribution (Efron, 1982). However, in bootstrapping, the sampling distribution is developed by a re-sampling process of a random sample obtained instead of extracting successive samples repeatedly from a population (i.e., the jack-knifing technique). Basic steps of the bootstrap re-sampling procedure are given as follows (Efron, 1979; 1987):

(i) Generate a bootstrap sample (sub-sample) randomly with replacement from the original sample or the full data set;

(ii) Compute the bootstrap sample statistics (i.e., average and median of the bootstrap sample) and save them;

(iii) Repeat step (ii) for *K* times to obtain *K* bootstrap samples;

(iv) Compute the bootstrap estimates (i.e., the sample averages and the average of sample averages); and

(v) Compute the standard deviation of the bootstrap estimates (i.e., the bootstrap standard error).

Through the above procedure, the underlying principle of the bootstrapping technique is to generate multiple sub-samples from the pool of data collected, and then draw inferences about the corresponding population and its parameters. According to Tinsley and Brown (2000), the bootstrap estimate is an estimate of the population statistic and its standard deviation is an estimate of the population standard error. They added that the bootstrap distribution can be used: (i) to estimate a range of confidence intervals and (ii) to test null hypotheses about the value of the test statistic in a population.

Based on the above reasons, the bootstrapping technique is adopted in this study because the sampling distribution of a target population (i.e., Singapore contractors) is either indeterminate or difficult to obtain empirically (Bone et al., 1989; Tinsley and Brown, 2000). It is an in-built procedure in the SmartPLS2.0 M3 software.

6.4.4 Construct validation process

In addition to the statistical functions, this section examines the construct validation process involved in the PLS modelling attempt. According to Anderson and Gerbing (1988), this process is a prerequisite in the PLS modelling technique, concerning the adequacy of individual sets of measurement items in capturing their corresponding constructs by assessing the internal consistency, convergent validity and discriminant validity of constructs specified. This view is shared by Schwab (1980) who pointed out that the construct validation process is a fundamental requirement in studies involving the use of theories to explain certain phenomena. In this case, the contingency, organizational learning, resource-based and complexity theories are adopted in explaining organizational flexibility.

According to O'Leary-Kelly and Vokurka (1998), the construct validation process comprises three basic steps as shown in Figure 6.8. Descriptions of the individual steps are as follows.

(i) Content validity, which is also known as face validity, is a step that involves the identification of corresponding groups of measurement items that are thought to measure individual constructs. Its emphasis is on the adequacy with which the domain of the characteristics of individual constructs is captured by the respective groups of measurement items identified (Churchill and Iacobucci, 2005).

(ii) Construct validity is a step that establishes the extent to which the items identified measure their corresponding constructs (Schwab, 1980). To establish construct validity, a series of empirical tests are used to examine the properties of the measurement items, namely: (i) uni-dimensionality; (ii) reliability; and (iii) validity.

(iii) Nomologial validity, which is also known as substantive validity, is a step that involves the determination of the extent to which a construct relates to other constructs in a predictable manner (Schwab, 1980; Venkatraman, 1989). Its emphasis is on hypothesis testing.

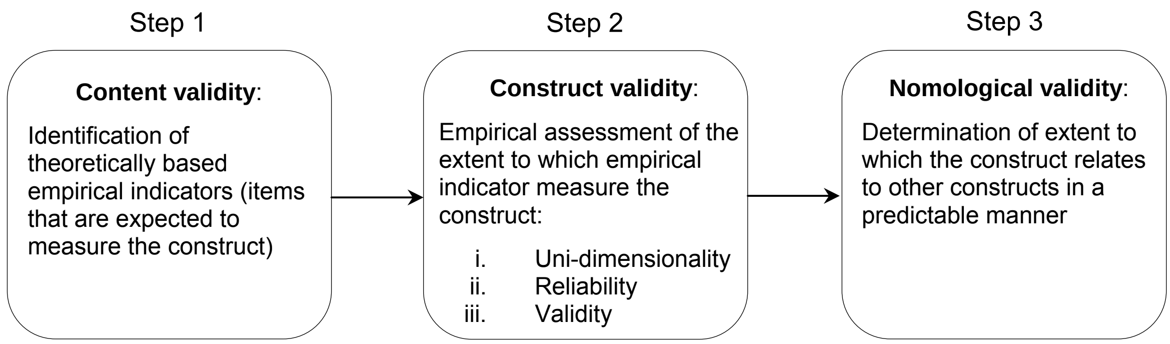


Figure 6.8 Construct validation process
Source: O'Leary-Kelly and Vokurka, 1998

As shown in Figure 6.8, it is clear that the ability to correctly identify significant relationships among constructs depends on the ability of measurement items to adequately capture the attributes of their corresponding constructs. In this study, Step 1 - the content validity - has been addressed during the measurement instrument development stage (see Section 5.4). These involved: (i) the specification of constructs' domain using multiple-item measures (i.e., a minimum of three items were developed for each construct identified); (ii) the generation of samples of measurement items based on literature searches and in-depth interviews; and (iii) the pilot-testing of the measurement instrument based on inputs from 12 industry practitioners. Likewise, the testing of structural relationships between individual constructs. i.e., Step 3 (or path analysis), has been discussed in Section 6.4.2.2. Thus, the emphasis here is on Step 2 of the construct validation process. That is, assessing the adequacy of the measurement items of individual constructs (i.e., the measurement models) in terms of their uni-dimensionality, reliability and validity.

Figure 6.9 shows that the construct validation process in this study was governed by two main assessment approaches. They are: (i) the classical validation approach (i.e., Cronbach's alpha and exploratory factor analysis), and (ii) the contemporary validation approach (i.e., confirmatory factor analysis). It is not uncommon to find studies using both exploratory factor analysis and confirmatory factor analysis to evaluate their measurement models, especially in instances where the number of measurement items that underlie a construct has not been firmly established within the research context (Kaynak, 2003; Wang and Li, 2007). Given the exploratory nature of this study, the classical approach plays a complementary role in exploring the pattern of relationship between measurement items and their corresponding constructs, and thus assesses the dimensionality of blocks of measurement items within their corresponding constructs. The contemporary approach was then employed to further confirm the composition of individual constructs. Details of the analytical techniques, comprising both the classical and contemporary validation approaches, are examined in accordance with the tests illustrated in Figure 6.9.

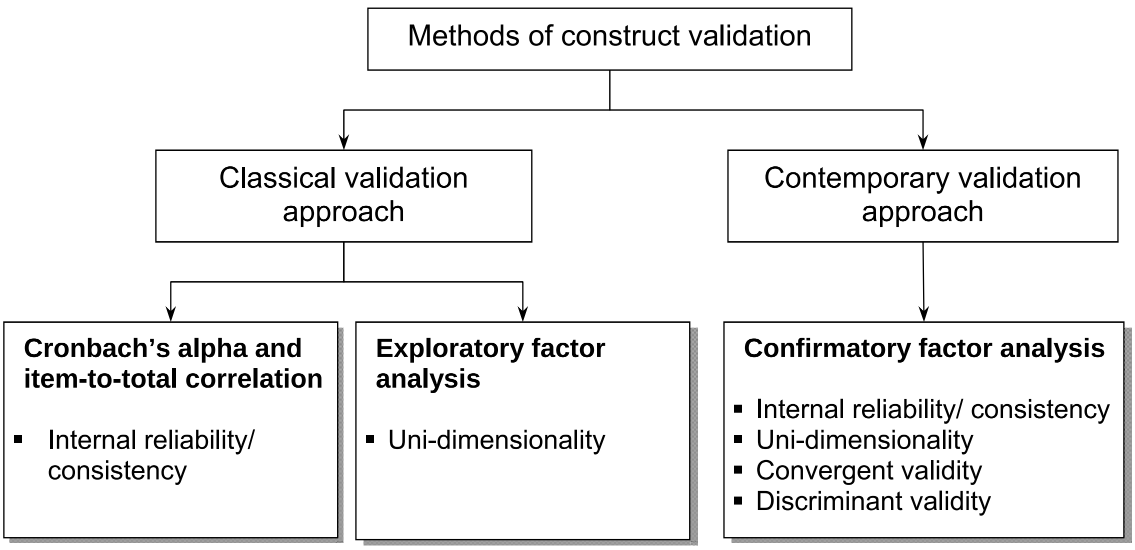


Figure 6.9 Methods of construct validation

6.4.4.1 Internal reliability

For the multiple-item approach, Churchill (1979) defined internal reliability as the extent to which independent measurement items, designed to measure the same trait of a construct, correlate among one another. In this situation, internal reliability can be seen as the degree to which individual multiple-item scales produce consistent and stable scores based on a series of repeated tests (Cronbach, 1970). That is, a higher level of correlation among measurement items provides a greater confidence in the measurement obtained.

The Cronbach's alpha reliability test in SPSS16.0 software was used to examine the internal reliability of individual constructs identified in this study. This method involves deriving an index (i.e., the alpha coefficient) that ranges from 0 to 1, signifying the estimated systematic variance of individual constructs (Peter, 1979; O'Leary-Kelly and Vokurka, 1998). The alpha coefficient is based on the correlations among measurement items of corresponding constructs. A high alpha coefficient indicates that the measurement items of a construct are highly correlated, and vice versa (Pedhazur and Schmelkin, 1991).

However, it is noted that there is no general consensus on the acceptable value of an alpha coefficient in assessing the internal consistency level of a construct. For example, Nunnally (1978) pointed out that an alpha value of below 0.70 is not acceptable. Despite this assertion, O'Leary-Kelly and Vokurka (1998) noted that many studies still quoted the earlier position taken by Nunnally (1967) that an alpha value of less than 0.50 is acceptable for exploratory research; especially when a low alpha value (for example, value < 0.50) was obtained in a particular study. With respect to this study, a threshold value of 0.70 was adopted to determine the internal consistency level of the constructs identified, following Nunnally (1978).

For a multi-dimensional construct comprising a large pool of measurement items that could be divided into different dimensions (for example, the organizational flexibility is a three-dimension construct), an item-to-total correlation analysis (i.e., a branch of the Cronbach's alpha reliability test) was used to evaluate the reliability of the measurement obtained (Churchill, 1979). This process involves calculation of (i) Cronbach's alpha coefficients for each dimension and (ii) item-to-total correlations in identifying inconsistent measurement items in individual dimensions. Here, an additional step is required to determine the Cronbach's alpha coefficient of the multi-dimensional constructs on the whole (i.e., the reliability of linear combination), using the formula by Nunnally (1978) as given below:

$$r_{YY} = 1 - \frac{\sum \sigma_i^2 - \sum r_{ii}\sigma_i^2}{\sigma_Y^2} \qquad \text{Eq. 6-4}$$

This formula requires only the variance of the linear combination (r_{YY}), the variance of the individual measurement items (σ_i^2) in the linear combination, and the estimates of each measurement items' reliability (r_{ii}), where σ_Y^2 is the variance of the sum of the individual measurement items involved. These figures are obtainable in the Cronbach's alpha reliability analysis in SPSS for the calculation of the reliability of linear combination. Similarly, the threshold value of 0.70 is applied to the reliability of linear combination score.

The item-to-total correlation, on the other hand, is calculated for the subscale and whole scale of multi-dimensional constructs. The subscale is calculated based on the data of individual dimensions of respective constructs, while the whole scale is calculated based on the data obtained within respective constructs, i.e., combining the data of various dimensions within individual constructs. Similarly, the respective subscale and whole scale of item-to-total correlation are obtainable in the reliability analysis in SPSS. According to Nunnally (1978), measurement items with item-to-total correlation scores less than 0.30, for both subscale and whole scale, are considered as inconsistent. He pointed out that deleting these inconsistent items may considerably increase the Cronbach's alpha coefficient of individual dimensions of corresponding constructs. In this study, the removal of any insignificant or inconsistent measurement item(s) is subjected to a set of rules of thumb (see Section 6.5.4) that take into consideration the findings from all related analysis in the construct validation process.

There are alternative tests in assessing internal reliability of constructs, i.e., test-retest and alternative forms methods (O'Leary-Kelly and Vokurka, 1998). These two methods are unfeasible in this study because they require at least two rounds of data collection at different points in time for assessing the reliability of constructs. It is very difficult to obtain the data needed as highlighted in Section 6.3.2.

Turning to the confirmatory factor analysis (CFA) in the contemporary validation approach, the composite reliability index obtained from the CFA in PLS can be used to assess the internal reliability of measurement items of individual constructs. It follows that a high level of the composite reliability index indicates high internal reliability, and vice versa. The suggested threshold value of 0.70 by Hair et al. (1998) is adopted in this study in identifying any inconsistent measurement item(s).

6.4.4.2 Uni-dimensionality

As shown in Figure 6.9, both exploratory factor analysis and CFA were used in establishing the uni-dimensionality of constructs. In general, factor analysis is a collection of models for explaining the correlations among variables in terms of more fundamental entities called ‘factors’ (Cudeck, 2000). The application of factor analysis in this study, however, is descriptive in nature. The goal is to summarize complicated patterns of correlations between observed variables into a simpler explanatory framework, i.e. the concept of uni-dimensionality. In this capacity, the method is typically referred to an exploratory factor analysis (EFA).

Uni-dimensionality involves establishing whether a set of empirical measurement items relates to an underlying construct (Gerbing and Anderson, 1988; O’Leary-Kelly and Vokurka, 1998). In order to be considered as uni-dimensional, measurement items must satisfy the following conditions (Hair et al., 1998): (i) they must be significantly related to their corresponding constructs; and (ii) they must be related to one and only one construct. For instance, a measurement item of the ‘supply chain capabilities’ construct must be related only to the ‘supply chain capabilities’ variable and not other constructs.

In EFA, a ‘factor’ is a construct or latent variable that is essentially outside of measurement. Organizational flexibility, for example, is a factor that is not actually measured. Rather it is thought to be superordinate to a set of particular collection of observed variables or measurement items being used to study it. In this study, organizational flexibility is a multi-dimensional construct that may comprise 15 measurement items, which could be further categorized into: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility (see Sections 3.6.1.3 and 3.8). Here, the EFA model was used to confirm the factor structures (or dimensions) among the measurement items in order to assess the proposed dimensionality of the construct. Generally, measurement items with good measurement properties should exhibit higher factor loadings on their pertinent factors (or dimensions), i.e., measurement items should exhibit small loadings on factors that they are not designed to measure.

Comrey (1973) suggested that factor loadings of 0.45 – 0.54, 0.55 – 0.62, 0.63 – 0.70 and >0.70 are considered as fair, good, very good and excellent, respectively. Therefore, a measurement item with a factor loading of less than 0.45 is considered as an inconsistent item in this study.

Two criteria were used in determining the number of factor structures (or dimensions) in the EFA, namely (Cudeck, 2000): (i) eigenvalues greater than unity; and (ii) scree test. For the former, the correct number of factor structures equals the number of eigenvalues that are greater than unity. The other interpretation of eigenvalues is as generalized measures of variance contained in a set of measurement items (Green and Carroll, 1976). For example, an eigenvalue of 2.62 explains 26.2% of the total variance contained in a set of measurement items. As with the eigenvalues greater than unity procedure, the scree test involves a plot of the ordered eigenvalues. The process follows a visual inspection of the graph from the smaller to the larger coefficients, checking for a break in magnitude. Here, the number of factor structures should be decided by the number of eigenvalues that are of appreciable size compared to the others in the distribution. For example, a break in magnitude between the third and fourth eigenvalues dictates that three factor structures seem plausible. Both criteria are best viewed as complementary in determining the number of factor structures.

Unlike the classical technique using EFA, CFA contains inferential statistics (i.e., *t*-statistic) that allows for hypothesis testing on the uni-dimensionality of a set of measurement items (see Section 6.4.3.1). This leads to a stricter and more objective interpretation of uni-dimensionality than does EFA.

6.4.4.3 Convergent and discriminant validities

Generally, construct validity refers to the extent to which a measurement instrument truly measures the constructs which it purports to measure (Peter, 1979). According to Campbell and Fiske (1959), two components (i.e., convergent and discriminant validities) must be considered when establishing the validity of a measure. Convergent validity refers to the correlation between different measurement items purporting to measure the same construct (Peter and Churchill, 1986; Crocker and Algina, 1986). Discriminant validity, on the other hand, refers to the extent to which individual constructs are unique and not simply reflections of other constructs (Churchill, 1979; Bagozzi et al., 1991). This means that a construct cannot correlate highly with other constructs from which it is supposed to differ within the same model. If their correlations are too high, this indicates that the constructs are not actually capturing a distinct or isolated trait (Churchill and Iacobucci, 2005).

These two validity components capture some of the aspects of the goodness of fit of measurement models, i.e., how well measurement items relate to their corresponding constructs when using the SEM technique (Gefen and Straub, 2005). An acceptable level of both types of validities indicates that each measurement item correlates strongly with the one construct it purports to measure, while correlating insignificantly with other constructs (Gefen and Straub, 2005).

Consistent with EFA, measurement items with good measurement properties should exhibit higher factor loadings (i.e., greater than 0.45) on their pertinent factors (or dimensions) in CFA. In this case, statistically significant high factor loadings (p-value > 0.05 based on t-test) of a particular set of measurement items indicate a high convergent validity (Anderson and Gerbing, 1988).

The second measure in CFA for assessing the convergent validity of constructs is the average variance extracted (AVE). According to Fornell and Larcker (1981), AVE represents the overall amount of variance in the measurement items accounted for by individual constructs, and is a more conservative measure than the composite reliability index. They suggested that the AVE value of individual constructs should be at least 0.50 in order to be considered as acceptable. Apart from its capacity to assess the convergent validity of measures, the AVE could also be adopted to evaluate the discriminant validity of individual constructs.

According to Hulland (1999), when using PLS, one criterion for adequate discriminant validity is that individual constructs should share more variance with their corresponding measurement items than they share with other constructs. In order to establish discriminant validity, the square root of the AVE value of a construct should be higher than the correlations between the construct and other constructs in the model (Fornell and Larcker; 1981; Fornell and Cha, 1994). This assessment is tabularized into a correlation matrix that includes the correlation between different constructs in the lower left off-diagonal elements of the matrix, and the square roots of AVE values calculated for individual constructs are placed along the diagonal. In a case where adequate discriminant validity is established, the value of the diagonal elements will be significantly greater than the off-diagonal elements in the corresponding rows and columns (Hulland, 1999).

In this study, the above three measures (i.e., EFA, AVE and square root of AVE) were adopted to assess the convergent and discriminant validities of constructs. However, it is noted that the other method suggested by O'Leary-Kelly and Vokurka (1998), that is the multitrait-multimethod matrix method, was considered inappropriate because it requires application of different data collection methods (for example, different informants or different instruments).

6.4.4.4 Removal of inconsistent measurement items

The removal of any inconsistent or insignificant measurement item(s) is subjected to a set of rules that take into consideration the findings from both the classical and contemporary validation approaches. Table 6.7 shows the set of rules adopted in this study.

Table 6.7 Rules on removal of inconsistent measurement items

Cronbach's alpha, item-to-total correlation, reliability of linear combination score	**Exploratory factor analysis (EFA)**	**Confirmatory factor analysis (CFA)**
• Constructs and their factor structures (or dimensions) with Cronbach's alpha coefficient that less than 0.70 (Nunnally, 1978) are considered as lack of internal consistency.	• Factor structures (or dimensions) of individual constructs that account for variance less than 1 (Kaiser's (1960) rule of eigenvalue) are not considered.	• Constructs and their factor structures (or dimensions) with a composite reliability index less than 0.70 (Hair et al., 1998) are considered lack of internal consistency.
• Measurement items with a threshold level that less than 0.30 in their item-to-total scores, for both subscale and whole scale (Nunnally, 1978) are considered inconsistent.	• Individual factor structures should have at least three measurement items that load highly on them (Norusis, 2007) in order to retain specific individual factor structures.	• Measurement items with factor loading that less than 0.45 (Comprey, 1973) are considered inconsistent, indicating a low level of convergent validity.
• Reliability of linear combination scores of multi-dimensional constructs should exceed the threshold value of 0.70 in order to retain specific multi-dimensional constructs.	• Measurement items with a factor loading that less than 0.45 (Comprey, 1973) are considered inconsistent, indicating low convergent validity.	• Individual measurement item's *t*-statistic should be significant at least at the $p < 0.05$ level as an acceptable gauge for convergent validity (Gefen and Straub, 2005).
		• Individual constructs with AVE value that less than 0.50 (Fornell and Larcker, 1981) are considered unacceptable, indicating low convergent validity.
		• The square root of the AVE value of a construct should be higher than the correlations between the construct and other constructs in the model in order to establish adequate discriminant validity (Fornell and Larcker; 1981).

6.4.5 Evaluating structural models in PLS

While the focus of the construct validation process is on the evaluation of measurement models in the PLS modelling, the predictive power of the structural model is evaluated by examining the amount of variance accounted for by the predictor (independent) constructs, i.e., the coefficient of determinant, R^2 for each predicted (dependent) construct. The R^2 or variance explained is presented in the SmartPLS2.0 M3 as part of its reporting of results. The rules proposed by Falk and Miller (1992) for evaluating the R^2 in PLS models were adopted in this study as follows.

(i) A predictor construct that explains less than 1.5 percent of the variance in a predicted construct should be eliminated and the model re-estimated (or known as model trimming). This leads to elimination of arrows or paths, followed by the recalculation of the model, which is seen as the most inductive approach to model trimming and may be justified from a grounded theory perspective (Falk and Miller, 1992). The following equation is used to obtain the percentage of variance in a predicted construct accounted for by each predictor construct (i.e., $PV_{explained}$):

$$PV_{explained} = (\beta \times r) \times 100$$

where β and r are the path coefficient and correlation between predictor and predicted constructs, respectively.

(ii) The R^2 or variances explained for predicted constructs should be ≥ 0.10 as recommended by Falk and Miller (1992). This indicates that 10% or more of the variance in predicted constructs is accounted for by the predictor constructs. They pointed out that a R^2 of less than 0.10, even if statistically significant, is uninformative and substantially meaningless. Similar to the situation when 10% variance is accounted for and many variables are required to achieve the 10%, the hypothesized relationships are uninformative.

(iii) The significance of R^2 or variances explained for all predicted constructs is evaluated based on the overall *F*-test as given below:

$$F = \frac{\left[R^2 / m\right]}{\left[(1 - R^2)/(N - m - 1)\right]}$$

where: (i) *m* is the number of predictor constructs; (ii) *N* is the number of respondents; and (iii) *F*-test statistic is distributed as *F*-distribution with degrees of freedom *m* and *(N-m-1)*. The hypothesis test follows that if the calculated *F*-test statistic exceeds the critical value (at α = 0.05), one can reject the null hypothesis that the R^2 or variances explained for all predicted constructs are equal to zero.

Using the above rules as criteria, the two specified structural models in Section 6.4.2 were evaluated prior to the interpretation of results. A successful model has to meet all the criteria.

6.5 Moderator analysis approach

In an attempt to examine the moderating effects of environmental turbulence (i.e. market and technological conditions) on the relationships between firms' resources-based determinants and organizational flexibility, the PLS product-indicator approach recommended by Chin et al. (1996; 2003) was adopted in this study. Before proceeding to the justification for choosing this approach over the others in this study, the general problems in moderator analysis are first examined.

6.5.1 General problems in moderator analysis

In construction research, it is noted that both regression and analysis of variance (ANOVA) are the most commonly-used techniques to examine interacting effects between independent and dependent variables (Tay and Morgan, 2002). However, these techniques often assume the single-item measures used are absolutely reliable (i.e., error free), and thus they lead to an inability to handle or present information about the impact of measurement error (Chin et al., 2003). In an attempt to compensate for this deficiency, multiple items are often generated and then combined into summated or averaged scales in a moderated regression or ANOVA analysis. In performing this analysis, the reliability of each scale is assessed by the Cronbach's alpha reliability test that assumes equal weighting for individual items within a summated scale.

Despite the advantage of using multiple-item over single-item measures in seeking for improved reliability, it is important to note that the generation of summated or averaged scales has incorporated at least two assumptions for which construct validity cannot be adequately assessed. These are (Chin et al., 2003):

(i) treating all items as equal in their reliabilities, and thus they contribute equally towards the estimation of the interaction effects being considered; and

(ii) assuming the reliability of generated summated scales remains identical when subsequently applied in a theoretical model. However, this assumption may not be true since the reliability estimate of generated summated scales for individual constructs is executed separately from the theoretical model in which it is to be subsequently applied. For instance, in most cases, data are first processed through the EFA and Cronbrach's alpha reliability analysis, before they are applied in a regression model. Through the two disintegrated processes, the reliability of each generated summated scale is unlikely to remain identical. As a result, maximal efficient fit between data and the theoretical model is less likely to occur.

In an attempt to resolve the accounting problem of measurement error in moderator analysis, Kenny and Judd (1984) proposed a product-indicator approach that uses the LISREL algorithm to examine interaction effects between constructs. However, this approach has progressively attracted criticisms for being too demanding and ineffective in that a large sample size and advanced programming knowledge are required for assessing a relatively large structural model (Bollen and Paxton, 1998; Li et al., 1998).

Having noted the complications of both the traditional moderator analysis and LISREL product-indicator approach, Chin et al. (1996; 2003) developed a product-indicator approach using the PLS algorithm to examine interaction effects between constructs. According to them, the PLS product-indicator approach: (i) can provide a more accurate estimate of interaction effects by considering measurement errors within measures, and (ii) is less restrictive than the LISREL product-indicator approach, in terms of sample size requirement and sampling distribution.

Indeed, the PLS product-indicator approach has been widely accepted in the field of information system and marketing research (Compeau and Higgins, 1995), and is gaining its popularity among construction researchers (Aibinu et al., 2008). Among studies that have used the PLS product-indicator moderating approach, Wang and Li (2007) have confirmed the feasibility and ability of the PLS product-indicator approach in examining the moderating effects of environmental turbulence on relationships between manufacturing firms' core competences, strategic flexibility and customer-focused performance.

6.5.2 Justification for using the PLS product-indicator approach

Justification for using the PLS product-indicator moderating approach in this study are now presented (Chin et al., 1996; 2003).

(i) The PLS approach allows the modelling of structural paths (i.e., inner relations) and measurement paths (i.e., outer relations between constructs and their corresponding observed variables) simultaneously. Furthermore, the PLS algorithm treats individual indicators (i.e., observed variables) separately, and allows each indicator to vary in the amount of its influence on the composite score of individual constructs rather than assuming equal weight for all indicators of a summated scale. During this process, indicators with weaker relationships to other related indicators and to their corresponding constructs are given lower weightings, and these varied weightings are carried forward through to an assessment of the estimates. Based on these, the PLS product-indicator approach is superior over other moderated techniques such as: (a) a regression analysis using single-item measures that assumes error free measurement; (b) a regression analysis using multiple-item measures (i.e., summated scales) that assumes equal-weighted measurement; and (c) a factor-score based regression analysis that assumes constrained measurement error within the estimates of variables.

(ii) The PLS product-indicator approach is developed as an integral technique that requires no additional specification of parameter constraints or assumptions of multivariate normal distribution. Also, it can be used to estimate large complex structural models with standard errors estimated via the bootstrapping technique.

The above justification strengthens the selection of the PLS modelling technique not only on the moderating analysis, but also the entire estimation process of this study. The procedure of the PLS product-indicator approach is examined next.

6.5.3 Procedure of the PLS product-indicator approach

This section provides a general description on the procedure of this approach in examining interacting effects among moderator, predictor and predicted constructs. Figure 6.10 shows an example of a moderated model comprising moderator, independent, dependent and interaction constructs. Each of the moderator, predictor and predicted constructs contains three reflective indicators (i.e., measurement items). Product indicators (i.e., X_1Z_1, X_1Z_2, $X_1Z_{3,\ldots,}X_3Z_3$) reflecting the interaction construct (X*Z) are generated by multiplying the standardized scores of individual indicators from the predictor and moderator constructs. Each set of indicators reflecting their underlying constructs is then used to estimate their moderating effect of Z on the relationship between X and Y in PLS.

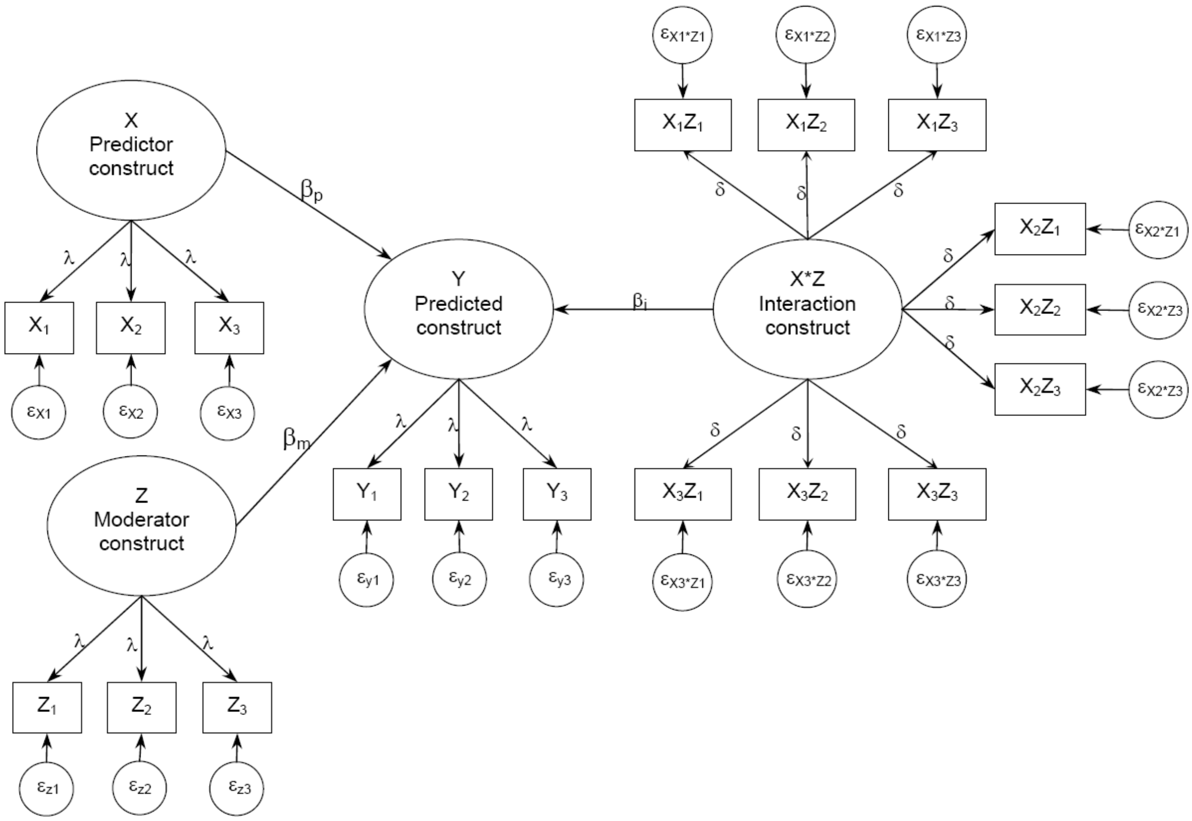


Figure 6.10 A moderated model with predictor, moderator and predicted variables
Adapted from Chin et al., 2003

Another important point to note, when performing the product-indicator analysis, is the use of standardized or centered indicators of corresponding predictor and moderator constructs. According to Smith and Sasaki (1979), standardizing or centering indicators helps to avoid computational errors by lowering the correlation between the product indicators and their individual components (for example, the correlation between X_1, and X_1Z_1). With this process, it allows an easier interpretation of the resultant regression weight, β, for the predictor variable at which the β indicates the effect expected at the mean value of the moderator variable that is set at zero (Chin et al., 2003). As highlighted in Section 6.5, all indicators in this study are standardized to a mean of zero and variance of one for the purposes of SEM modelling since standardization is preferred over centerization for PLS under a reflective mode for all constructs (Chin et al., 2003; Wang and Li, 2007).

To facilitate the interpretation of results obtained from the PLS product-indicator analysis, a two-stage hierarchical process was adopted in this study. Stage 1 concerns the 'main effect' model, i.e., the model without the interaction construct. Using the information from Figure 6.9, the path coefficient, β_p of the predictor construct (X) on the dependent construct (Y) indicates the amount of influence of X on Y when only the moderator construct (Z) is present. In the Stage 2 of the moderating process, a moderated model is formed with the inclusion of the interaction construct. The path coefficient, β_i, of the interaction variable (X*Z) indicates a beta effect change of X on Y from β_p to $\beta_p + \beta_i$ when Z is present. The overall size for the interaction effect, f^2 can be assessed by applying the squared multiple correlation (R^2) values for the moderated model and the main effect model into the following equation (Cohen, 1988):

$$f^2 = \frac{R^2(\text{Moderated} - \text{model}) - R^2(\text{Main - effect - model})}{\left[1 - R^2(\text{Moderated} - \text{model})\right]} \quad \text{Eq. 6-7}$$

According to Cohen (1988), the f^2 values of 0.02, 0.15 and 0.35 are considered as small, moderate and large interaction effects, respectively. In relation to this, Chin et al. (2003) take the view that a small f^2 value does not necessarily imply an unimportant effect. According to them, a small interaction effect can be meaningful if the resultant changes in β estimates are found to be statistically significant under extreme moderating conditions.

6.6 Summary

Taking into consideration the nature of sample data of this research, a partial least square (PLS) approach (a component-based structural equation modelling (SEM) technique) was chosen over other statistical modelling techniques. The PLS approach is a second-generation multivariate technique that combines both econometric and psychometric perspectives in statistical modelling attempts. Two PLS models (i.e., Figures 6.3 and 6.4) on organizational flexibility were specified corresponding to the second and third research objectives of the study. The details of the modelling approach are covered in separate sections including: the estimation process, the required construct validation processes and the model evaluation process, and the moderating process in examining the moderating effects of environmental turbulence (i.e., market conditions and technological conditions) on the relationships between the key determinants (i.e., firms' resources, capabilities and strategies) and organizational flexibility. The subsequent chapter sets out the results of the construct validation processes, both classical and contemporary, of the two specified PLS models.

CHAPTER 7

MEASUREMENT MODELS

7.1 Introduction

This chapter presents the research results that help to address the first research objective, i.e., design and test a conceptual framework for organizational flexibility in construction firms. Before proceeding to the results reporting, the sample profile of interviewees and response rate are first examined (Section 7.2) in an attempt to establish the trustworthiness of the sample data. This is followed by the results of both the classical (Section 7.3) and contemporary (Section 7.4) validation processes, that provide confidence of reliability and validity of constructs (i.e., measurement models) needed for the subsequent modelling attempts. Standard deviation of measurement items of respective constructs are also discussed (Section 7.5). The last section presents the conclusion drawn for the respective hypothesis testing of the study (Section 7.6).

7.2 Sample profile and response rate

A total of 41 face-to-face interviews were conducted with key personnel of the targeted construction firms. There are 34 local and 7 foreign firms with their firm age ranging from 14 years to 81 years old (at the end of 2008) in the sample involved. Of these, 17 are from Group A1, 12 are from Group A2 and the remaining are Group B1 contractors. This represents a response rate of 45% (i.e., 41 out of 91 contractors), which appears both representative and reasonable. It should be noted that no conscious effort was made to exclude the seven foreign construction firms in the sample involved because the interviewees acknowledged that their firms are localized with independent profit centre. Table 7.1 summarizes the general information about the interviewees' firms.

Table 7.1 General information of interviewees' firms

Description	Frequency	% of interviewees
Age of firm		
<16 years	2	4.9%
16 - 30 years	23	56.1%
>30 years	16	39.0%
Mean	30 years	
Median	30.5 years	
Average annual turnover		
<S$50 million	14	34.1%
S$50 – S$99 million	11	26.8%
S$100 - $199 million	13	31.7%
>S$199 million	3	7.4%
Mean	S$86.7 million	
Median	S$70 million	
Size of workforce (supervisory staff and above)		
<50	10	24.4%
51-100	12	29.3%
101-200	12	29.3%
201-500	4	9.7%
>500	3	7.3%
Mean	152 staff	
Median	85 staff	

It can be seen from Table 7.1 that the majority (65.9%) of the firms had an average annual turnover of ≥ S$50 million over the study period 1997 - 2007. Corresponding to this, the average annual turnover of individual firms was computed via averaging the inputs given by individual interviewees in Question 1.4 of the questionnaire (see Appendix C). Based on this data, the overall mean value of S$86.7 million was obtained with a median of S$70 million.

For the size of firms' workforce, it is noted that 24 (58.5%) out of the 41 large-and medium-sized companies interviewed have a workforce size ranging from 51 – 199. In this case, only supervisory staff and above are included in the workforce size calculation (see Section 4.4). Other employees at lower levels (for example, clerks and junior staff) are excluded from this study because they are considered as administrative staff who may have little or no involvement in decision making, and do not partake in sharing business information (following Lewin, 2003).

The next issue to consider is the characteristic of the interviewees in an attempt to establish the trustworthiness of information given. As shown in Table 7.2, all the interviewees are from senior management levels including managing directors, directors, general managers and senior contract managers who are key decision makers in their organizations. Also, it is noted that they have extensive working experience in the Singapore construction industry, ranging from 15 to 40 years. An average working experience of 25.4 years with a standard deviation score of 5.8 was obtained, indicating that most interviewees have at least 20 years of working experience in the Singapore construction industry. Based on this information, their views may be noteworthy and reliable.

Table 7.2 Characteristics of the interviewees

Description	**Frequency**	**Percentage**
Designation		
Director (i.e., managing director, executive director)	18	43.9%
General manager	6	14.6%
Senior manager (e.g., assistant general manager and senior project manager)	17	41.5%
Years in the Singapore construction industry		
1 - 15 years	1	2.4%
16 - 30 years	32	78.0%
>30 years	8	19.5%
Mean	25.4 years	
Median	25 years	

In order to preserve anonymity, individual interviewees were assigned a code starting with a ‘S’ letter and followed by the numbering from 1 to 41 (i.e., S1,…,S41). This coding is designed to facilitate (i) development of the organizational flexibility indices matrix and (ii) discussion of certain phenomena observed during the interviews.

7.3 Results of classical validation approach

Having discussed the profile of interviewees and their companies, this section examines the adequacy of measurement items of individual constructs via statistical measures. These include the Cronbach's alpha reliability test (see Section 6.4.4.1) and exploratory factor analysis (EFA) (see Sections 6.4.4.2 and 6.4.4.3). The categorization of eight constructs that forms the basis for the construct validity and assessment exercise is shown in Table 7.3. It can be seen that half of the number of constructs are multi-dimensional with the expected number of factor structures (i.e., the number of dimensions) ranging from two to four. Corresponding to this, EFA was initially conducted to determine the dimensionality of the 'organizational structure' and 'technological capabilities' constructs (as highlighted in Sections 4.3.5 and 4.5.4). It was found that these two constructs are single-dimensional in this study, as shown in Table 7.3. Overall, there is a total of 76 measurement items.

Table 7.3 Categorization of constructs

Item	Constructs	Expected no. of factor structures	No. of measurement items
1	Organizational learning culture (X1)	3	10
2	Organizational structure (X2)	1	4
3	Employees' skills and behaviour (X3)	1	8
4	Technological capabilities (X4)	1	7
5	Supply chain capabilities (X5)	1	7
6	Business strategies (X6)	4	16
7	Environmental conditions (Z)	2	9
8	Organizational flexibility (Y)	3	15

Table 7.4 summarizes the (i) Cronbach's alpha coefficients, (ii) item-to-total correlation scores, (iii) reliability of linear combination scores, and (iv) factor loadings of all measurement items within their corresponding dimensions and constructs. The

factor loadings from the EFA are included here to provide overall results of the classical validation approach that facilitate the subsequent discussion. It should also be noted that, if there is any removal of inconsistent measurement item (see Section 6.4.4.4), two sets of scores are reported in Table 7.4 for the above four statistical tests. In this case, the values in parenthesis show the relevant scores of individual measurement items before removal of inconsistent measurement items. Also, the inconsistent measurement items that have been removed are italicized and marked with asterisk (*) sign.

Table 7.4 Results of classical validation approach

Item code (1)	Constructs and corresponding measurement items (2)	Item-total correlation Subscale (3)	Item-total correlation Whole scale (4)	Factor Loadings (5)
X1: Organizational learning culture construct [Reliability of linear combination = 0.875)				
CL: Commitment to learning **[Cronbrach's alpha = 0.726]**				
CL1	Employees' training and learning are seen as investment rather than expenses	0.565	0.491	0.754
CL2	Performance mistakes are seen as opportunities for learning and development	0.494	0.394	0.817
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	0.613	0.599	0.749
SV: Shared vision and value **[Cronbrach's alpha = 0.811]**				
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	0.566	0.531	0.717
SV2	Our firm provides support to employees to reach organizational goals	0.674	0.654	0.771
SV3	Employees are constantly informed on the firm's business objectives	0.677	0.452	0.866
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	0.602	0.532	0.724
O: Open-mindedness **[Cronbrach's alpha = 0.829]**				
O1	Our firm encourages participative decision making among employees	0.71	0.48	0.844
O2	Our firm promotes open communication among subordinates and superiors	0.671	0.706	0.743
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	0.705	0.368	0.894
X2: Organizational structure construct [Cronbrach's alpha = 0.833 *(0.739)*]				
OS1	Our firm operates in a flexible work procedure		0.727 (0.759)	0.882 (0.877)
OS2	Our firm adopts a more decentralized decision making process		0.689 (0.610)	0.834 (0.848)
OS3	Our firm has an open communication channel with flexible access to important information for decision making		0.672 (0.608)	0.835 (0.729)
*OS4**	*Our firm adopts a loose & informal control which depends on informal relationship and norms of cooperation for getting work done*		*(0.202)*	*(0.305)*

Item code (1)	Constructs and corresponding measurement items (2)	Item-total correlation Subscale (3)	Item-total correlation Whole scale (4)	Factor Loadings (5)
X3: Employees' skills and behaviour construct [Cronbrach's alpha = 0.833*(0.746)*]				
ESB1	Our employees have the ability to adopt an open mindset to all alternatives		0.588 (0.580)	0.774 (0.857)
ESB2	Our employees have the ability to work in a team environment		0.775 (0.688)	0.841 (0.813)
*ESB3**	*Our employees have the ability to travel overseas on assignments for an extended period*		*(0.429)*	*(0.348)*
ESB4	Our employees have the ability to learn and adapt to different business conditions		0.654 (0.592)	0.719 (0.717)
ESB5	Our employees have the ability to perform a diverse range of tasks and responsibilities		0.581 (0.491)	0.721 (0.560)
ESB6	Our employees have the ability to gain customer satisfaction		0.489 (0.579)	0.567 (0.400)
*ESB7**	*Our employees have the ability to perform highly sophisticated tasks*		*(-0.128)*	*(-0.323)*
ESB8	Our employees have the ability to work independently		0.576 (0.485)	0.685 (0.679)
X4: Technological capabilities construct [Cronbrach's alpha = 0.906]				
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion		0.794	0.791 (0.794)
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion		0.787	0.789 (0.783)
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion		0.692	0.781 (0.759)
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies		0.785	0.884 (0.879)
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements		0.724	0.793 (0.807)
PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process		0.630	0.712 (0.734)
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage		0.632	0.711 (0.719)
X5: Supply chain capabilities construct [Cronbrach's alpha = 0.788*(0.719)*]				
*SC1**	*Ability to obtain more competitive prices from suppliers/ subcontractors*		*(0.141)*	*(0.253)*
SC2	Ability to procure materials on a global basis		0.615 (0.573)	0.711 (0.654)
SC3	Ability to improve the quality of construction services and products		0.613 (0.620)	0.765 (0.694)
SC4	Ability to attract repeat business from clients		0.498 (0.473)	0.680 (0.667
SC5	Ability to improve construction delivery speed		0.671 (0.685)	0.813 (0.888)
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis		0.596 (0.514)	(0.683 (0.618)
*SC7**	*Ability to assemble effective business teams (including suppliers & subcontractors) to provide one-stop services for clients*		*(0.201)*	*(0.148)*

Item code (1)	Constructs and corresponding measurement items (2)	Item-total correlation: Subscale (3)	Item-total correlation: Whole scale (4)	Factor Loadings (5)
X6.1: Main business strategies construct (see Section 7.3.1.2 for further explanation) [Reliability of linear combination = 0.812 *(0.606)***]**				
CLS: Cost leadership **[Cronbach's alpha = 0.737]**				
B9	Implementing stricter financial management on company cash flow	0.541	0.460 (0.404)	0.783 (0.746)
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	0.535	0.488 (0.384)	0.706 (0.688)
B14	Implementing stricter site management to reduce material wastage	0.657	0.699 (0.624)	0.762 (0.709)
B15	Implementing stricter procurement management	0.530	0.409 (0.258)	0.755 (0.725)
RLS: Risk leadership **[Cronbach's alpha = 0.733***(0.454)***]**				
B5	Bidding for more projects that are within the firm's capabilities	0.528 (0.403)	0.378 (0.398)	0.803 (0.735)
*B6**	*Bidding for projects with low tender prices and tiny/zero margins*	*(0.145)*	*(0.044)*	*(0.347)*
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	0.518 (0.367)	0.382 (0.385)	0.766 (0.760)
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	0.641 (0.418)	0.574 (0.533)	0.780 (0.789)
X6.2: Supporting business strategies construct (see Section 7.3.2.2 for further explanation) [Reliability of linear combination = 0.817 *(0.802)***]**				
PLS: Product leadership **[Cronbach's alpha = 0.723***(0.599)***]**				
*B1**	*Adopting merger and acquisition strategies*	*(0.013)*	*(0.112)*	*(-0.014)*
B7	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	0.470 (0.481)	0.344 (0.351)	0.762 (0.759)
B12	Investing into R & D to further explore business opportunities	0.606 (0.640)	0.590 (0.601)	0.755 (0.734)
B16	Investing surplus funds into financial investments and property development	0.624 (0.465)	0.468 (0.412)	0.837 (0.827)
CIS: Customer intimacy **[Cronbach's alpha = 0.761]**				
B2	Forming joint-venture with other contractors to serve a group of targeted clients	0.530	0.501 (0.514)	0.657 (0.631)
B3	Forming partnership with clients	0.651	0.572 (0.575)	0.795 (0.766)
B4	Diversifying into different construction business	0.523	0.361 (0.361)	0.804 (0.801)
B13	Following clients abroad	0.567	0.507 (0.514)	0.738 (0.740)
Z: Environmental conditions construct [Reliability of linear combination = 0.864 *(0.862)***]**				
MC: Market conditions **[Cronbach's alpha = 0.748** *(0.681)***]**				
MC1	Fluctuation of demand for constructed facilities	0.521 (0.485)	0.470 (0.454)	0.706 (0.707)
*MC2**	*Changes of clients' need*	*(0.201)*	*(0.299)*	*(0.232)*
*MC3**	*Unpredictable actions of competitors*	*(0.250)*	*(0.413)*	*(0.273)*
MC4	Price competition in the construction market	0.713 (0.678)	0.623 (0.608)	0.840 (0.831)
MC5	Intense competition in the construction market	0.514 (0.532)	0.546 (0.533)	0.746 (0.727)
MC6	Fluctuation of supply of construction resources	0.446 (0.538)	0.371 (0.430)	0.723 (0.730)

Item code (1)	Constructs and corresponding measurement items (2)	Item-total correlation Subscale (3)	Whole scale (4)	Factor Loadings (5)
TCn: Technological conditions **[Cronbrach's alpha = 0.867]**				
TCn1	Rapid emergence of new information technology on business operations	0.739	0.595 (0.610)	0.870 (0.856)
TCn2	Rapid emergence of new construction process technology on business operations	0.760	0.678 (0.719)	0.855 (0.867)
TCn3	Demand for advanced technological constructed facilities (e.g., intelligent building)	0.742	0.610 (0.622)	0.880 (0.859)
Y: Organizational flexibility construct [Reliability of linear combination = 0.892 *(0.888)***]**				
OF: Operational flexibility **[Cronbrach's alpha = 0.825***(0.791)***]**				
F1	Ability to modify your firm's operational structure	0.658 (0.562)	0.555 (0.480)	0.766 (0.813)
F2	Ability to integrate, construct and reshape your firm's financial resources	0.576 (0.626)	0.500 (0.515)	0.799 (0.749)
*F9**	*Ability of your firm's construction equipment to be modified to suit different operational needs*	*(0.359)*	*(0.474)*	*(0.243)*
F10	Ability to construct facilities using different construction methods and materials	0.594 (0.604)	0.601 (0.602)	0.675 (0.646)
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	0.656 (0.603)	0.603 (0.598)	0.700 (0.680)
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	0.644 (0.652)	0.648 (0.612)	0.708 (0.720)
TF: Tactical flexibility **[Cronbrach's alpha = 0.783]**				
F3	Ability to change the number of employees in your business operation	0.615	0.511 (0.559)	0.767 (0.716)
F4	Ability of your firm's employees to handle multiple responsibilities	0.612	0.373 (0.345)	0.809 (0.879)
F5	Ability to add and expand your business capacity efficiently	0.665	0.544 (0.549)	0.800 (0.743)
F7	Ability to adopt a range of alternative logistics supports to operations	0.473	0.447 (0.451)	0.621 (0.594)
SF: Strategic flexibility **[Cronbrach's alpha = 0.703** *(0.572)***]**				
*F6**	*Ability to operate effectively in both local and overseas markets*	*(0.282)*	*(0.426)*	*(0.222)*
F8	Ability to operate effectively and profitably in different market conditions	0.430 (0.408)	0.381 (0.380)	0.650 (0.644)
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management	0.619 (0.552)	0.396 (0.394)	0.827 (0.808)
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	0.467 (0.464)	0.477 (0.487)	0.532 (0.470)
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	0.451 (0.304)	0.371 (0.345)	0.713 (0.701)

Note: * denotes the measurement item has been deleted from the scale; number in ( ) denotes the relevant value of the measurement item before its removal.

Table 7.4 shows that 11 out of the 76 measurement items were removed in an effort to improve the confidence of reliability and validity of individual single- and multi-dimensional constructs. Justification on the removal is now discussed.

7.3.1 Cronbach's alpha and item-to-total correlation

The focus of the Cronbach's alpha (α) and item-to-total correlation tests is on the internal reliability of the measurement items of individual constructs (see Section 6.4.4.1). As shown in Table 7.4, the Cronbach's alpha coefficients of all dimensions of respective multi-dimensional constructs and single-dimensional constructs have exceeded the threshold level of 0.70 (Nunnally, 1978) following the removal of inconsistent measurement items based on the set of rules in Table 6.2. In this case, the reported Cronbrach's alpha coefficients range from 0.703 to 0.906. Along with this, the reliability of linear combination (i.e., overall reliability) scores for all multi-dimensional constructs are also well above the threshold value of 0.70, ranging from 0.812 to 0.892. The relatively high values of both the Cronbrach's alpha coefficients and overall reliability scores indicate a high degree of internal reliability within individual constructs involved, thus providing a greater level of confidence in the reliability of the measurement obtained.

The third and fourth columns of Table 7.4 show the subscale and whole scale correlation scores of individual measurement items of respective factors. The item-to-total correlation analysis was conducted on account of constructs' dimensionality, i.e., single- and multi-dimensionality of constructs involved (see Section 6.4.4.1). In the case of multi-dimensional constructs, say the organizational learning culture construct, three factor structures are identified: (i) commitment to learning (CL); (ii) shared vision and value (SV); and (iii) open-mindedness (O). The subscale score of CL was then calculated solely based on the data obtained from its three measurement items, i.e., CL1, CL2 and CL3, and the same applies to the other two factor structures. For the whole scale scores, all data obtained within the organizational learning construct (i.e., all measurement items of CL, SV and O) were collectively used to compute the whole scale score of individual measurement items of the organizational learning culture construct. Following the same process, the whole scale score of individual measurement items of respective single-dimensional constructs were calculated.

As can be seen from Table 7.4, the subscale and whole scale scores corresponding to all dimensions of multi- and single-dimensional constructs are well above the threshold level of 0.30 (Nunnally, 1978) after the trimming process (see Section 6.4.4.4). The subscale and whole scale scores range from 0.430 to 0.760 and 0.361 to 0.794, respectively. Again, this provides strong evidence of internal reliability within individual constructs involved.

Based on the satisfactory results of the above three measures, no further removal of inconsistent measurement item is required to satisfy the internal reliability of the measurement items of both single- and multi-dimensional constructs. Justification for removal of inconsistent measurement items, i.e., the italicized items with asterisk (*) sign in Table 7.4, are discussed in the following EFA section.

7.3.2 Exploratory factor analysis (EFA)

In exploring the uni-dimensionality of measurement items of individual constructs, the last column of Table 7.4 shows the factor loadings of all measurement items derived from the EFA. These results are discussed in two main parts. The first part of the discussion focuses on the EFA of the four multi-dimensional constructs: (i) organizational learning culture (X1); (ii) business strategies (X6); (iii) environmental conditions (Z); and (iv) organizational flexibility (Y). In this case, four sets of EFA were conducted independently based on the data of the respective constructs, i.e., combining the data of various dimensions of individual constructs (following Wang et al., 2007). It appears reasonable to analyze these multi-dimensional constructs independently since their corresponding blocks (i.e., dimensions) of measurement items were specified according to their common theoretical underpinning and meaning within individual concepts.

Next, the second part of the discussion is on the EFA results of the four proposed single-dimensional constructs. They are: (i) organizational structure (X2); (ii) employees' skills and behaviour (X3); (iii) technological capabilities (X4); and (iv) supply chain capabilities (X5). Unlike the EFA of the multi-dimensional constructs, these constructs were analysed as a group (following Wang et al., 2007). This involves combining all data obtained for these four single-dimensional constructs when performing the EFA.

The appropriateness of the EFA process for analyzing the multi-dimensional constructs independently, while examining the single-dimensional construct as a group is further justified based on the test results of the square root of average variance extracted (see Section 7.4.3). For consistency, the term "factor" is used in this EFA section to denote: (i) respective dimensions of each multi-dimensional construct; (ii) individual single-dimensional constructs; and (iii) the term "component" used in findings generated by SPSS software.

7.3.2.1 <u>Factor analysis of organizational learning culture (X1)</u>

In terms of uni-dimensionality, Table 7.5 shows that three factors (i.e., dimensions) have met the eigenvalue greater than 1.0 criterion (see Section 6.4.4.4), and this finding is further supported by the scree plot in Figure 7.1. This finding agrees with Sinkula et al. (1997) that organizational learning culture can be operationalized along three dimensions: (i) commitment to learning; (ii) open-mindedness; and (iii) shared vision and value.

Table 7.5 Total variance explained for organizational learning culture

Factor	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	**4.071**	40.715	40.715
2	**1.691**	16.912	57.627
3	**1.253**	12.525	70.152
4	0.853	8.532	78.684

Note: Extraction method: principal component analysis

Table 7.5 shows that the identified three factors jointly explain 70.15% of the total variance, suggesting that the EFA procedure is appropriate. Of these, the 'shared vision and value' factor was first identified with an eigenvalue of 4.071, representing 40.71% of the explained variance. Subsequently, the 'open-mindedness' factor was identified with an eigenvalue of 1.691, and accounts for 16.91% of the explained variance. Lastly, the third factor 'commitment to learning' was established with an eigenvalue of 1.253. This report is in tally with the results presented in Table 7.6.

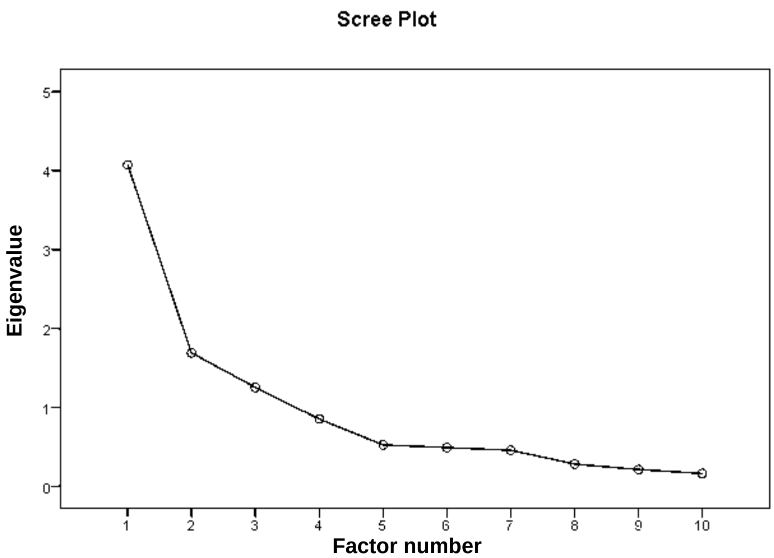


Figure 7.1 Scree plot for organizational learning culture

As can be seen from Table 7.4, all measurement items have loaded considerably on their corresponding factors, showing the minimum and maximum factor loadings of 0.717 and 0.894, respectively. These relatively high factor loadings establish the high convergent validity of individual measurement items within the three factors of the organizational learning culture construct. Besides this, Table 7.6 shows that all measurement items did not cross-load excessively on other factors that they are not designed to measure, thus suggesting an adequate level of discriminant validity of individual factors. In fact, all the cross-loadings are well below the level of 0.45 (see Sections 6.4.4.2 and 6.4.4.4).

Table 7.6 Factor matrix for measurement items of organizational learning culture

Measurement items	**Factor**		
	1	**2**	**3**
SV1	**.717**	.301	.044
SV2	**.771**	.272	.217
SV3	**.866**	-.082	.101
SV4	**.724**	-.011	.298
O1	.080	**.844**	.167
O2	.350	**.743**	.311
O3	.001	**.894**	.018
CL1	.204	.142	**.754**
CL2	.065	.025	**.817**
CL3	.246	.261	**.749**

Note: **Bolded factor loadings** are similar to those reported in Table 7.4. Extraction method: principal component analysis; Rotation method: varimax with Kaiser normalization.

7.3.2.2 Factor analysis of business strategies (X6)

Five factor structures were preliminarily emerged from the EFA based on a total of 16 measurement items. It was found that the emergence of one additional factor structure was primarily due to the presence of two inconsistent measurement items with factor loadings (FL) of less than 0.45 (see Table 7.4). They are: (i) B6 - bidding for projects with low tender prices and tiny/zero margins (FL=0.347), and (ii) B1 - adopting merger and acquisition strategies (FL=-0.014).

For the 'product leadership' factor, measurement item B1 'adopting merger and acquisition strategies' has been removed due to two reasons. First, it is found that less than five out of the 41 firms interviewed have adopted the merger and acquisition strategies. Second, this strategy has a low factor loading of 0.347, indicating its inconsistency within the respective factor.

Turning to the 'risk leadership' factor, the removal of measurement item B6 'bidding for projects with low tender prices and tiny/zero margins' is supported by the interview findings; where all interviewees criticized the detrimental effects of 'suicidal' bids (see Section 7.3.2.3). This agrees with Oo et al. (2007) who, in their experimental comparative study on Hong Kong and Singapore contractors' bidding behaviour, found that Singapore contractors are conscious of the risks associated with irrational bidding attempts.

As shown in Table 7.7 and Figure 7.2, four factor structures, which have met both the eigenvalues greater than 1 and scree plot criteria, emerged in the EFA retest following the removal of the two inconsistent items. In this case, the four factors jointly account for 65.63% of the total variance explained. These identified factor structures, denoted as factors 1, 2, 3 and 4 in Table 7.7, are related to: (i) firms' cost leadership endeavour; (ii) firms' customer intimacy endeavour; (iii) firms' risk leadership endeavour; and (iv) firms' product leadership endeavour, respectively.

Table 7.4 shows, following the removal of the two inconsistent items, that the remaining 14 measurement items have loaded highly on their respective factors with loadings ranging from 0.657 to 0.837. The loadings obtained are well above the cut-off value of 0.45 (see Section 6.4.4.4), indicating a high degree of convergent validity of measurement items. Also, the factor loadings of individual measurement items are reproduced in Table 7.8 in an attempt to establish the discriminant validity of individual dimensions. It can be seen that all measurement items of respective factors did not cross-load excessively (all cross-loadings <0.45) on other factors that they are not purported to measure, thus indicating an acceptable level of discriminant validity.

Table 7.7 Total variance explained for business strategies

Factor	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	**3.135**	22.391	22.391
2	**2.996**	21.403	43.794
3	**1.624**	11.598	55.392
4	**1.434**	10.242	65.634
5	0.888	6.342	71.976

Note: Extraction method: principal component analysis

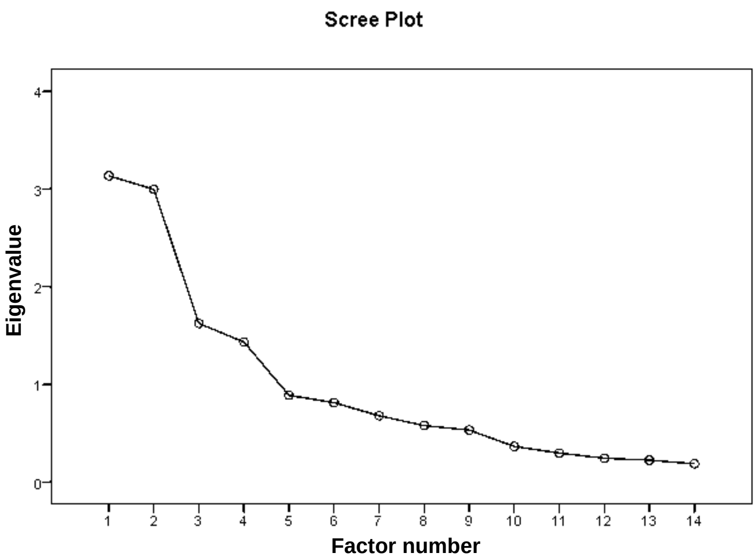


Figure 7.2 Scree plot for business strategies

Apart from the above, it should be noted that the 'business strategies' construct was restructured into two smaller-scaled constructs (see Table 7.4), namely: (i) main business strategies (X6.1) and (ii) supporting business strategies (X6.2). The former relates to firms' cost and risk leadership initiatives while the latter refers to firms' customer intimacy and product leadership initiatives. The restructuring was induced by the item-to-total correlation analysis, and was conducted in a two-stage process.

Table 7.8 Factor matrix for measurement items of business strategies

Measurement items	Factor			
	1	2	3	4
B9	**.783**	-.115	.046	-.025
B10	**.706**	.142	.167	-.019
B14	**.762**	-.151	.373	-.075
B15	**.755**	.105	-.012	-.012
B2	.115	**.657**	-.064	.250
B3	.147	**.795**	.158	.211
B4	-.183	**.804**	.008	-.122
B13	-.030	**.738**	.031	.123
B5	.065	.013	**.803**	-.092
B8	.078	.168	**.766**	.079
B11	.283	-.071	**.780**	.017
B7	.076	.022	-.359	**.762**
B12	.028	.304	.247	**.755**
B16	-.227	.134	.057	**.837**

Note: **Bolded factor loadings** are similar to those reported in Table 7.4. Extraction method: principal component analysis; Rotation method: varimax with Kaiser normalization.

In the initial item-to-total correlation analysis, it was found that the item-to-total correlation scores obtained for all measurement items of both firms' cost and risk leadership initiatives were below the threshold value of 0.30 (see Section 6.4.4.4) if all 14 measurement items were considered under a single construct, i.e., the business strategies construct. Noting this effect, these 14 items were subsequently categorized into the two smaller-scaled constructs as highlighted in Table 7.4. It appears that the restructuring process has improved the overall reliability of the constructs involved in terms of the item-to-total correlation and reliability of linear combination scores (see Table 7.4). For example, the item-to-total correlation scores for all measurement items of both firms' cost and risk leadership factors have improved from the previous scores range of 0.044 - 0.624 to 0.378 – 0.699, following the restructuring process and the removal of inconsistent measurement items. All these establish the uni-dimensionality of the respective factors within the two constructs.

7.3.2.3 Factor analysis of environmental conditions (Z)

The EFA for the environmental conditions construct involves the removal of two inconsistent items from the 'market-conditions' dimension: (i) MC2 - changes of clients' need (FL= 0.232) and (ii) MC3 - unpredictable actions of competitors (FL = 0.273). Their removals are justified by the low factor loadings obtained (FLs < 0.450) and the majority of interviewees, who indicated that they were not affected by items 'MC2' and 'MC3' during the study periods 1997 – 2007, even though Singapore's construction industry underwent eight years of unprecedented economic downturn from 1997 to 2005. Many interviewees pointed out that clients' need for residential, industrial, commercial and institutional buildings remain static. This may also be explained by the small physical size of Singapore.

The inconsistency of item MC3 'unpredictable actions of competitors' can be explained in relation to contractors' resourcefulness in obtaining tender information. In practice, contractors have access to the likely number and identities of their competitors through the 'site show round' exercise (Betts and Brown, 1992) and personal contacts, for example, the concrete suppliers or piling subcontractors who usually submit quotations to a group of contractors competing for the same particular project. Hitherto, the 'site show round' exercise is still practiced in the Singapore construction industry (Oo et al., 2007) where all interested contractors are invited at the same time to inspect a particular project site. Some interviewees commented that many contractors would rather spend more time counting and identifying their competitors than inspecting the site during this exercise.

The Singapore government procures construction services through the GeBIZ website and publishes tender results (known as tender schedules). Participants can access information such as names of all participating bidders and their bid prices, and the name of the winning contractor together with the awarded contract sum for particular public projects. Through these avenues, contractors could roughly identify their closest potential competitors for subsequent public tenders of a similar nature, and use their past behaviour to predict their bidding behaviour.

For the private sector contracts, the interviewees shared the view that Singapore contractors who ‘try hard enough’ can find out their competitors’ bid prices. Some interviewees added that bid cutting is practised in the private sector. Shortlisted contractors are asked to lower their bid prices to that of the lowest bidder during the tender evaluation stage. However, many contractors pointed out that the element of ‘unpredictable actions of competitors’ is becoming less applicable in the industry because many companies that made ‘suicidal bids’ had already gone into liquidation during the 1997-2005 economic downturn.

Following the removal of the two inconsistent items, Table 7.9 and Figure 7.3 show that two factors, which emerged in the EFA retest, have met both the eigenvalues greater than 1 and scree plot criteria (see Section 6.4.4.4). In this case, factors 1 and 2 represent technological conditions and market conditions, respectively (see Table 7.9) and jointly account for 68.622% of the total variance explained. From Table 7.4, it can be seen that all measurement items of the ‘technological conditions’ and ‘market conditions’ factors have loaded considerably on the factor that they are supposed to measure with factor loadings ranging from 0.706 to 0.880. This indicates a high level of convergent validity, and further establishes the uni-dimensionality of individual factors within the ‘environmental conditions’ construct.

Table 7.9 Total variance explained for environmental conditions

Factor	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	**3.404**	48.635	48.635
2	**1.399**	19.987	68.622
3	0.757	10.821	79.444

Note: Extraction method: principal component analysis

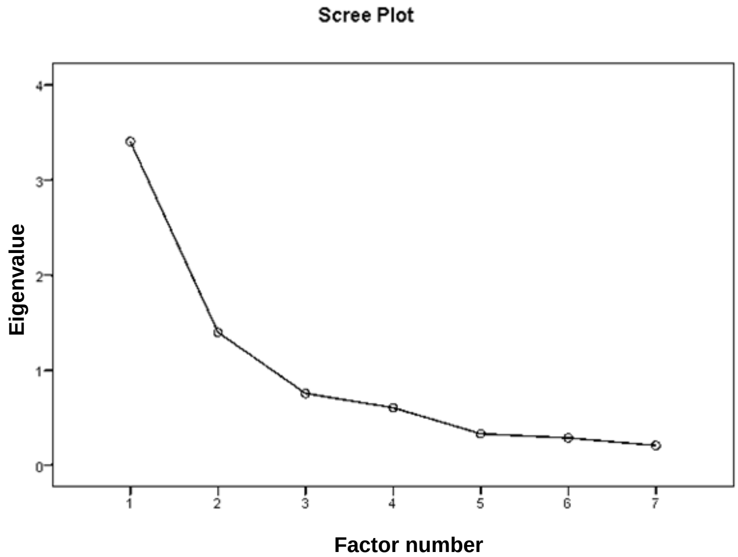


Figure 7.3 Scree plot for environmental conditions

Table 7.10 shows the factor matrix for the environment conditions construct. It appears that all measurement items of the respective factors did not cross-load excessively (all cross loadings <0.45) on the other factor, indicating a high level of discriminant validity.

Table 7.10 Factor matrix for measurement items of environmental conditions

Measurement items	Factor	
	1	2
TCn1	**.870**	.131
TCn2	**.855**	.241
TCn3	**.880**	.174
MC1	.165	**.706**
MC4	.220	**.840**
MC5	.277	**.746**
MC6	.029	**.723**

Note: **Bolded factor loadings** are similar to those reported in Table 7.4. Extraction method: principal component analysis; Rotation method: varimax with Kaiser normalization.

7.3.2.4 Factor analysis of organizational flexibility (Y)

For the organizational flexibility construct, four factors initially emerged in the EFA. This however differs from the proposed dimensionality of the organizational flexibility construct specified in Chapter 4. It is noted that the fourth factor surfaced due to the presence of two inconsistent items: (i) F6 - the ability of your firm to operate effectively in both local and overseas markets, and (ii) F9 - the ability of your firm's construction equipment to be modified to suit different operational needs. While items F6 and F9 loaded highly on the fourth factor (i.e., F6 and F9 have the corresponding factor loadings of 0.769 and 0.703), the option of combining these two items under a single factor appears not viable. This is because: (i) this combination does not possess common theoretical underpinning, and (ii) it does not meet the criterion established in Table 6.7, i.e., individual factors should comprise at least three measurement items (see Section 5.4.1).

The preliminary EFA shows that, apart from the fourth factor, both items F6 and F9 have loaded on the corresponding 'strategic flexibility' and 'operational flexibility' factors, but with low factor loadings of 0.222 and 0.243 (see values in parenthesis in Table 7.4). All these suggest the need to remove both items F6 and F9 in an attempt to improve the uni-dimensionality of the individual dimensions within the organizational flexibility construct. Further justification for the removal of items F6 and F9 is given below.

The removal of item F6 is in some way supported by Dulaimi and Tan (2001), who found that Singapore contractors were not interested in overseas ventures due to the high risk involved. In this study, less than one-third of the interviewees' firms had ventured overseas during the study period 1997 – 2007. This group of contractors noted that their overseas venture have not been successful due to the lack of government support in their global operations. This agrees with Dulaimi and Tan's (2001) findings that: (i) Singapore contractors are not self-reliant in their overseas venture, and (ii) the Singapore government policies may not be effective in enabling construction firms to be world class contractors. All these attest that the item F6 'the ability of your firm to operate effectively in both local and overseas markets' is less applicable in the context of the Singapore construction industry.

All interviewees pointed out that item F9 is less applicable in the context of the Singapore construction industry. Most interviewees shared the view that equipment and machinery used in the construction industry are relatively standardized, rarely requiring any special modification to suit different operational needs. Some interviewees pointed out that if special-purpose equipment and machinery are required, they would rather rent them from vendors than modify their existing equipment or buy new machines to suit their one-off needs. This agrees with Dulaimi and Hong's (2002) findings that Singapore contractors are highly reliant on leasing rather than buying their own equipment and machinery in performing their works. They found that about 30% of the respondents leased 50% to 75% of the construction equipment used.

Following the removal of the two inconsistent items (i.e. F6 and F9), the EFA retest showed that three factors have satisfactorily met the eigenvalue greater than 1 and scree plot criteria (see Table 7.11 and Figure 7.4), and jointly account for 59.84% of the total variance. Correspondingly, factors 1, 2 and 3 represent: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility.

Table 7.11 Total variance explained for organizational flexibility

Factor	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	**4.562**	35.092	35.092
2	**1.704**	13.109	48.201
3	**1.513**	11.635	59.836
4	0.987	7.589	67.425

Note: Extraction method: principal component analysis

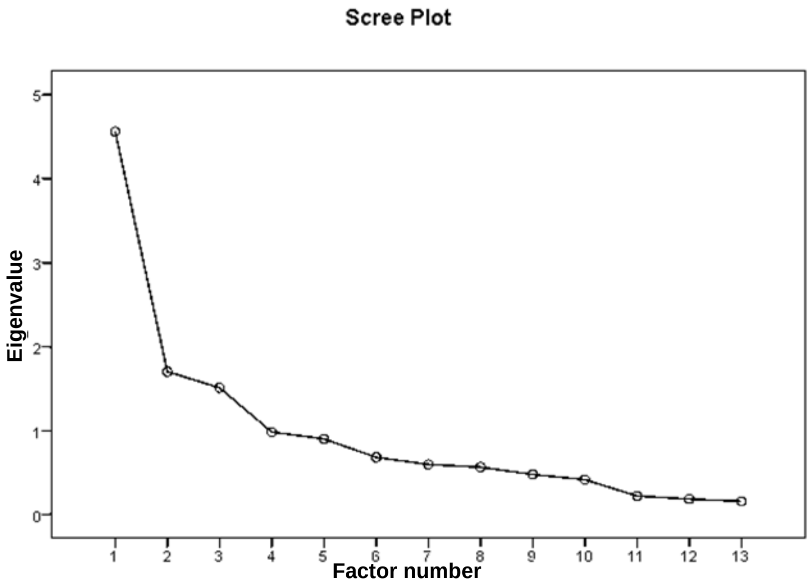


Figure 7.4 Scree plot for organizational flexibility

As noted from Table 7.4, all measurement items of the respective dimensions (i.e., operational flexibility, tactical flexibility and strategic flexibility) have loaded highly on the factor that they are designed to measure. The corresponding minimum and maximum factor loadings for the 13 measurement items of 0.532 and 0.827 are well above the cut-off value of 0.45. This indicates a high degree of convergent validity of measurement items, and further attests the uni-dimensionality of the three identified dimensions within the organizational flexibility construct

In an attempt to establish the discriminate validity of measurement items within their corresponding factors, Table 7.12 shows the loadings of all measurement items generated across the three identified factors. It can be seen that all cross loadings of measurement items on other factors are well below 0.45, indicating an acceptable degree of discriminant validity of the measurement items of respective factors within the organizational flexibility construct.

Table 7.12 Factor matrix for measurement items of organizational flexibility

Measurement items	**Factor**		
	1	**2**	**3**
F1	**.766**	.071	.165
F2	**.799**	.219	-.149
F10	**.675**	.117	.344
F11	**.700**	.051	.365
F14	**.708**	.294	.168
F3	.167	**.767**	.141
F4	-.015	**.809**	.078
F7	.158	**.621**	.217
F5	.309	**.800**	-.002
F8	.228	-.007	**.650**
F12	.016	.179	**.827**
F13	.309	.194	**.532**
F15	.083	.106	**.713**

Note: **Bolded factor loadings** are similar to those reported in Table 7.4.
Extraction Method: principal component analysis; Rotation Method: varimax with Kaiser normalization.

7.3.2.5 Factor analysis of single-dimensional constructs

Having discussed the factor analyses of multi-dimensional constructs, the focus here is on the EFA of the single-dimensional constructs identified. These include: (i) organizational structure (X2), (ii) employees' skills and behaviour (X3); (iii) technological capabilities (X4); and (iv) supply chain capabilities (X5). All measurement items of these four single-dimensional constructs were analyzed as a group (see Section 7.3.2). Instead of the proposed four, seven factors were detected in the preliminary EFA. It is noted that the three additional factors surfaced due to the presence of five inconsistent measurement items with loadings of less than 0.45 on their corresponding factors. Justification for removing these inconsistent items is examined next.

Two inconsistent items were identified in the 'employees' skills and behaviour' construct. They are: (i) ESB3 - our employees have the ability to travel overseas on assignments for an extended period (FL = 0.348) and (ii) ESB7- our employees have the ability to perform highly sophisticated tasks (FL = -0.323) (see Table 7.4). Following the removal of item F6 from the organizational flexibility construct (see Section 7.3.2.4), in which it was established that it is not important for firms to operate effectively in both local and overseas markets, it follows that item ESB3 is less relevant to Singapore contractors. Hence, item ESB3 was removed from the 'employees' skills and behaviour' construct.

Next, item ESB7 was found less viable because most interviewees shared the view that they do not require their employees to perform highly sophisticated tasks in their business operation, but rather to be adaptive and able to multi-task. They explained that construction is a sophisticated production process that requires teamwork for successful completion, rather than one which relies on the ability of an individual to perform highly sophisticated tasks.

Turning to the 'organizational structure' construct (X2), item OS4 'our firm adopts a loose and informal control which depends on informal relationship and norms of cooperation for getting work done' was found not viable. As can be seen from Table 7.4, item OS4 has a factor loading of 0.305, which is far below the cut-off value of 0.45. This can partly be explained by the variety and uniqueness of the output of construction firms that require a wide range of intermediate activities. Integration of these activities will demand an extra effort, in terms of internal monitoring and coordination, for which a formal control mechanism has to be put in place to minimize the associated costs, especially since contractors will normally work within a multi-project environment. A group of interviewees expressed their concerns on collusion among employees and subcontractors/suppliers in relation to the lack of formal organizational control mechanisms, and suggested that ‘good’ and ‘right’ controls are key towards effective business management.

The remaining two inconsistent items resided in the ‘supply chain capabilities’ construct (X5). They are: (i) SC1 - ability to obtain more competitive prices from suppliers and/or subcontractors (FL = 0.253), and (ii) SC7- ability to assemble effective business teams to provide one-stop services for clients (FL = 0.148). In this case, both the factor loadings are well below the threshold value of 0.45, indicating the inconsistency of items SC1 and SC7.

Although SC1 appears sensible in contributing positively towards a contractor’s supply chain capabilities, most interviewees pointed out that their regular subcontractors and/or suppliers are often being asked to match the prices which their competitors offer instead of obtaining more competitive prices from them. They explained that there is always price competition in the supply market, among subcontractors and suppliers within their own trades, and it is therefore not necessary that their regular subcontractors and/or suppliers offer them more competitive prices.

Similarly, item SC7 ‘firms’ ability to assemble effective business teams to provide one-stop services for clients’ was removed because interviewees shared the view that it is less applicable in the Singapore construction industry in which the traditional design-bid-construct system predominates (see Section 2.5). Therefore, the demand for one-stop services for building procurement is relatively low. However, it is noted that a small group of the interviewees had provided one-stop services for clients in design-and-build contracts.

Upon the removal of the five inconsistent items (i.e., ESB3, ESB7, OS4, SC1 and SC2), four factors, corresponding to the four single-dimensional constructs, were identified during the EFA retest, and collectively accounted for 65.03% of the total variance explained (see Table 7.13 and Figure 7.5). Correspondingly, these four factors represent: (i) technological capabilities (X4); (ii) employees' skills and behaviour (X3); (iii) supply chain capabilities (X5); and (iv) organizational structure (X2). From Table 7.4, it can be seen that the factor loadings of all measurement items of the respective factors are well above the threshold value of 0.45. In this case, the obtained factor loadings range from 0.567 to 0.884, indicating a relatively high degree of convergent validity of measurement items within the respective factors. This further establishes the uni-dimensionality of the respective factors.

Table 7.13 Total variance explained for single-dimensional constructs

Factor	**Initial eigenvalues**		
	Total	**% of variance**	**Cumulative %**
1	**5.952**	28.341	28.341
2	**3.396**	16.172	44.512
3	**2.265**	10.787	55.299
4	**2.043**	9.729	65.029
5	0.992	4.724	69.753

Note: Extraction method: principal component analysis

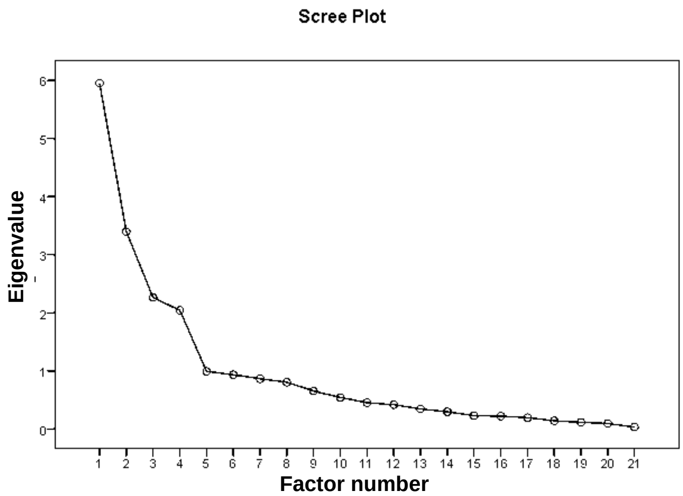


Figure 7.5 Scree plot for single-dimensional constructs

As for the testing of discriminant validity, Table 7.14 shows that measurement items of respective factors did not cross-load on other factors which they are not designed to measure. All cross-loadings obtained are well below 0.45. This means that measurement items are distinctive enough to capture the characteristics of their corresponding factors. As a result, an adequate level of discriminant validity is achieved among the measurement items of respective factors.

Table 7.14 Rotated component matrix for all single-dimensional construct

Measurement items	Factor			
	1	2	3	4
IT1	**.791**	.104	.311	-.157
IT2	**.789**	.126	.181	-.254
IT3	**.781**	.113	-.020	.004
IT4	**.884**	-.013	-.054	-.063
PT1	**.793**	.116	.144	-.034
PT2	**.712**	-.063	.258	-.008
PT3	**.711**	.192	.069	.033
ESB1	-.080	**.774**	-.102	.201
ESB2	.164	**.841**	.101	.105
ESB4	.127	**.719**	.245	.173
ESB5	-.089	**.721**	.165	-.102
ESB6	.247	**.567**	.281	-.192
ESB8	.289	**.685**	-.025	-.015
SC2	.023	.356	**.711**	.105
SC3	.076	-.001	**.765**	-.248
SC4	.199	.006	**.680**	.085
SC5	.105	.027	**.813**	-.024
SC6	.176	.252	**.683**	.136
OS1	-.038	-.032	.103	**.882**
OS2	-.048	.151	-.088	**.834**
OS3	-.170	.051	.032	**.835**

Note: **Bolded factor loadings** are similar to those reported in Table 7.4. Extraction Method: principal component analysis; Rotation Method: varimax with Kaiser normalization.

7.4 Results of contemporary validation approach

The retained measurement items of individual single- and multi-dimensional constructs (i.e., measurement models) in the classical validation procedure formed the input to the subsequent contemporary validation procedure, using the confirmatory factor analysis (CFA) in the PLS modelling technique. As highlighted in Section 6.4.3.1, the use of the CFA could provide a stricter and more objective interpretation of uni-dimensionality than does EFA. In addition, the CFA has its application to establish the strength of measurement models via examining the internal reliability, and the convergent and discriminant validities of measurement models.

Table 7.15 shows the revised categorization of constructs based on the results obtained from the classical validation procedure reported in Section 7.3. Similar to the classical validation approach, any removal of inconsistent measurement items in the CFA is subjected to the rules set in Table 6.7 (see Section 6.4.4.4).

Table 7.15 Revised categorization of constructs

Item	Constructs	No. of factors (or dimensions)	No. of measurement items
1	Organizational learning culture (X1)	3	10
2	Organizational structure (X2)	1	3
3	Employees' skills and behaviour (X3)	1	6
4	Technological capabilities (X4)	1	7
5	Supply chain capabilities (X5)	1	5
6	Main business strategies (X6.1)	2	7
7	Supporting business strategies (X6.2)	2	7
8	Environmental conditions (Z)	2	7
9	Organizational flexibility (Y)	3	13

Unlike the discover-oriented nature of EFA, CFA focuses on the theoretical specification, i.e., the prescribed relations between constructs, in its entire estimation process (see Section 6.4). In this case, the prescribed relations between constructs in both PLS M1 and M2 are shown in Figures 6.3 and 6.4, respectively, and these relationships are taken into account in the CFA.

Tables 7.16 and 7.17 show the corresponding results of the CFA for PLS M1 and M2. Each of these tables comprises: (i) the factor loadings and *t*-statistics of individual measurement items; (ii) the composite reliability scores; and (iii) average variance extracted values for respective dimensions within their corresponding constructs. However, it must be noted that results of the CFA for PLS M1 and M2 are only marginally different for the majority of the measurement items and their corresponding dimensions. For example, the factor loadings for the measurement item CL1 in both PLS M1 and M2 are 0.830 and 0.850, respectively, and the differences in both the composite reliability scores (i.e., 0.851 vs. 0.849) and average variance extracted values (i.e., 0.655 vs. 0.653) between the two models are as low as 0.002. This can be explained in that the preference in PLS is given to minimizing the residuals on the observed variables (i.e., measurement items) based on the assumption that the theory is softer (less precise, less developed) than empirical observations (see Section 6.4). This means that preference is given to the data and measurement models (i.e., the outer relations) by staying as close to data as possible while investigating the specified relationships between constructs (i.e., the inner relations). Results of the CFA for PLS M1 and M2 are jointly discussed in the subsequent sections (7.4.1 to 7.4.3) given their close similarity.

Table 7.16 Results of confirmatory factor analysis for PLS M1

Item code	**Constructs and corresponding measurement items**	**Factor Loadings**	***t*-statistic**	**Composite reliability**	**Average variance extracted**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
X1: Organizational learning culture construct					
CL: Commitment to learning				0.851	0.655
CL1	Employees' training and learning are seen as investment rather than expenses	0.830	10.028		
CL2	Performance mistakes are seen as opportunities for learning and development	0.765	6.388		
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	0.832	6.286		

Item code (1)	Constructs and corresponding measurement items (2)	Factor Loadings (3)	*t*-statistic (4)	Composite reliability (5)	Average variance extracted (6)
SV: Shared vision and value				0.853	0.598
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	0.878	5.266		
SV2	Our firm provides support to employees to reach organizational goals	0.879	5.128		
SV3	Employees are constantly informed on the firm's business objectives	0.719	3.274		
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	0.578	2.322		
O: Open-mindedness				0.894	0.738
O1	Our firm encourages participative decision making among employees	0.837	5.231		
O2	Our firm promotes open communication among subordinates and superiors	0.918	8.672		
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	0.819	5.137		
X2: Organizational structure construct				0.898	0.747
OS1	Our firm operates in a flexible work procedure	0.868	3.650		
OS2	Our firm adopts a more decentralized decision making process	0.822	3.538		
OS3	Our firm has an open communication channel with flexible access to important information for decision making	0.900	3.801		
X3: Employees' skills and behaviour construct				0.878	0.546
ESB1	Our employees have the ability to adopt an open mindset to all alternatives	0.686	6.469		
ESB2	Our employees have the ability to work in a team environment	0.846	11.680		
ESB4	Our employees have the ability to learn and adapt to different business conditions	0.774	7.331		
ESB5	Our employees have the ability to perform a diverse range of tasks and responsibilities	0.691	5.862		
ESB6	Our employees have the ability to gain customer satisfaction	0.693	7.797		
ESB8	Our employees have the ability to work independently	0.732	6.780		
X4: Technological capabilities construct				0.924	0.637
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	0.856	5.853		
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	0.855	6.056		
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	0.742	4.250		
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	0.814	5.026		

Item code (1)	Constructs and corresponding measurement items (2)	Factor Loadings (3)	*t*-statistic (4)	Composite reliability (5)	Average variance extracted (6)
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	0.834	4.879		
PT2	Ability to apply different process technology software (e.g., estimating and purchasing software) to improve firm's operational process	0.766	3.353		
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	0.707	4.421		
X5: Supply chain capabilities construct				0.867	0.568
SC2	Ability to procure materials on a global basis	0.804	10.973		
SC3	Ability to improve the quality of construction services and products	0.763	8.150		
SC4	Ability to attract repeat business from clients	0.628	4.468		
SC5	Ability to improve construction delivery speed	0.772	6.654		
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	0.788	13.036		
X6.1: Main business strategies construct					
CLS: Cost leadership				0.853	0.594
B9	Implementing stricter financial management on company cash flow	0.757	4.617		
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	0.776	4.7612		
B14	Implementing stricter site management to reduce material wastage	0.859	7.505		
B15	Implementing stricter procurement management	0.682	4.381		
RLS: Risk leadership				0.853	0.659
B5	Bidding for more projects that are within the firm's capabilities	0.787	4.089		
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	0.802	6.598		
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	0.845	4.268		
X6.2: Supporting business strategies construct					
PLS: Product leadership				0.791	0.570
B7	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	0.939	4.045		
B12	Investing into R & D to further explore business opportunities	0.555	1.744		
B16	Investing surplus funds into financial investments and property development	0.721	2.601		
CIS: Customer intimacy				0.844	0.577
B2	Forming joint-venture with other contractors to serve a group of targeted clients	0.741	5.476		
B3	Forming partnership with clients	0.869	14.649		
B4	Diversifying into different construction business	0.621	3.592		
B13	Following clients abroad	0.787	5.251		

Item code	Constructs and corresponding measurement items	Factor Loadings	*t*-statistic	Composite reliability	Average variance extracted
(1)	(2)	(3)	(4)	(5)	(6)
Z: Environmental conditions construct					
MC: Market conditions				0.850	0.591
MC1	Fluctuation of demand for constructed facilities	0.618	2.349		
MC4	Price competition in the construction market	0.868	4.290		
MC5	Intense competition in the construction market	0.859	4.112		
MC6	Fluctuation of supply of construction resources	0.702	2.937		
TCn: Technological conditions				0.914	0.781
TCn1	Rapid emergence of new information technology on business operations	0.839	3.861		
TCn2	Rapid emergence of new construction process technology on business operations	0.941	6.487		
TCn3	Demand for advanced technological constructed facilities (e.g., intelligent building)	0.868	5.251		
Y: Organizational flexibility construct					
OF: Operational flexibility				0.880	0.594
F1	Ability to modify your firm's operational structure	0.798	8.377		
F2	Ability to integrate, construct and reshape your firm's financial resources	0.699	3.595		
F10	Ability to construct facilities using different construction methods and materials	0.757	12.867		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	0.821	10.328		
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	0.772	9.311		
TF: Tactical flexibility				0.855	0.597
F3	Ability to change the number of employees in your business operation	0.748	4.043		
F4	Ability of your firm's employees to handle multiple responsibilities	0.747	4.926		
F5	Ability to add and expand your business capacity efficiently	0.819	6.449		
F7	Ability to adopt a range of alternative logistics supports to operations	0.775	6.843		
SF: Strategic flexibility				0.818	0.530
F8	Ability to operate effectively and profitably in different market conditions	0.662	4.500		
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)	0.828	11.749		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	0.728	7.063		
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	0.684	3.999		

Table 7.17 Results of confirmatory factor analysis for PLS M2

Item code	Constructs and corresponding measurement items	Factor Loadings	*t*-statistic	Composite reliability	Average variance extracted
(1)	(2)	(3)	(4)	(5)	(6)
X1: Organizational learning culture construct					
CL: Commitment to learning				0.849	0.653
CL1	Employees' training and learning are seen as investment rather than expenses	0.855	14.028		
CL2	Performance mistakes are seen as opportunities for learning and development	0.716	5.600		
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	0.845	6.783		
SV: Shared vision and value				0.862	0.613
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	0.851	3.901		
SV2	Our firm provides support to employees to reach organizational goals	0.876	4.226		
SV3	Employees are constantly informed on the firm's business objectives	0.762	4.215		
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	0.616	2.732		
O: Open-mindedness				0.899	0.749
O1	Our firm encourages participative decision making among employees	0.865	9.830		
O2	Our firm promotes open communication among subordinates and superiors	0.879	12.587		
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	0.853	8.956		
X2: Organizational structure construct				0.901	0.752
OS1	Our firm operates in a flexible work procedure	0.869	5.818		
OS2	Our firm adopts a more decentralized decision making process	0.873	6.378		
OS3	Our firm has an open communication channel with flexible access to important information for decision making	0.860	5.472		
X3: Employees' skills and behaviour construct				0.878	0.547
ESB1	Our employees have the ability to adopt an open mindset to all alternatives	0.694	6.645		
ESB2	Our employees have the ability to work in a team environment	0.845	8.616		
ESB4	Our employees have the ability to learn and adapt to different business conditions	0.778	7.470		
ESB5	Our employees have the ability to perform a diverse range of tasks and responsibilities	0.694	5.713		
ESB6	Our employees have the ability to gain customer satisfaction	0.696	6.867		
ESB8	Our employees have the ability to work independently	0.720	5.714		

Item code	Constructs and corresponding measurement items	Factor Loadings	*t*-statistic	Composite reliability	Average variance extracted
(1)	(2)	(3)	(4)	(5)	(6)
X4: Technological capabilities construct				0.926	0.641
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	0.869	23.472		
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	0.861	15.967		
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	0.770	9.076		
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	0.838	10.366		
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	0.801	8.785		
PT2	Ability to apply different process technology software (e.g., estimating and purchasing software) to improve firm's operational process	0.735	6.153		
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	0.720	9.648		
X5: Supply chain capabilities construct				0.867	0.568
SC2	Ability to procure materials on a global basis	0.810	12.209		
SC3	Ability to improve the quality of construction services and products	0.763	8.757		
SC4	Ability to attract repeat business from clients	0.634	4.719		
SC5	Ability to improve construction delivery speed	0.771	6.804		
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	0.778	12.714		
X6.1: Main business strategies construct					
<u>CLS: Cost leadership</u>				0.852	0.591
B9	Implementing stricter financial management on company cash flow	0.722	3.637		
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	0.800	5.362		
B14	Implementing stricter site management to reduce material wastage	0.855	6.733		
B15	Implementing stricter procurement management	0.689	4.777		
<u>RLS: Risk leadership</u>				0.852	0.657
B5	Bidding for more projects that are within the firm's capabilities	0.815	6.123		
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	0.796	4.375		
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	0.820	4.488		

Item code (1)	Constructs and corresponding measurement items (2)	Factor Loadings (3)	*t*-statistic (4)	Composite reliability (5)	Average variance extracted (6)
X6.2: Supporting business strategies construct					
PLS: Product leadership				0.845	0.645
B7	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	0.826	2.761		
B12	Investing into R & D to further explore business opportunities	0.770	2.877		
B16	Investing surplus funds into financial investments and property development	0.813	4.164		
CIS: Customer intimacy				0.846	0.582
B2	Forming joint-venture with other contractors to serve a group of targeted clients	0.665	5.046		
B3	Forming partnership with clients	0.874	23.079		
B4	Diversifying into different construction business	0.702	5.841		
B13	Following clients abroad	0.793	8.272		
Z: Environmental conditions construct					
MC: Market conditions				0.850	0.591
MC1	Fluctuation of demand for constructed facilities	0.619	2.706		
MC4	Price competition in the construction market	0.867	4.365		
MC5	Intense competition in the construction market	0.857	4.013		
MC6	Fluctuation of supply of construction resources	0.704	2.911		
TCn: Technological conditions				0.914	0.781
TCn1	Rapid emergence of new information technology on business operations	0.841	3.750		
TCn2	Rapid emergence of new construction process technology on business operations	0.940	5.098		
TCn3	Demand for advanced technological constructed facilities (e.g., intelligent building)	0.867	4.150		
Y: Organizational flexibility construct					
OF: Operational flexibility				0.880	0.594
F1	Ability to modify your firm's operational structure	0.788	5.832		
F2	Ability to integrate, construct and reshape your firm's financial resources	0.707	3.245		
F10	Ability to construct facilities using different construction methods and materials	0.752	11.104		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	0.819	9.341		
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	0.784	6.805		
TF: Tactical flexibility				0.854	0.594
F3	Ability to change the number of employees in your business operation	0.725	3.520		
F4	Ability of your firm's employees to handle multiple responsibilities	0.757	5.432		
F5	Ability to add and expand your business capacity efficiently	0.806	6.156		
F7	Ability to adopt a range of alternative logistics	0.792	6.308		

Item code	Constructs and corresponding measurement items	Factor Loadings	*t*-statistic	Composite reliability	Average variance extracted
(1)	(2)	(3)	(4)	(5)	(6)
	supports to operations				
SF: Strategic flexibility				0.818	0.530
F8	Ability to operate effectively and profitably in different market conditions	0.675	4.397		
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)	0.824	9.209		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	0.731	6.269		
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	0.672	3.949		

7.4.1 Composite reliability

Composite reliability scores are used to assess the internal reliability of measurement models (see Section 6.4.4.1). It can be seen that the composite reliability scores of all individual constructs in both PLS M1 and M2 are above the threshold level of 0.70 (Hair et al., 1998), suggesting a high level of internal reliability for the constructs involved (see third column of Tables 7.16 and 7.17). The corresponding composite reliability scores, ranging from 0.791 to 0.924 and 0.818 to 0.926, support the retention of all items in measurement models of PLS M1 and M2.

7.4.2 Standardized factor loadings and average variance extracted (AVE)

As noted in both Tables 7.16 and 7.17, factor loadings for all items of respective measurement models are well above the cut-off value of 0.45 (Comprey, 1973; see Section 6.4.4.4), ranging from 0.555 to 0.940. Besides this, it can be seen that *t*-statistics of all individual measurement items are greater than 2.430 (i.e., the *t*-test values required to achieve statistical significant at $p < 0.05$). For the hypothesis testing, this means that all factor loadings (or parameter estimates in CFA) in both PLS M1 and M2 are significantly different from zero, and thus they are significantly related to their corresponding constructs and should be retained in the models.

Overall, these statistically significant high factor loadings of all measurement items provide strong evidence of convergent validity of measurement items within their respective constructs, in addition to the EFA.

In tandem with the above, the average variance extracted (AVE) value is another measure used to assess the convergent validity of individual constructs (see Section 6.4.4.3). As can be seen from Tables 7.16 and 7.17, the AVE values of all constructs in PLS M1 and M2 are above the cut-off value 0.50 (Fornell and Larcker, 1981; see Section 6.4.4.4), ranging from 0.530 to 0.781. This means that at least 50% of measurement variance is captured by individual constructs involved, thus indicating a satisfactory level of convergent validity. Therefore, no corrective action is required; all items are retained in their respective measurement models.

7.4.3 Square root of AVE and cross loading analysis

Using the AVE values in Tables 7.16 and 7.17, Table 7.18 shows the descriptive statistics, Pearson correlation matrix and the square roots of AVE (see Section 6.4.4.3) of individual constructs (or factors) in PLS M1 and M2. It can be seen that the square roots of AVE of all constructs in PLS M1 and M2 are greater than the correlation between any pair of constructs in the models. This provides strong evidence of discriminant validity, suggesting that all the constructs involved are both conceptually and empirically distinct from each other. In fact, the test result has proven the appropriateness of the EFA process (as shown in Section 7.3.2) for analyzing multi-dimensional constructs individually, while examining single-dimensional constructs as a group. Although there may be correlations between measurement items of respective multi-dimensional and single-dimensional constructs, which have been ignored during the EFA process in an attempt to establish factor structures, the square root of AVE values have proven that individual constructs are discriminate.

Table 7.18 Descriptive statistics, correlation matrix and the square roots of AVE for PLS M1 and M2

Code	Factors	Min	Max	Mean	SD	$X1_{CL}$	$X1_{SV}$	$X1_{SV}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
$X1_{CL}$	Commitment to learning	3.00	7.00	5.50	0.93	**0.809** [PLSM1] **0.808** [PLSM2]															
$X1_{SV}$	Shared vision and value	2.75	7.00	5.35	0.93	**0.421****	**0.773** [PLSM1] **0.783** [PLSM2]														
$X1_{O}$	Open-mindedness	3.00	6.67	5.00	0.98	**0.358***	**0.327***	**0.858** [PLSM1] **0.865** [PLSM2]													
X2	Organizational structure	1.00	6.00	3.35	1.39	0.034	-0.030	**0.412****	**0.864** [PLSM1] **0.867** [PLSM2]												
X3	Employees' skills and behaviour	4.17	6.67	5.20	0.52	**0.587****	0.259	0.279	0.107	**0.739** [PLSM1] **0.740** [PLSM2]											
X4	Technological capabilities	1.00	6.00	4.57	1.10	0.194	**0.390***	**0.316***	0.240	-0.175	**0.798** [PLSM1] **0.801** [PLSM2]										
X5	Supply chain capabilities	3.40	7.00	5.45	0.86	**0.325***	0.119	0.234	**0.358***	0.055	0.303	**0.754** [PLSM1, PLSM2]									
$X6.1_{CLS}$	Cost leadership	4.33	6.50	5.50	0.49	-0.084	0.105	-0.072	0.065	-0.008	**0.323***	0.085	**0.771** [PLSM1] **0.769** [PLSM2]								
$X6.1_{RLS}$	Risk leadership	4.33	6.78	5.22	0.47	0.122	0.015	0.192	0.158	**0.336***	**0.424****	0.004	**0.324***	**0.812** [PLSM1] **0.811** [PLSM2]							
$X6.2_{PLS}$	Product leadership	1.00	6.11	3.75	1.65	-0.167	0.092	**0.342***	-0.011	0.077	0.043	0.228	-0.096	-0.026	**0.755** [PLSM1] **0.803** [PLSM2]						
$X6.2_{CIS}$	Customer intimacy	1.00	5.58	3.15	1.37	0.098	0.099	**0.389***	**0.395***	0.156	0.265	**0.544****	0.043	0.116	**0.325***	**0.760** [PLSM1] **0.763** [PLSM2]					
Z_{MC}	Market conditions	3.17	7.00	5.75	0.87	-0.126	0.003	-0.073	-0.132	-0.059	-0.139	0.066	-0.260	**-0.325***	-0.041	-0.059	**0.769** [PLSM1, PLSM2]				
Z_{TCn}	Technological conditions	2.33	7.00	4.15	1.21	**-0.405****	**-0.351***	-0.065	-0.153	0.035	-0.133	-0.081	0.042	-0.045	0.047	0.011	**0.410****	**0.884** [PLSM1, PLSM2]			
Y_{OF}	Operational flexibility	2.60	6.60	5.04	0.89	**0.531****	0.118	**0.311***	**0.553****	-0.078	**0.587****	0.279	0.300	**0.355***	-0.255	0.208	**-0.365***	-0.165	**0.771** [PLSM1 PLSM2]		
Y_{TF}	Tactical flexibility	3.75	7.00	5.25	0.73	**0.325***	0.096	-0.061	0.270	-0.139	**0.453****	0.031	0.162	0.173	-0.230	0.081	-0.014	-0.185	**0.410****	**0.773** [PLSM1, PLSM2]	
Y_{SF}	Strategic flexibility	3.40	6.60	5.05	0.62	0.272	**0.371***	0.213	0.305	0.144	0.292	0.205	**0.481****	**0.497****	-0.100	**0.409****	-0.203	-0.215	**0.423****	**0.318***	**0.728** [PLSM1, PLSM2]

Note: The **square roots values** of average variance extracted for PLS M1 and M2 are denoted as [PLSM1] and [PLSM2], respectively in the diagonal, whereas the Pearson correlation coefficients are below the diagonal; * correlation is significant at the 0.05 level (2-tailed); ** correlation is significant at the 0.01 level (2 -tailed)

To reinforce the above findings, the cross loading matrices generated for PLS M1 and M2 by the SmartPLS 2.0 M3 software are presented in Tables 7.20 and 7.21, respectively. Both tables show that all items (a total of 65 items in each table) loaded higher on the construct that they were theoretically specified to measure than any other constructs in the models. This further demonstrates a strong evidence of discriminate validity. Therefore, no corrective action is required in PLS M1 and M2. More importantly, the cross loading analysis re-confirms that the factor structures emerged were not distorted by the proposed EFA process.

7.5 Standard deviation of measurement items of individual constructs

With reference to Table 7.18, it should be noted the standard deviation (SD) values were computed based on the composite scores of individual constructs; whereby individual composite score was obtained by summing the weighted scores of individual measurement items of the respective constructs (see Section 6.4.3). As highlighted in Section 5.4.1, a multiple-item scale was adopted to assess individual constructs in an attempt to achieve a more accurate prediction of constructs, and thus increase the reliability of data.

In order to demonstrate that the prediction of constructs was more reliable, through the applications of the multiple-item scale and PLS approach, efforts were made to compare the SD values between individual items (i.e., a single-item scale) and individual constructs (i.e., a multiple-item scale). Tables 7.18 and 7.19 show that the SD values for individual constructs and measurement items range from 0.47 to 1.65 and 0.52 to 2.55, respectively. Taking the ‘commitment to learning’ ($X1_{CL}$) factor as an example, if the three measurement items (i.e., CL1, CL2 and CL3) are treated as a single-item measure to the factor, their predictions could appear to be less reliable; since their SD values range from 0.98 to 1.29 within the domain of the same factor (see Section 5.4.1 for further explanation on the inadequacy of single-item measures). On the other hand, if the three items are treated as multi-item measures of the $X1_{CL}$ factor, in which the weighted scores of individual measurement items are considered in the calculation of the composite score of the $X1_{CL}$ factor, the prediction tends to be more accurate and reliable. First, the multi-item measures are able to collectively capture the domain of the $X1_{CL}$ factor more adequately and accurately than if the three items are treated individually (see Section 5.4.1). Second, the PLS approach treats individual measurement items separately within its factor's domain and allows each item to vary in the amount of influence on the composite score of the $X1_{CL}$ factor rather than assuming equal weight for all the items of the summated scale (see Section 6.5.2). All these may contribute to achieving a more accurate and reliable prediction of the $X1_{CL}$ factor, and further help to explain the low SD value obtained for the $X1_{CL}$ factor compared to the individual SD values of its measurement items. In fact, these further establish the reliability of data for the subsequent modelling process.

Table 7.19 Standard deviation of measurement items

Item code	Standard deviation	Item code	Standard deviation	Item code	Standard deviation	Item code	Standard deviation	Item code	Standard deviation
CL1	1.29	ESB4	0.73	SC6	1.32	MC1	1.34	F7	0.87
CL2	1.18	ESB5	0.79	B9	0.52	MC4	0.84	F8	0.66
CL3	0.98	ESB6	0.60	B10	0.92	MC5	1.06	F12	0.84
SV1	1.19	ESB8	0.58	B14	0.52	MC6	1.30	F13	0.74
SV2	1.12	IT1	1.53	B15	0.60	TCn1	1.32	F15	0.81
SV3	1.22	IT2	1.45	B5	0.60	TCn2	1.36		
SV4	1.14	IT3	1.56	B8	0.63	TCn3	1.40		
O1	1.27	IT4	1.42	B11	0.52	F1	1.39		
O2	0.99	PT1	1.24	B7	1.80	F2	1.19		
O3	1.13	PT2	1.18	B12	1.73	F10	1.14		
OS1	1.50	PT3	1.24	B16	2.55	F11	1.05		
OS2	1.58	SC2	1.65	B2	1.92	F14	1.01		
OS3	1.74	SC3	0.79	B3	2.11	F3	0.96		
ESB1	0.79	SC4	0.88	B4	1.54	F4	0.87		
ESB2	0.72	SC5	1.00	B13	1.56	F5	1.05		

Table 7.20 Cross-loadings for individual measurement items of respective factors for PLS M1

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
CL1	**0.830**	0.369	0.336	0.156	0.533	0.250	0.400	0.033	0.153	-0.261	0.142	-0.181	-0.385	0.430	0.270	0.294
CL2	**0.765**	0.185	0.244	-0.042	0.430	-0.010	0.220	-0.057	0.166	-0.172	0.009	-0.160	-0.290	0.462	0.167	0.216
CL3	**0.832**	0.407	0.430	-0.030	0.484	0.232	0.155	-0.252	-0.064	-0.099	0.141	-0.058	-0.319	0.394	0.365	0.124
SV1	0.300	**0.878**	0.362	0.016	0.183	0.417	0.300	0.284	0.106	0.154	0.236	0.019	-0.310	0.137	0.277	0.464
SV2	0.423	**0.879**	0.450	-0.042	0.357	0.297	0.132	0.050	0.143	0.073	0.166	-0.102	-0.302	0.228	0.225	0.311
SV3	0.249	**0.719**	0.200	-0.116	0.243	0.320	0.021	0.019	-0.083	0.108	0.131	-0.011	-0.238	0.079	-0.022	0.312
SV4	0.401	**0.578**	0.232	0.050	0.098	0.146	-0.065	-0.095	-0.124	0.133	-0.145	0.113	-0.299	-0.005	-0.091	0.091
O1	0.306	0.285	**0.837**	0.467	0.202	0.130	0.171	-0.134	0.242	0.181	0.305	-0.173	0.021	0.243	-0.156	0.138
O2	0.486	0.510	**0.918**	0.158	0.457	0.480	0.224	-0.147	0.076	0.175	0.515	-0.112	-0.132	0.392	0.121	0.290
O3	0.178	0.175	**0.819**	0.373	0.098	0.263	0.235	-0.021	0.146	0.243	0.287	-0.069	-0.078	0.198	-0.034	0.136
OS1	0.005	-0.174	0.235	**0.868**	0.019	-0.103	0.066	-0.082	0.278	0.001	0.075	-0.047	-0.048	-0.176	-0.135	0.023
OS2	-0.012	0.008	0.402	**0.822**	0.122	-0.130	-0.011	0.041	0.252	-0.055	0.207	-0.087	0.128	0.031	-0.079	0.166
OS3	0.082	0.047	0.272	**0.900**	0.053	-0.221	0.029	-0.059	0.330	0.041	0.063	-0.106	0.012	-0.103	-0.126	0.189
ESB1	0.392	0.286	0.289	0.250	**0.686**	-0.026	0.069	-0.159	0.070	-0.087	0.298	-0.127	-0.017	0.272	0.240	0.122
ESB2	0.424	0.157	0.332	0.118	**0.846**	0.241	0.318	-0.052	0.174	0.046	0.407	-0.267	-0.157	0.585	0.132	0.221
ESB3	0.436	0.177	0.151	0.173	**0.774**	0.221	0.359	0.185	0.223	-0.129	0.386	-0.106	-0.118	0.371	0.302	0.379
ESB5	0.444	0.057	0.231	-0.023	**0.691**	0.050	0.253	-0.016	-0.064	-0.091	0.178	-0.032	-0.271	0.353	0.149	0.124
ESB6	0.506	0.277	0.361	-0.137	**0.693**	0.370	0.382	0.024	0.176	-0.205	0.357	-0.006	-0.033	0.502	0.373	0.326
ESB8	0.432	0.348	0.160	0.009	**0.732**	0.330	0.169	0.220	0.138	-0.321	0.106	-0.261	-0.181	0.539	0.126	0.268
IT1	0.097	0.389	0.359	-0.202	0.279	**0.856**	0.426	0.193	0.117	0.100	0.501	-0.037	-0.033	0.298	0.036	0.191
IT2	0.224	0.363	0.339	-0.279	0.286	**0.855**	0.288	-0.015	-0.052	0.096	0.447	0.029	-0.237	0.265	0.153	0.159
IT3	0.263	0.359	0.279	-0.081	0.230	**0.742**	0.137	0.077	0.016	0.186	0.424	-0.086	-0.044	0.226	-0.095	0.158
IT4	0.125	0.420	0.353	-0.157	0.154	**0.814**	0.081	-0.072	-0.033	0.221	0.373	-0.045	-0.084	0.131	-0.128	0.149
PT1	0.192	0.246	0.284	-0.117	0.290	**0.834**	0.280	0.024	-0.025	0.019	0.353	-0.018	-0.050	0.307	0.148	0.252

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
PT2	0.089	0.326	0.340	-0.082	0.148	**0.766**	0.304	0.014	-0.033	0.087	0.445	0.197	0.013	0.259	0.219	0.150
PT3	0.117	0.311	0.151	-0.096	0.297	**0.707**	0.223	0.176	-0.025	-0.017	0.407	-0.053	0.068	0.154	0.078	0.105
SC2	0.154	0.183	0.168	0.140	0.439	0.197	**0.804**	0.362	0.426	-0.213	0.263	-0.054	0.070	0.482	0.443	0.333
SC3	0.305	0.211	0.172	-0.185	0.115	0.257	**0.763**	0.296	0.375	0.049	0.242	-0.181	-0.201	0.405	0.432	0.219
SC4	0.308	0.193	0.353	0.061	0.191	0.291	**0.628**	0.028	0.223	0.039	0.180	-0.150	-0.233	0.297	0.294	0.005
SC5	0.326	0.147	-0.034	-0.022	0.199	0.242	**0.772**	0.151	0.244	-0.230	0.035	-0.095	-0.181	0.383	0.270	0.089
SC6	0.212	0.085	0.259	0.103	0.370	0.314	**0.788**	0.233	0.281	-0.047	0.307	-0.221	-0.080	0.600	0.376	0.355
B9	-0.085	0.213	-0.108	-0.044	-0.079	0.049	-0.007	**0.757**	0.185	-0.044	-0.021	-0.290	0.051	0.108	0.042	0.411
B10	-0.091	0.218	0.087	0.014	0.180	0.086	0.390	**0.776**	0.268	-0.048	0.144	-0.032	0.103	0.336	0.101	0.397
B14	-0.144	0.038	-0.293	-0.157	-0.017	-0.007	0.292	**0.859**	0.444	-0.179	-0.061	-0.336	-0.078	0.298	0.216	0.400
B15	0.024	0.032	-0.080	0.093	0.122	0.130	0.235	**0.682**	0.126	-0.090	0.076	-0.201	0.050	0.155	0.115	0.252
B5	0.111	0.086	0.147	0.424	0.144	-0.041	0.397	0.243	**0.787**	-0.239	0.065	-0.210	-0.097	0.230	0.193	0.415
B8	0.141	0.150	0.242	0.173	0.273	0.184	0.331	0.233	**0.802**	-0.092	0.195	-0.264	0.053	0.346	0.098	0.439
B11	0.003	-0.037	-0.014	0.236	0.017	-0.167	0.302	0.394	**0.845**	-0.142	0.024	-0.242	-0.115	0.262	0.277	0.354
B7	-0.243	0.120	0.138	-0.023	-0.288	0.057	-0.191	-0.061	-0.251	**0.939**	0.166	-0.151	-0.026	-0.352	-0.402	-0.157
B12	-0.089	0.012	0.373	0.201	0.096	0.345	0.262	0.048	0.215	**0.555**	0.386	0.031	0.148	-0.048	-0.005	0.034
B16	-0.090	0.131	0.283	0.044	0.087	0.149	0.072	-0.208	-0.021	**0.721**	0.293	0.001	0.010	-0.188	-0.155	-0.111
B2	-0.115	0.123	0.083	-0.046	0.207	0.328	0.080	0.016	0.058	0.313	**0.741**	-0.290	-0.130	0.132	-0.001	0.378
B3	0.225	0.320	0.535	0.082	0.439	0.540	0.334	0.134	0.195	0.160	**0.869**	-0.053	0.062	0.256	0.059	0.422
B4	0.049	-0.013	0.246	0.288	0.294	0.450	0.114	-0.157	0.026	0.002	**0.621**	0.121	0.106	0.021	0.097	0.145
B13	0.152	0.099	0.455	0.159	0.272	0.332	0.286	-0.001	0.036	0.196	**0.787**	-0.228	-0.017	0.284	0.230	0.274
MC1	0.123	-0.028	0.174	0.027	0.064	0.272	0.002	-0.320	-0.306	-0.127	0.058	**0.618**	0.318	-0.141	-0.014	-0.055
MC4	-0.108	-0.088	-0.176	-0.173	-0.094	0.088	-0.060	-0.172	-0.209	-0.177	-0.272	**0.868**	0.372	-0.213	0.058	-0.264
MC5	-0.111	-0.002	-0.138	-0.107	-0.182	-0.139	-0.228	-0.261	-0.222	-0.084	-0.341	**0.859**	0.401	-0.349	-0.139	-0.331
MC6	-0.289	0.007	-0.122	0.016	-0.235	0.027	-0.186	-0.148	-0.242	-0.003	0.140	**0.702**	0.233	-0.402	0.123	-0.021

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
TCn1	-0.414	-0.284	-0.138	0.009	-0.101	-0.116	-0.137	-0.023	-0.019	-0.068	0.021	0.327	**0.839**	-0.183	0.011	-0.147
TCn2	-0.425	-0.356	-0.110	0.030	-0.240	-0.049	-0.100	0.061	-0.100	0.015	-0.048	0.418	**0.941**	-0.230	-0.241	-0.262
TCn3	-0.241	-0.263	0.014	0.023	-0.045	-0.051	-0.150	0.022	-0.008	-0.009	0.038	0.372	**0.868**	-0.073	-0.188	-0.172
F1	0.544	0.142	0.401	0.007	0.525	0.212	0.348	0.240	0.285	-0.408	0.104	-0.371	-0.044	**0.798**	0.238	0.320
F2	0.306	-0.041	0.165	0.089	0.278	0.109	0.461	0.093	0.395	-0.193	0.086	-0.354	-0.107	**0.699**	0.351	0.148
F10	0.389	0.137	0.240	-0.232	0.421	0.365	0.481	0.237	0.112	-0.332	0.239	-0.096	-0.144	**0.757**	0.342	0.418
F11	0.464	0.264	0.330	-0.107	0.623	0.371	0.506	0.188	0.282	-0.161	0.390	-0.340	-0.293	**0.821**	0.272	0.409
F14	0.296	0.128	0.168	-0.139	0.453	0.107	0.531	0.424	0.286	-0.215	0.144	-0.324	-0.130	**0.772**	0.424	0.368
F3	0.360	0.126	-0.041	-0.026	0.260	-0.118	0.193	0.050	0.082	-0.256	0.054	-0.152	-0.304	0.330	**0.748**	0.307
F4	0.181	-0.077	-0.171	-0.210	0.135	-0.105	0.335	0.133	0.006	-0.318	-0.057	-0.056	-0.155	0.203	**0.747**	0.157
F5	0.265	0.250	0.045	-0.143	0.151	0.263	0.415	0.283	0.072	-0.191	0.052	0.009	-0.167	0.408	**0.819**	0.227
F7	0.225	0.276	0.105	-0.066	0.345	0.172	0.503	0.043	0.417	-0.353	0.241	0.105	-0.028	0.308	**0.775**	0.305
F8	0.262	0.096	0.257	0.071	0.331	0.114	0.248	0.125	0.337	-0.206	0.480	-0.118	-0.108	0.345	0.183	**0.662**
F12	0.196	0.458	0.106	0.073	0.248	0.155	0.225	0.303	0.461	-0.114	0.295	-0.225	-0.423	0.267	0.273	**0.828**
F13	0.122	0.363	0.166	0.249	0.302	0.224	0.280	0.487	0.346	-0.108	0.260	-0.069	-0.054	0.383	0.300	**0.728**
F15	0.202	0.336	0.201	0.037	0.131	0.137	0.139	0.476	0.291	-0.042	0.239	-0.330	-0.061	0.304	0.201	**0.684**

Table 7.21 Cross-loadings for individual measurement items of respective factors for PLS M2

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
CL1	**0.855**	0.365	0.306	0.135	0.531	0.247	0.397	0.030	0.162	-0.232	0.172	-0.181	-0.385	0.421	0.264	0.295
CL2	**0.716**	0.201	0.235	-0.053	0.432	-0.009	0.219	-0.051	0.166	-0.122	0.012	-0.161	-0.291	0.460	0.161	0.217
CL3	**0.845**	0.405	0.406	-0.021	0.486	0.230	0.157	-0.253	-0.058	-0.105	0.169	-0.058	-0.320	0.390	0.361	0.125
SV1	0.319	**0.851**	0.349	0.012	0.182	0.433	0.302	0.277	0.113	0.155	0.239	0.019	-0.310	0.136	0.275	0.459
SV2	0.432	**0.876**	0.414	-0.039	0.357	0.309	0.137	0.045	0.149	0.051	0.162	-0.102	-0.301	0.225	0.227	0.305
SV3	0.244	**0.762**	0.164	-0.120	0.241	0.324	0.020	0.022	-0.078	0.062	0.092	-0.011	-0.239	0.075	-0.031	0.310
SV4	0.397	**0.616**	0.220	0.063	0.098	0.156	-0.066	-0.087	-0.125	0.053	-0.150	0.112	-0.300	-0.006	-0.101	0.093
O1	0.301	0.275	**0.865**	0.480	0.204	0.143	0.174	-0.131	0.257	0.259	0.332	-0.173	0.020	0.240	-0.155	0.139
O2	0.498	0.507	**0.879**	0.169	0.460	0.477	0.226	-0.143	0.085	0.233	0.530	-0.111	-0.133	0.386	0.119	0.293
O3	0.183	0.164	**0.853**	0.398	0.100	0.252	0.237	-0.014	0.144	0.339	0.324	-0.069	-0.079	0.193	-0.036	0.137
OS1	0.020	-0.181	0.267	**0.869**	0.021	-0.108	0.067	-0.078	0.297	0.080	0.128	-0.046	-0.048	-0.172	-0.136	0.027
OS2	-0.005	0.007	0.434	**0.873**	0.127	-0.120	-0.007	0.047	0.259	0.001	0.256	-0.086	0.128	0.029	-0.085	0.169
OS3	0.087	0.043	0.294	**0.860**	0.055	-0.228	0.031	-0.061	0.336	0.085	0.081	-0.105	0.012	-0.106	-0.129	0.188
ESB1	0.388	0.285	0.271	0.254	**0.694**	-0.019	0.074	-0.154	0.072	-0.040	0.323	-0.126	-0.017	0.271	0.240	0.122
ESB2	0.418	0.159	0.318	0.133	**0.845**	0.249	0.315	-0.041	0.182	0.126	0.412	-0.267	-0.157	0.587	0.126	0.227
ESB4	0.446	0.168	0.114	0.168	**0.778**	0.218	0.362	0.197	0.231	-0.036	0.414	-0.106	-0.118	0.372	0.306	0.387
ESB5	0.436	0.064	0.213	-0.010	**0.693**	0.041	0.253	0.007	-0.057	-0.046	0.191	-0.032	-0.271	0.352	0.156	0.130
ESB6	0.508	0.284	0.324	-0.114	**0.696**	0.357	0.386	0.032	0.177	-0.110	0.372	-0.006	-0.034	0.495	0.375	0.328
ESB8	0.441	0.348	0.138	-0.005	**0.720**	0.323	0.170	0.217	0.146	-0.263	0.103	-0.261	-0.181	0.531	0.122	0.265
IT1	0.105	0.380	0.342	-0.196	0.274	**0.869**	0.428	0.197	0.124	0.213	0.531	-0.036	-0.033	0.297	0.044	0.190
IT2	0.237	0.354	0.321	-0.268	0.283	**0.861**	0.288	-0.016	-0.051	0.157	0.477	0.029	-0.237	0.261	0.156	0.161
IT3	0.271	0.360	0.259	-0.064	0.227	**0.770**	0.139	0.074	0.022	0.193	0.455	-0.086	-0.045	0.223	-0.093	0.160
IT4	0.139	0.418	0.331	-0.148	0.146	**0.838**	0.080	-0.081	-0.021	0.264	0.374	-0.045	-0.085	0.123	-0.130	0.149
PT1	0.208	0.251	0.258	-0.120	0.282	**0.800**	0.278	0.027	-0.020	0.110	0.361	-0.018	-0.050	0.303	0.149	0.252

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
PT2	0.108	0.321	0.311	-0.085	0.144	**0.735**	0.302	0.020	-0.029	0.162	0.448	0.197	0.013	0.257	0.214	0.149
PT3	0.138	0.307	0.113	-0.074	0.294	**0.720**	0.221	0.176	-0.015	0.081	0.434	-0.052	0.068	0.152	0.080	0.103
SC2	0.153	0.174	0.168	0.150	0.441	0.183	**0.810**	0.385	0.425	-0.072	0.284	-0.055	0.070	0.485	0.454	0.336
SC3	0.293	0.200	0.185	-0.192	0.117	0.250	**0.764**	0.311	0.366	0.125	0.240	-0.181	-0.201	0.410	0.437	0.221
SC4	0.324	0.162	0.351	0.050	0.193	0.287	**0.634**	0.039	0.238	0.105	0.211	-0.150	-0.233	0.303	0.302	0.006
SC5	0.333	0.135	-0.036	-0.053	0.195	0.233	**0.771**	0.168	0.253	-0.162	0.044	-0.096	-0.181	0.385	0.278	0.088
SC6	0.222	0.071	0.251	0.108	0.368	0.291	**0.778**	0.240	0.295	0.054	0.293	-0.221	-0.080	0.605	0.374	0.359
B9	-0.076	0.191	-0.103	-0.044	-0.087	0.062	-0.010	**0.722**	0.187	-0.070	-0.047	-0.290	0.051	0.107	0.034	0.404
B10	-0.091	0.212	0.095	0.039	0.177	0.075	0.392	**0.799**	0.258	-0.023	0.144	-0.032	0.102	0.338	0.101	0.396
B14	-0.150	0.019	-0.290	-0.154	-0.023	0.002	0.293	**0.855**	0.438	-0.153	-0.086	-0.336	-0.078	0.306	0.219	0.396
B15	0.022	0.026	-0.068	0.099	0.117	0.122	0.235	**0.689**	0.114	-0.029	0.073	-0.200	0.050	0.150	0.114	0.247
B5	0.116	0.068	0.158	0.418	0.141	-0.035	0.397	0.240	**0.815**	-0.124	0.077	-0.211	-0.096	0.235	0.199	0.417
B8	0.124	0.146	0.247	0.166	0.274	0.187	0.336	0.240	**0.796**	0.023	0.201	-0.265	0.052	0.346	0.108	0.439
B11	-0.003	-0.052	0.005	0.230	0.017	-0.172	0.303	0.401	**0.820**	-0.072	0.008	-0.242	-0.115	0.263	0.275	0.352
B7	-0.234	0.122	0.143	-0.030	-0.287	0.070	-0.193	-0.066	-0.259	**0.826**	0.121	-0.150	-0.027	-0.348	-0.409	-0.160
B12	-0.090	-0.001	0.391	0.200	0.098	0.341	0.263	0.055	0.218	**0.770**	0.392	0.032	0.148	-0.044	-0.001	0.032
B16	-0.111	0.129	0.287	0.030	0.094	0.162	0.075	-0.204	-0.020	**0.813**	0.275	0.001	0.010	-0.182	-0.154	-0.112
B2	-0.110	0.122	0.061	-0.046	0.208	0.326	0.077	0.016	0.051	0.314	**0.665**	-0.289	-0.130	0.132	-0.001	0.381
B3	0.231	0.302	0.513	0.082	0.442	0.544	0.338	0.141	0.194	0.273	**0.874**	-0.051	0.061	0.251	0.067	0.424
B4	0.067	-0.028	0.243	0.320	0.301	0.454	0.117	-0.148	0.033	0.081	**0.702**	0.122	0.106	0.019	0.102	0.150
B13	0.158	0.095	0.442	0.195	0.279	0.335	0.285	0.004	0.047	0.252	**0.793**	-0.227	-0.016	0.290	0.224	0.281
MC1	0.130	-0.023	0.161	0.018	0.067	0.247	0.002	-0.310	-0.291	-0.089	0.122	**0.619**	0.318	-0.146	-0.007	-0.049
MC4	-0.108	-0.083	-0.175	-0.177	-0.094	0.065	-0.061	-0.164	-0.204	-0.105	-0.221	**0.867**	0.372	-0.210	0.061	-0.260
MC5	-0.112	0.004	-0.136	-0.098	-0.177	-0.133	-0.222	-0.255	-0.220	-0.090	-0.286	**0.857**	0.401	-0.351	-0.135	-0.327
MC6	-0.280	0.002	-0.123	0.014	-0.229	0.014	-0.185	-0.139	-0.251	0.057	0.162	**0.704**	0.234	-0.401	0.130	-0.021

Measurement items	$X1_{CL}$	$X1_{SV}$	$X1_{O}$	X2	X3	X4	X5	$X6.1_{CLS}$	$X6.1_{RLS}$	$X6.2_{PLS}$	$X6.2_{CIS}$	Z_{MC}	Z_{TCn}	Y_{OF}	Y_{TF}	Y_{SF}
TCn1	-0.408	-0.290	-0.133	0.030	-0.097	-0.115	-0.138	-0.025	-0.010	-0.005	0.053	0.328	**0.841**	-0.182	0.015	-0.149
TCn2	-0.427	-0.360	-0.094	0.041	-0.237	-0.045	-0.098	0.062	-0.101	0.051	-0.010	0.418	**0.940**	-0.232	-0.229	-0.260
TCn3	-0.250	-0.256	0.018	0.034	-0.043	-0.058	-0.148	0.021	-0.010	0.040	0.053	0.371	**0.867**	-0.075	-0.185	-0.168
F1	0.543	0.131	0.388	0.019	0.517	0.212	0.347	0.241	0.286	-0.353	0.108	-0.372	-0.044	**0.787**	0.234	0.320
F2	0.298	-0.042	0.159	0.098	0.275	0.096	0.459	0.103	0.397	-0.161	0.074	-0.355	-0.107	**0.707**	0.341	0.153
F10	0.387	0.140	0.216	-0.212	0.416	0.339	0.477	0.241	0.111	-0.309	0.232	-0.096	-0.145	**0.752**	0.339	0.421
F11	0.461	0.269	0.310	-0.102	0.621	0.357	0.503	0.202	0.270	-0.100	0.368	-0.340	-0.293	**0.819**	0.267	0.408
F14	0.280	0.108	0.163	-0.121	0.450	0.100	0.531	0.431	0.295	-0.137	0.130	-0.324	-0.129	**0.784**	0.426	0.370
F3	0.360	0.121	-0.056	-0.023	0.262	-0.142	0.191	0.048	0.069	-0.235	0.040	-0.152	-0.302	0.332	**0.725**	0.304
F4	0.186	-0.103	-0.172	-0.218	0.139	-0.131	0.337	0.138	-0.005	-0.250	-0.055	-0.055	-0.155	0.204	**0.757**	0.156
F5	0.277	0.236	0.025	-0.129	0.152	0.236	0.413	0.279	0.065	-0.133	0.052	0.009	-0.166	0.413	**0.806**	0.226
F7	0.231	0.256	0.076	-0.062	0.351	0.157	0.508	0.054	0.426	-0.236	0.269	0.106	-0.027	0.314	**0.792**	0.308
F8	0.261	0.099	0.252	0.089	0.334	0.107	0.246	0.133	0.345	-0.178	0.472	-0.117	-0.108	0.345	0.189	**0.675**
F12	0.193	0.447	0.094	0.064	0.246	0.162	0.224	0.295	0.463	-0.065	0.272	-0.224	-0.422	0.266	0.268	**0.824**
F13	0.121	0.356	0.134	0.243	0.300	0.209	0.278	0.482	0.353	-0.072	0.240	-0.068	-0.054	0.385	0.293	**0.731**
F15	0.206	0.326	0.206	0.039	0.128	0.123	0.137	0.472	0.288	-0.025	0.219	-0.328	-0.061	0.300	0.200	**0.672**

7.6 Hypothesis testing of H1

Based on the results obtained from both the classical and contemporary validation procedures, an important finding is derived - Organizational flexibility is a multi-dimensional construct comprising: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility. This means that H_1, stating that organizational flexibility (Y) can be characterized by three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}) (see Section 3.6.1.3), is supported in this study. The EFA and CFA show that the three dimensions are distinctive with at least three measurement items loaded highly on them. More importantly, they have satisfied all the criteria set to determine the reliability and validity of a construct.

7.7 Summary

This chapter presents the results for validating the conceptual framework for organizational flexibility in construction firms. The results show that organizational structure (X2), employee skills and behaviour (X3), technological capabilities (X4) and supply chain capabilities (X5) are single-dimensional constructs. Organizational learning culture (X1), business strategies (X6) and environmental conditions (Z) each comprises various dimensions. The three dimensions for X1 are: (i) commitment to learning, (ii) shared vision and value; and (iii) open-mindedness. This is followed by X6, which can be characterized by four dimensions: (i) cost leadership; (ii) risk leadership; (iii) customer intimacy; and (iv) product leadership. Lastly, Z can be characterized by the market and technological conditions surrounding construction firms.

Besides the above findings, the result has, in particular, supported the research hypothesis (H_1) that organizational flexibility is a multi-dimensional construct in construction comprising: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility.

Overall, the results show that the retained data are valid and reliable for subsequent modelling attempts and hypotheses testing in Chapter 8.

CHAPTER 8

STRUCTURAL MODELS AND HYPOTHESES TESTING

8.1 Introduction

This chapter presents the results of PLS M1 (Sections 8.2 and 8.3) and PLS M2 (Sections 8.4 and 8.5) in an attempt to address the second objective (i.e., identify the key determinants of organization flexibility in construction firms) and third objective (i.e., investigate the effects of inter-relationships among the key determinants on organizational flexibility dimensions), respectively. This involves the assessment of the path coefficients (i.e., influences) that describe the hypothesized relationships among construction firms' resources, capabilities, strategies and their flexibility dimensions (i.e., constructs). In this study, the path coefficient is known as the standardized regression weight and it should be statistically significant to support hypothesized relationships among the constructs specified. Also, to address the fourth research objective (i.e., investigate the moderating effects of market and technological conditions on the relationships between the determinants and organizational flexibility dimensions), three sets of moderated structural models were developed to examine the moderating effects of environmental conditions on the relationships between the key determinants and organizational flexibility (Section 8.6).

8.2 Evaluation of structural model of PLS M1

In evaluating the PLS M1 structural model, the process starts with the examination of the magnitude of variance explained (R^2) for each predicted (dependent) construct in detecting any redundant path. Using the set rules for evaluating the R^2, the results of the model trimming process and overall *F*-test (see Section 6.4.5) are examined next.

This is followed by the assessment of path coefficients. The evaluation is concluded with a section on the interpretation and discussion of findings of PLS M1.

8.2.1 Model trimming process

Figure 8.1 shows the original (or specified) PLS M1 that comprises 33 paths connecting directly from the key determinants to organizational flexibility. As shown in the circles that represent the three predicted constructs (i.e., operational flexibility (Y_{OF}), tactical flexibility (Y_{TF}) and strategic flexibility (Y_{SF})), the R^2 values are 0.735, 0.448 and 0.647, respectively. This means that the six determinants, which have been operationalized into 11 predictor constructs, have explained 73.5%, 44.8% and 64.7% of the corresponding variance on operational flexibility, tactical flexibility and strategic flexibility.

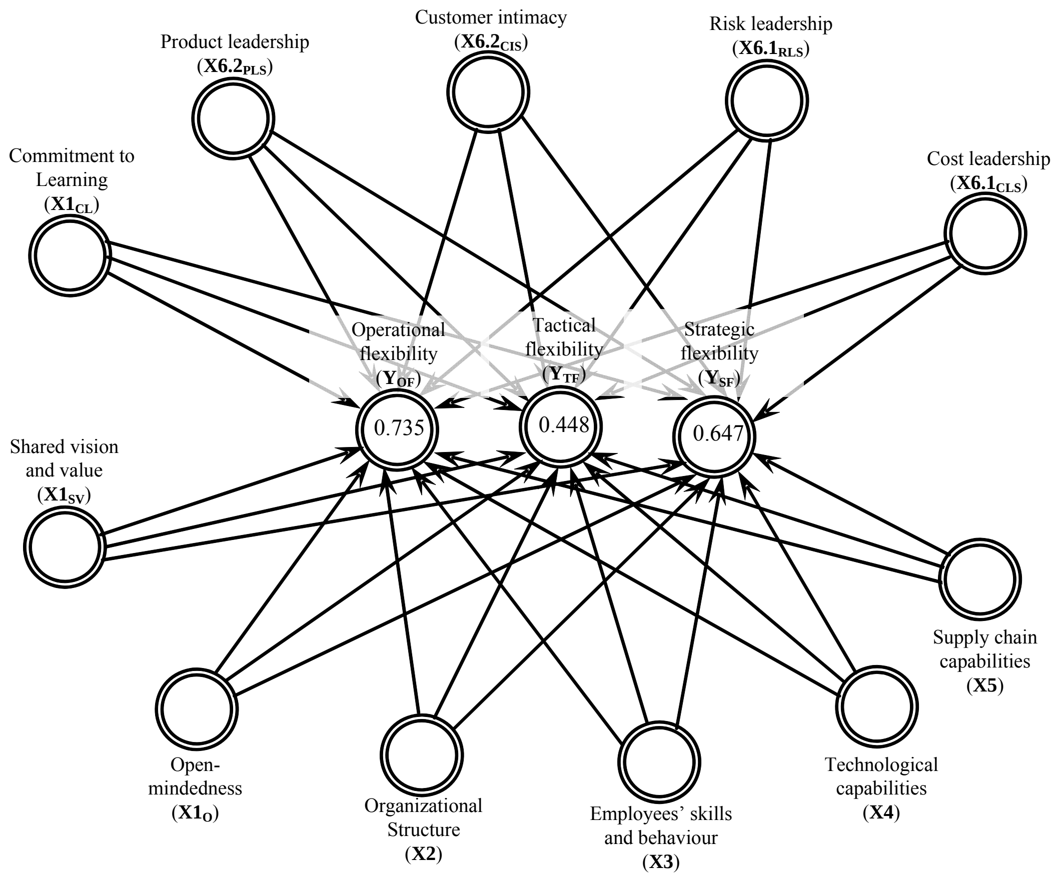
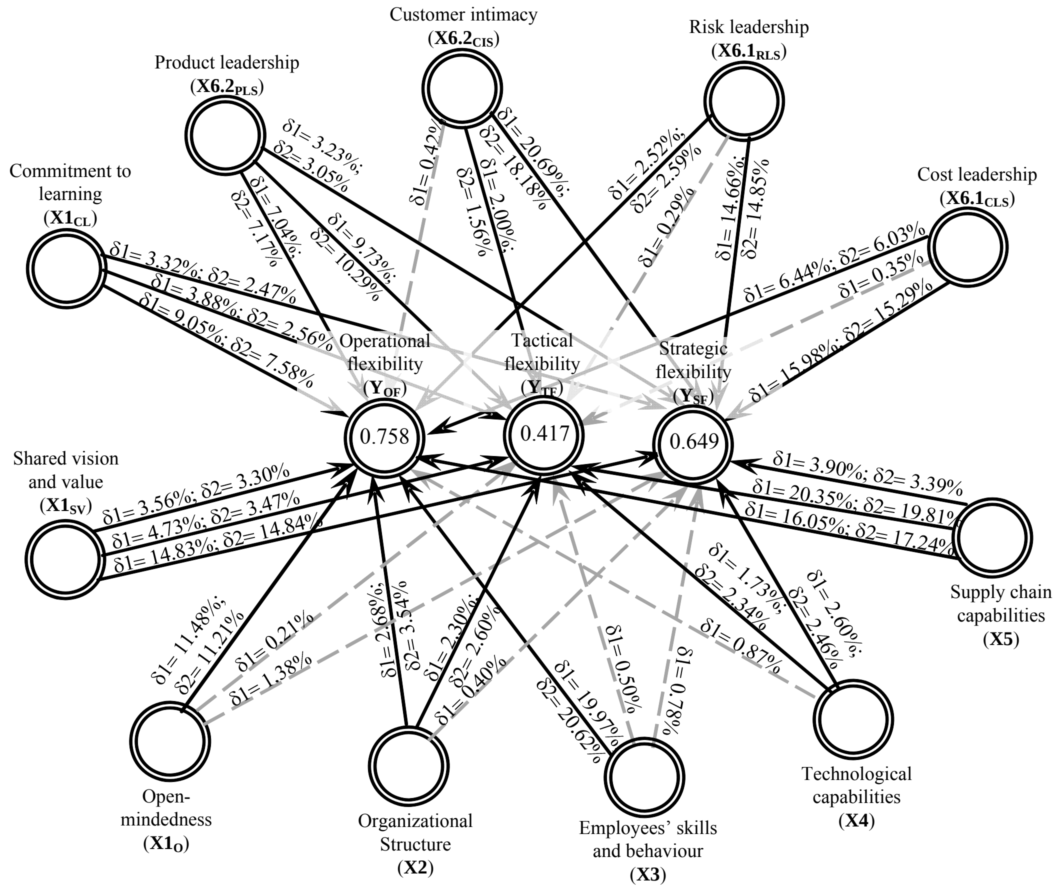


Figure 8.1 The original PLS M1

Though the obtained R^2 values indicate that the PLS M1 has a reasonably satisfactory predictive power (i.e., R^2 > 0.10) (following Falk and Miller, 1992; see Section 6.4.5), a model trimming process was conducted to identify any redundant predictor for the respective predicted constructs. Table 8.1 shows the standardized path coefficient, the correlation and the percentage of variance explained ($P_{V\text{ explained}}$) for each relationships in the original PLS M1. In this study, the correlation was used to calculate the $P_{V\text{ explained}}$ using Eq. 6-5 (see Section 6.4.5). It can be seen that nine out of the 33 proposed paths are considered as redundant with recorded $P_{V\text{ explained}}$ values ranging from 0.05% to 1.38% (i.e., below the cut-off value of 1.5%). Of these, two (i.e., technological capabilities (X4) and customer intimacy initiative ($X6.2_{CIS}$)) are related to operational flexibility (Y_{OF}), four (i.e., open-mindedness ($X1_O$), employees' skills and behaviour (X3), cost leadership ($X6.1_{CLS}$) and risk leadership initiatives ($X6.1_{RLS}$)) are detected in tactical flexibility (Y_{TF}), and the remaining (i.e., open-mindedness ($X1_O$), organizational structure (X2) and employees' skills and behaviour (X3)) are found in strategic flexibility (Y_{SF}).

Given that these nine paths contribute little to the understanding of the variance of organizational flexibility in this exploratory research, it was decided to exclude them in the recalculation of the model. It should be noted that the removal of these redundant paths are justified from a theoretical viewpoint because the relationships between the key determinants and organizational flexibility (i.e., the 11 predictor constructs and three predicted constructs) are maintained in the trimmed PLS M1 as shown in Figure 8.2. It can be seen that each of the 11 predictor constructs has at least one arrow pointed towards one of the three predicted constructs upon the removal of the nine redundant paths. In this case, the goal is to obtain a more precise model via a parsimonious approach by limiting the number of arrows, which can be justified theoretically (i.e., the overriding criterion in removal of redundant path) (following Falk and Miller, 1992). With the exception of tactical flexibility (Y_{TF}), the R^2 values of operational flexibility (Y_{OF}) and strategic flexibility (Y_{SF}) in the trimmed PLS M1 have slightly improved, indicating better predictive power of the resultant trimmed model. Also, all the predictor constructs have now accounted for at least 1.5% of the variance in their respective predicted constructs as demonstrated by the $P_{V\,\text{explained}}$ for each relationship in the trimmed PLS M1 (see last column of Table 8.1). Therefore, no further model trimming process is needed.



Legend: = Redundant path removed; δ1 = $PV_{explained}$ (%) for original PLS M1; δ2 = $PV_{explained}$ (%) for trimmed PLS M1

Figure 8.2 The trimmed PLS M1

Table 8.1 Results of structural model of PLS M1 before and after the model trimming process

Construct relationships			Original PLS M1				Trimmed PLS M1			
			R^2	Standardized path coefficient	Correlation	*Pv explained*+ *(%)*	R^2	Standardized path coefficient	Correlation	*Pv explained*+ (%)
Commitment to learning ($X1_{CL}$)	→	Operational flexibility (Y_{OF})	0.735	0.171	0.530	9.05%	0.758	0.143	0.529	7.58%
Shared vision and value ($X1_{SV}$)	→	Operational flexibility (Y_{OF})		-0.196	0.182	3.56%		-0.185	0.178	3.30%
Open-mindedness ($X1_{O}$)	→	Operational flexibility (Y_{OF})		0.327	0.351	11.48%		0.323	0.347	11.21%
Organizational structure (X2)	→	Operational flexibility (Y_{OF})		-0.245	-0.109	2.68%		-0.243	-0.146	3.54%
Employees' skills and behaviour (X3)	→	Operational flexibility (Y_{OF})		0.325	0.615	19.97%		0.332	0.622	20.62%
Technological capabilities (X4)	→	Operational flexibility (Y_{OF})		0.027	0.318	0.87%		-	-	-
Supply chain capabilities (X5)	→	Operational flexibility (Y_{OF})		0.268	0.599	16.05%		0.288	0.598	17.24%
Cost leadership ($X6.1_{CLS}$)	→	Operational flexibility (Y_{OF})		0.208	0.310	6.44%		0.195	0.310	6.03%
Risk leadership ($X6.1_{RLS}$)	→	Operational flexibility (Y_{OF})		0.074	0.343	2.52%		0.074	0.349	2.59%
Customer intimacy ($X6.2_{CIS}$)	→	Operational flexibility (Y_{OF})		-0.016	0.265	0.42%		-	-	-
Product leadership ($X6.2_{PLS}$)	→	Operational flexibility (Y_{OF})		-0.206	-0.341	7.04%		-0.209	-0.343	7.17%
Commitment to learning ($X1_{CL}$)	→	Tactical flexibility (Y_{TF})	0.448	0.118	0.328	3.88%	0.417	0.078	0.327	2.56%
Shared vision and value ($X1_{SV}$)	→	Tactical flexibility (Y_{TF})		0.208	0.227	4.73%		0.157	0.221	3.47%
Open-mindedness ($X1_{O}$)	→	Tactical flexibility (Y_{TF})		-0.137	0.016	0.21%		-	-	-
Organizational structure (X2)	→	Tactical flexibility (Y_{TF})		-0.172	-0.134	2.30%		-0.178	-0.146	2.60%
Employees' skills and behaviour (X3)	→	Tactical flexibility (Y_{TF})		0.002	0.308	0.05%		-	-	-
Technological capabilities (X4)	→	Tactical flexibility (Y_{TF})		-0.150	0.116	1.73%		-0.166	0.141	2.34%
Supply chain capabilities (X5)	→	Tactical flexibility (Y_{TF})		0.407	0.500	20.35%		0.399	0.497	19.81%

Construct relationships			Original PLS M1				Trimmed PLS M1			
			R^2	Standardized path coefficient	Correlation	$Pv_{explained}^{+}$ (%)	R^2	Standardized path coefficient	Correlation	$Pv_{explained}^{+}$ (%)
Cost leadership ($X6.1_{CLS}$)	→	Tactical flexibility (Y_{TF})		-0.022	0.160	0.35%		-	-	-
Risk leadership ($X6.1_{RLS}$)	→	Tactical flexibility (Y_{TF})		0.012	0.238	0.29%		-	-	-
Customer intimacy ($X6.2_{CIS}$)	→	Tactical flexibility (Y_{TF})		0.154	0.130	2.00%		0.139	0.112	1.56%
Product leadership ($X6.2_{PLS}$)	→	Tactical flexibility (Y_{TF})		-0.265	-0.367	9.73%		-0.284	-0.363	10.29%
Commitment to learning ($X1_{CL}$)	→	Strategic flexibility (Y_{SF})	0.647	0.126	0.263	3.32%	0.649	0.095	0.262	2.47%
Shared vision and value ($X1_{SV}$)	→	Strategic flexibility (Y_{SF})		0.338	0.439	14.83%		0.332	0.447	14.84%
Open-mindedness ($X1_{O}$)	→	Strategic flexibility (Y_{SF})		-0.056	0.246	1.38%		-	-	-
Organizational structure (X2)	→	Strategic flexibility (Y_{SF})		0.026	0.155	0.40%		-	-	-
Employees' skills and behaviour (X3)	→	Strategic flexibility (Y_{SF})		-0.022	0.351	0.78%		-	-	-
Technological capabilities (X4)	→	Strategic flexibility (Y_{SF})		-0.118	0.220	2.60%		-0.111	0.222	2.46%
Supply chain capabilities (X5)	→	Strategic flexibility (Y_{SF})		-0.126	0.310	3.90%		-0.111	0.306	3.39%
Cost leadership ($X6.1_{CLS}$)	→	Strategic flexibility (Y_{SF})		0.331	0.483	15.98%		0.312	0.490	15.29%
Risk leadership ($X6.1_{RLS}$)	→	Strategic flexibility (Y_{SF})		0.295	0.497	14.66%		0.298	0.499	14.85%
Customer intimacy ($X6.2_{CIS}$)	→	Strategic flexibility (Y_{SF})		0.479	0.432	20.69%		0.426	0.427	18.18%
Product leadership ($X6.2_{PLS}$)	→	Strategic flexibility (Y_{SF})		-0.201	-0.161	3.23%		-0.194	-0.157	3.05%

Note: + denotes the absolute value of the percentage of $P_{V\ explained}$; ⊗ denotes redundant path removed

8.2.2 Overall F-test for R^2

Table 8.2 shows the results of an overall *F*-test to determine the significance of R^2 values obtained for individual predicted constructs in both the original and trimmed PLS M1. It appears that the *F*-test statistics have significantly improved after the model trimming process, and that they are statistically significant at $p < 0.05$ level. This means that the null hypothesis that the R^2 or variances explained for all predicted constructs are equal to zero is rejected. The trimmed PLS M1 forms the basis of the next section on assessment of path coefficients.

Table 8.2 Results of the overall *F*-test for R^2 in PLS M1

Description	Original PLS M1			Trimmed PLS M1		
Predicted constructs	R^2	F	Significance (p)	R^2	F	Significance (p)
Operational flexibility (Y_{OF})	0.735	7.312	0.000	0.758	10.730	0.000
Tactical flexibility (Y_{TF})	0.448	2.140	0.050	0.417	3.372	0.008
Strategic flexibility (Y_{SF})	0.647	4.832	0.000	0.649	7.396	0.000

8.2.3 Assessment of path coefficients

Having examined the magnitude of the R^2 values for each predicted construct of the trimmed PLS M1, the focus here is to assess the path coefficients that describe the relationships among the constructs. The significance of individual path coefficients was determined using the standard errors of the path coefficients obtained from the bootstrapping technique, which in turn determine the *t*-statistics for individual relationships. Table 8.3 summarizes the results of the standardized path coefficient and *t*-statistics for all paths in the trimmed PLS M1. Among the 24 paths in the trimmed PLS M1, three are found to be statistically significant at $p < 0.01$, and nine are statistically significant at $p < 0.05$. These 12 statistically significant paths demonstrate the relationships among the constructs in this research. Of these, three predictor constructs are found to have negative predictive relationships on operational flexibility (Y_{OF}) and tactical flexibility (Y_{TF}), and the remaining have varying positive predictive relationships on the respective three dimensions of the organizational flexibility construct. Figure 8.2 is modified here as Figure 8.3, showing only the significant paths in the trimmed PLS M1.

Table 8.3 Results for the trimmed PLS M1

Proposed paths (1)			**Standardized path coefficient (β)** (2)	***t*-values (*p*)** (3)
Commitment to learning ($X1_{CL}$)	→	Operational flexibility (Y_{OF})	0.143	0.962
Shared vision and value ($X1_{SV}$)	→	Operational flexibility (Y_{OF})	-0.185	1.746*
Open-mindedness ($X1_{O}$)	→	Operational flexibility (Y_{OF})	0.323	2.529**
Organizational structure (X2)	→	Operational flexibility (Y_{OF})	-0.243	2.215*
Employees' skills and behaviour (X3)	→	Operational flexibility (Y_{OF})	0.332	2.362**
Supply chain capabilities (X5)	→	Operational flexibility (Y_{OF})	0.288	2.311*
Cost leadership ($X6.1_{CLS}$)	→	Operational flexibility (Y_{OF})	0.195	2.050*
Risk leadership ($X6.1_{RLS}$)	→	Operational flexibility (Y_{OF})	0.074	0.862
Product leadership ($X6.2_{PLS}$)	→	Operational flexibility (Y_{OF})	-0.209	1.581
Commitment to learning ($X1_{CL}$)	→	Tactical flexibility (Y_{TF})	0.078	0.333
Shared vision and value ($X1_{SV}$)	→	Tactical flexibility (Y_{TF})	0.157	0.838
Organizational structure (X2)	→	Tactical flexibility (Y_{TF})	-0.178	1.135
Technological capabilities (X4)	→	Tactical flexibility (Y_{TF})	-0.166	0.642
Supply chain capabilities (X5)	→	Tactical flexibility (Y_{TF})	0.399	2.252*
Customer intimacy ($X6.2_{CIS}$)	→	Tactical flexibility (Y_{TF})	0.139	0.694
Product leadership ($X6.2_{PLS}$)	→	Tactical flexibility (Y_{TF})	-0.284	1.992*
Commitment to learning ($X1_{CL}$)	→	Strategic flexibility (Y_{SF})	0.095	0.910
Shared vision and value ($X1_{SV}$)	→	Strategic flexibility (Y_{SF})	0.332	2.197*
Technological capabilities (X4)	→	Strategic flexibility (Y_{SF})	-0.111	0.701
Supply chain capabilities (X5)	→	Strategic flexibility (Y_{SF})	-0.111	0.898
Cost leadership ($X6.1_{CLS}$)	→	Strategic flexibility (Y_{SF})	0.312	2.027*
Risk leadership ($X6.1_{RLS}$)	→	Strategic flexibility (Y_{SF})	0.298	1.940*
Customer intimacy ($X6.2_{CIS}$)	→	Strategic flexibility (Y_{SF})	0.426	2.785**
Product leadership ($X6.2_{PLS}$)	→	Strategic flexibility (Y_{SF})	-0.194	1.233

Notes: ** significant at $p < 0.01$; * significant at $p < 0.05$ (one-tailed).

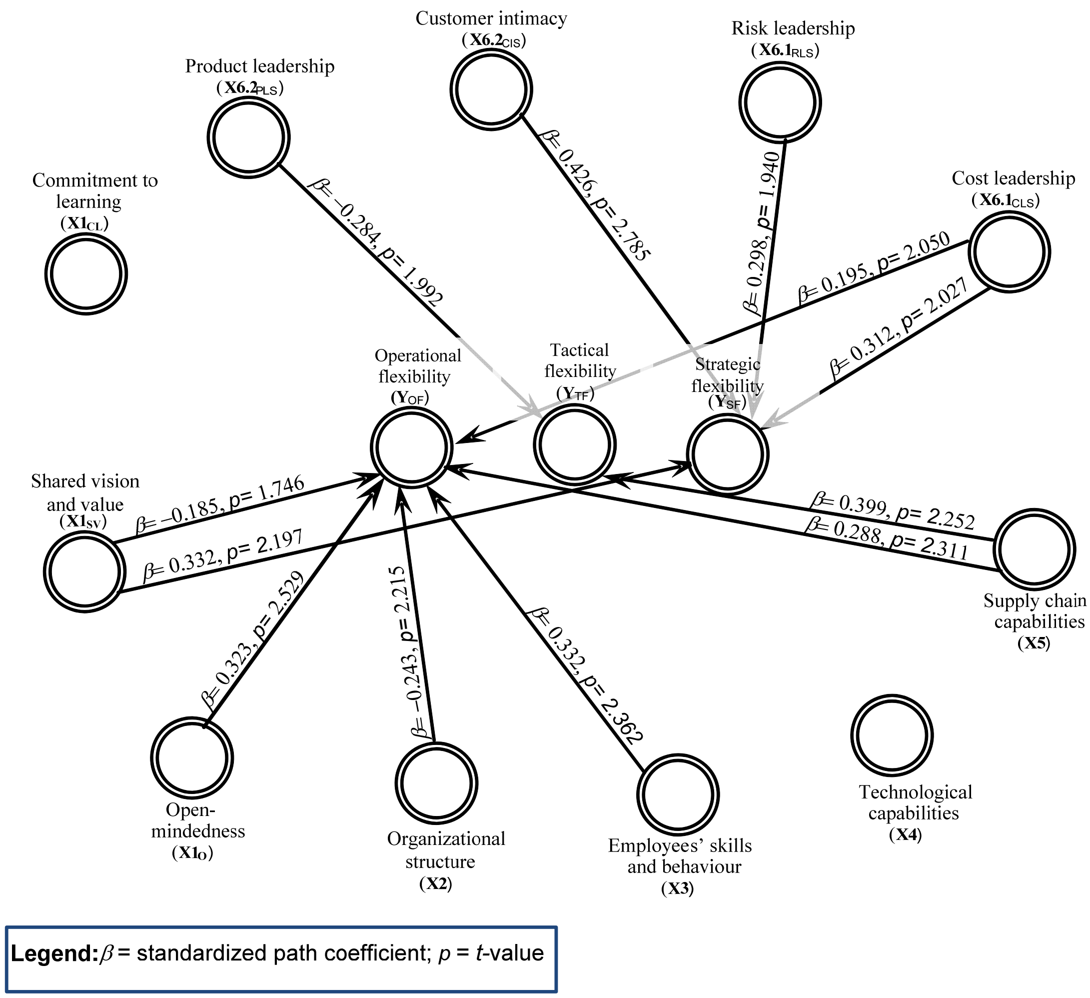


Figure 8.3 Statistically significant paths in the trimmed PLS M1

8.3 Interpretation and discussion of findings of PLSM1

The interpretation and discussion of the findings of the trimmed PLS M1 are presented below corresponding to the three dimensions of organizational flexibility. Qualitative data from the interview findings are also presented to supplement the discussion. Also, the observed predictive relationships were explained by referring to the measurement items of the respective predictor and predicted constructs (Table 7.16).

8.3.1 Direct positive impact on operational flexibility (Y_{OF})

As shown in Table 8.3, six predictor constructs have significant influences on firms' operational flexibility. Of these, four predictor constructs have positive standardized path coefficients (i.e., positive impacts on attainment of firms' operational flexibility) while the remaining two are of negative path coefficients (to be discussed in Section 8.3.2). The magnitudes of positive impacts, in their order of importance, are: (i) employees' skills and behaviour (X3) (β = 0.332); (ii) open-mindedness ($X1_o$) (β = 0.323); (iii) supply chain capabilities (X5) (β = 0.288); and (iv) cost leadership initiative ($X6.1_{CLS}$) (β = 0.195). These are now discussed.

8.3.1.1 Employees' skills and behaviour (X3)

For the employees' skills and behaviour (X3) construct, Table 7.16 shows that the statistically significant measurement items of high factor loadings are firms' employees' abilities: (i) to adopt an open mindset to all alternatives (ESB1; FL = 0.686); (ii) to work in a team environment (ESB2; FL = 0.846); (iii) to learn and adapt to different business conditions (ESB4; FL = 0.774); (iv) to perform a diverse range of tasks and responsibilities (ESB5; FL = 0.691); (v) to gain customer satisfaction (ESB6; FL = 0.693); and (vi) to work independently (ESB8; FL = 0.732). These measurement items characterize a flexible workforce (Correa, 1994), which in turn contribute positively towards firms' operational flexibility (Y_{OF}).

Table 8.4 shows the correlations between employees' skills and behaviour and operational flexibility. The results indicate that a firm's ability to make decisions on non-routine and significant events which cannot be anticipated in advance (F11) is significantly and positively correlated with all features of its employees' skills and behaviour. One possible explanation is that when individuals are able to work independently and cohesively within a team environment, and adopting an open-mindset to learn and adapt to different business conditions and clients' requirements, they could improve their abilities to perform a diverse range of tasks and responsibilities. All these may in turn improve a firm's responsiveness to non-routine and important events.

Table 8.4 Correlations between employees' skills and behaviour and firms' operational flexibility

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	F1	F2	F10	F11	F14
ESB1	Ability to adopt an open-mindset to all alternative	1.000										
ESB2	Ability to work in a team environment	.643**	1.000									
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000								
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000							
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000						
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000					
F1	Ability to modify your firm's operational structure	.246	**.441****	.261	.237	**.425****	**.611****	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	.157	**.437****	.143	.062	.153	.218	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	.007	.288	.173	**.372***	**.560****	**.334***	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	**.366***	**.576****	**.415****	**.353***	**.499****	**.484****	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	.220	**.489****	**.385***	.288	.231	**.358***	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

Likewise, the significant positive correlations among F14, ESB2, ESB4 and ESB8 may be explained by the fact that a firm's capacity to collaborate with its partners may depend on its employees' abilities to work independently and cohesively with external parties within a team environment, learning and adapting to different conditions which arise during the partnership. In events where employees are able to work well with external parties, the synergy created may lead to improved organizational capabilities in offering high value-added services to clients, and thus improving a firm's competitiveness. Corresponding to this, the synergistic partnership may enhance a firm's abilities to integrate, construct and reshape its financial resources in the face of any unforeseen events. Some interviewees (approximately 30%) shared the view that it is important to have synergistic partnerships with supply chain partners because it is an operational hedging strategy that could mitigate the environment's impact on a firm's performance (see Section 8.3.4.1). This agrees with Young-Ybarra and Wiersema (1999), who found that formation of synergistic partnership enables firms to achieve competitive positioning, while avoiding major cost commitment in product development. This further may help to explain the positive correlation between ESB2 and F2. As for the positive correlations among F10, ESB5, ESB6 and ESB8 (see Table 8.4), these indicate that a firm's ability to construct facilities using different construction methods and materials is likely to improve when its employees possess high abilities: (i) to perform a diverse range of tasks and responsibilities; (ii) to gain customer satisfaction; and (iii) to work independently.

In this study, the importance of superior employees' skills and behaviour in accomplishing firms' operational flexibility can be further explained by taking into consideration the study period 1997 – 2007. One-third of the interviewees shared the view that management would desire a flexible workforce with a high level of commitment to learn and adapt themselves when their companies took different courses of action during the eight years of unprecedented economic downturn from 1997 - 2005. Under such conditions, it would seem that employees had limited or no choice but be propelled to stay adaptive in order to retain their jobs during the long period of industry downturn.

8.3.1.2 Open-mindedness ($X1_O$)

Open-mindedness ($X1_O$), which leads to operational flexibility (Y_{OF}), is associated with: (i) participative decision among employees (O1; FL = 0.837); (ii) open communication (O2; FL = 0.918); and (iii) ability to change current practices following the industry trend (O3; FL = 0.819) (see Table 7.16). Some interviewees suggested that the increasing complexity involved in construction business have placed the element of open-mindedness as a key towards continued business existence. Interviewee S34 expressed that:

> The business environment of the Singapore construction industry has become less predictable…Signs of uncertainties and complexities in the industry include: the sharp increase in construction demand in 2007; the upsurge in the prices of steel bars in 2003 and concrete and aggregate prices in 2006; and the escalation of social expectations on safety and environmental issues. Therefore, it is increasingly becoming important for construction firms to embrace an attitude of open-mindedness since it is difficult to predict what will happen next. They need to regularly review their business roadmap and scan for changes within the business environment in order to remain viable in the industry.

The foregoing discussion is in agreement with Sull (1999; 2005), who found that decision-makers must be open-minded to regularly review their companies' strategic frame, processes, relationships, routines and values so as to avoid organizational inertia (see Section 3.9.1). Table 8.5 shows the correlations between firms' open-mindedness and their operational flexibility.

Table 8.5 Correlations between firms' open-mindedness and their operational flexibility

Item Code	Description	O1	O2	O3	F1	F2	F10	F11	F14
O1	Our firm encourages participative decision making among employees	1.000							
O2	Our firm promotes open communication among subordinates and superiors	.615**	1.000						
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	.656**	.607**	1.000					
F1	Ability to modify your firm's operational structure	**.372***	**.409****	.204	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	.220	.163	.017	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	-.027	**.338***	.219	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	.181	**.383***	.214	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	.179	.168	.066	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

As noted from Table 8.5, F1 is found to have significant positive correlations with the O1 and O2. This is followed by F10 and F11, which are positively correlated with O2. These suggest that O2 is an important feature to achieving operational flexibility. Many interviewees shared the view that creating an environment that fosters open communication is the key towards improved firms' responsiveness to environmental changes. They explained that an open communication environment often encourages knowledge sharing and interactive learning among employees, and thus improves their knowledge about different operational processes and technologies. All these may in turn affect a firm's abilities to construct facilities using different construction methods and materials, and respond to non-routine and significant events.

8.3.1.3 Supply chain capabilities (X5)

Table 7.16 shows that supply chain capabilities (X5), which lead to operational flexibility (Y_{OF}), is associated to firms' abilities: (i) to procure material globally (SC2; FL = 0.804); (ii) to improve the quality of construction services and products (SC3; FL = 0.763); (iii) to attract repeat business from clients (SC4; FL = 0.628); (iv) to improve construction speed (SC5; FL = 0.772); and (v) to coordinate delivery requirement to meet clients' need globally (SC6; FL = 0.788). Table 8.6 shows the correlations between these five abilities and firms' operational flexibility.

Table 8.6 Correlations between firms' supply chain capabilities and their operational flexibility

Item Code	Description	SC2	SC3	SC4	SC5	SC6	F1	F2	F10	F11	F14
SC2	Ability to procure materials on a global basis	1.000									
SC3	Ability to improve the quality of construction services and products	.538**	1.000								
SC4	Ability to attract repeat business from clients	.294	.432**	1.000							
SC5	Ability to improve construction delivery speed	. 518**	.511**	.564**	1.000						
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	.530**	.408**	.381*	.487**	1.000					
F1	Ability to modify your firm's operational structure	.300	.172	.194	.271	**.341***	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	**.317***	**.343***	.292	.298	**.454****	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	**.421****	**.324***	.130	.218	**.557****	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	**.412****	**.410****	.173	**.359***	**.466****	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	**.409****	**.322***	**.392***	**.328***	**.523****	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

As can be seen from Table 8.6, SC2, SC3 and SC6 are positively correlated with F2, F10, F11 and F14. One possible explanation is that a firm's supply chain abilities to procure materials and coordinate delivery requirement to meet clients' need on a global basis, while improving the quality of construction services and products offered, are important features relating to the firm's operational abilities to respond to non-routine and significant events, and offer value-added services to clients, constructing facilities with different construction methods and materials.

8.3.1.4 Cost leadership initiative ($X6.1_{CLS}$)

The last predictor construct that has a positive impact on operational flexibility (Y_{OF}) is the firms' cost leadership initiative ($X6.1_{CLS}$). Through approaches such as (i) implement stricter site management to reduce material wastages; (ii) implement stricter financial management on company cash flow; (iii) set limits on project size; and (iv) implement stricter procurement management (see Table 7.16), contractors could improve their operational flexibility. Many interviewees (approximately 83%) pointed out that it is important for their firms to set limits on their projects, in terms of size, for better control and responsiveness to changes within the business environment. This may also be explained by the significant positive correlation between a firm's effort to set limits on its project size (B10) and its ability to make decisions on non-routine and significant events which cannot be anticipated in advance (F11) (see Table 8.7).

Table 8.7 Correlations between firms' cost leadership initiative and their operational flexibility

Item Code	Description	B9	B10	B14	B15	F1	F2	F10	F11	F14
B9	Implementing stricter financial management on company cash flow	1.000								
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	.350*	1.000							

Item Code	Description	B9	B10	B14	B15	F1	F2	F10	F11	F14
B14	Implementing stricter site management to reduce material wastage	.625**	.507**	1.000						
B15	Implementing stricter procurement management on company cash flow	.411**	.442**	.435**	1.000					
F1	Ability to modify your firm's operational structure	.173	.203	.154	.236	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	-.083	.083	.238	-.030	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	.122	.256	.185	.145	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	-.023	**.319***	.133	.097	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	.216	**.396***	**.481****	.114	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Also, the significant positive correlations among F14, B10 and B14 (see Table 8.7), may indicate that a firm's ability to integrate its internal functions with external firms in providing value-added services to clients is likely to increase when the firm places greater emphasis on its site management and project portfolio management (by setting limit on project size). Interviewees shared the view that the joint efforts (among supply chain parties) to implement stricter site management are the key towards effective project cost savings, which will lead to higher client satisfaction.

8.3.2 Direct negative impact on operational flexibility (Y_{OF})

Table 8.3 shows the significant direct negative influences of (i) organizational structure (X2) (β = -0.243) and (ii) shared vision and value ($X1_{SV}$) (β = -0.185) on firms' operational flexibility. The negative influence of organizational structure on firms' operational flexibility is in contrast to Carlsson's (1989) argument that a flexible organization would need a flexible structure, and not only flexible people. Table 8.8 shows the correlations among firms' shared vision and value, organizational structure and their operational flexibility.

It can be seen from Table 8.8 that there is no significant correlation between firms' structure and their operational flexibility. However, the negative influence of organizational structure (X2) on operational flexibility (Y_{OF}) can partly be explained by the ownership of the majority of interviewees' firms (approximately 54%), which are considered as family controlled business. Many interviewees shared the view that their firms are more inclined to a centralized decision making process, and explained that even though the firms encourage the participation of managers and supervisors in contributing new ideas, the final decision is always made by top management. Likewise, this finding may help to explain the negative influence of firms' shared vision and value ($X1_{SV}$) on their operational flexibility (Y_{OF}), since there is no sufficient evidence to establish the correlations between measurement items of the two constructs (see Table 8.8).

8.3.3 Direct impact on tactical flexibility (Y_{TF})

Supply chain capabilities (X5) and product leadership ($X6.2_{PLS}$) are the only two predictor constructs with significant impacts on firms' tactical flexibility (Y_{TF}) as shown in Table 8.3.

8.3.3.1 <u>Supply chain capabilities (X5)</u>

Similar to that of operational flexibility (Y_{OF}), firms' supply chain capabilities (X5) are found to positively influence the firms' tactical flexibility (Y_{TF}), posing a path coefficient of 0.399. In this study, it is found that firms' supply chain capabilities have greater impact on their tactical flexibility than operational flexibility given the higher magnitude of the respective path coefficients (i.e., 0.399 vs. 0.288). Most interviewees (approximately 93%) acknowledged the importance of firms' supply chain capabilities in response to changes in the business environment, and pointed out that their firms' ability to add and expand their business capacity efficiently (F5) is, to some extent, determined by their established and good relationships with clients, subcontractors and suppliers. The interviewees explained that these relationships have directly and indirectly benefited them, in terms of improved capabilities in (i): exploring and sourcing of materials; (ii) improving their quality of services and products; and (iii) obtaining sufficient business turnover. These agree with Kale and Arditi (2001), who found that having high quality relationship with subcontractors is positively associated with contractors' economic performance.

Table 8.9 shows the correlations between firms' supply chain capabilities and their tactical flexibility. The findings show that a firm's ability to add and expand its business capacity efficiently (F5) is likely to increase when the firm enhances its abilities to improve the quality of construction services and products (SC3), and to coordinate delivery requirement to meet clients' need on a global basis (SC6). Likewise, it is found that a firm's ability to adopt a range of alternative logistics supports to operations (F7) is positively correlated with the firm's abilities to procure materials on a global basis (SC2), and improve the quality of construction services and products (SC3). Based on these, it appears that SC3 is an important feature relating to a firm's tactical flexibility since it is positively correlated with F5 and F7 (i.e., two out of the four features of tactical flexibility). This may also indicate that Singapore contractors are quality-oriented in their business endeavours.

Table 8.8 Correlations among firms' shared vision and vision, organizational structure and their operational flexibility

Item Code	Description	SV1	SV2	SV3	SV4	OS1	OS2	OS3	F1	F2	F10	F11	F14
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	1.000											
SV2	Our firm provides support to employees to reach organizational goals	.627**	1.000										
SV3	Employees are constantly informed on the firm's business objectives	.415**	.574**	1.000									
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	.394*	.436**	.663**	1.000								
OS1	Our firms operates in a flexible work procedure	-.071	-.183	-.258	.028	1.000							
OS2	Our firm adopts a more decentralized decision making process	.022	.027	-.068	.119	.662**	1.000						
OS3	Our firm has an open communication channel with flexible access to important information for decision making	.071	.032	-.008	.010	.636**	.591**	1.000					
F1	Ability to modify your firm's operational structure	.145	.175	-.004	-.021	-.137	.123	.041	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	-.046	.005	-.083	.044	.086	.126	.043	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	.040	.205	.138	.003	-.279	-.057	-.232	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	.151	.290	.269	.074	-.205	-.025	-.052	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	.191	.146	-.089	-.125	-.089	-.029	-.197	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Table 8.9 Correlations between firms' supply chain capabilities and their tactical flexibility

Item Code	Description	SC2	SC3	SC4	SC5	SC6	F3	F4	F5	F7
SC2	Ability to procure materials on a global basis	1.000								
SC3	Ability to improve the quality of construction services and products	.538**	1.000							
SC4	Ability to attract repeat business from clients	.294	.432**	1.000						
SC5	Ability to improve construction delivery speed	. 518**	.511**	.564**	1.000					
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	.530**	.408**	.381*	.487**	1.000				
F3	Ability to change the number of employees in your business operation	.152	.185	.032	.097	.201	1.000			
F4	Ability of your firm's employees to handle multiple responsibilities	.296	.292	.232	.292	.180	.515**	1.000		
F5	Ability to add and expand your business capacity efficiently	.269	**.380***	.282	.146	**.430****	.622**	.507**	1.000	
F7	Ability to adopt a range of alternative logistics supports to operations	**.549****	**.417****	.308	.285	.302	.315*	.447**	.429**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.3.3.2 Product leadership ($X6.2_{PLS}$)

The negative influence of product leadership initiative (β = -0.284) on firms' tactical flexibility can be partially explained in relation to the conservativeness of the majority of interviewees' firms. Interviewees said that their firms are very cautious in product development, and would rather adopt a 'wait-and-see' approach, than advance into areas that they are not familiar with. Interviewee S33 highlighted that:

> Diversification is a hedging approach against uncertainty... but you need to know your trades in order to survive...going into areas which you are not familiar with can be very destructive...Indeed, this was one of the main reasons triggering the bankruptcy of a large contractor during the last economic downturn...

The interviews revealed that firms are increasingly aware of the sunk cost incurred in product development (for example, major investment in machinery and equipment) (see Section 7.3.2.4). Table 8.10 shows the correlations between firms' product leadership initiative and their tactical flexibility. It can be seen that B7 has significant negative correlations with F4 and F7, suggesting that the greater the firms' investment on general multiple usage assets, the lower will be their employees' ability to handle multiple responsibilities and their ability to adopt a range of alternative logistics supports to their core operations. One possible implication is that, when firms place too much emphasis on investment in general multiple usage assets for another line of business, they may lose the core competence (in terms of their employees' skills and logistics supports) of their fundamental business.

Table 8.10 Correlations between firms' product leadership initiative and their tactical flexibility

Item Code	Description	B7	B12	B16	F3	F4	F5	F7
B7	Investing on assets that have high liquidity value (e.g. general multiple-usage equipment)	1.000						
B12	Investing into R & D to further explore business opportunities	.395*	1.000					
B16	Investing surplus funds into financial investments and property developments	.441**	.604**	1.000				
F3	Ability to change the number of employees in your business operation	-.256	-.128	-.152	1.000			
F4	Ability of your firm's employees to handle multiple responsibilities	**-.335***	-.032	-.164	.515**	1.000		
F5	Ability to add and expand your business capacity efficiently	-.191	.046	-.126	.622**	.507**	1.000	
F7	Ability to adopt a range of alternative logistics supports to operations	**-.429****	.052	.072	.315*	.447**	.429**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.3.4 Direct impact on strategic flexibility (Y_{SF})

For firms' strategic flexibility (Y_{SF}), four positive significant predictor constructs are detected (see Table 8.3). In order of importance, they are: (i) customer intimacy initiative ($X6.2_{CIS}$) (β = 0.426); (ii) shared vision and value ($X1_{SV}$) (β =0.332); (iii) cost leadership initiative ($X6.1_{CLS}$) (β = 0.312); and (iv) risk leadership initiative ($X6.1_{RLS}$) (β =0.298). It should be noted that three out of the four determinants of firms' strategic flexibility are the dimensions of the business strategies (X6) construct (i.e., customer intimacy, cost leadership, and risk leadership).

8.3.4.1 Customer intimacy initiative ($X6.2_{CIS}$)

Tables 7.16 and 8.3 show that firms' customer intimacy initiative ($X6.2_{CIS}$), which leads to their strategic flexibility (Y_{SF}), is associated with: (i) forming joint-venture with other contractors (B2; FL = 0.741); (ii) forming partnership with clients (B3; FL = 0.869); (iii) diversifying into different construction businesses (B4; FL = 0.621) and (iv) following clients abroad (B13; FL = 0.787). Many interviewees (approximately 60%) recognized that it is very important for firms to develop and maintain intimate relationships with clients, especially the private sector clients, and shared the view that it is these established relationships that had lessened the impact of the 1997-2005 economic downturn on their business operation. Interviewee S32 expressed that:

> During the bad times, one of our repeat clients approached us to construct its overseas factories...Of course, we followed them and constructed their overseas factories...I think we were approached by them mainly due to our established relationship and reputation...We built their factories in Singapore. Indeed, we are grateful that we have followed them to venture overseas... It opens up another business opportunity for us and now we are operating in that country by providing project management consultancy services to clients in the host country.

Besides the above findings, Table 8.11 shows that there are significant positive correlations between firms' customer intimacy initiative and their strategic flexibility. It is found that F8 is positively correlated with B2, B3 and B13. All these indicate that interviewees' firms are customer-oriented, emphasizing the importance of developing partnership relationships with their clients for effective business operation. Also, it is found that B3 has a significant positive correlation with F12, suggesting that building and forming partnership relationships with clients are important towards contractors' efforts to explore and implement a range of procurement methods effectively. This is especially true since the introduction of a more integrated and relationship-based procurement approach (see Sections 2.4.3).

Table 8.11 Correlations between firms' customer intimacy initiative and their strategic flexibility

Item Code	Description	B2	B3	B4	B13	F8	F12	F13	F15
B2	Forming joint-venture with other contractors to serve a group of targeted clients	1.000							
B3	Forming partnership with clients	.524**	1.000						
B4	Diversifying into different construction business	.381*	.435**	1.000					
B13	Following clients abroad	.350*	.544**	.459**	1.000				
F8	Ability to operate effectively and profitably in different market conditions	**.371***	**.390***	.299	**.394***	1.000			
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)	.278	**.332***	.051	.140	.370*	1.000		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	.220	.249	.047	.196	.293	.522**	1.000	
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	.246	.267	.052	.093	.337*	.450**	.249	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); *denotes correlation is significant at the 0.05 level (2-tailed)

8.3.4.2 Shared vision and value ($X1_{SV}$)

Table 8.3 shows that shared vision and value ($X1_{sv}$) is one of the key predictor constructs of strategic flexibility. Table 7.16 shows that a firm's shared vision and value are significantly associated with the firm's efforts: (i) to encourage employees to share new ideas (SV1; FL= 0.878); (ii) to provide supports to employees in achieving its organizational goals (SV2; FL = 0.879); (iii) to update employees on its business objectives on a constant basis (SV3; FL = 0.719); and (iv) to seek employees' contributions when charting its organizational direction (SV4; FL = 0.578). Many interviewees agreed that a firm's shared vision and value are vital to its continued existence on the basis that they affect employees' commitment, and in turn determine the effectiveness of the firm's business operations and implementation of change. This agrees with Verona (1999), who pointed out that without a shared vision, it is difficult for employees to commit and direct their learning towards a firm's strategic goals. Interviewee S26 pointed out that:

> It is important to take care of your firm's employees. We do not just recruit and retrench people based on economic conditions…In the 1997-2005 economic downturn, our company tried our best not to retrench employees or cut their salaries…Although we slashed our employees' salaries as the last resort, this measure applied to the entire organization from top management to our clerical staff, including myself as vice-chairman of the firm. This was done to put forth our management commitment to tide over the difficult period as a big family. Besides this, we constantly updated our employees on the firm's objectives and provided them with necessary support to reach them…

Along with the above findings, it is found that there are significant positive correlations between the features of firms' shared vision and value and their strategic flexibility (see Table 8.12). The results show that F12 is positively correlated with SV1, SV2 and SV3. Also, it is found that F13 and F15 are positively correlated with SV1. All these indicate that SV1 is an important feature relating to strategic flexibility; considering its relationships with three out of the four features of a firm's strategic flexibility. One possible explanation is that a firm encourages its employees to interact and share new ideas, in its efforts to facilitate knowledge-sharing and improve employees' knowledge, for enhanced organizational abilities in: (i) exploiting a range of procurement options; (ii) providing a range of construction services; and (iii) responding to unpredictable changes.

Table 8.12 Correlations between firms' shared vision and value and their strategic flexibility

Item Code	Description	SV1	SV2	SV3	SV4	F8	F12	F13	F15
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	1.000							
SV2	Our firm provides support to employees to reach organizational goals	.627**	1.000						
SV3	Employees are constantly informed on the firm's business objectives	.415**	.574**	1.000					
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	.394*	.436**	.663**	1.000				
F8	Ability to operate effectively and profitably in different market conditions	.120	.007	.110	.124	1.000			
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management	**.473****	**.338***	**.321***	.023	.370*	1.000		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	**.387***	.237	.270	.077	.293	.522**	1.000	
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	**.335***	.296	.182	.051	.337*	.450**	.249	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.3.4.3 Cost leadership initiative ($X6.1_{CLS}$)

Table 8.3 shows that a firm's cost leadership ($X6.1_{CLS}$) initiative plays a vital role in influencing its strategic flexibility (Y_{SF}). All interviewees recognized the need to assume a more active role in managing their project sites, company's cash flow and procurement procedures, and setting limits on project size in order to remain strategically flexible in a changing business environment. Along with this, Table 8.13 shows the correlations between firms' cost leadership initiative and their strategic flexibility.

Table 8.13 Correlations between firms' cost leadership initiative and their strategic flexibility

Item Code	Description	B9	B10	B14	B15	F8	F12	F13	F15
B9	Implementing stricter financial management on company cash flow	1.000							
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	.350*	1.000						
B14	Implementing stricter site management to reduce material wastage	.625**	.507**	1.000					
B15	Implementing stricter procurement management	.411**	.442**	.435**	1.000				
F8	Ability to operate effectively and profitably in different market conditions	.010	.213	.082	.044	1.000			
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management	**.319***	.213	.307	.049	.370*	1.000		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	**.430****	**.381***	**.433****	.225	.293	.522**	1.000	
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in clients' requirements	**.411****	**.355***	**.318***	**.438****	.337*	.450**	.249	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

It can be seen from Table 8.13 that F15 has statistically significant positive correlations with B9, B10, B14 and B15. Of these, B9, B10 and B14 are also found to have positive correlations with F13. This is followed by F12, having significant positive correlation with B9. Based on these, it appears that B9, B10 and B14 are important features relating to strategic flexibility since they are correlated with F13 and F15 (i.e., two out of the four features of strategic flexibility). This phenomenon can be partly explained in relation to a firm's effective business operation; where the firm places greater emphasis on: (i) site management for improved control of project costs (in terms of material usage); (ii) financial management for improved control of company cash inflow and outflow; and (iii) company project portfolio management, via setting limits on project size, for improved resource management within a multi-project environment. Many interviewees (approximately 80%) shared the view that, through these practices, their firms achieve improved capabilities in response to unpredictable changes made by clients (for example, changes in design and material requirement) and environmental impacts fuelled by the levels of wider economic activity. Some interviewees added that these practices help a firm to gain effective cash flow management without jeopardizing its business operations.

8.3.4.4 Risk leadership initiative ($X6.1_{RLS}$)

Tables 7.16 and 8.3 show that a firm's risk leadership initiative ($X6.1_{RLS}$), which leads to strategic flexibility (Y_{SF}), is associated with the firm's efforts: (i) to bid for more projects that are within its capabilities (B5; FL = 0.787); (ii) to create uncommitted financial resources (e.g., setting aside contingency funds) (B8; FL = 0.802); and (iii) to enter into forward contracts with suppliers and subcontractors (B11; FL = 0.845). The correlations between these three practices and firms' strategic flexibility are shown in Table 8.14.

Table 8.14 Correlations between firms' risk leadership initiative and their strategic flexibility

Item Code	Description	B5	B8	B11	F8	F12	F13	F15
B5	Bidding for more projects that are within the firm's capabilities	1.000						
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	.393*	1.000					
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	.545**	.526**	1.000				
F8	Ability to operate effectively and profitably in different market conditions	**.325***	.291	.203	1.000			
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)	**.372***	**.396***	**.352***	.370*	1.000		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	**.322***	.303	.215	.293	.522**	1.000	
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	.178	.280	.247	.337*	.450**	.249	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Table 8.14 shows that a firm's effort to bid for more projects within its capabilities (B5) is a key feature relating to its strategic flexibility, having significant positive correlations with F8, F12 and F13 (three out of the four features of strategic flexibility). Its importance for a firm's strategic flexibility is recognized by many interviewees, who pointed out that contractors who survived the deep downturn in the Singapore construction industry were those who have bid rationally and learnt from their counterparts who were forced out of the industry. One of the contractors mentioned by the interviewees was a G7 contractor (see Section 5.5.4 for elaboration of G7 contractors' category) who competed fiercely and had more than 10 public sector projects (i.e., schools, hostels and camps) at the same time before it went into receivership. Interviewee S30 added that contractors have to consider the detrimental effect of intense competition and be very selective in their bidding decisions, especially during an economic downturn. This agrees with Hillebrandt et al. (1995), who found that 'bidding for projects within a firm's capabilities' is one common practice adopted by their interviewees, who survived the 1989–1993 downturn in the UK construction industry. All these may explain the significant positive correlation between B5 and F8.

Also, the significant positive correlations among F12, B5, B8 and B11, as shown in Table 8.14, indicate that a firm's efforts to bid for more projects within its capabilities, while creating uncommitted funds and entering into forward contracts with suppliers and subcontractors, may collectively contribute to the firm's ability to exploit a range of procurement options effectively. From another perspective, these findings suggest that contractors should not undertake projects under different procurement options which are beyond their firms' capabilities. In the event that their firms undertake projects under different procurement options, they should create contingency funds and enter into forward contracts with their suppliers and subcontractors to mitigate the impact of unanticipated events on the firms' operations. These practices may be important because different procurement options involve different type of risks.

Some interviewees shared the view that overstretching a firm's resources and capabilities had led to the liquidations of two Singapore contractors, denoted as Company X and Y, during the 1997 – 2005 economic downturn. In describing the business failure of Company X, Interviewee S6 noted that:

> The business failure of Company X was a self-destruction case. It undertook excessive number of D&B projects simultaneously in an attempt to improve its book value without giving much consideration to its resources and capabilities.

For Company Y, Interviewee S41 pointed out that:

> The failure of Company Y was one of the reasons why his firm dismissed its intention to venture abroad. At one time, Company Y had undertaken two large overseas projects that involved civil engineering work along the coastline. Without having sufficient knowledge on the nature of project sites, it subsequently went into series of problems in designing and constructing the breakwaters and went bankrupt.

The foregoing cases are in agreement with Smith's (1986) discussion on the danger of 'over-trading' of work relating to a firm's resources and capabilities. He observed that 'over-trading' could often increase contractors' turnover (sales volume), but it could also lead to disaster if the contractors excessively overstretch their resources and capabilities. Likewise, these findings may help to explain the relationship between B5 and F13, in which contractors should not overstretch their capabilities by offering different construction services which they are unfamiliar with.

The above discussion attests that a contractor's risk and cost leadership initiatives are closely related, whereby the contractor should be risk and cost conscious in its strategic business management (see Section 8.5.6.3 further explanation). These may further help to explain why a firm's cost and risk leadership initiatives are classified under the same category of business strategies (see Table 7.4 and Section 7.3.2.2).

8.4 Evaluation of structural model of PLS M2

Similar to the evaluation process of PLS M1, the structural model of PLS M2 was examined by means of model trimming process and overall *F*-test prior to assessment of path coefficients and hypotheses testing. Considering the complexity of the PLS M2 that examines interactions of determinants in influencing organizational flexibility, the interpretation and discussion of findings of PLS M2 are discussed separately in Section 8.5.

8.4.1 Model trimming process

Figure 8.4 shows the original (or specified) PLS M2 that examines the interactions of constructs (or determinants) in influencing organizational flexibility with 65 paths. These paths were constructed among three independent and 11 dependent constructs. It can be seen that respective dependent constructs have R^2 values ranging from 0.189 to 0.633. The operational flexibility (Y_{OF}) construct registers the highest R^2 value, having 63.3% of its variance accounted for by its predictor constructs. The supply chain capabilities (X5) construct, on the other hand, registers the lowest R^2 value, having only 18.9% of its variance accounted for by its predictor constructs.

Nevertheless, all the reported R^2 values have exceeded the threshold value of 0.10, indicating a satisfactory level of predictive power for the PLS M2. A model trimming process was then conducted to identify any redundant predictor for the respective predicted constructs.

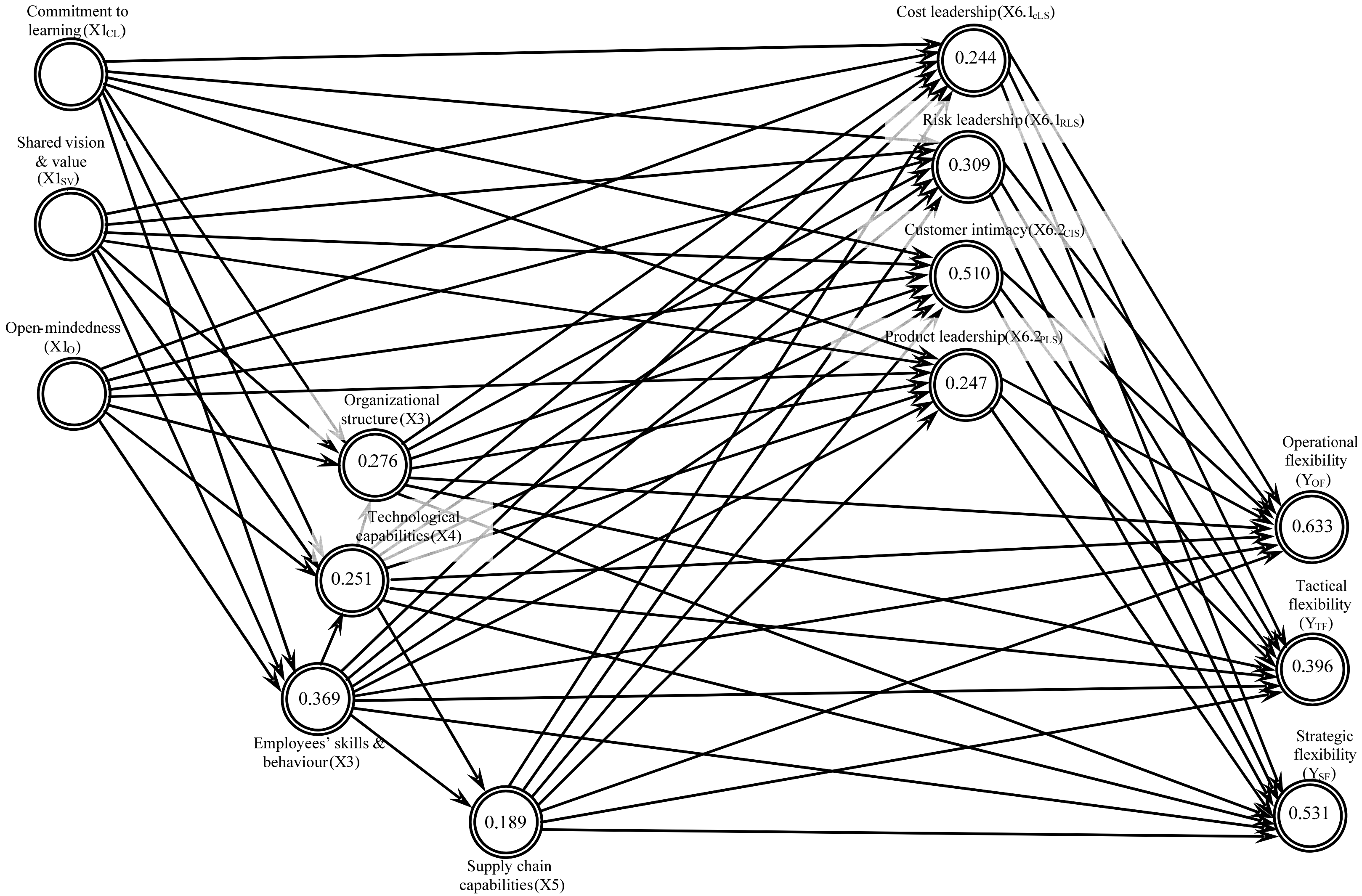


Figure 8.4 The original PLS M2

Table 8.16 shows the standardized path coefficient, the correlation and the percentage of variance explained ($P_{V \text{ explained}}$) for each hypothesized relationships in the original PLS M2. As noted from the computed $Pv_{\ explained}$ values of respective paths in PLS M2, 23 out of the proposed 65 paths are found to be redundant, having their respective $Pv_{\ explained}$ values that range from 0.00% to 1.36%. Five redundant paths, being the highest number, are detected in the risk leadership dimension. This is followed by the product leadership ($X6.2_{PLS}$) and cost leadership ($X6.1_{CLS}$) dimensions with four and three redundant paths, respectively. It should be noted that the majority of the identified redundant paths are detected in the respective dimensions of firms' business strategies (X6).

For the same reason highlighted in the model trimming of PLS M1 (see Section 8.2.1), it was decided to remove the 23 redundant paths in the recalculation of the model towards a parsimonious model with an improved level of predictive power. In this study, the inter-relationships among the constructs which were established based on the theoretical ground (see Chapter 4) are maintained in the trimmed PLS M2, with at least one arrow pointed towards the 11 predicted constructs upon the removal of the 23 redundant paths.

Figure 8.5 shows the trimmed PLS M2 with the respective R^2 values for individual predicted constructs. It can be seen that the majority of the R^2 value of predicted constructs have varied slightly from the respective R^2 value in the original PLS M2. For example, the R^2 value of the cost leadership ($X6.1_{CLS}$) dimension has dropped from 0.244 to 0.236, following the removal of two predictor constructs (i.e., firms' commitment to learning ($X1_{CL}$), and shared vision and value ($X1_{SV}$)). The decrease can be explained because the two predictor constructs are close enough to zero to be dropped, even if they do contribute very little to the understanding of the variance of the predicted construct. Nonetheless, it appears that all R^2 values in the trimmed PLS M2 have exceeded the threshold value of 0.10, indicating substantial predictive power of respective paths. Also, the $P_{V\,\text{explained}}$ values for the trimmed PLS M2 in the last column of Table 8.15 indicate that all predictor constructs have now accounted for at least 1.5% of the variance in their respective predicted constructs.

8.4.2 Overall F-test for R^2

Table 8.15 presents results of the overall *F*-test on the R^2 values of individual predicted constructs in the PLS M2. An overall improvement is noted in the *F*-test statistics of the predicted constructs after the model trimming process. In particular, the corresponding *F*-test statistics for the cost leadership and product leadership dimensions have significantly improved from 1.524 to 2.786 and 1.546 to 3.395, respectively. It can be seen that the R^2 values of these two predicted constructs are now statistically significant at $p < 0.05$ after the model trimming process. On the whole, all R^2 values in the trimmed PLS M2 are statistically significant, indicating that the model substantially explains the variance in the predicted constructs, i.e., a model with relatively good predictive power.

Table 8.15 Results of the overall *F*-test for R^2 in PLS M2

Description	**Original PLS M2**			**Trimmed PLS M2**		
Predicted constructs	R^2	F	Significance (p)	R^2	F	Significance (p)
Organizational structure (X2)	0.276	3.431	0.018	0.261	6.718	0.003
Employees' skills and behaviour (X3)	0.369	7.204	0.001	0.366	10.966	0.000
Technological capabilities (X4)	0.251	3.016	0.030	0.260	3.155	0.025
Supply chain capabilities (X5)	0.189	4.419	0.019	0.189	4.415	0.019
Cost leadership ($X6.1_{CLS}$)	0.244	1.524	0.194	0.236	2.786	0.041
Risk leadership ($X6.1_{RLS}$)	0.309	2.105	0.071	0.293	7.873	0.001
Customer intimacy ($X6.2_{CIS}$)	0.510	4.914	0.001	0.511	5.931	0.000
Product leadership ($X6.2_{PLS}$)	0.247	1.546	0.187	0.242	3.935	0.016
Operational flexibility (Y_{OF})	0.633	6.903	0.000	0.614	9.030	0.000
Tactical flexibility (Y_{TF})	0.396	2.627	0.025	0.369	4.096	0.005
Strategic flexibility (Y_{SF})	0.531	4.529	0.001	0.531	6.415	0.000

Table 8.16 Results of structural model of PLS M2 before and after the model trimming process

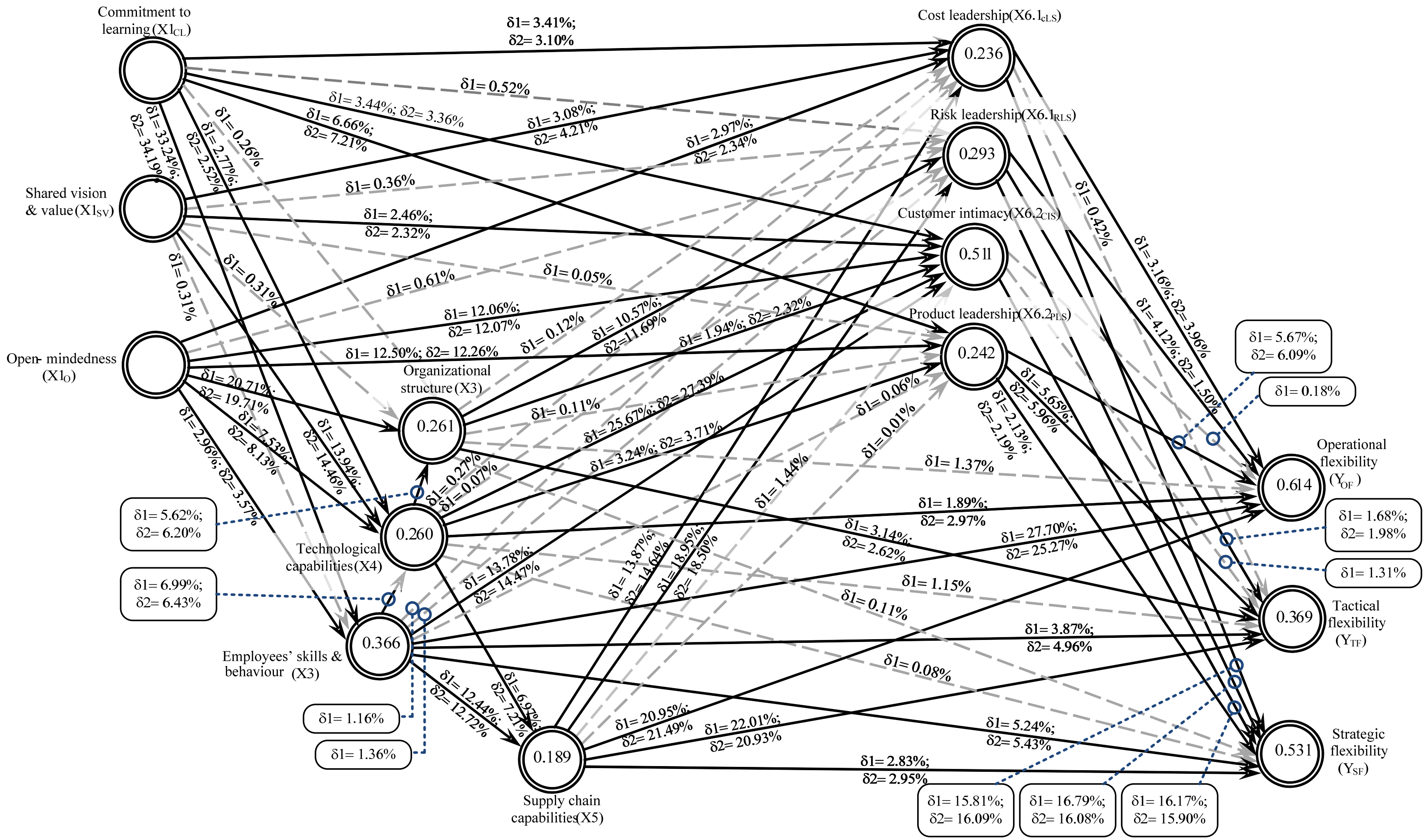
Hypotheses	Construct relationships			Original PLS M2				Trimmed PLS M2			
				R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)	R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)
⊗H_2	Commitment to learning ($X1_{CL}$)	→	Organizational structure (X2)	0.276	-0.066	0.039	0.26%	0.261	-	-	-
⊗H_2	Shared vision and value ($X1_{SV}$)	→	Organizational structure (X2)		-0.073	-0.043	0.31%		-	-	-
H_2	Open-mindedness ($X1_o$)	→	Organizational structure(X2)		0.536	0.387	20.71%		0.511	0.386	19.71%
H_{12}	Technological capabilities (X4)	→	Organizational structure(X2)		-0.317	-0.177	5.62%		-0.352	-0.176	6.20%
H_3	Commitment to learning ($X1_{CL}$)	→	Employees' skills and behaviour (X3)	0.369	0.554	0.600	33.24%	0.366	0.571	0.599	34.19%
⊗H_3	Shared vision and value ($X1_{SV}$)	→	Employees' skills and behaviour (X3)		0.048	0.301	1.46%		-	-	-
H_3	Open-mindedness ($X1_o$)	→	Employees' skills and behaviour(X3)		0.094	0.314	2.96%		0.112	0.319	3.57%
H_4	Commitment to learning ($X1_{CL}$)	→	Technological capabilities (X4)	0.251	-0.129	0.214	2.77%	0.260	-0.117	0.216	2.52%
H_4	Shared vision and value ($X1_{SV}$)	→	Technological capabilities (X4)		0.327	0.426	13.94%		0.330	0.438	14.46%
H_4	Open-mindedness ($X1_o$)	→	Technological capabilities(X4)		0.215	0.351	7.53%		0.229	0.356	8.13%
H_8	Employees' skills and behaviour (X3)	→	Technological capabilities(X4)		0.235	0.297	6.99%		0.220	0.292	6.43%
H_9	Employees' skills and behaviour (X3)	→	Supply chain capabilities (X5)	0.189	0.333	0.374	12.44%	0.188	0.339	0.375	12.72%
H_{13}	Technological capabilities (X4)	→	Supply chain capabilities (X5)		0.216	0.322	6.97%		0.226	0.319	7.21%
H_5	Commitment to learning ($X1_{CL}$)	→	Cost leadership ($X6.1_{CLS}$)	0.244	-0.312	-0.109	3.41%	0.236	-0.269	-0.115	3.10%
H_5	Shared vision and value ($X1_{SV}$)	→	Cost leadership ($X6.1_{CLS}$)		0.212	0.145	3.08%		0.250	0.168	4.21%
H_5	Open-mindedness ($X1_o$)	→	Cost leadership ($X6.1_{CLS}$)		-0.256	-0.116	2.97%		-0.204	-0.115	2.34%

Hypotheses	Construct relationships			Original PLS M2				Trimmed PLS M2			
				R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)	R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)
⊗H_6	Organizational structure (X2)	→	Cost leadership ($X6.1_{CLS}$)		0.036	-0.032	0.12%		-	-	-
⊗H_{10}	Employees’ skills and behaviour (X3)	→	Cost leadership ($X6.1_{CLS}$)		0.161	0.072	1.16%		-	-	-
⊗H_{14}	Technological capabilities (X4)	→	Cost leadership ($X6.1_{CLS}$)		-0.036	0.075	0.27%		-	-	-
H_{16}	Supply chain capabilities (X5)	→	Cost leadership ($X6.1_{CLS}$)		0.418	0.332	13.87%		0.447	0.327	14.64%
⊗H_5	Commitment to learning ($X1_{CL}$)	→	Risk leadership ($X6.1_{RLS}$)		-0.049	0.106	0.52%		-	-	-
⊗H_5	Shared vision and value ($X1_{SV}$)	→	Risk leadership ($X6.1_{RLS}$)		0.047	0.077	0.36%		-	-	-
⊗H_5	Open-mindedness ($X1_o$)	→	Risk leadership ($X6.1_{RLS}$)		-0.033	0.181	0.61%		-	-	-
H_6	Organizational structure (X2)	→	Risk leadership ($X6.1_{RLS}$)	0.309	0.308	0.343	10.57%	0.293	0.341	0.343	11.69%
⊗H_{10}	Employees’ skills and behaviour (X3)	→	Risk leadership ($X6.1_{RLS}$)		0.072	0.190	1.36%		-	-	-
⊗H_{14}	Technological capabilities (X4)	→	Risk leadership ($X6.1_{RLS}$)		-0.108	0.007	0.07%		-	-	-
H_{16}	Supply chain capabilities (X5)	→	Risk leadership ($X6.1_{RLS}$)		0.439	0.432	18.95%		0.431	0.429	18.50%
H_5	Commitment to learning ($X1_{CL}$)	→	Customer intimacy ($X6.2_{CIS}$)	0.510	-0.217	0.159	3.44%	0.511	-0.216	0.156	3.36%
H_5	Shared vision and value ($X1_{SV}$)	→	Customer intimacy ($X6.2_{CIS}$)		-0.129	0.190	2.46%		-0.117	0.199	2.32%
H_5	Open-mindedness ($X1_o$)	→	Customer intimacy ($X6.2_{CIS}$)		0.257	0.469	12.06%		0.260	0.464	12.07%
H_6	Organizational structure (X2)	→	Customer intimacy ($X6.2_{CIS}$)		0.107	0.181	1.94%		0.125	0.186	2.32%
H_{10}	Employees’ skills and behaviour (X3)	→	Customer intimacy ($X6.2_{CIS}$)		0.326	0.423	13.78%		0.340	0.426	14.47%
H_{14}	Technological capabilities (X4)	→	Customer intimacy ($X6.2_{CIS}$)		0.463	0.554	25.67%		0.491	0.557	27.39%

Hypotheses	Construct relationships			Original PLS M2				Trimmed PLS M2			
				R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)	R^2	Standardized path coefficient (β)	Correlation (ρ)	$Pv_{explained}^{+}$ (δ)
⊗H_{16}	Supply chain capabilities (X5)	→	Customer intimacy ($X6.2_{CIS}$)		0.048	0.303	1.44%		-	-	-
H_5	Commitment to learning ($X1_{CL}$)	→	Product leadership ($X6.2_{PLS}$)		-0.340	-0.196	6.66%		-0.378	-0.191	7.21%
⊗H_5	Shared vision and value ($X1_{SV}$)	→	Product leadership ($X6.2_{PLS}$)		-0.004	0.114	0.05%		-	-	-
H_5	Open-mindedness ($X1_o$)	→	Product leadership ($X6.2_{PLS}$)		0.399	0.313	12.50%		0.384	0.319	12.26%
⊗H_6	Organizational structure (X2)	→	Product leadership ($X6.2_{PLS}$)		-0.019	0.061	0.11%		-	-	-
⊗H_{10}	Employees' skills and behaviour (X3)	→	Product leadership ($X6.2_{PLS}$)		-0.007	-0.085	0.06%		-	-	-
H_{14}	Technological capabilities (X4)	→	Product leadership ($X6.2_{PLS}$)	0.247	0.154	0.210	3.24%	0.242	0.171	0.217	3.71%
⊗H_{16}	Supply chain capabilities (X5)	→	Product leadership ($X6.2_{PLS}$)		0.005	0.012	0.01%		-	-	-
⊗H_7	Organizational structure (X2)	→	Operational flexibility (Y_{OF})		-0.144	-0.095	1.37%		-	-	-
H_{11}	Employees' skills and behaviour (X3)	→	Operational flexibility (Y_{OF})		0.457	0.607	27.70%		0.419	0.603	25.27%
H_{15}	Technological capabilities (X4)	→	Operational flexibility (Y_{OF})		0.063	0.298	1.89%		0.101	0.293	2.97%
H_{17}	Supply chain capabilities (X5)	→	Operational flexibility (Y_{OF})		0.348	0.602	20.95%		0.358	0.600	21.49%
H_{18}	Cost leadership ($X6.1_{CLS}$)	→	Operational flexibility (Y_{OF})	0.633	0.098	0.323	3.16%	0.614	0.123	0.322	3.96%
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Operational flexibility (Y_{OF})		0.120	0.343	4.12%		0.044	0.342	1.50%
⊗H_{18}	Customer intimacy ($X6.2_{CIS}$)	→	Operational flexibility (Y_{OF})		-0.007	0.251	0.18%		-	-	-
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Operational flexibility (Y_{OF})		-0.209	-0.271	5.67%		-0.229	-0.266	6.09%
H_7	Organizational structure (X2)	→	Tactical flexibility (Y_{TF})		-0.236	-0.133	3.14%		-0.197	-0.133	2.62%

Hypotheses	Construct relationships			Original PLS M2				Trimmed PLS M2			
				R^2	Standardized path coefficient (β)	Correlation (ρ)	*Pv* *explained*[+] (δ)	R^2	Standardized path coefficient (β)	Correlation (ρ)	*Pv* *explained*[+] (δ)
H_{11}	Employees' skills and behaviour (X3)	→	Tactical flexibility (Y_{TF})	0.396	0.123	0.314	3.87%	0.369	0.158	0.314	4.96%
⊗H_{15}	Technological capabilities (X4)	→	Tactical flexibility (Y_{TF})		-0.128	0.090	1.15%		-	-	-
H_{17}	Supply chain capabilities (X5)	→	Tactical flexibility (Y_{TF})		0.431	0.511	22.01%		0.415	0.504	20.93%
⊗H_{18}	Cost leadership ($X6.1_{CLS}$)	→	Tactical flexibility (Y_{TF})		-0.026	0.163	0.42%		-	-	-
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Tactical flexibility (Y_{TF})		0.069	0.244	1.68%		0.081	0.245	1.98%
⊗H_{18}	Customer intimacy ($X6.2_{CIS}$)	→	Tactical flexibility (Y_{TF})		0.091	0.144	1.31%		-	-	-
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Tactical flexibility (Y_{TF})		-0.205	-0.276	5.65%		-0.220	-0.271	5.96%
⊗ H_7	Organizational structure (X2)	→	Strategic flexibility (Y_{SF})	0.531	-0.007	0.160	0.11%	0.531	-	-	-
H_{11}	Employees' skills and behaviour (X3)	→	Strategic flexibility (Y_{SF})		0.148	0.355	5.24%		0.154	0.353	5.43%
⊗H_{15}	Technological capabilities (X4)	→	Strategic flexibility (Y_{SF})		-0.004	0.211	0.08%		-	-	-
H_{17}	Supply chain capabilities (X5)	→	Strategic flexibility (Y_{SF})		-0.091	0.311	2.83%		-0.095	0.309	2.95%
H_{18}	Cost leadership ($X6.1_{CLS}$)	→	Strategic flexibility (Y_{SF})		0.333	0.475	15.81%		0.339	0.474	16.09%
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Strategic flexibility (Y_{SF})		0.335	0.501	16.79%		0.324	0.497	16.08%
H_{18}	Customer intimacy ($X6.2_{CIS}$)	→	Strategic flexibility (Y_{SF})		0.391	0.414	16.17%		0.384	0.414	15.90%
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Strategic flexibility (Y_{SF})		-0.178	-0.120	2.13%		-0.188	-0.117	2.19%

Note: [+] denotes the absolute value of the percentage of *Pv* $_{explained}$; ⊗ denotes redundant path removed.



Legend: = Redundant path removed; δ1 = $PV_{explained}$ (%) for original PLS M2; δ2 = $PV_{explained}$ (%) for trimmed PLS M2

Figure 8.5 The trimmed PLS M2

8.4.3 Assessment of path coefficients and proposition testing

Table 8.17 shows the standardized path coefficients, *t*-values and the statistical significance inferences for all paths in the trimmed PLS M2. A total of 20 out of the 42 proposed paths are found to be statistically significant, supporting the hypothesized relationships among the constructs in this research. These paths are statistically significant at $p < 0.05$ level or less. Of these, four predictor constructs have negative path coefficients (i.e., negative impacts on the respective predicted constructs). The remaining 16 statistically significant path coefficients have positive impacts on their respective predicted constructs. Figure 8.5 is modified here as Figure 8.6, showing only the statistically significant paths in the trimmed PLS M2.

Table 8.17 Hypotheses testing in the trimmed PLS M2

Hypotheses (1)	**Proposed paths** (2)			**Standardized path coefficient (β)** (3)	***t*-values (*p*)** (4)	**Inference** (5)
H_2	Open-mindedness ($X1_O$)	→	Organizational structure (X2)	0.511	3.764***	S
H_3	Commitment to learning ($X1_{CL}$)	→	Employees' skills and behaviour (X3)	0.571	5.553***	S
H_3	Open-mindedness ($X1_O$)	→	Employees' skills and behaviour (X3)	0.112	0.701	N.S
H_4	Commitment to learning ($X1_{CL}$)	→	Technological capabilities (X4)	-0.117	0.588	N.S
H_4	Shared vision and value ($X1_{SV}$)	→	Technological capabilities (X4)	0.330	1.685*	S
H_4	Open-mindedness ($X1_O$)	→	Technological capabilities (X4)	0.229	1.203	N.S
H_5	Commitment to learning ($X1_{CL}$)	→	Cost leadership ($X6.1_{CLS}$)	-0.269	1.926*	S
H_5	Shared vision and value ($X1_{SV}$)	→	Cost leadership ($X6.1_{CLS}$)	0.250	1.432	N.S
H_5	Open-mindedness ($X1_O$)	→	Cost leadership ($X6.1_{CLS}$)	-0.204	1.508	N.S
H_5	Commitment to learning ($X1_{CL}$)	→	Customer intimacy ($X6.2_{CIS}$)	-0.216	1.347	N.S
H_5	Shared vision and value ($X1_{SV}$)	→	Customer intimacy ($X6.2_{CIS}$)	-0.117	0.610	N.S
H_5	Open-mindedness ($X1_O$)	→	Customer intimacy ($X6.2_{CIS}$)	0.260	1.514	N.S
H_5	Commitment to learning ($X1_{CL}$)	→	Product leadership ($X6.2_{PLS}$)	-0.378	2.276*	S
H_5	Open-mindedness ($X1_O$)	→	Product leadership ($X6.2_{PLS}$)	0.384	2.163*	S
H_6	Organizational structure (X2)	→	Risk leadership ($X6.1_{RLS}$)	0.341	2.521**	S
H_6	Organizational structure (X2)	→	Customer intimacy ($X6.2_{CIS}$)	0.125	0.935	N.S

Hypo-theses (1)	Proposed paths (2)			Standardized path coefficient (β) (3)	*t*-values (*p*) (4)	Infer-ence (5)
H_7	Organizational structure (X2)	→	Tactical flexibility (Y_{TF})	-0.197	0.988	N.S
H_8	Employees' skills and behaviour (X3)	→	Technological capabilities (X4)	0.220	1.398	N.S
H_9	Employees' skills and behaviour (X3)	→	Supply chain capabilities (X5)	0.339	2.823**	S
H_{10}	Employees' skills and behaviour (X3)	→	Customer intimacy ($X6.2_{CIS}$)	0.340	2.016*	S
H_{11}	Employees' skills and behaviour (X3)	→	Operational flexibility	0.419	3.209**	S
H_{11}	Employees' skills and behaviour (X3)	→	Tactical flexibility (Y_{TF})	0.158	0.812	N.S
H_{11}	Employees' skills and behaviour (X3)	→	Strategic flexibility (Y_{SF})	0.154	0.897	N.S
H_{12}	Technological capabilities (X4)	→	Organizational structure (X2)	-0.352	2.673**	S
H_{13}	Technological capabilities (X4)	→	Supply chain capabilities (X5)	0.226	1.449	N.S
H_{14}	Technological capabilities (X4)	→	Customer intimacy ($X6.2_{CIS}$)	0.491	3.237**	S
H_{14}	Technological capabilities (X4)	→	Product leadership ($X6.2_{PLS}$)	0.171	0.637	N.S
H_{15}	Technological capabilities (X4)	→	Operational flexibility (Y_{OF})	0.101	0.578	N.S
H_{16}	Supply chain capabilities (X5)	→	Cost leadership ($X6.1_{CLS}$)	0.447	2.503**	S
H_{16}	Supply chain capabilities (X5)	→	Risk leadership ($X6.1_{RLS}$)	0.431	3.691***	S
H_{17}	Supply chain capabilities (X5)	→	Operational flexibility (Y_{OF})	0.358	2.514**	S
H_{17}	Supply chain capabilities (X5)	→	Tactical flexibility (Y_{TF})	0.415	2.114*	S
H_{17}	Supply chain capabilities (X5)	→	Strategic flexibility (Y_{SF})	-0.095	0.704	N.S
H_{18}	Cost leadership ($X6.1_{CLS}$)	→	Operational flexibility (Y_{OF})	0.123	1.167	N.S
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Operational flexibility (Y_{OF})	0.044	0.409	N.S
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Operational flexibility (Y_{OF})	-0.229	2.008*	S
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Tactical flexibility (Y_{TF})	0.081	0.323	N.S
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Tactical flexibility (Y_{TF})	-0.220	1.563	N.S
H_{18}	Cost leadership ($X6.1_{CLS}$)	→	Strategic flexibility (Y_{SF})	0.339	1.767*	S
H_{18}	Risk leadership ($X6.1_{RLS}$)	→	Strategic flexibility (Y_{SF})	0.324	1.838*	S
H_{18}	Customer intimacy ($X6.2_{CIS}$)	→	Strategic flexibility (Y_{SF})	0.384	2.772**	S
H_{18}	Product leadership ($X6.2_{PLS}$)	→	Strategic flexibility (Y_{SF})	-0.188	1.092	N.S

NB: *** denotes significant at p <0.001; ** denotes significant at p < 0.01; * denotes significant at p <0.05 (one-tailed). Under the inference column (fifth column), the abbreviation S and N.S are referred as hypothesis supported and not supported, respectively.

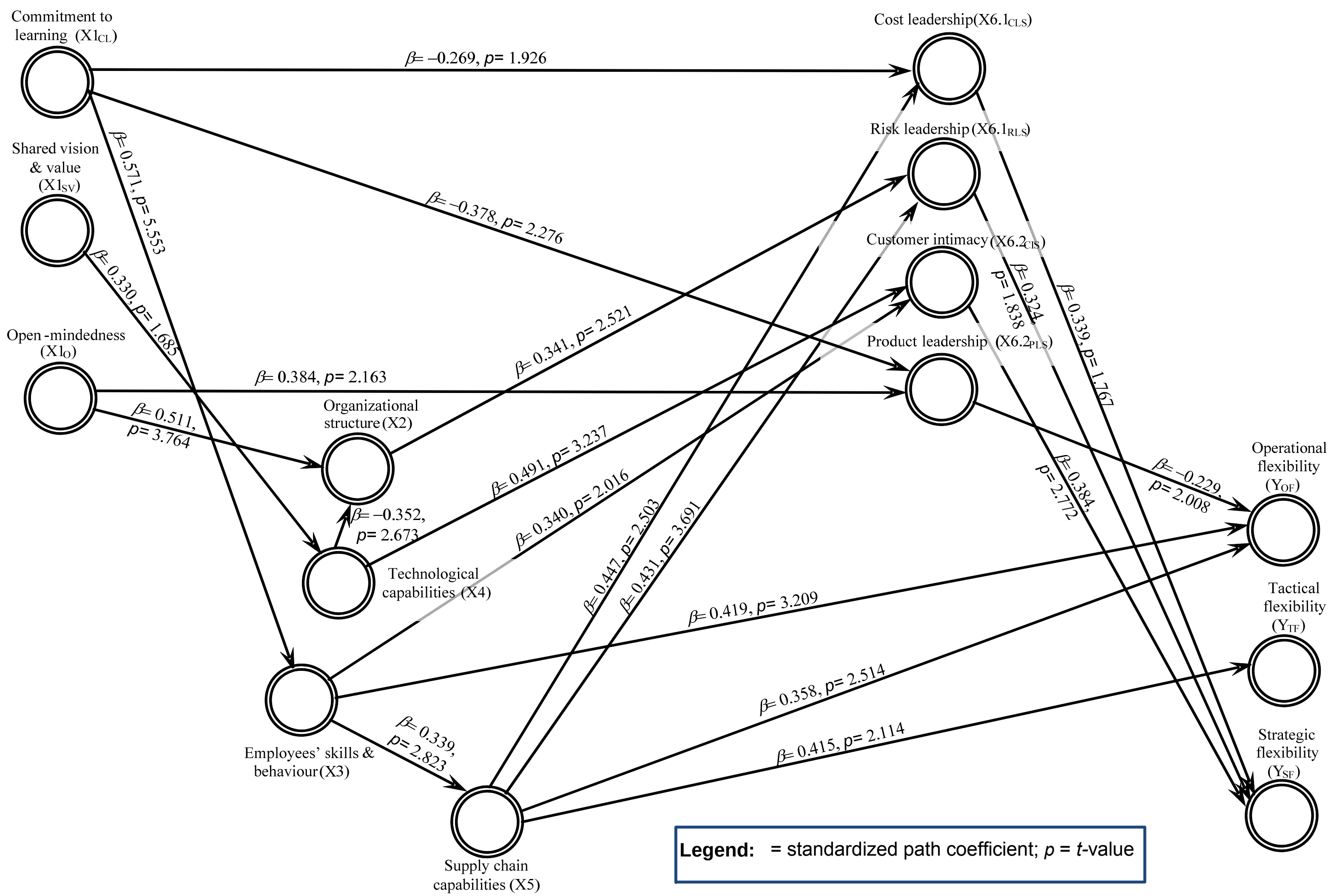


Figure 8.6 Significant paths within the trimmed PLS M2

8.5 Interpretation and discussion of findings

This section focuses on interpretation and discussion of the interaction effects between firms' resources, capabilities and business strategies, and how these effects collectively influence firms' organizational flexibility. Similar to PLS M1, interview findings have been integrated into the respective sections to supplement the discussion. Also, all observed predictive relationships were explained in relation to the measurement items of the respective predictor and predicted constructs reported in Table 7.17.

8.5.1 Predictors of organizational structure (X2)

8.5.1.1 <u>Open-mindedness ($X1_O$)</u>

Table 8.17 shows that the attribute of open-mindedness ($X1_O$) has a positive influence on firms' organizational structure (X2), posing a path coefficient of 0.511 (H_2 - Organizational learning culture (X1) has a significant direct impact on organizational structure (X2)). This phenomenon can be partly explained by the significant positive correlations between firms' open-mindedness and their organizational structure (see Table 8.18). The findings indicate that firms with a higher degree of open-mindedness is more likely to have a more flexible organizational structure, as exemplified by their approaches in encouraging employees' involvement in decision-making process (O1) and adapting freely to changes within the environment without much concern to past practices and management practices (O3). These approaches are important to an organizational structure that facilitates: (i) flexible working procedures (OS1); (ii) decentralized decision-making processes (OS2); and (iii) easy access to important information for decision making (OS3).

Table 8.18 Correlations between firms' open-mindedness and their organizational structure

Item Code	Description	O1	O2	O3	OS1	OS2	OS3
O1	Our firm encourages participative decision making among employees	1.000					
O2	Our firm promotes open communication among subordinates and superiors	.615**	1.000				
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	.656**	.607**	1.000			
OS1	Our firm operates in a flexible work procedure	**.345***	.073	**.316***	1.000		
OS2	Our firm adopts a more decentralized decision making process	**.490****	.218	**.460****	.662**	1.000	
OS3	Our firm has an open communication channel with flexible access to important information for decision making	**.402****	.137	.253	.636**	.591**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

The impact of firms' open-mindedness on organizational structure is further examined based on the: (i) type of organizational planning approach; (ii) leadership style; (iii) organizational hierarchical level; and (iv) organizational structure system of the interviewees' firms. Table 8.19 shows the interviewees' firms organizational planning approach and leadership style in a matrix form. According to Volberda (1998), the leadership style usually symbolizes the directing and collaborating behaviour of a firm. A directing or task-oriented behaviour emphasizes an instructive style of one-way communication and management control, while a collaborating or relation-oriented behaviour emphasizes consultative, participative and delegation styles of two-way communication, focusing on mutual relationship and employees' involvement in decision-making process. The results show that the majority of interviewees' firms (approximately 70%) are embracing consultative and participative leadership styles that emphasize maintaining a balance between directing and collaborating behaviour. This suggests that these firms are relatively open-minded and have displayed a certain degree of flexibility potential in their organizational structure.

Table 8.19 Organizational planning approach and leadership style of interviewees' firms

Type of leadership style	Number of firms (% of firms)			
	Type of planning approach			
	Passive: establishing stable goals and integrated plan	**Proactive:** establishing broad goal and plan incrementally with short-term aim	**Interactive:** planning iteratively and interactively	**Total**
Instructive style	4	2	6	12 (29.27%)
Consultative style	6	4	7	17 (41.46%)
Participative style	3	5	4	12 (29.27%)
Delegative style	-	-	-	-
Total	13 (31.71%)	11 (26.82%)	17 (41.46%)	**41 (100%)**

Although a small group of contractors (i.e., 12 out of 41) embraced the instructive leadership style (i.e., more directing and less collaborating behaviour), it appears that these firms have demonstrated a certain degree of open-mindedness since most of them (i.e., 8 out of 12) adopt either a proactive or interactive planning approach. The former involves contractors in establishing a broad goal and planning incrementally with short-term aim, while the latter involves contractors to plan iteratively and interactively in accordance with the business environment (i.e., keeping all options open). It therefore appears that this group of contractors is able to re-position themselves in a timely manner to changes within the business environment.

The next issue to examine is the hierarchical level and structural configuration of interviewees' firms (see Table 8.20). The organizational hierarchy was computed based on the line of authority stemming from a line manager. It can be seen that the organizational hierarchical levels range from two to six with a mode of four, suggesting that most interviewees' firms have relatively thin lines of communication among managers. Also, it is found that the matrix configuration is one of the most commonly adopted structural configurations among interviewees' firms (i.e., 20 out of 41). This indicates that most interviewees' firms possess a high degree of flexibility potential in their organizational structure, enabling them to respond flexibly to changes within the business environment (see Section 4.3.3.4). Although there may be an issue of power structure between managers within a matrix configuration, as suggested by Volberda (1998), many interviewees do not consider the power structure issue as a major problem in their workplace. From their perspective, conflicts are unavoidable in human-to-human interactions. They shared the view that healthy conflict can be constructive. This agrees with Lencioni (2007), who expressed that employees do not make a solid commitment towards organizational plans and decisions without healthy conflict.

Table 8.20 Hierarchical levels and structural configurations of interviewees' firms

Structural configuration	**Number of firms (% of firms)**					
	Hierarchical levels					
	2	**3**	**4**	**5**	**6**	**Total**
Sole trader (S)	1	1	1	-	-	3 (7.32%)
Functional (F)	1	5	3	4	1	14 (34.15%)
Divisional (D)	-	-	-	-	-	-
Matrix (M)	-	3	10	4	3	20 (48.78%)
F + D	-	-	-	1	-	1 (2.44%)
D + M	-	-	1	2	-	3 (7.32%)
Total	2 (4.88%)	9 (21.95%)	15 (36.59%)	11 (26.82%)	4 (9.76%)	**41 (100%)**

8.5.1.2 <u>Technological capabilities (X4)</u>

The other predictor of organizational structure (X2), as shown in Table 8.17, is technological capabilities (X4), posing a path coefficient of -0.352 (H_{12} -

Technological capabilities (X4) have a significant direct impact on organizational structure (X2)). As can be seen from Table 7.17, a firm's technological capabilities are associated with various features (for example: a firm's ability to communicate and share real time information among supply chain parties (IT1; FL = 0.869), and among all decision makers and employees regardless of geographic dispersion (IT2; FL = 0.861)).

Table 8.21 shows the correlations between firms' technological capabilities and their organizational structure. It is found that IT2 has a significant negative correlation with OS3, indicating that a firm's ability to communicate and share real time information among all decision makers and employees negate the firm's effort to create an open communication channel with flexible access to important information for decision making. This may show the deficiency of a firm's technological capabilities to support its effort to create an open communication platform with flexible access to important information for decision making (see Section 8.5.3).

Table 8.21 Correlations between firms' technological capabilities and their organizational structure

Item Code	Description	IT1	IT2	IT3	IT4	PT1	PT2	PT3	OS1	OS2	OS3
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	1.000									
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	.799**	1.000								
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	.594**	.606**	1.000							
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	.644**	.693**	.709**	1.000						

Item Code	Description	IT1	IT2	IT3	IT4	PT1	PT2	PT3	OS1	OS2	OS3
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	.558**	.580*	.535**	.654**	1.000					
PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process	.536**	.585**	.398*	.534**	.639**	1.000				
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	.647**	.470**	.496**	.498**	.565**	.424**	1.000			
OS1	Our firms operates in a flexible work procedure	-.152	-.168	-.083	-.102	-.045	-.019	.003	1.000		
OS2	Our firm adopts a more decentralized decision making process	-.149	-.197	.033	-.095	-.134	-.104	.014	.662**	1.000	
OS3	Our firm has an open communication channel with flexible access to important information for decision making	-.208	**-.324***	-.121	-.185	-.124	-.091	-.202	.636**	.591**	.1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

From another perspective, the negative influence of firms' technological capabilities on their organizational structure may be partially explained by the ownership of the majority of interviewees' firms (see Section 8.3.2). The interviews revealed that firms have placed a certain degree of restrictions on employees' access to company information and records. These restrictions impede an organizational structure that facilitates flexible working procedures and decentralized decision-making processes. Interviewee S14, who is a managing director of an A1 contractor, explained that:

> Controlling employees' access to company information and records is important to prevent any unauthorized information transmission. This precautionary measure is needed because of high employee turnover in the industry. More importantly, it also prevents any possible collusion between employees and outsiders.

8.5.2 Predictors of employees' skills and behaviour

Table 8.17 shows that a firm's commitment to learning ($X1_{CL}$) is a significant predictor of its employees' skills and behaviour (X3), posing a path coefficient of 0.571 (H_3 - Organizational learning culture (X1) has a significant direct impact on employees' skills and behaviour (X3)). This finding agrees with Sinkula et al. (1997), who found that top management commitment to create an environment that is more instrumental and conducive to learning is an important factor in influencing employees' skills and behaviour.

In this study, a firm's commitment to learning is associated with its efforts to create a working environment, where: (i) employees' training and learning are seen as an investment rather than an expense (CL1; FL = 0.855); (ii) performance mistakes are seen as opportunities for learning and development (CL2; FL = 0.716); and (iii) employees' learning is the key towards the firm's success in response to changes within the industry (CL3; FL = 0.845) (see Table 7.17). Table 8.22 shows that these organizational endeavours have significant positive correlations with employees' skills and behaviour. It can be seen that CL1, CL2 and CL3 are positively correlated with employees' abilities: (i) to work in a team environment (ESB2); (ii) to perform a diverse range of tasks and responsibilities (ESB5); and (iii) to gain customer satisfaction (ESB6). One possible explanation is that employees will feel motivated to work in a team environment, which promotes learning and a "no-blame" attitude, and are willing to share and perform diverse ranges of tasks and responsibilities towards gaining customer satisfaction.

Table 8.22 Correlations between firms' commitment to learning and their employees' skills and behaviour

Item Code	Description	CL1	CL2	CL3	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8
CL1	Employees training and learning are seen as investment rather than expenses	1.000								
CL2	Performance mistakes are seen as opportunities for learning and development	.418**	1.000							
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	.564**	.464**	1.000						
ESB1	Ability to adopt an open-mindset to all alternative	.282	**.323***	**.351***	1.000					
ESB2	Ability to work in a team environment	**.332***	**.367***	**.333***	.643**	1.000				
ESB4	Ability to learn and adapt to different business conditions	**.502****	.252	.291	.463**	.597**	1.000			
ESB5	Ability to perform a diverse range of tasks and responsibilities	**.329***	**.402****	**.352***	.351*	.575**	.518**	1.000		
ESB6	Ability to gain customer satisfaction	**.400****	**.348***	**.481****	.290	.391*	.413**	.423**	1.000	
ESB8	Ability to work independently	**.467****	.246	**.324***	.477**	.576**	.431**	.326*	.377*	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Similarly, the statistically significant positive correlations among CL2, CL3, and ESB1 may be explained by a working environment that promotes "no-blame" and "continuous improvement" cultures. Employees will feel motivated and be adventurous in exploring new and different alternatives (for example, ideas, technologies and processes) in search of new opportunities or better solutions. In fact, this helps to avoid the problem of 'active inertia' (see Section 3.9.1). In addition, employees may become more willing to learn and adapt to different conditions following their firm's strategic direction (see Section 8.3.1.1).

Relationships between firms' human resource management practices and their employees' skills and behaviour are now presented. In this study, human resource management practices are classified under: (i) competence development; (ii) stress management; (iii) performance management; (iv) intra-organizational relationship management

8.5.2.1 Competence development (C)

Table 8.23 shows the correlations between firms' competence development practices and their employees' skills and behaviour. It is found that C6 'offering on-job trainings' has significant positive correlations with all features of a firm's employees' skills and behaviour. Many interviewees shared the view that it is important to offer on-the-job training to their employees because it provides necessary organizational support for the employees' continuous skills development and more importantly, it shows the firms' commitment to create a shared vision and value environment, and thus offering them 'a sense of belonging' in the organizations.

As for the significant positive correlations among C10, ESB2, ESB5 and ESB6, these may indicate that firms encourage their employees to attend continuing professional development and qualification courses, and expect them to socialize with external professional and update their knowledge on current operational and management issues. All these may, in turn, lead to improved employees' abilities to perform diverse ranges of tasks and responsibilities within a team environment. In terms of C13 'subsidizing tuition fees of self-upgrading courses and seminars attended by employees', many interviewees (approximately 80%) shared the view that this practice is commonly adopted by their firms in rewarding employees' loyalty to the firms, in addition to their competence development. Interviewees pointed out that the amount of subsidy is largely dependent on the employees' performance and tenure, and usually amounts to 50% of the tuition fees.

Table 8.23 Correlations between firms' competence development and their employees' skills and behaviour

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	C6	C7	C8	C9	C10	C11	C12	C13
ESB1	Ability to adopt an open-mindset to all alternative	1.000													
ESB2	Ability to work in a team environment	.643**	1.000												
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000											
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000										
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000									
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000								
C6	Providing on-the-job training to improve employees' skills	**.390***	**.603****	**.386***	**.536****	**.440****	**.328***	1.000							
C7	Offering job rotation programme to broaden versatility of its employees	-.091	-.046	.070	.125	.252	-.273	.281	1.000						
C8	Practising job enrichment programme to encourage employees to take higher responsibility role	-.249	.048	-.137	-.115	.132	.006	.462**	.188	1.000					
C9	Offering day release scheme to attend part-time courses in institution	.183	.252	.118	.303	.239	.149	.461**	-.036	.544**	1.000				
C10	Allowing employees to take day off for their continual professional development and professional qualification course	.229	**.459****	.129	**.398****	**.348***	.214	.624**	.182	.535**	.613**	1.000			
C11	Implementing mentoring scheme to support new recruits and recently promoted employees	.121	.266	.122	.046	.283	.179	.506**	.132	.655**	.541**	.597**	1.000		
C12	Collaborating with management institute for employees training	-.008	.175	.206	.193	.202	.208	.257	.278	.293	.335*	.234	.399**	1.000	
C13	Subsidizing tuition fees of self-upgrading courses and seminars attended by employees	.205	.233	.163	.307	**.371***	.206	.557**	.149	.422**	.690**	.597**	.542**	.306	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.5.2.2 Stress management (SM)

Table 8.24 shows the correlations between firms' stress management practices and their employees' skills and behaviour. Of the four stress management practices, only SM2 and SM4 are found to have significant positive correlations with respective features of a firm's employees' skills and behaviour. It can be seen that SM4 'implementing personal counselling program' is an important practice relating to employees' skills and behaviour, considering its significant positive correlations with ESB6 and ESB8. Most interviewees shared the view that private discussion, either through an informal or formal session, is a good way for superiors to counsel subordinates who are distressed or frustrated due to personal or work-related reasons. They explained that this practice encourages superiors to guide their subordinates with different alternatives to problem-solving and more importantly, it offers superiors a way to resolve conflicts between subordinates from the same or different departments. All these help to lessen employees' emotional frustration and resistance to change towards work-related issues and practices, and thus do not affect their abilities to perform their tasks and work independently and effectively.

Table 8.24 Correlations between firms' stress management practices and their employees' skills and behaviour

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	SM1	SM2	SM3	SM4
ESB1	Ability to adopt an open-mindset to all alternative	1.000									
ESB2	Ability to work in a team environment	.643**	1.000								
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000							
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000						
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000					
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000				
SM1	Allowing employees to take time-off	.094	.065	.112	.082	.025	.165	1.000			
SM2	Organizing stress coping and management courses	.108	-.011	.216	.049	**.331***	.274	.464**	1.000		
SM3	Implementing buddy scheme	-.041	.016	-.156	-.134	.227	-.010	.247	.120	1.000	

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	SM1	SM2	SM3	SM4
SM4	Implementing personal counselling programs	.119	.164	.242	.177	**.441****	**.401****	.358*	.699**	.331*	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.5.2.3 Performance management (PM)

Table 8.25 shows the correlations between firms' performance management practices and their employees' skills and behaviour. It can be seen that four out of the five performance management practices have significant positive correlations with respective features of employees' skills and behaviour. PM1 and PM3, which provide opportunity for networking among employees, are found to have a significant positive correlation with employees' ability to work as a team (ESB2). Interviewees shared the view that informal gatherings can take the form of: (i) buffet lunches upon completion of major project milestones; (ii) annual company dinner; and (iii) monthly dinner meetings. One-third of the interviewees added that sending birthday cards and cakes to respective employees is another effective approach to recognize employees' performance as well as improve employer-employee relationship. Although PM3 is found to have positive correlations with ESB2 and ESB4, interviewees shared the view that it is difficult to organize and gather all employees for an overseas trip since employees are often assigned to different projects that have different construction agendas. Therefore, they pointed out that an overseas trip is used as a mechanism to reward individual teams for their project performance, which is determined by four criteria: (i) cost; (ii) time; (iii) quality; and (iv) customer satisfaction.

Table 8.25 Correlations between firms' performance management and employees' skills and behaviour

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	PM1	PM2	PM3	PM4	PM5
ESB1	Ability to adopt an open-mindset to all alternatives	1.000										
ESB2	Ability to work in a team environment	.643**	1.000									
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000								
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000							
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000						
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000					
PM1	Organizing informal gathering to recognize employees' achievement	.274	**.368***	.276	.122	.250	.401**	1.000				
PM2	Providing flexible compensation plan to motivate employees	.277	.306	.293	-.007	-.031	.214	.654**	1.000			
PM3	Organizing company trips to reward employees' contributions to firms' performance	.266	**.315***	**.352***	.176	.098	.287	.532**	.523**	1.000		
PM4	Conducting staff performance appraisal exercise as a formal means of discussing, identifying and recording their training needs	.293	**.476****	**.330***	**.358***	.246	.272	.683**	.663**	.568**	1.000	
PM5	Offering career development and promotion	**.319***	**.363***	**.371***	.136	-.010	.257	.739**	.759**	.609**	.789**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Also, the significant positive correlations among PM4, ESB2, ESB4 and ESB5, as shown in Table 8.25, may indicate that a firm's effort to conduct staff performance and training appraisal exercises plays an important role in developing its employees' abilities: (i) to work in a team environment; (ii) to learn and adapt to different business conditions; and (iii) to perform a diverse range of tasks and responsibilities. Many interviewees (approximately 66%) emphasized the importance of an evaluation exercise to determine employees' performance and training needs, and added that the evaluation exercise has to align with a firm's guiding principle, reflecting and identifying the type of training and employees' skills and behaviour necessitated in meeting the firm's strategic direction. As for PM5 'offering career development and promotion', some interviewees (approximately 37%) pointed out that this practice shows signs of a firm's appreciation and commitment to employees' achievement and development, and has both direct and indirect influences on employees' skills and behaviour. They explained that this practice will directly shape employees' commitment, and thus indirectly encourage them to learn about and adapt to the firm's business decision.

8.5.2.4 Intra-organizational relationship management (RM)

Table 8.26 shows the correlations between firms' intra-organizational relationship management practices and their employees' skills and behaviour. It can be seen that RM2 is positively correlated with five out of the six features of employees' skills and behaviour, which place emphasis on multi-skilled employees who can work independently and as team members (i.e., ESB1, ESB2, ESB4, ESB5 and ESB8). Many interviewees agreed that conducting regular weekly meetings is the most effective approach to share, update and discuss operational issues, and thus improve the interaction among superiors and subordinates and minimize the likelihood of unnecessary conflicts. All these may lead to improved intra-organizational relationships; individual employees work, learn, adapt and strive cohesively for a firm's continued existence. This agrees with Raiden and Dainty (2006), who found that regular weekly meetings between senior managers and directors would encourage innovation and sharing of good practices, which in turn improve a firm's business performance.

Table 8.26 Correlations between employees' skills and behaviour and firms' intra-organizational relation management

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	RM1	RM2	RM3	RM4	RM5
ESB1	Ability to adopt an open-mindset to all alternative	1.000										
ESB2	Ability to work in a team environment	.643**	1.000									
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000								
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000							

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	RM1	RM2	RM3	RM4	RM5
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000						
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000					
RM1	Encouraging face to face communication among employees	**.377***	.195	.264	.106	.189	.306	1.000				
RM2	Conducting regular meetings among subordinates and superiors	**.401****	**.363***	**.345***	**.348***	.230	**.329***	.807**	1.000			
RM3	Implementing survey feedback programmes to track the well-being of employees	**.348***	.202	**.311***	.100	**.313***	.264	.632**	.660**	1.000		
RM4	Conducting induction programmes for all new recruits	**.358***	.233	.297	.249	.153	.172	.673**	.832**	.624**	1.000	
RM5	Encouraging regular meetings among employees & SC parties	.199	.096	.132	.180	.126	.082	.719**	.699**	.671**	.576**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

As for the correlations among RM3, ESB1, ESB4 and ESB6 (see Table 8.26), this may indicate that a firm's effort to implement a survey feedback programme could help the firm to assess its employees' job satisfaction and identify their concerns that may have affected their performance. Based on the feedback obtained, the firm may implement several practices or provide necessary support to employees, in exchange for better employees' performance, in terms of their abilities: (i) to learn and adapt to different business conditions; (ii) to gain customer satisfaction; and (iii) to adopt an open-mindset to all alternatives. Many interviewees agreed that it is important for their firms to track the well-being of their employees for improved business performance. Most interviewees' firms (approximately 73%) have conducted their employees' feedback programme on a semi-annual basis. This agrees with Lansley et al. (1979), who found that a firm that looks after its employees' welfare is likely to exhibit a higher degree of flexibility potential in response to changes within its business environment

Likewise, Table 8.26 shows that ESB1, is the only feature of employees' skills and behaviour, which has significant positive correlations with four out of the five relationship management practices (i.e., RM1 to RM4). These results indicate the importance of these four practices in relation to employees' ability to adopt an open-mindset. The interviews revealed that the employees' ability to adopt an open-mindset to alternatives is increasingly appreciated by many interviewees' firms (approximately 90%). Interviewees shared the view that employees' open-mindset is the key towards continuous improvement, which could affect a firm's business performance in a changing business environment. They added that practices such as conducting induction programmes and weekly meetings among superiors and subordinates are some ways to train employees to have an open-mindset. Interviewees S32 expressed that:

> The only way to indoctrinate people to have an open-mind is to keep reminding them during weekly meetings or brain-storming sessions…This is the key to inducing flexible thinking into my employees. It is important for employees to think flexibly and not to have preconceived solutions to any events. The preconceived solutions could restrict the employees' capabilities to excel in their tasks since they do not think "beyond the box or comfort zone". Therefore, an open-mindset is the first step to realizing employees' potential and a key toward achieving better business performance.

8.5.3 Predictors of technological capabilities (X4)

Among the three organizational learning culture (X1) dimensions shown in Table 8.17, the attribute of shared vision and value ($X1_{SV}$) is the only dimension that has a statistically significant positive influence on a firm's technological capabilities (X4), posing a path coefficient of 0.330 (H_4 - Organizational learning culture (X1) has a significant direct impact on technological capabilities (X4)). This may indicate that firms with higher levels of shared vision and value are likely to possess superior technological capabilities. Many interviewees shared the view that top management commitment to create an environment that promotes shared vision and value is the key towards realizing the desired level of technological capabilities within a firm. This agrees with Carlsson (1989), who emphasized that effective implementation and capitalization of a firm's technological capabilities depends on its top management commitment to make the desired difference. Corresponding to this, Interviewee S1 pointed out that:

> Having up-to-date information and communication technological (ICT) system and a group of employees who possess certain level of ICT knowledge are beneficial to a firm's operation. However, management attitude plays the key towards effective system implementation. In the case where firms' top management is conservative in their information administration approach (for example, middle- and low-level managers are not given the access to necessary information for decision-making), the benefits of ICT system cannot be fully realized.

Table 8.27 shows the correlations between firms' shared vision and value and their technological capabilities. It can be seen that SV1 has significant positive correlations with most features of a firm's technological capabilities (i.e., IT1, IT2, IT3, IT4 and PT2). This is followed by SV2 and SV3, which are positively correlated with IT1 and IT4, respectively. The results indicate that a firm's effort to encourage knowledge-sharing and interactive learning, via brainstorming sessions, is highly related to the firm's technological capabilities. One possible explanation is that a firm, which emphasizes employees' knowledge-sharing for improved expertise and abilities within a multi-project environment (regardless of its geographic dispersion), is likely to establish and manage an integrated information and communication technological platform to facilitate (i) information sharing among employees and (ii) information retrieval from the firm's database. This is consistent with Betts (1991), who stated that an integrated database will improve the flexibility of information retrieval. Many interviewees agreed that it is becoming increasingly important for firms to establish an integrated information and communication technological platform for improved information sharing and retrieval in a changing business environment involving overseas venture. It is found that the majority of interviewees' firms (approximately 61%) have uploaded at least 50% of company information and records into their database, and are gradually moving towards an office automation system.

Table 8.27 Correlations between firms' shared vision and value and their technological capabilities

Item Code	Description	SV1	SV2	SV3	SV4	IT1	IT2	IT3	IT4	PT1	PT2	PT3
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	1.000										
SV2	Our firm provides support to employees to reach organizational goals	.627**	1.000									
SV3	Employees are constantly informed on the firm's business objectives	.415**	.574**	1.000								
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	.394*	.436**	.663**	1.000							
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	**.362***	**.349***	.261	-.010	1.000						
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	**.386***	.277	.207	.115	.799**	1.000					
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	**.372***	.224	.275	.302	.594**	.606**	1.000				
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	**.447***	.247	**.338***	.219	.644**	.693**	.709**	1.000			
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	.234	.132	.273	.137	.558**	.580*	.535**	.654**	1.000		
PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process	**.340***	.212	.259	.075	.536**	.585**	.398*	.534**	.639**	1.000	
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	.282	.271	.224	.082	.647**	.470**	.496**	.498**	.565**	.424**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Further evidence of interviewees' firms' commitment towards creating a shared vision and value environment can be exemplified by the number of technological-related training sessions offered to their employees as shown in Table 8.28. It can be seen that almost half of interviewees' firms have organized at least one training session for their employees on an annual basis. The trainings involve the use of: (i) information and communication technology equipment and applications; (ii) computer-aided operational tools; (iii) procurement systems; and (iv) construction methods and technologies.

Table 8.28 Number of technological-related training sessions provided by interviewees' firms

Description	Number of firms#			
	Training sessions/ year			
	1	2	> 2	Total##
Training to upgrade employees' knowledge and skills in using ICT equipment and applications	19	12	3	34
Training to upgrade employees' knowledge and skills in using computer-aided operational tools (including web-based tool)	23	10	5	38
Training to upgrade employees' knowledge and skills on application of different procurement options	16	10	9	35
Training to upgrade employees' knowledge and skills on application of different construction methods and technologies	15	8	13	36

Total number of firms is 41
Total number of firms for individual technological-related training is less than 41 because some firms did not offer any of the four technological-related training sessions

8.5.4 Predictors of supply chain capabilities (X5)

Table 8.17 shows that employees' skills and behaviour (X3) have a positive impact on firms' supply chain capabilities (X5), posing a path coefficient of 0.339 (H_9 - Employees' skills and behaviour (X3) have a significant direct impact on supply chain capabilities (X5)). This suggests that superior employees' skills and behaviour are likely to enhance firms' supply chain capabilities. Table 8.29 shows the correlations between firms' supply chain capabilities and their employees' skills and behaviour. It can be seen that ESB4 have significant positive correlations with SC2 and SC6. This is followed by ESB2 and ESB6, which are found to have significant positive correlations with SC6 and SC2, respectively. These results indicate that employees' abilities: (i) to learn and adapt to different business conditions; (ii) to work in a team environment; and (iii) to gain customer satisfaction, will collectively contribute to a firm's supply chain capabilities in procuring materials and coordinating delivery requirement to meet clients' need on a global basis. This may be explained in relation to the changing competitive business environment (see Sections 2.4 and 2.5), in which firms may require their employees to learn and adapt to different business conditions, be customer-oriented, continually explore new and better alternatives of materials and establish new supply chain networks for improved organizational abilities in response to changes in clients' requirement.

Table 8.29 Correlations between firms' supply chain capabilities and their employees' skills and behaviour

Item Code	Description	SC2	SC3	SC4	SC5	SC6	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8
SC2	Ability to procure materials on a global basis	1.000										
SC3	Ability to improve the quality of construction services and products	.538**	1.000									
SC4	Ability to attract repeat business from clients	.294	.432**	1.000								
SC5	Ability to improve construction delivery speed	. 518**	.511**	.564**	1.000							
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	.530**	.408**	.381*	.487**	1.000						
ESB1	Ability to adopt an open-mindset to all alternative	.223	-.014	.039	-.072	.028	1.000					
ESB2	Ability to work in a team environment	.284	.112	.116	.121	**.445** **	.643**	1.000				
ESB4	Ability to learn and adapt to different business conditions	**.399** **	.096	.236	.283	**.315** *	.463**	.597**	1.000			
ESB5	Ability to perform a diverse range of tasks and responsibilities	.266	.077	.132	.113	.296	.351*	.575**	.518**	1.000		
ESB6	Ability to gain customer satisfaction	**.462** **	.220	.225	.161	.300	.290	.391*	.413**	.423**	1.000	
ESB8	Ability to work independently	.243	-.043	.051	.184	.167	.477**	.576**	.431**	.326*	.377*	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

Table 8.30 shows the correlations between firms' inter-organizational relationship management practices and their supply chain capabilities. It can be seen that four out of the six practices (i.e., RM8 to RM11) are found to have significant positive correlations with the respective features of a contractor's supply chain capabilities. The significant positive correlations among SC4, SC6 and RM9 may be explained in relation to contractors' efforts to provide training to their supply chain parties, by means of sharing their safety procedures and requirements, in their attempts to gain mutual understanding and provide an overview of their firm's operational requirements. All these may lead to improved project performance, and subsequently, more repeat business from satisfied customers. Besides this, RM10 and RM11 which emphasize improving a contractor's relationship with its supply chain parties (i.e., both clients and subcontractors) via a continuous effort are found to have a significant positive correlation with SC4. All these indicate that RM9, RM10 and RM11 are important practices in relating to a contractor's ability to gain repeat business from clients.

Table 8.30 Correlations between firms' inter-organizational relationship management practices and their supply chain capabilities

Item Code	Description	SC2	SC3	SC4	SC5	SC6	RM6	RM7	RM8	RM9	RM10	RM11
SC2	Ability to procure materials on a global basis	1.000										
SC3	Ability to improve the quality of construction services and products	.538**	1.000									
SC4	Ability to attract repeat business from clients	.294	.432**	1.000								
SC5	Ability to improve construction delivery speed	.518**	.511**	.564**	1.000							
SC6	Ability to coordinate delivery requirement to meet clients need on global basis	.530**	.408**	.381*	. 487**	1.000						
RM6	Providing subcontractors/ suppliers the flexibility to plan their delivery schedule	-.109	-.057	-.012	-.140	-.157	1.000					
RM7	Offering incentive scheme to suppliers and subcontractors	.020	.041	.272	.059	-.039	.302	1.000				
RM8	Providing prompt after-sales services to clients	.289	**.339***	.147	.190	.109	.313*	.458**	1.000			
RM9	Organizing trainings for supply chain parties	.260	.249	**.336***	.042	**.341***	.200	.295	.042	1.000		

Item Code	Description	SC2	SC3	SC4	SC5	SC6	RM6	RM7	RM8	RM9	RM10	RM11
RM10	Keeping constant contact with clients (e.g., end users and consultant) to keep track of their need	.257	.256	**.453****	.144	.257	.146	.480**	.476**	.377*	1.000	
RM11	Organizing informal gathering among supply chain parties	.263	.272	**.471****	.225	.283	.197	.466**	.463**	.446**	.785**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

Also, it can be seen from Table 8.30 that a contractor’s effort to provide prompt after-sales services to clients (RM8) has a statistically significant positive correlation with its ability to improve the quality of construction services and products (SC3). This finding may indicate that contractors emphasize providing responsive services as part of their efforts to improve the quality of construction services and products offered to their clients.

Contractors’ ability in offering responsive services, via their supply chain network, is now examined.

The focus is on the downstream supply chain members, i.e., both subcontractors and suppliers, who may affect contractors’ responsiveness to clients’ requests given the high level of subcontracting in the industry. Figure 8.7 shows the level of subcontracting exercised by interviewees’ firms. It can be seen that the majority (approximately 90%) of interviewees’ firms have subcontracted more than 50% of their work, with only four contractors who subcontracted less than 50% of their work. This is consistent with Dulaimi and Hong’s (2002) findings that the majority of their survey respondents, comprising large and medium-sized Singapore contractors, subcontracted 50% or more of their work. Therefore, it is justifiable to consider that contractors’ ability to provide responsive services is largely influenced by the responsiveness of their subcontractors and suppliers.

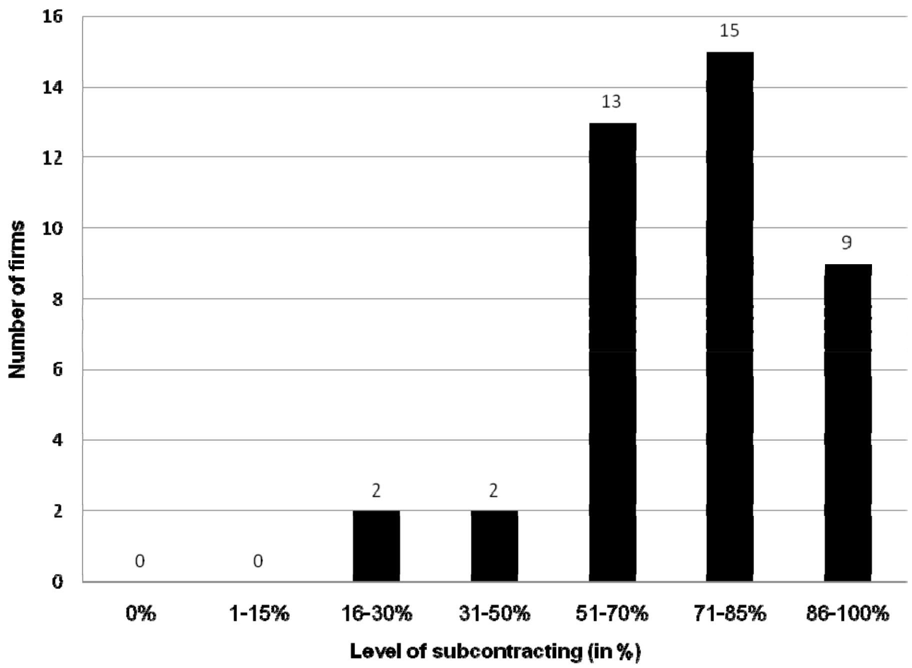


Figure 8.7 Level of subcontracting of interviewees' firms

As can be seen from Table 8.31, at least 75% of the contractors receive responses to their requests for basic information, proposal of minor work, after sales services, routines services and products (i.e., R1 to R4) within five working days from the date of enquiry. For request for services for overseas projects (R5), only a handful of contractors (approximately 10%) receive responses to their requests within five working days given the increased complexity involved. Sixteen contractors highlighted the fact that R5 is not applicable to their firms since they only focus on the Singapore construction market. Overall, the result suggests that the majority of interviewees' firms possess a relatively responsive supply chain infrastructure.

Table 8.31 Responsiveness of subcontractors and suppliers to requests made by interviewees' firms

Item code	Description	Number of firms#							
		Response time (number of working days)							
		1	2-3	4-5	6-7	8-14	15-28	>28	N.A
R1	Request for basic information, e.g., product specification	8	23	3	5	2	-	-	-
R2	Request for proposal for minor work, e.g., variation to existing works	3	17	12	5	3	1	-	-
R3	Request for after sales services, e.g., rectification works	1	17	13	6	4	-	-	-
R4	Request for urgent but routine services and products	13	18	6	4	-	-	-	-
R5	Request for assistance for overseas assignments when their services (i.e., subcontractors and suppliers) are needed	-	1	3	7	4	4	6	16

Total number of firms is 41

8.5.5 Predictors of business strategies (X6)

This section examines the predictors of the four business strategies specified in this study: (i) cost leadership ($X6.1_{CLS}$); (ii) risk leadership ($X6.1_{RLS}$); (iii) customer intimacy ($X6.2_{CIS}$); and (iv) product leadership ($X6.2_{PLS}$).

8.5.5.1 Impact on cost leadership initiative ($X6.1_{CLS}$)

Table 8.17 shows the two predictors of a firm's cost leadership initiative ($X6.1_{CLS}$): (i) supply chain capabilities (X4) and (ii) commitment to learning ($X1_{CL}$). First, a firm's supply chain capabilities (X4) are found to have a positive impact on its cost leadership initiative ($X6.1_{CLS}$) with a path coefficient of 0.447 (H_{16} - Supply chain capabilities (X5) have a significant direct impact on business strategies (X6)). The correlations between firms' supply chain capabilities and their cost leadership initiative are shown in Table 8.32. It can be seen that SC2 and SC3 are important features relating to a firm's cost leadership initiative, having significant positive correlations with B10 and B14. One possible explanation is that a firm's supply chain capabilities in sourcing materials globally and offering superior quality of construction services and products, could improve the firm's abilities to establish an efficient and reliable supply of materials, and eliminate unnecessary rework. As a result, these mitigate the impact of unanticipated events on the firm's operation. This agrees with Treacy and Wiersema (1993) and Morash (2001), who found that a firm's supply chain capabilities are directly related to the firm's abilities to: (i) minimize overhead costs; (ii) eliminate unnecessary work process; and (iii) provide an efficient and reliable supply of products and services.

Table 8.32 Correlations between firms' supply chain capabilities and their cost leadership initiative

Item Code	Description	SC2	SC3	SC4	SC5	SC6	B9	B10	B14	B15
SC2	Ability to procure materials on a global basis	1.000								
SC3	Ability to improve the quality of construction services and products	.538**	1.000							
SC4	Ability to attract repeat business from clients	.294	.432**	1.000						
SC5	Ability to improve construction delivery speed	.518**	.511**	.564**	1.000					
SC6	Ability to coordinate delivery requirement to meet clients need on global basis	.530**	.408**	.381*	. 487**	1.000				
B9	Implementing stricter financial management on company cash flow	-.024	.032	-.113	-.107	.098	1.000			
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	**.463****	**.348***	.095	.197	.264	.350*	1.000		
B14	Implementing stricter site management to reduce material wastage	**.338***	.296	.041	.175	.177	.625**	.507**	1.000	
B15	Implementing stricter procurement management	.276	.178	.040	.176	.161	.411**	.442**	.435**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

Second, firms' commitment to learning ($X1_{CL}$) is found to have a negative impact on firms' cost leadership initiative ($X6.1_{CLS}$), having a path coefficient of -0.269 (H_5 - Organizational learning culture (X1) has a significant direct impact on business strategies (X6)). Although there is no sufficient evidence to establish the correlations between measurement items of the two constructs (see Table 8.33), the negative impact may partly be explained in relation to a firm's business management. It appears reasonable that firms become less tolerant towards employees' mistakes in their endeavours to enforce stricter management on their site, financial and procurement procedures. Many interviewees recognized that it is important to differentiate between negligent and intentional acts, and added that their firms could, to some extent, tolerate minor mistakes of employees but not their intentional performance errors (see Section 8.5.5.2).

Table 8.33 Correlations between firms' commitment to learning and their cost leadership initiative

Item Code	Description	CL1	CL2	CL3	B9	B10	B14	B15
CL1	Employees training and learning are seen as investment rather than expenses	1.000						
CL2	Performance mistakes are seen as opportunities for learning and development	.418**	1.000					
CL3	Our ability to learn is the key toward our firm's success in response to changes within the industry	.564**	.464**	1.000				
B9	Implementing stricter financial management on company cash flow	.055	-.131	-.144	1.000			
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	-.001	-.061	-.166	.350*	1.00		
B14	Implementing stricter site management to reduce material wastage	-.027	-.022	-.306	.625**	.507**	1.000	
B15	Implementing stricter procurement management on company cash flow	.121	.056	-.127	.411**	.442**	.435**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.5.5.2 <u>Impact on risk leadership initiative ($X6.1_{RLS}$)</u>

As shown in Table 8.17, both supply chain capabilities (X5) and organizational structure (X2) have statistically significant positive impacts on a contractor's risk leadership initiative ($X6.1_{RLS}$), posing the path coefficients of 0.431 (H_{16}, see Section 8.5.5.1 for description) and 0.341 (H_6 - Organizational structure (X2) has a significant direct impact on business strategies (X6)), respectively. The findings indicate that supply chain capabilities exert a higher positive impact on a firm's risk leadership initiative than its organizational structure does. One possible explanation is that superior inter-organizational relationship management and supply chain infrastructure (see Section 8.5.4) would facilitate a firm's risk leadership initiatives, as demonstrated by the observed higher impact of supply chain capabilities.

Table 8.34 shows the correlations between firms' supply chain capabilities and their risk leadership initiative. It can be seen that SC4 and SC6 have significant positive correlations with B5. This is followed by SC2 and SC3, which are positively correlated with B8 and B11, respectively. One possible explanation for the correlations among SC4, SC6 and B5 is that a firm's abilities to coordinate delivery requirement to meet clients' need and attract repeat business from the clients enable the firm to be customer-focused, and it thus bids for more projects that are within its capabilities from a targeted group of clients. Many interviewees (approximately 85%) shared the view that it is important for their firms to work with clients with whom they are familiar in order to minimize the possibility of default in payment by clients.

Table 8.34 Correlations between firms' supply chain capabilities and their risk leadership initiative

Item Code	Description	SC2	SC3	SC4	SC5	SC6	B5	B8	B11
SC2	Ability to procure materials on a global basis	1.000							
SC3	Ability to improve the quality of construction services and products	.538**	1.000						
SC4	Ability to attract repeat business from clients	.294	.432**	1.000					
SC5	Ability to improve construction delivery speed	.518**	.511**	.564**	1.000				
SC6	Ability to coordinate delivery requirement to meet clients need on global basis	.530**	.408**	.381*	. 487**	1.000			
B5	Bidding for more projects that are within the firm's capabilities	.280	.227	**.330***	.301	**.375***	1.000		
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	**.442****	.290	.127	.156	.167	.393*	1.000	
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	.307	**.398***	.093	.140	.148	.545**	.526**.	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

The next issue to examine is the positive impact of organizational structure (X2) on a firm's risk leadership initiative ($X6.1_{RLS}$). All interviewees recognized that the decision making procedure within a firm's organizational structure is of paramount importance to its risk management endeavour, and added that it is essential for top management to exert control over firms' bidding decision making to avoid any overstretching of resources and capabilities in the project execution phase. Interviewee S19 added that:

> As a senior management, you need to ensure that your contracting team is aware and bidding within the firm's resources and capabilities…Contracts managers should possess a good feel of prevailing market conditions and be aware of their firms' circumstances. Some companies had actually gone bust partly due to the negligence of their contract managers (for example, under-pricing and unaware of company's financial resources).

Besides the above findings, the correlations between firms' organizational structure and their risk leadership initiative are shown in Table 8.35. It can be seen that OS1 and OS3 have significant positive correlations with B5. One possible explanation is that a firm should adopt a more flexible and transparent working procedure, sharing important information among decision makers, so that the decision-makers have updated information about its workload. This would enable them to plan for successive projects, without overstretching the firm's resources and capabilities.

Table 8.35 Correlations between firms' organizational structure and their risk leadership initiative

Item Code	Description	OS1	OS2	OS3	B5	B8	B11
OS1	Our firms operates in a flexible work procedure	1.000					
OS2	Our firm adopts a more decentralized decision making process	.662**	1.000				
OS3	Our firm has an open communication channel with flexible access to important information for decision making	.636**	.591**	1.000			

Item Code	Description	OS1	OS2	OS3	B5	B8	B11
B5	Bidding for more projects that are within the firm's capabilities	**.459****	.297	**.347***	1.000		
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	.088	.131	.206	.393*	1.000	
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	.144	.192	.256	.545**	.526**.	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed).

8.5.5.3 Impact on customer intimacy initiative ($X6.2_{CIS}$)

As reported in Table 8.17, a firm's employees' skills and behaviour (X3) and technological capabilities (X4) are the two key positive determinants of the firm's customer intimacy initiative ($X6.2_{CIS}$). Of these, firms' technological capabilities have a greater impact on their customer intimacy endeavour, registering a path coefficient of 0.491 (H_{14} - Technological capabilities (X4) have a significant direct impact on business strategies (X6)). Firms with superior technological capabilities are likely to create superior customer value in their customer intimacy endeavour. Table 8.36 shows the correlations between firms' technological capabilities and their customer intimacy initiative. B3 is found to have statistically significant positive correlations with all features of a firm's technological capabilities. This followed by B4, which is positively correlated with IT1, IT2, IT3, PT2 and PT3. Likewise, there are significant correlations among IT1, IT4, PT2, B2 and B13. The results suggest the importance of a firm's technological capabilities in its efforts to develop and manage collaborative relationships with supply chain parties, via efficient information transmission and exchange, for improved business performance. This agrees with Crocitto and Youssef (2003), who pointed out that appropriate application of information and communication technologies can potentially enhance a firm's competitiveness via establishing an effective and responsive network to facilitate information processing and communication among supply chain members. This is especially true in the project-oriented and information intensive environment of the construction industry where highly responsive contacts among their supply chain members is the key towards on-time delivery of products and services (Hinze and Tracey, 1994). In this case, supply chain members refer to clients, consultants, subcontractors and suppliers

Table 8.36 Correlations between firm's technological capabilities and their customer intimacy initiative

Item Code	Description	IT1	IT2	IT3	IT4	PT1	PT2	PT3	B2	B3	B4	B13
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	1.000										
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	.799**	1.000									
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	.594**	.606**	1.000								
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	.644**	.693**	.709**	1.000							
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	.558**	.580*	.535**	.654**	1.000						
PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process	.536**	.585**	.398*	.534**	.639**	1.000					
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	.647**	.470**	.496**	.498**	.565**	.424**	1.000				
B2	Forming joint-venture with other contractors to serve a group of targeted clients	.176	.270	.267	**.321***	.291	**.321***	.206	1.000			
B3	Forming partnership with clients	**.603****	**.441****	**.386***	**.378***	**.364***	**.408****	**.429****	.524**	1.000		
B4	Diversifying into different construction business	**.334***	**.457****	**.481****	.279	.306	**.317***	**.366***	.381*	.435**	1.000	
B13	Following clients abroad	**.366***	.281	.276	.174	.154	**.319***	.278	.350*	.544**	.459**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

The next issue to examine is the positive impact of a firm's employees' skills and behaviour (X3) on the firm's customer intimacy initiative ($X6.2_{CIS}$), posing a path coefficient of 0.340 (see Table 8.17; H_{10} - Employees' skills and behaviour (X3) have a significant direct impact on business strategies (X6)). This finding is consistent with Treacy and Wiersema (1993), who found that employees are the most important determinant in gaining clients' loyalty, and thus shaping the firm's customer intimacy endeavour. They also found that multi-skilled employees with abilities to behave adaptively and collaboratively are central to a firm's attempt to build and gain customers' loyalty. In this study, the correlations between firms' employees' skills and behaviour and their customer intimacy initiative are shown in Table 8.37.

Table 8.37 Correlations between firms' employees' skills and behaviour and their customer intimacy initiative

Item Code	Description	ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	B2	B3	B4	B13
ESB1	Ability to adopt an open-mindset to all alternative	1.000									
ESB2	Ability to work in a team environment	.643**	1.000								
ESB4	Ability to learn and adapt to different business conditions	.463**	.597**	1.000							
ESB5	Ability to perform a diverse range of tasks and responsibilities	.351*	.575**	.518**	1.000						
ESB6	Ability to gain customer satisfaction	.290	.391*	.413**	.423**	1.000					
ESB8	Ability to work independently	.477**	.576**	.431**	.326*	.377*	1.000				
B2	Forming joint-venture with other contractors to serve a group of targeted clients	.130	.265	.202	.073	.141	.075	1.000			
B3	Forming partnership with clients	.277	.305	**.407****	.221	**.435****	.241	.524**	1.000		
B4	Diversifying into different construction businesses	.307	**.309***	**.372***	.140	.203	-.011	.381*	.435**	1.000	
B13	Following clients abroad	.251	**.389***	.247	.104	.253	-.059	.350*	.544**	.459**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Table 8.37 shows that B3 has significant positive correlations with ESB4 and ESB6, and B4 has significant positive correlations with ESB2 and ESB4. This is followed by B13, which is positively correlated with ESB2. These results indicate the importance of employees' abilities to gain customer satisfaction and work in a team environment, whereby they learn and adapt to different business environments, enabling firms to diversify into different construction businesses and form partnerships with their clients, by means of following them abroad for business venture.

8.5.5.4 Impact on product leadership initiative ($X6.2_{PIS}$)

A firm's open-mindedness ($X1_{O}$) is found to positively influence its product leadership initiative ($X6.2_{PLS}$), posing a path coefficient of 0.384 (see Table 8.17 and section 8.5.5.1 for description of H_5). This suggests that a contractor with a positive attitude of open-mindedness is likely to possess a stronger capacity in pursuing its product leadership strategy. In this study, the correlations between contractors' open-mindedness and their product leadership initiative are shown in Table 8.38. It can be seen that B12 has significant positive correlations with O1 and O3, indicating that a construction firm that places greater emphasis on participative decision making and interactive adaptation is more likely to invest in R&D activities to further explore business opportunities. This agrees with Treacy and Wiersema (1993), who highlighted the importance of top management commitment to create and maintain an environment that encourages employees' contribution of ideas, and more importantly, top management needs to listen and consider these ideas in their strategic and interactive planning.

Table 8.38 Correlations between firms' open-mindedness and their product leadership initiative

Item Code	Description	O1	O2	O3	B7	B12	B16
O1	Our firm encourages participative decision making among employees	1.000					
O2	Our firm promotes open communication among subordinates and superiors	.615**	1.000				
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	.656**	.607**	1.000			

Item Code	Description	O1	O2	O3	B7	B12	B16
B7	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	.082	.106	.193	1.000		
B12	Investing into R & D to further explore business opportunities	**.311***	.267	**.463****	.395*	1.000	
B16	Investing surplus funds into financial investments and property development	.297	.233	.218	.411**	.604**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

The second predictor of product leadership initiative ($X6.2_{PLS}$) is a firm's commitment to learning ($X1_{CL}$), with a negative path coefficient -0.378 (H_5; see Table 8.17). Although there is insufficient evidence to establish the correlations between measurement items of the two constructs as shown in Table 8.39, the significant negative impact may be explained by the conservativeness of the majority of interviewees' firms (see Section 8.3.3.2). They are often risk adverse and would rather adopt a 'wait-to-see' than a 'trial-and-error' approach. All these may impede their commitment to learn and prevent them from becoming a product leader.

Table 8.39 Correlations between firms' commitment to learning and their product leadership initiative

Item Code	Description	CL1	CL2	CL3	B7	B12	B16
CL1	Employees training and learning are seen as investment rather than expenses	1.000					
CL2	Performance mistakes are seen as opportunities for learning and development	.418**	1.000				
CL3	Our ability to learn is the key toward our firm's success in response to changes within the industry	.564**	.464**	1.000			
B7	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	-.247	-.276	-.063	1.000		
B12	Investing into R & D to further explore business opportunities	-.089	-.059	-.067	.395*	1.000	
B16	Investing surplus funds into financial investments and property development	-.189	.114	-.132	.411**	.604**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

8.5.6 Predictors of organizational flexibility (Y)

The predictors of the three dimensions of organizational flexibility are now discussed.

8.5.6.1 Impact on operational flexibility (Y_{OF})

The results reported in Table 8.17 show that a firm's operational flexibility (Y_{OF}) is significantly influenced by three determinants: (i) employees' skills and behaviour (X3; β = 0.419); (ii) supply chain capabilities (X5; β = 0.358); and (iii) product leadership initiative ($X6.2_{PLS}$; β = -0.229). The three hypotheses tested are: H_{11} - Employees' skills and behaviour (X3) have a significant direct impact on organizational flexibility (Y); H_{17} - Supply chain capabilities (X5) have a significant direct impact on organizational flexibility (Y); and H_{18} - Business strategies (X6) have a significant direct impact on organizational flexibility (Y). In terms of positive path coefficients (i.e., influence), it appears that employees' skills and behaviour pose a larger impact on a firm's operational flexibility compared to that of its supply chain capabilities. This phenomenon can be partially explained by the triangular relationship among these three constructs. Within these relationships, a firm's employees' skills and behaviour are the primary enablers, both directly and indirectly, of its operational flexibility (see Figure 8.6). For an indirect influence, it follows that a firm's employees' skills and behaviour have positive impact on its supply chain capabilities (see Section 8.5.4) in which the latter shapes the firm's operational flexibility (i.e., employees' skills and behaviour$\rightarrow$ supply chain capabilities$\rightarrow$ operational flexibility). Although Figure 8.3 shows that a firm's supply chain capabilities could directly influence the firm's operational flexibility without the interference of its employees' skills and behaviour (see Section 8.3.1.3), it is rational to maintain the identified triangular relationship because employees' skills and behaviour are the mediators between a firm's capabilities and its performance (following Wright et al., 1994). Most interviewees shared the view that employees are one of the greatest assets in their organizations, and added that their employees are the main linkage between the firms and supply chain parties (for example, clients, consultants and subcontractors) that helps the firms to sustain continuity in business.

The next issue to consider is the influence of a firm's product leadership initiative on its operational flexibility. The negative path coefficient of -0.229 suggests that firms with a strong focus on product leadership are likely to have a low operational flexibility potential. One possible explanation is that firms (or product leaders) with wide business portfolios are likely to incur a major investment (i.e., sunk cost) in their product development, and thus become less operationally flexible in the face of any environmental turbulence.

8.5.6.2 Impact on tactical flexibility (Y_{TF})

Table 8.17 shows that a firm's supply chain capabilities (X5) are the sole positive determinant of the firm's tactical flexibility (Y_{TF}), posing a path coefficient of 0.415 (see Section 8.5.6.1 for description of H_{17}). This agrees with Debrah and Ofori (1997), who found that Singapore contractors are heavily dependent on labour subcontracting as a means of achieving flexibility in response to the instability, uncertainly and discontinuity inherent in the construction industry and their work environment. In this study, it is found that Singapore contractors' ability to expand or contract their business capacity efficiently is, to some extent, influenced by their supply chain capabilities (see Section 8.3.3.1).

8.5.6.3 Impact on strategic flexibility (Y_{SF})

As can be seen from Table 8.17, three out of the four dimensions of business strategies are found to have positive influences on a firm's strategic flexibility (Y_{SF}) (see Section 8.5.6.1 for description of H_{18}). In the order of importance, the three dimensions are: (i) customer intimacy initiative ($X6.2_{CIS}$) (β = 0.384); (ii) cost leadership initiative ($X6.1_{CLS}$) (β = 0.339); and (iii) risk leadership initiative ($X6.1_{RLS}$) (β = 0.324). These findings are similar to those found in PLS M1; apart from having different degrees of influence (i.e., path coefficients) on a firm's strategic flexibility (see Sections 8.3.4.1, 8.3.4.3 and 8.3.4.4). Therefore, this section focuses on the qualitative data obtained from the interview findings, identifying the practices adopted by interviewees' firms in response to the unprecedented 1997 – 2005 economic downturn following the Asian financial crisis in 1997. This seeks to provide a deeper insight on how interviewees' firms operated flexibly during the downturn.

One-third of the interviewees pointed out that their firms survived the economic downturn by forming partnerships with clients and following them abroad in order to obtain sufficient turnover. Besides this, some interviewees (approximately 12%) shared the view that their firms had initiated some residential building projects, which were subsequently undertaken via joint-ventures with previous clients, in order to keep their resources occupied and sustain business operations. This agrees with Betts and Ofori (1994) and Raftery et al. (1998), who found that contractors have the capacity to evoke dormant demand by acting as project initiators. All these may attest to the importance of a firm's customer intimacy initiative ($X6.2_{CIS}$) for its strategic business operation, and thus indicating that construction firms should proactively and continuously engage themselves in relationship building and management with their clients regardless of whether times are good or bad.

Turning to a firm's cost leadership initiative ($X6.1_{CLS}$), all interviewees shared the view that it is important to embrace a more active and stringent role in their site management for better responsiveness to changes within the business environment especially during the 1997-2005 economic downturn. Some practices adopted by interviewees' firms to curb site material wastage are: (i) adopting the just-in-time delivery concept; (ii) delegating responsibility for material inventory management to respective site managers; (iii) imposing wastage rates for construction materials on site; (iv) implementing profit-sharing schemes by rewarding employees for the amount of materials they saved; and (v) implementing materials recycling programmes. These identified waste management practices are similar to those highlighted by Ekanayake and Ofori (2004) and Tam and Tam (2006).

Besides placing greater emphasis on site management, interviewees recognized that a proper cash flow management is another key to their continued existence. It is found that various financial management practices adopted by interviewees' firms include: (i) establishing a project milestones monitoring system – comparing project cash flow with estimated project budget based on pre-determined progressive points or milestones; (ii) requiring project directors/managers to submit monthly progress reports; (iii) implementing Days Sales Outstanding matrix systems to measure the efficiency of a firm in converting receivables to cash; and (iv) implementing Unbilled Receivable (UBR) systems to monitor unbilled project receivables against project procurement expenses; where a high index of UBR reflects a large amount of unclaimed payment. Some interviewees (approximately 25%) shared the view that their firms have engaged or created an additional role of a 'company project cost auditor or officer' in monitoring their company's cash flow.

Also, the interviews revealed that firms adopted several practices to tighten their procurement procedures as part of their cost leadership endeavour. The practices identified are: (i) implementing stricter purchase orders systems – purchase orders are to be endorsed by at least three parties (a site quantity surveyor, a project manager/director, a director from head office); (ii) requiring project managers/directors to review and reconfirm the approximate quantity of materials and amount of work required in respective projects; and (iii) procuring the required materials and services in bulk volume to realize the value of economies of scale. Some interviewees (approximately 36%) explained that, through implementing stricter procurement procedures, their firms could minimize fraudulent and negligent acts of their employees (for example, collusion among employees, subcontractors and suppliers, and negligence of employees in project cost estimating).

Many interviewees (approximately 93%) shared the view that a firm's cost leadership initiative should complement its risk leadership endeavour, and added that it is not realistic to undertake projects that are too large for the firm's size, beyond its experience range and contracts that are likely to stretch its available resources and capabilities. Also, interviewees pointed out that it is important for contractors to set size limitations on projects undertaken such that the failure of one project would not endanger their operations. In relation to this, Interviewee S30 stated that:

> We set size limitation on projects undertaken using the ratio of 1:3. Our target is to have either one big project of contract values S$60 – S$100 million or three small projects of individual contract value not more than S$30 million at any point of time. However, we prefer to bid for smaller contracts and fast tracked projects because these projects are usually less resource intensive and subjected to less fluctuation in material prices, and thus unlikely to jeopardize our operational cash flow.

In this study, it is found that more than two-thirds of the interviewees' firms have concentrated on short-term and fast-tracked projects as well as smaller contracts especially during the long 1997 – 2005 economic downturn. This suggests that this group of contractors are risk conscious in their bidding attempts. This is consistent with Sharnkari (2008), who found that a Singapore Exchange listed main contractor preferred to have a smaller order book with opportunities for better profit margins than a large order book comprising many contracts with locked-in costs, which would squeeze margins if costs rose while building was in progress. Also, it is found that many interviewees' firms have entered into forward contracts with their suppliers and subcontractors (for example, concrete and reinforcement bars suppliers) in their efforts to hedge against escalation in material prices, and have set aside contingency funds from their companies' reserves as part of their risk leadership initiative. Interviewees revealed that their firms have reserved at least three to six months of fixed operational costs (for example, employees' salaries and office expenses) to mitigate the impact of the downturn on the business operation following the periods 1997 to 2005.

8.6 Moderating effects of environmental conditions (Z)

Three sets of moderated structural models were developed to examine the moderating effects of environmental conditions on the relationship between the key determinants and organizational flexibility. Individual moderated structural models were built in relation to the results obtained in Table 8.17. This means that only statistically significant predictor constructs of the corresponding predicted constructs were included in the moderated structural models. The three predicted constructs concerned are: (i) operational flexibility, (ii) tactical flexibility and (iii) strategic flexibility.

Following the two-stage PLS moderating approach described in Section 6.8.3, main-effect and moderated models were developed in the corresponding stages 1 and 2 of the moderating procedure. Subsequently, these two models were compared to determine the overall size (f^2) of interaction effect using Eq. 6-7 (see Section 6.5.3).

The bootstrapping re-sampling method was used to compute the standard errors for significance testing of path coefficients in the developed moderated structural models.

8.6.1 Moderating effects of environmental conditions on the relationship between significant determinants and firms' operational flexibility

Three predictor constructs (i.e., employees' skills and behaviour, supply chain capabilities and product leadership initiative) were included in the moderated structural model in testing the effect of environmental conditions (i.e., market and technological conditions) on the relationships between the predictor constructs and firms' operational flexibility as shown in Figure 8.8. Stage 1 (grey dashed line) represents the main-effect model that involves the predictor, moderator and predicted constructs, while stage 2 (black dotted line) represents the moderated model that comprises the predictor, product (i.e., interaction between predictor and moderator) and predicted constructs.

Table 8.40 shows the PLS path analysis for the developed moderated structural model for stages 1 and 2. In stage 1, the majority of the constructs have significant influnces (p < 0.01) on firms' operational flexibility, namely (i) supply chain capabilities (X5); (ii) employees' skills and behaviour (X3); (iii) product leadership initiative ($X6.2_{PLS}$); and (iv) market conditions (Z_{MC}). Their corresponding path coefficients are 0.39, 0.37, -0.23 and -0.28. In this case, technological conditions (i.e., Z_{TCn}) are found to have an insignificant impact on firms' operational flexibility. The predictor constructs, (i) to (iii), have the expected signs similar to that of PLS M2 (see Section 8.5.6.1), while the moderator construct (i.e., Z_{MC}) is found to have negative influence on a firm's operational flexibility. This means that a high degree of market volatility is likely to hamper the firm's operational flexibility. The correlations between a firm's operational flexibility and its market conditions are shown in Table 8.41

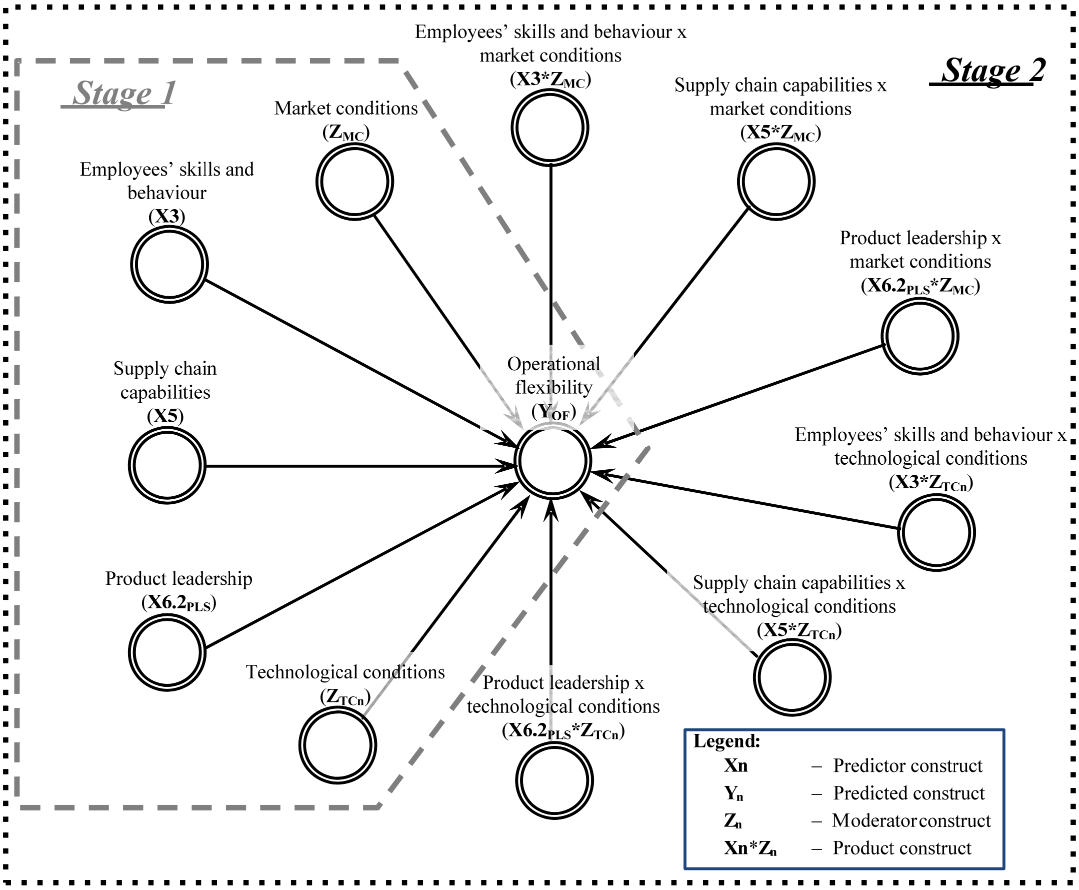


Figure 8.8 Moderating effects of environmental conditions on operational flexibility

Table 8.40 Path analysis on moderating effects of environmental conditions on operational flexibility

	Operational flexibility			
	Stage 1 (Main-effect model)		Stage 2 (Moderated model)	
Independent variables	**β-value**	**t-value**	**β-value**	**t-value**
Employees' skills and behaviour	0.37	4.24**	0.22	1.78*
Supply chain capabilities	0.39	4.60**	0.26	1.86*
Product leadership initiative	-0.23	2.24*	-0.16	1.69*
Market conditions	-0.28	2.84**	-0.18	1.55
Technological conditions	0.01	0.24	-0.01	0.01
Employees' skills and behaviour x market conditions			0.01	0.01
Employees' skills and behaviour x technological conditions			0.08	1.28
Supply chain capabilities x market conditions			0.10	1.04
Supply chain capabilities x technological conditions			0.01	1.16
Product leadership x market conditions			-0.15	1.59
Product leadership x technological conditions			0.07	1.21
R^2	0.665		0.825	
f^2			0.914	

Note: ** denotes significant at p <0.01 level; * denotes significant at p <0.05 level (one tailed)

Table 8.41 Correlations between firms' operational flexibility and market conditions

Item Code	Description	MC1	MC4	MC5	MC6	F1	F2	F10	F11	F14
MC1	Fluctuation of demand for constructed facilities	1.000								
MC4	Price competition in the construction market	.489**	1.000							
MC5	Intense competition in the construction market	.403**	.697**	1.000						
MC6	Fluctuation of supply of construction resources	.388*	.468**	.342*	1.000					
F1	Ability to modify your firm's operational structure	-.078	-.279	-.246	**-.466****	1.000				
F2	Ability to integrate, construct and reshape your firm's financial resources	-.244	-.161	-.284	**-.400****	.519**	1.000			
F10	Ability to construct facilities using different construction methods and materials	.170	-.011	-.121	-.180	.501**	.346*	1.000		
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	-.198	-.212	**-.364***	-.221	.516**	.410**	.621**	1.000	
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	-.198	-.133	**-.316***	**-.313***	.517**	.561**	.427**	.511**	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

As can be seen from Table 8.41, MC6 has significant negative correlations with F1, F2, F11 and F14. This is followed by MC6, which is negatively correlated with F11 and F14. These findings suggest that in a volatile market, characterized by unstable supply of resources and intense competition, contractors' abilities, in terms of: (i) modifying their organizational structure; (ii) integrating and reshaping their financial resources; (iii) making decisions on non-routine and significant events that cannot be anticipated in advance; and (iv) integrating their internal functions with external firms, will be affected to a great extent. More often than not, contractors are posed with the following questions in a volatile market (following Wernerfelt and Karnani, 1987):

- When is the most appropriate time to respond - shall they act now or wait until the uncertainty has been fully or partially resolved?
- What is the best solution at the most appropriate moment – to focus firms' resources on several scenarios or just one scenario?

In search for solutions to the above questions, it is not uncommon to note that contractors would adopt a 'wait-to-see' approach. In fact, under such scenarios, contractors would need to rely heavily on their employees' skills and behaviour and supply chain capabilities in sustaining their firms' operational flexibility. The desired attributes include employees' adaptiveness and receptiveness in seeking for better alternatives, and superior supply chain capabilities in procuring materials globally and improving the quality of construction services and products.

Next, in the 2nd stage of the moderating procedure when the product constructs were added to the predictor and moderator constructs, a R^2 value of 0.825 is obtained for the moderated model. Using the R^2 values obtained in both stage 1 and 2, it is found that the overall size (f^2) for the interaction effect is 0.914, indicating a large moderating effect. However, it is noted that all product constructs, $Xn*Z_n$, are not statistically significant with their path coefficients ranging from -0.15 to 0.10. This means that moderating effects of market and technological conditions were found not to be statistically significant on the relationships between determinants and operational flexibility.

8.6.2 Moderating effects of environmental conditions on the relationship between supply chain capabilities and firms' tactical flexibility

Turning to tactical flexibility, Figure 8.9 shows the moderated structural models constructed to test the moderating effect of environmental conditions on the relationship between firms' supply chain capabilities (X5) and their tactical flexibility (Y_{TF}). Results of the corresponding PLS path analysis of the main-effect and moderated models are reported in Table 8.42. It can be seen that 'supply chain capabilities' is the only construct with a statistically significant positive influence on firms' tactical flexibility in both the main-effect and moderated models. Also, the moderator constructs (i.e., Z_{MC} and Z_{TCn}) are found to have an insignificant impact on firms' tactical flexibility. Further evidence of the insignificance of the interaction effect can be obtained by considering the relatively small overall size for the interaction effect (f^2 = 0.10). This suggests that firms' tactical flexibility is less likely to be influenced by environmental conditions. From another perspective, this may indicate that firms that possess strong supply chain capabilities are able to remain tactically flexible without being significantly influenced by changes in environmental conditions.

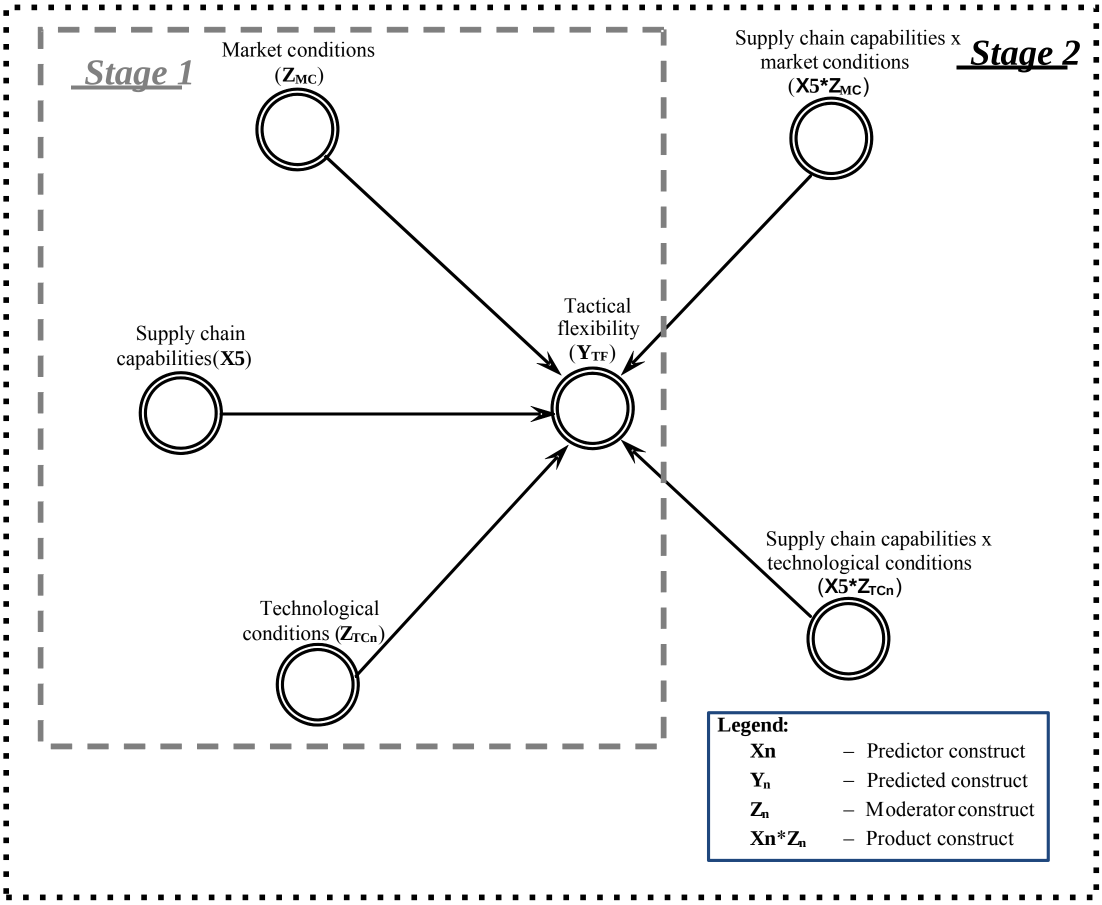


Figure 8.9 Moderating effects of environmental conditions on tactical flexibility

Table 8.42 Path analysis on the moderating effects of environmental conditions on tactical flexibility

	Tactical flexibility			
	Stage 1 (Main-effect model)		Stage 2 (Moderated model)	
Independent variables	**β-value**	***t*-value**	**β-value**	***t*-value**
Supply chain capabilities	0.47	3.17**	0.34	2.42*
Market conditions	0.01	0.11	0.01	0.12
Technological conditions	-0.15	0.71	-0.04	0.38
Supply chain capabilities x market conditions			0.03	0.60
Supply chain capabilities x technological conditions			0.14	0.84
R^2	0.260		0.326	
f^2			0.10	

Note: ** denotes significant at p <0.01 level; * denotes significant at p <0.05 level (one tailed)

8.6.3 Moderating effects of environmental conditions on the relationship between business strategies and firms' strategic flexibility

Figure 8.10 shows the moderated structural models constructed to test the moderating effect of environmental conditions on the relationship between firms' business strategies (X6) and strategic flexibility (Y_{SF}). Results of the path analysis in Table 8.43 show that the three dimensions of firms' business strategies pose significant positive impacts on firms' strategic flexibility, similar to that of PLS M2. It is however noted that the order of importance of these predictor constructs is different from that of PLS M2. In this case, firms' cost leadership initiative ($X6.1_{CLS}$) has the largest impact on their strategic flexibility, and is followed by customer intimacy ($X6.2_{CIS}$) and risk leadership ($X6.1_{RLS}$) initiatives. One possible explanation is that the inclusion of the moderator constructs has caused the changes to the order of importance among the predictor constructs.

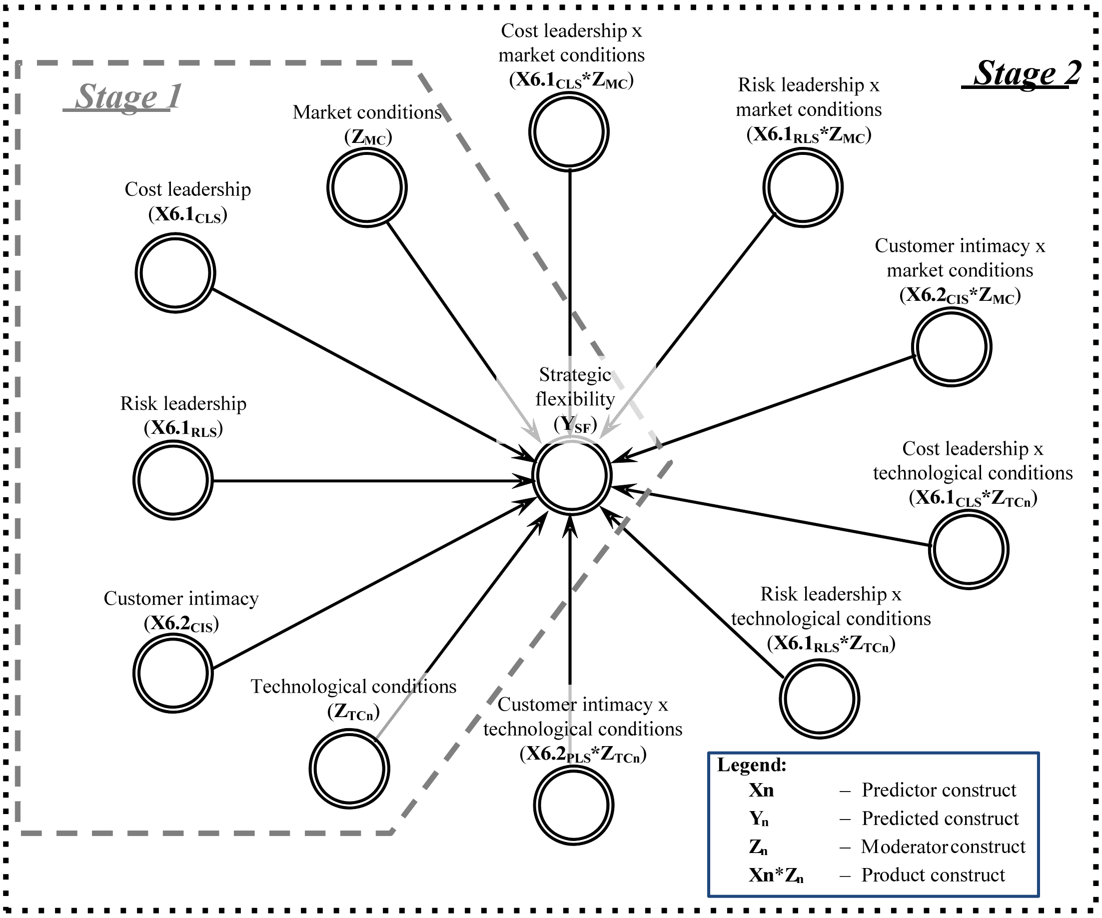


Figure 8.10 Moderating effects of environmental conditions on strategic flexibility

Table 8.43 Path analysis on moderating effects of environmental conditions on strategic flexibility

	Strategic flexibility			
	Stage 1 (Main-effect model)		**Stage 2 (Moderator model)**	
Independent variables	**β-value**	***t*-value**	**β-value**	***t*-value**
Cost leadership initiative	0.39	2.41*	0.30	1.98*
Risk leadership initiative	0.30	2.25*	0.20	1.12
Customer intimacy initiative	0.38	3.80**	0.32	2.52*
Market conditions	0.05	0.71	0.15	0.91
Technological conditions	-0.24	1.91*	-0.20	1.39
Cost leadership initiative x market conditions			-0.14	0.47
Cost leadership initiative x technological conditions			-0.08	0.35
Risk leadership initiative x market conditions			0.03	0.01
Risk leadership initiative x technological conditions			-0.04	0.09
Customer intimacy initiative x market conditions			-0.06	0.03
Customer intimacy initiative x technological conditions			-0.16	1.03
R^2	0.560		0.638	
f^2			0.22	

Note: ** denotes significant at p <0.01 level; * denotes significant at p <0.05 level (one tailed)

In the main-effect model with a R^2 value of 0.560, technological conditions is the only moderator construct that has a significant negative influence (β = -0.24) on firms' strategic flexibility. This means that a high degree of technological volatility is likely to restrict a firm's ability to be strategically flexible. It is possible that interviewees' firms possess a relatively high strategic flexibility potential, considering the comparatively low and steady rate of technological changes within the Singapore construction industry. This is consistent with Lim et al. (2006), who found that the Singapore construction industry has been relatively slow in technological progress. This phenomenon may also help to explain why firms' operational and tactical flexibility potentials are not significantly affected by the technological conditions within the industry.

However, the interviews also revealed that some contractors are becoming concerned about the increasing pace of technological progress in the construction industry. Interviewee S12 expressed the view that:

> Our company was awarded an eco-precinct project under a Design-and-Build contract. However, we were asked to resubmit our tender in the later contractual phase on the ground that our design was not sufficiently "green". Eventually we needed to incorporate "greener" technologies and re-design the entire layout and surroundings.

The above findings may indicate the growing need for contractors to closely monitor and follow the trends of technological change within the Singapore construction industry. It appears that contactors' failure to follow current trends may have a detrimental effect on their strategic flexibility potential since technological conditions are found to negate firms' strategic flexibility in this study. As can be seen from Table 8.44, TCn2 and TCn3 have significant negative correlations with F12. This may indicate that the rapid emergence of new construction process technologies and increasing demand for facilities fitted with advanced technology could weaken contractors' ability to exploit a range of procurement options effectively. This is especially true in the business environment where clients are seeking for more integrated value-added services (see Sections 2.4.3, 2.4.4 and 2.5), and highly customized and complicated high-tech built facilities (see Section 2.4.5 and 2.5).

Table 8.44 Correlations between a firm's strategic flexibility and technological conditions

Item Code	Description	TCn1	TCn2	TCn3	F8	F12	F13	F15
TCn1	Rapid emergence of new information technology on business operations	1.000						
TCn2	Rapid emergence of new construction process technology on business operations	.693**	1.000					
TCn3	Demand for advanced technological constructed facilities (e.g., intelligent building)	.669**	.696**	1.000				
F8	Ability to operate effectively and profitably in different market conditions	-.108	-.134	-.025	1.000			
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)	-.219	**-.424****	**-.425****	.370*	1.000		
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	-.097	-.077	.036	.293	.522**	1.000	
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	.015	-.093	-.044	.337*	.450**	.249	1.000

Note: ** denotes correlation is significant at the 0.01 level (2-tailed); * denotes correlation is significant at the 0.05 level (2-tailed)

Turning to the moderated model with R^2 value of 0.638, it is found that the f^2 value for the overall size of the interaction effect is 0.22, indicating a fair interaction effect. Despite this indication, it can be seen that none of the six product constructs (for example, $X6.1_{CLS}*Z_{MC}$ and $X6.2_{CIS}*Z_{TCn}$) is found to have a statistically significant influence on firms' strategic flexibility. This indicates that environmental conditions do not have moderating effects on the relationship between firms' customer intimacy, cost and risk leadership initiatives, and their strategic flexibility.

8.7 Summary

This chapter completes the reporting and discussion of the results based on two structural models (i.e., PLS M1 and PLS M2) that specified the relationships among construction firms' resources, capabilities, strategies (i.e., determinants) and their flexibility potentials. The results of PLS M1 show that all determinants, except technological capabilities (X4), have statistically significant influences on different dimensions of organizational flexibility. It is found that a firm's operational flexibility (Y_{OF}) is positively influenced by: (i) employees' skills and behaviour (X3); (ii) open-mindedness ($X1_{O}$); (iii) supply chain capabilities (X5); and (iv) cost leadership initiative ($X6.1_{CLS}$). However, organizational structure (X2) and shared vision and value ($X1_{SV}$) are found to have significant negative influences on firms' operational flexibility (Y_{OF}). As for tactical flexibility (Y_{TF}), supply chain capabilities (X5) and product leadership ($X6.2_{PLS}$) are the only two predictor constructs found to have significant impacts. Turning to firms' strategic flexibility (Y_{SF}), four positive significant predictor constructs are detected: (i) customer intimacy initiative ($X6.2_{CIS}$); (ii) shared vision and value ($X1_{SV}$); (iii) cost leadership initiative ($X6.1_{CLS}$); and (iv) risk leadership initiative ($X6.1_{RLS}$). All these help to address the second research objective.

Seventeen hypotheses are tested based on the inter-relationships developed within PLS M2. Of these, 13 are partially supported (i.e., H_2, H_3, H_4, H_5, H_6, H_9, H_{10}, H_{11}, H_{12}, H_{14}, H_{16}, H_{17} and H_{18}). H_7, H_8, H_{13} and H_{15} are not supported. The results show that the attribute of open-mindedness ($X1_{O}$) and technological capabilities (X4) are the only two predictor constructs found with significant impacts on organizational structure (X2). This is followed by organizational structure (X2), having a statistically significant influence on firms' risk leadership ($X6.1_{RLS}$) (i.e., $X1_{O} \rightarrow X2 \rightarrow X6.1_{RLS}$).

Also, the findings indicate that a firm's technological capabilities (X4) is significantly influenced by its shared vision and value ($X1_{SV}$) before the former shapes the firm's organizational structure (X2) (i.e., $X1_{SV} \rightarrow X4 \rightarrow X2$) and customer intimacy initiative ($X6.2_{CIS}$) (i.e., $X1_{SV} \rightarrow X4 \rightarrow X6.2_{CIS}$). Thereafter, the firm's customer intimacy initiative ($X6.2_{CIS}$), cost leadership ($X6.1_{CLS}$) and risk leadership ($X6.1_{RLS}$) are found to collectively influence its strategic flexibility (Y_{SF}).

Turning to tactical flexibility (Y_{TF}), supply chain capabilities (X5) is the only predictor construct that impacts it significantly. The results indicate that a firm's commitment to learning (X_{CL}) significantly influences its employees' skills and behaviour (X3), in which the latter in turn shapes the firm's supply chain capabilities (X5) (i.e., $X_{CL} \rightarrow X3 \rightarrow X5$). Subsequently, the firm's employees' skills and behaviour (X3), supply chain capabilities (X5) and product leadership initiative ($X6.2_{PLS}$) collectively shape its operational flexibility (Y_{OF}).

In general, the results, based on PLS M2, indicate that employees' skills and behaviour (X3), supply chain capabilities (X5) and business strategies (X6) are found to pose the greatest positive impacts on firms' operational flexibility, tactical flexibility and strategic flexibility, respectively. Also, the results indicate that supply chain capabilities (X5) is the only determinant that has an effect on two dimensions of organizational flexibility, i.e., operational and tactical flexibilities. All these help to address the third research objective.

To address the fourth research objective, the moderating effects of environmental conditions (i.e., market and technological conditions) on the relationships between the key determinants and organizational flexibility were examined. Based on the empirical results obtained, no moderating effects of market and technological conditions were found statistically significant on the relationships between organizational flexibility and its key determinants. However, it was found that market and technological conditions have statistically a significant negative direct impact on firms' operational and strategic flexibility potentials, respectively. The next chapter presents the application and validation of results.

CHAPTER 9

VALIDATION OF RESULTS AND PRACTICAL APPLICATION

9.1 Introduction

The focus of this chapter is on the validation of the results, derived from the two structural models, and their practical application. First, it discusses the design (Section 9.2) and testing (Section 9.3) of flexibility indices, followed by presenting the interview findings concerning the practicality and comprehensiveness of the results derived from PLS M1 and M2 (Section 9.4). Finally, it describes the practical application of the results (Section 9.5). These help to address the fifth research objective of this study.

9.2 Designing flexibility indices

Objective 5 of this study is to design and test flexibility indices that measure a construction firm's flexibility potential. Flexibility indices are calculated using the three equations derived from the resultant PLS M2. Three equations are provided to predict: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility. These are elaborated below.

9.2.1 Operational flexibility (Y_{OF})

As reported in Section 8.5.6.1, the three statistically significant predictor constructs of operational flexibility (Y_{OF}) are: (i) employees' skills and behaviour (X3); (ii) supply chain capabilities (X5); and (iii) product leadership initiative ($X6.2_{PLS}$). By substituting the respective path coefficients (i.e., parameter estimates) for the predictor constructs, a mathematical model for predicting a firm's operational flexibility potential is formulated as follows:

$$Y_{OF} = 0.419\ (X3) + 0.358\ (X5) - 0.229\ (X6.2_{PLS}) \qquad \text{Eq. 9-1}$$

where: Y_{OF} = predicted operational flexibility index of individual interviewees' firms;

X3 = the 'employees' skills and behaviour' construct score of individual interviewees' firms;

X5 = the 'supply chain capabilities' construct score of individual interviewees' firms; and

$X6.2_{PLS}$ = the 'product leadership initiative' construct score of individual interviewees' firms.

Considering the mathematical model (Eq. 9-1) and constructs' scores, it appears that the higher the constructs' scores for both 'employee skills and behaviour (X3)' and 'supply chain capabilities (X5)', the greater will be contractors' operational flexibility potential (Y_{OF}). On the other hand, contractors' aggressive endeavours in their product leadership initiative, exemplified by the high construct's score, are likely to reduce their operational flexibility potential. This leads to the negative parameter estimate (i.e., –0.229) of the product leadership initiative construct. Corresponding to this, a lower product leadership initiative score will contribute to higher firms' operational flexibility.

9.2.2 Tactical flexibility (Y_{TF})

As established in Section 8.5.6.2, supply chain capability (X5) is the sole statistically significant predictor of tactical flexibility (Y_{TF}). It follows that the mathematical model developed for predicting tactical flexibility is given as:

$$Y_{TF} = 0.415\ (X5) \qquad \text{Eq. 9-2}$$

where: Y_{TF} = predicted tactical flexibility index for individual interviewees' firms; and

X5 = the ‘supply chain capabilities’ construct score of individual interviewees’ firms

Based on Eq. 9-2, this indicates that contractors with a higher positive supply chain capabilities construct’s score are likely to possess a higher tactical flexibility potential.

9.2.3 Strategic flexibility (Y_{SF})

Turning to a firm’s strategic flexibility potential, three statistically significant predictors, deriving from the firm’s business strategies, were identified. They are: (i) customer intimacy initiative ($X6.2_{CIS}$); (ii) cost leadership initiative ($X6.1_{CLS}$); and (iii) risk leadership initiative ($X6.1_{RLS}$). The following is the mathematical model developed to predict a firm’s strategic flexibility potential:

$$Y_{SF} = 0.384\ (X6.2_{CIS}) + 0.339\ (X6.1_{CLS}) + 0.324\ (X6.1_{RLS}) \quad \text{Eq. 9-3}$$

where: Y_{SF} = predicted strategic flexibility index of individual interviewees’ firms;

$X6.2_{CIS}$ = the ‘customer intimacy initiative’ construct score of individual interviewees’ firms;

$X6.1_{CLS}$ = the ‘cost leadership initiative’ construct score of individual interviewees’ firms; and

$X6.1_{RLS}$ = the ‘risk leadership initiative’ construct score of individual interviewees’ firms.

Looking at Eq. 9-3, it can be seen that contractors who have higher positive scores in their customer intimacy, cost leadership and risk leadership initiatives constructs are likely to possess a higher strategic flexibility potential.

9.3 Testing flexibility indices

9.3.1 Subject domain experts

After much persuasion, four experts agreed to validate the resultant models (see Section 5.6 for the selection process). Face-to-face interviews were conducted with these subject matter experts. They are from senior management of construction firms in Singapore, comprising two senior managers and two directors. In order to preserve anonymity and to facilitate further discussion, individual experts were assigned with a code starting with an 'E' letter and followed by the numbering from one to four (i.e., E1, E2, E3 and E4). These experts have extensive working experience in the Singapore construction industry, ranging from 20 years (min.) to 35 years (max.), and an average of 24 years.

The experts were asked to: (i) comment on the practicality and comprehensiveness of the resultant models, administered by an interview guide (which will be discussed below), and (ii) complete a questionnaire. The questionnaire, used for the development of the structural models, was modified based on the findings reported in Chapter 7 in which inconsistent measurement items of respective constructs were removed from the structured questionnaire appended in Appendix C. Through this exercise, the length of the questionnaire was shortened, and interviews could be conducted efficiently. Similar to the data collection procedure discussed in Section 5.5.2, the experts were asked to justify their responses or selections in the questionnaire. Also, to facilitate the interviewing process, an interview guide was developed in an attempt to seek the experts' opinion on the practicality of the constructed models. As shown in Appendix E, this guide consists of: (i) a brief introduction to the validation process; (ii) a list of questions; and (iii) the diagrams of PLS M1 and PLS M2 showing the influences and interrelationships between the identified determinants and organizational flexibility.

The interviews took an average of 100 minutes each. Two interviews were recorded and transcribed, and for the other two, notes were taken because of the experts' request not to be recorded.

9.3.2 Comparing actual and predicted indices

New datasets collected from the four experts were used to test the flexibility indices. Using Eq. 9-1 to 9-3, predictive flexibility indices were calculated. These were compared to actual flexibility indices (see page 428 for definitions of predicted and actual flexibility indices).

In calculating the predicted and actual flexibility indices, weights (ω_ξ) for individual measurement items of respective constructs were used (see Section 6.4.2). These weights provide a more realistic and accurate prediction of the individual contribution of each measurement item on the solitary score of respective constructs compared with the averaged and summated scale used in a regression analysis (see Section 6.5.2). This is because the latter assumes equal weighting for individual measurement items of respective constructs.

Table 9.1 shows the weights for individual measurement items of respective constructs for the model prediction purposes. In this study, these weights were generated by the PLS algorithm based on the SmartPLS 2.0 M3 Software. Taking the 'employees' skills and behaviour' construct as an example, it can be seen from Table 9.1 that individual items contribute, to a varying degree (i.e., different weightings), to the composite score of the construct. The weights (ω_ξ) of individual items are amounted to the value of 1, i.e., an accumulative value of 100% of the construct score.

Table 9.1 Weights for individual measurement items of respective constructs

Employees' skills and behaviour (X3)		**Supply chain capabilities (X5)**		**Cost leadership initiative ($X6.1_{CLS}$)**		**Risk leadership initiative ($X6.1_{RLS}$)**		**Customer intimacy initiative ($X6.2_{CIS}$)**	
Item code	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**
ESB1	0.136	SC2	0.139	B9	0.281	B5	0.328	B2	0.202
ESB2	0.183	SC3	0.272	B10	0.168	B6	0.291	B3	0.240
ESB4	0.167	SC4	0.204	B14	0.323	B11	0.382	B4	0.267
ESB5	0.139	SC5	0.218	B15	0.228			B13	0.291
ESB6	0.183	SC6	0.167						
ESB8	0.192								
Product leadership initiative ($X6.2_{PLS}$)		**Operational flexibility (Y_{OF})**		**Tactical flexibility (Y_{TF})**		**Strategic flexibility (Y_{SF})**			
Item code	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**	**Item code**	**Weight (ω_ξ)**		
B7	0.370	F1	0.168	F3	0.225	F8	0.274		
B12	0.367	F2	0.176	F4	0.266	F12	0.252		
B16	0.263	F10	0.197	F5	0.227	F13	0.260		
		F11	0.229	F7	0.282	F15	0.214		
		F14	0.230						

Based on the varying weights of individual measurement items of the respective constructs, the model prediction procedure for the experts' flexibility potential, in terms of their: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility, are as follows.

1. The inputs (or ratings), i.e., Section 10 of the questionnaire, provided by the experts concerning the 13 measurement items of organizational flexibility, were used to compute the indices for the three flexibility dimensions. As reported in Chapter 7, the measurement items were factorized into their respective dimensions based on the results of the exploratory and confirmatory factor analyses. In this study, the ratings assigned to individual items were multiplied by the respective weights shown in Table 9.1, under the headings of Y_{OF}, Y_{TF} and Y_{SF}. Following this, these weighted ratings were totalled to yield the composite scores for the respective flexibility dimensions. These resultant scores are termed as actual flexibility indices in the subsequent discussion.

2. The ratings assigned to measurement items of various constructs (i.e., the key resource-based determinants) were used to predict the indices for the three flexibility dimensions. In this study, the weighted sums of corresponding measurement items formed the composite scores of the respective constructs. These scores were subsequently substituted into Eq. 9-1, 9-2 and 9-3 to predict the indices for the three flexibility dimensions. Hereinafter, these resultant values are termed as predicted flexibility indices. In this study, the predicted indices were normalized to a 1-7 scale using a linear interpolation method.

3. The actual and normalized predicted indices of the three flexibility dimensions were compared to test the robustness of the three models developed based on the findings of the PLS M2. Also, the predicted indices w

To determine the robustness of the predictive models, three equations were adopted (following Upton and Cook, 2006):

(i) Eq. 9-4 is used to measure the percentage errors between the actual and predicted flexibility indices of respective flexibility dimensions.

Percentage error (*PE*) = $\frac{\text{Actual flexibility indices} - \text{Model's predicted flexibility indices}}{\text{Actual flexibility indices}} \times 100\%$ Eq.9-4

(ii) Eq.9-5 is used to measure the mean percentage error by adding all percentage errors (*PE*) found in Step (i), and then dividing the sum by the number of observations, *n.* and

Mean percentage error (*MPE*) = $\frac{\sum PE}{n}$ Eq.9-5

(iii) Using Eq. 9-6 to measure the mean absolute percentage error by adding all percentage errors (*PE*) found in Step (i), using their absolute values, and then dividing the sum by the number of observations, *n*.

$$\textbf{Mean absolute percentage error (\textit{MAPE})} = \frac{\sum |PE|}{n} \qquad \text{Eq.9-6}$$

The results in Table 9.2 show that the percentage errors obtained for the three predictive models range from -43.72% to 31.53%. As the percentage errors registered for Model Y_{SF} are all positive, the mean percentage errors and mean absolute percentage errors are the same at 24.84%. This indicates that Model Y_{SF} underestimated the strategic flexibility of the four experts' firms. On the other hand, the corresponding mean percentage errors and mean absolute percentage errors registered for Model Y_{TF} at -27.36% and 27.36% indicate that the model overestimated the tactical flexibility potentials of the experts' firms. All these suggest that Models Y_{TF} and Y_{SF} do not yield high levels of accuracy in predicting tactical flexibility and strategic flexibility, and are therefore not robust predictive models.

Turning to Model Y_{OF}, it can be seen that the corresponding mean percentage error and mean absolute percentage error of -5.89% and 6.59% were obtained (see Table 9.2). These relatively small error percentages suggest that Model Y_{OF} is relatively robust to predict a firm's operational flexibility potential.

Table 9.2 Comparison of actual and normalized predicted indices

Flexibility dimensions	Expert code	Actual flexibility indices	Predicted flexibility indices (Normalized)	Percentage error (%) (PE)	Mean percentage error (%) (MPE)	Mean absolute percentage error (%) (MAPE)
Operational flexibility (Y_{OF})	E1	4.062	4.124	-1.53%	-5.89%	6.59%
	E2	4.832	4.764	1.41%		
	E3	4.205	4.396	-4.54%		
	E4	3.811	4.531	-18.89%		
Tactical flexibility (Y_{TF})	E1	3.266	4.694	-43.72%	-27.36%	27.36%
	E2	4.813	5.694	-18.30%		
	E3	3.983	4.898	-22.97%		
	E4	4.266	5.308	-24.43%		
Strategic flexibility (Y_{SF})	E1	4.466	3.658	18.09%	24.84%	24.84%
	E2	5.740	3.93	31.53%		
	E3	4.940	3.797	23.14%		
	E4	4.986	3.659	26.61%		

The above results substantiate that Model Y_{OF} is able to predict more accurately than Model Y_{TF} and Y_{SF}. Although Models Y_{TF} and Y_{SF} have not performed satisfactorily in predicting a firm's tactical and strategic flexibility potentials, it does not imply that the models are not informative since they provide valuable insights about the driving factors of the firm's tactical and strategic flexibilities. Also, the imprecision of the two models may be largely due to the small sample size used for model validation (n=4).

9.3.3 Correlations between organizational flexibility and annual turnover

To further confirm that the flexibility indices are valid measures, correlations between the three flexibility dimensions and firms' annual turnover is investigated. This also seeks to answer the question whether the higher a firm's flexibility potential, the higher will be the firm's annual turnover.

In assessing the correlations between the three dimensions of organizational flexibility and firms' annual turnover, these steps were adopted:

1. calculating the predicted standardized flexibility indices of individual interviewees' firms by substituting the standardized scores of respective

constructs (generated by the PLS estimation algorithm based on the SmartPLS 2.0 M3 software) in Eq. 9-1, Eq. 9-2 and Eq. 9-3;

2. entering the predicted standardized flexibility indices (obtained in Step 1) and interviewees' firms annual turnover into the SPSS software;
3. standardizing the annual turnover of individual interviewees' firms into a Z-score, with a mean of 0 and standard deviation of 1; and
4. performing the Pearson correlation test to determine the presence (or absence) and intensity of the correlation between the predicted standardized flexibility indices and standardized annual turnovers.

In this study, the standardization process is used to enable direct comparison among the three flexibility dimensions and annual turnover on a common basis. It is because contractors' turnover was measured in terms of real value (SGD$), while the three flexibility indices were predicted based on respective constructs that were measured using an ordinal scale format (see Appendix C).

Table 9.3 shows that the three flexibility dimensions are significantly and positively correlated with contractors' annual turnover. This suggests that the higher the level of contractors' flexibility potential, the higher will be their annual turnover (sales volume). Also, it is found that the three distinctive flexibility dimensions are positively correlated among one another, similar to the results reported in Table 7.18. The implication here is that the higher the level of contractors' flexibility potential in one of three flexibility dimensions, the higher will be their flexibility potential in the other two flexibility dimensions. Despite sharing similar findings, it should be noted that different components were used to compute the correlation coefficients of the three flexibility dimensions in both Tables 9.3 and 7.18. The correlation coefficients, shown in Table 9.3, were derived from the predicted flexibility indices extracted from

Sections 9.2.1 to 9.2.3. As for the coefficient coefficients reflected in Table 7.18, they were computed based on the weighted sum of measurement items of respective constructs.

Table 9.3 Correlations between three flexibility dimensions and annual turnover

Description	Annual Turnover	Operational flexibility (Y_{OF})	Tactical flexibility (Y_{TF})	Strategic flexibility (Y_{SF})
Annual Turnover	-	-	-	-
Operational flexibility (Y_{OF})	0.320*	-	-	-
Tactical flexibility (Y_{TF})	0.337*	0.738**	-	-
Strategic flexibility (Y_{SF})	0.336*	0.456**	0.528**	-

Note: * denotes correlation is significant at 0.05 level (2-tailed); ** denotes correlation is significant at 0.01 level (2-tailed)

9.4 Experts' views about the resultant structural models

This section focuses on the external validity of the resultant models PLS M1 and PLS M2, examining the extent to which the models are comprehensive and applicable in a real world situation.

9.4.1 Experts' opinions about the results of the PLS M1

During the interviews, the PLS M1 diagram was introduced to the four experts after completing the structured questionnaire. They were requested to comment on: (i) the dimensionality of organization flexibility in construction, and (ii) the practicality of the findings of PLS M1. The interview findings on PLS M1 are now discussed.

9.4.1.1 Three dimensions of organizational flexibility

A consensus was obtained among all experts that organizational flexibility could be characterized along three dimensions, i.e., (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}). In view of the definitions attached to individual dimensions, they pointed out that these dimensions are pertinent to the construction industry. Among the three dimensions, three experts (i.e., E1, E3 and E4) shared the view that being operationally and tactically flexible is more important than being strategically flexible. They explained that the operational and tactical flexibility deal with more immediate and anticipated changes, while the strategic flexibility dimension contains a more 'mysterious' and unfamiliar nature. Expert E1 expressed that:

> If a firm could not even deal with operational and tactical changes, there is no way the firm can cope with non-routine and unstructured changes...Especially in the prevailing business environment, it is becoming more difficult to plan and forecast in advance what will happen in the Singapore construction industry. The pre-requisite for continued existence is to be responsive to changes in a timely and cost-effective manner. In my opinion, a firm would need to be at least operationally and tactically flexible.

From another perspective, interviewee E2 pointed out that the three dimensions are equally important to a firm's continued existence. He added that different organization members should be involved and responsible to develop a firm's flexibility potential, i.e., flexible options. According to him, managers (for example, senior project manager, departmental manager and general manager) are the best personnel to develop the firm's operational and tactical flexibility potentials, whereas directors should focus on developing strategic flexibility, which involves mapping the firm's future directions.

The next question was related to whether there is a need to combine the three flexibility dimensions and subsequently, offer a single index reflecting a firm's flexibility potential. Two streams of viewpoints were collected. Experts E2 and E4 shared the view that it is useful to have three indices corresponding to the three flexibility dimensions. They stated that individual dimensions could provide different insights of firms' strengths and/or weaknesses. Expert E4 added that it is difficult for firms to detect their standings and areas for improvement based on a single index.

On the other hand, Experts E1 and E3 pointed out that it would be helpful if the three flexibility dimensions could be combined into two indices showing the flexibility potential of construction firms. They suggested that the operational and tactical flexibility dimensions might be combined as a single index, while the strategic flexibility dimension could be a standalone index. This suggestion is consistent with the aforementioned view that operational and tactical flexibility are responsive options dealing with immediate and familiar changes, while the strategic flexibility involves with unstructured changes.

This study acknowledges that different companies may have different emphasis on the importance of the three flexibility dimensions, and in turn setting different objectives and implementing different practices towards achieving each dimension. Thus, it appears reasonable to discover the differences in experts' opinions on the permutation of flexibility dimensions. A research decision was made not to integrate the three indices into one global flexibility index. This is consistent with hypothesis H_1 that organizational flexibility is not single-dimensional, and hence, flexibility indices can be reflected in three components.

Admittedly, there is a potential to research this further to find out the relative importance of each flexibility dimension, and then use a weighted approach, integrate three indices into one global index (see Section 10.7).

9.4.1.2 Practicality and comprehensiveness of the results concerning PLS M1

In view of the practicality of result concerning PLS M1, all experts shared the view that the resultant model has, to a great extent, identified all the key determinants of organizational flexibility. However, Experts E1 and E3 pointed out that the model is only sufficient to provide an overview of the influential determinants of firms' flexibility potential. Expert E1 added that the model could consider the influence of financial resources on a firm's flexibility potential.

Consistent with the resource-based view of firms discussed in Section 3.9.3, all experts shared the view that it is important to consider the inter-relationships between the key determinants identified for a better understanding of construction business flexibility management. According to them, the integration and configuration of those interrelated key determinants are the means towards better firm performance. Expert E2 explained that an organization's culture will directly affect its employees' behaviour and organizational structure, and added that these cause-and-effect relationships will, in turn, shape the firm's performance. Experts' concerns for the inter-relationships between the key determinants were noted, even before PLS M2 was presented to them.

9.4.2 Experts' opinions about the results of PLS M2

Upon presenting PLS M2, all experts pointed out that this model is more practical compared to PLS M1. They however shared the view that the resultant PLS M2 may appear too complex for application in construction. Experts E2 and E4 suggested that it would be good to develop a computer program (i.e., decision support system) to help contractors to determine their flexibility potential based on PLS M2. In view of contractors' literacy level and busy work commitment, all experts commented that, if the mathematical models derived from PLS M2 are not further developed into an easy-to-use instrument, the models are simply too theoretical, and of less practical use in a real-life business environment.

In terms of the comprehensiveness of the resultant PLS M2, the four experts agreed that the model has captured the essential inter-relationships among respective key determinants and the flexibility dimensions. Various discussions arose on the resultant inter-relationships, for example, the negative influence of contractors' technological capabilities on organizational structure. All experts shared the view that the negative impact was expected, considering contractors' slow adoption of advanced technologies along with their 'secretive' and 'defensive' working nature. Three experts (i.e., E1, E2 and E4) explained that it is a long-established practice, especially in family-controlled businesses, where only company executives (e.g., chairman, directors and general managers) have access to price-related and past projects records. Expert E1 added that this phenomenon could be one of the reasons why organizational structure has a positive influence on a firm's risk leadership initiative (see Section 8.5.5.2).

9.5 Application

In this study, the structural model (PLS M2) developed could be used as self-assessment tools for construction firms, providing them with valuable insights into the inter-relationships of determinants, towards achieving organizational flexibility. Three checklists were developed to help construction firms to direct their strategic endeavour in acquiring and developing key resources and capabilities towards attaining different dimensions of flexibility, i.e., operational flexibility (see Figure 9.1), tactical flexibility (see Figure 9.2) and strategic flexibility (see Figure 9.3). For illustration purpose, the application of the checklist for attainment of operational flexibility (Y_{OF}) is now discussed.

Figure 9.1 shows the checklist for construction firms to achieve and develop their operational flexibility. Three key determinants of operational flexibility are identified: (i) employees' skills and behaviour (X3); (ii) supply chain capabilities (X5); and (iii) product leadership initiative ($X6.2_{PLS}$). The weights (ω_{ξ}) assigned represent the importance of individual measurement items within their respective constructs (for example, F14 and F11 are the two most important features in a firm's operational flexibility). This provides managers with valuable insights concerning the important features of their operational flexibility (Y_{OF}), and thus enabling them to prioritize their concerns. Upon identifying their concerns, managers may examine the relationships between the key determinants and operational flexibility (Y_{OF}), as shown in Table 9.4, and subsequently, identify and implement appropriate means for achieving improved operational flexibility (Y_{OF}). Taking an example where managers seek to improve F14 for improved operational flexibility, they should assess their firms' attributes, in terms of ESB2, ESB4, ESB8, SC2, SC3, SC4, SC5 and SC6, taking into consideration the weights of individual attributes and absolute effects (i.e., magnitude of influence) of employees' skills and behaviour (0.419) and supply chain capabilities (0.358) on their operational flexibility (see Figure 9.1). These magnitudes of influence indicate that managers should give priority to development of employees' skills and behaviour (X3), followed by supply chain capabilities (X5).

Next, managers should consider the inter-relationships between their supply chain capabilities and employees' skills and behaviour, and recognize the complementary roles of their inter-organizational relationship management practices and employees' skills and behaviour towards achieving improved supply chain capabilities for attainment of operational flexibility. Table 9.5 summarizes the relationships between firms' supply chain capabilities, inter-relationship management practices and employees' skills and behaviour. This enables managers to identify the appropriate practices and types of employees' skills and behaviour for the type of supply chain capabilities required by their firms. Consistent with the aforementioned example, in the event where managers decided to emphasize on SC2 and SC3 (besides ESB2, ESB4 and ESB8) in their attempts to improve F14, they may consider placing greater emphasis on RM8, ESB4 and ESB6.

As for employees' skills and behaviour, Table 9.6 summarizes the relationships between firms' commitment to learning, employees' skills and behaviour and human resource management practices. Mangers could examine these relationships, and in turn implement appropriate practices and promote desired cultures for the types of employees' skills and behaviour desired by their firms. Relating to the example above, managers may consider a range of attributes and practices in their efforts to improve ESB2, ESB4, ESB6 and ESB8. Some of the relevant practices and organizational attributes include: (i) CL1; (ii) C6; (iii) SM2; (iv) PM3; and (v) RM2 (see Table 9.6).

On the other hand, firms may consider the negative influences (i.e., magnitude of influence) of commitment to learning ($X1_{CL}$) → product leadership ($X6.2_{PLS}$), and product leadership ($X6.2_{PLS}$) → operational flexibility (Y_{OF}) when evaluating their organizational attributes for improved operational flexibility. The checklist indicates that managers may have to maintain a balance between their commitment to create a learning environment towards pursuing a product leadership initiative and developing their employees' skills and behaviour.

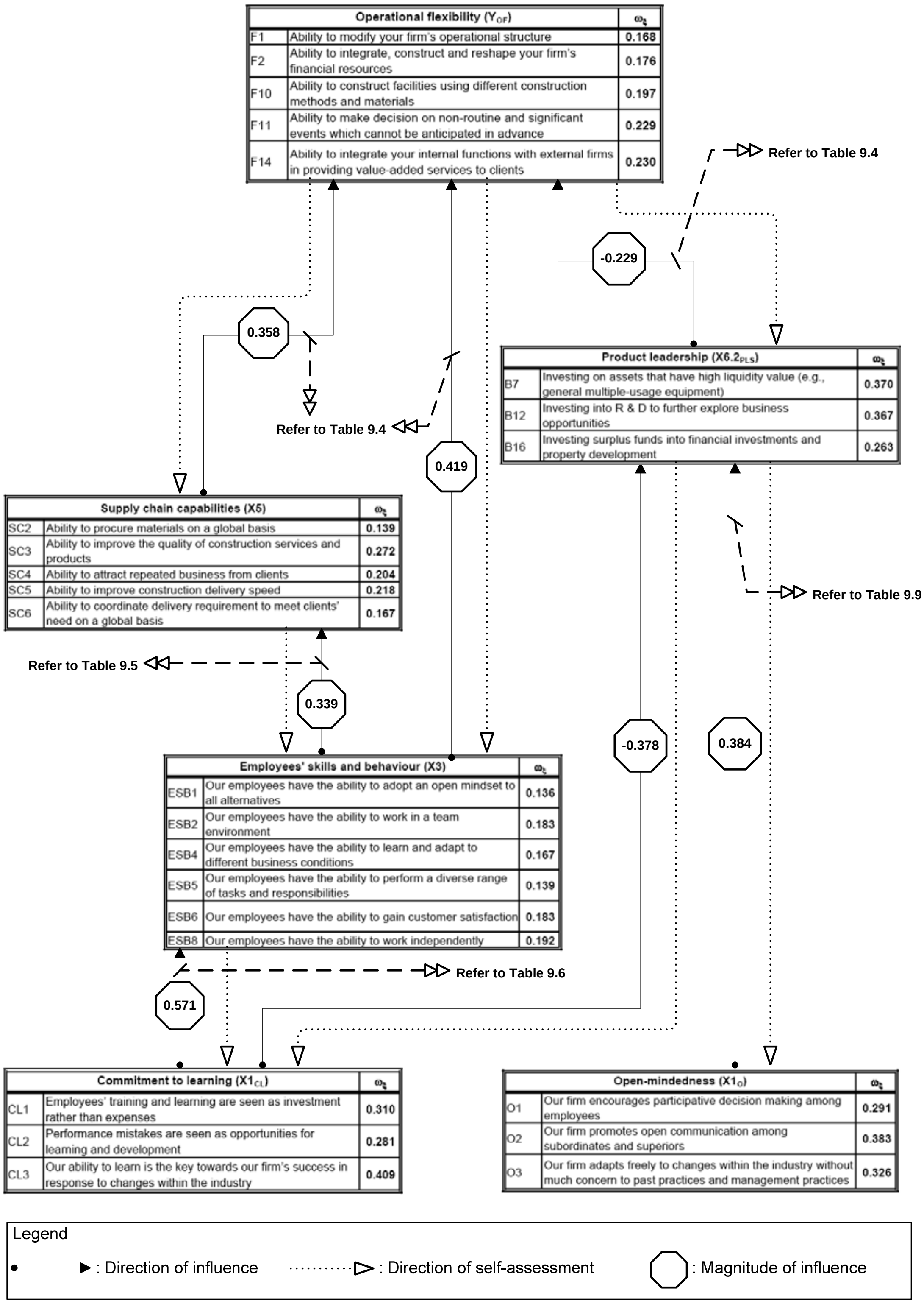


Figure 9.1 Checklist for attainment of operational flexibility

Tactical flexibility (Y_{TF})		ω_ξ
F3	Ability to change the number of employees in your business operation	**0.225**
F4	Ability of your firm's employees to handle multiple responsibilities	**0.266**
F5	Ability to add and expand your business capacity efficiently	**0.227**
F7	Ability to adopt a range of alternative logistics supports to operations	**0.282**

Refer to Table 9.4

0.415

Supply chain capabilities (X5)		ω_ξ
SC2	Ability to procure materials on a global basis	**0.139**
SC3	Ability to improve the quality of construction services and products	**0.272**
SC4	Ability to attract repeated business from clients	**0.204**
SC5	Ability to improve construction delivery speed	**0.218**
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	**0.167**

Refer to Table 9.5

0.339

Employees' skills and behaviour (X3)		ω_ξ
ESB1	Our employees have the ability to adopt an open mindset to all alternatives	**0.136**
ESB2	Our employees have the ability to work in a team environment	**0.183**
ESB4	Our employees have the ability to learn and adapt to different business conditions	**0.167**
ESB5	Our employees have the ability to perform a diverse range of tasks and responsibilities	**0.139**
ESB6	Our employees have the ability to gain customer satisfaction	**0.183**
ESB8	Our employees have the ability to work independently	**0.192**

Refer to Table 9.6

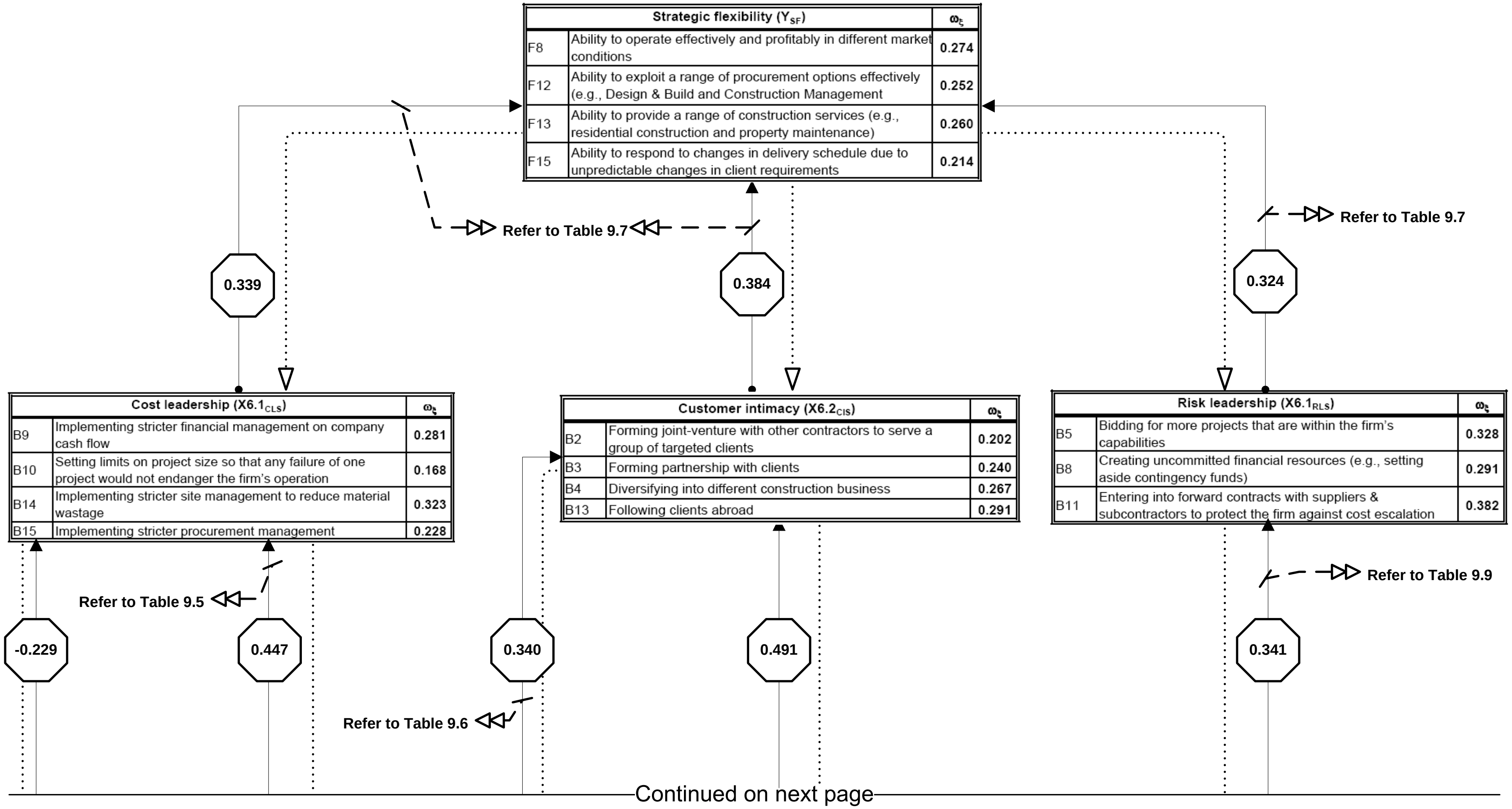
0.571

Commitment to learning ($X1_{CL}$)		ω_ξ
CL1	Employees' training and learning are seen as investment rather than expenses	**0.310**
CL2	Performance mistakes are seen as opportunities for learning and development	**0.281**
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	**0.409**

Legend

: Direction of influence : Direction of self-assessment : Magnitude of influence

Figure 9.2 Checklist for attainment of tactical flexibility



	Strategic flexibility (Y_{SF})	ω_ξ
F8	Ability to operate effectively and profitably in different market conditions	0.274
F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management	0.252
F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)	0.260
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements	0.214

	Cost leadership ($X6.1_{CLS}$)	ω_ξ
B9	Implementing stricter financial management on company cash flow	0.281
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	0.168
B14	Implementing stricter site management to reduce material wastage	0.323
B15	Implementing stricter procurement management	0.228

	Customer intimacy ($X6.2_{CIS}$)	ω_ξ
B2	Forming joint-venture with other contractors to serve a group of targeted clients	0.202
B3	Forming partnership with clients	0.240
B4	Diversifying into different construction business	0.267
B13	Following clients abroad	0.291

	Risk leadership ($X6.1_{RLS}$)	ω_ξ
B5	Bidding for more projects that are within the firm's capabilities	0.328
B8	Creating uncommitted financial resources (e.g., setting aside contingency funds)	0.291
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	0.382

Continued on next page

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Refer to Table 9.8

Supply chain capabilities (X5)		ω_ξ
SC2	Ability to procure materials on a global basis	0.139
SC3	Ability to improve the quality of construction services and products	0.272
SC4	Ability to attract repeated business from clients	0.204
SC5	Ability to improve construction delivery speed	0.218
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	0.167

-0.352

Organizational structure (X2)		ω_ξ
OS1	Our firm operates in a flexible work procedure	0.356
OS2	Our firm adopts a more decentralized decision making process	0.343
OS3	Our firm has an open communication channel with flexible access to important information for decision making	0.301

Refer to Table 9.5

0.339

Technological capabilites (X4)		ω_ξ
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	0.139
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	0.145
IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	0.121
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	0.144
PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements	0.158
PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process	0.152
PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage	0.141

Employees' skills and behaviour (X3)		ω_ξ
ESB1	Our employees have the ability to adopt an open mindset to all alternatives	0.136
ESB2	Our employees have the ability to work in a team environment	0.183
ESB4	Our employees have the ability to learn and adapt to different business conditions	0.167
ESB5	Our employees have the ability to perform a diverse range of tasks and responsibilities	0.139
ESB6	Our employees have the ability to gain customer satisfaction	0.183
ESB8	Our employees have the ability to work independently	0.192

Refer to Table 9.9

0.511

0.571

Refer to Table 9.6

Refer to Table 9.8

0.330

Commitment to learning ($X1_{CL}$)		ω_ξ
CL1	Employees' training and learning are seen as investment rather than expenses	0.310
CL2	Performance mistakes are seen as opportunities for learning and development	0.281
CL3	Our ability to learn is the key towards our firm's success in response to changes within the industry	0.409

Shared vision and value ($X1_{SV}$)		ω_ξ
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	0.281
SV2	Our firm provides support to employees to reach organizational goals	0.290
SV3	Employees are constantly informed on the firm's business objectives	0.231
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	0.198

Open-mindedness ($X1_O$)		ω_ξ
O1	Our firm encourages participative decision making among employees	0.291
O2	Our firm promotes open communication among subordinates and superiors	0.383
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	0.326

Figure 9.3 Checklist for attainment of strategic flexibility

Legend

: Direction of influence

: Direction of self-assessment

: Magnitude of influence

Table 9.4 Relationship guide 1 for checklists

			Employees' skills and behaviour						Supply chain capabilities					Product leadership initiative		
	Item codes/description		Ability to adopt an open-mindset to all alternative	Ability to work in a team environment	Ability to learn and adapt to different business conditions	Ability to perform a diverse range of tasks and responsibilities	Ability to gain customer satisfaction	Ability to work independently	Ability to procure materials on a global basis	Ability to improve the quality of construction services and products	Ability to attract repeat business from clients	Ability to improve construction delivery speed	Ability to coordinate delivery requirement to meet clients' need on a global basis	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)	Investing into R & D to further explore business opportunities	Investing surplus funds into financial investments and property `development
			ESB1	ESB2	ESB4	ESB5	ESB6	ESB8	SC2	SC3	SC4	SC5	SC6	B7	B12	B16
Operational flexibility	F1	Ability to modify your firm's operational structure		↑			↑	↑					↑	↓		
	F2	Ability to integrate, construct and reshape your firm's financial resources		↑					↑	↑			↑			
	F10	Ability to construct facilities using different construction methods and materials				↑	↑	↑	↑	↑			↑			
	F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	↑	↑	↑	↑	↑	↑	↑	↑		↑	↑			
	F14	Ability to integrate your internal functions with external firms in providing value-added services to clients		↑	↑			↑	↑	↑	↑	↑	↑			

Note: ↑ = significant positive correlation between two variables; ↓ = significant negative correlation between two variables. Results were extracted from Tables 8.4 and 8.6.

Table 9.5 Relationship guide 2 for checklists

			Employees' skills and behaviour						Inter-organizational relationship management				Tactical flexibility				Cost leadership initiative			
		Item code/description	Ability to adopt an open-mindset to all alternative	Ability to work in a team environment	Ability to learn and adapt to different business conditions	Ability to perform a diverse range of tasks and responsibilities	Ability to gain customer satisfaction	Ability to work independently	Providing prompt after-sales services to clients	Organizing trainings for supply chain parties	Keeping constant contact with clients (e.g., end users and consultant) to keep track of their need	Organizing informal gathering among supply chain parties	Ability to change the number of employees in your business operation	Ability of your firm's employees to handle multiple responsibilities	Ability to add and expand your business capacity efficiently	Ability to adopt a range of alternative logistics supports to operations	Implementing stricter financial management on company cash flow	Setting limits on project size so that any failure of one project would not endanger the firm's operation	Implementing stricter site management to reduce material wastage	Implementing stricter procurement management
			ESB1	**ESB2**	**ESB4**	**ESB5**	**ESB6**	**ESB8**	**RM8**	**RM9**	**RM10**	**RM11**	**F3**	**F4**	**F5**	**F7**	**B9**	**B10**	**B14**	**B15**
Supply chain capabilities	**SC2**	Ability to procure materials on a global basis			↑		↑									↑		↑	↑	
	SC3	Ability to improve the quality of construction services and products							↑						↑	↑		↑		
	SC4	Ability to attract repeat business from clients								↑	↑	↑								
	SC5	Ability to improve construction delivery speed																		
	SC6	Ability to coordinate delivery requirement to meet clients' need on global basis		↑	↑					↑					↑					

Note: ↑ = significant positive correlation between two variables. Results were extracted from Tables 8.8, 8.29 8.30 and 8.32.

The above presents the application of the checklist for attainment and development of operational flexibility. It should be noted that the assessment procedure discussed previously (following the direction of assessment) is similar to those of tactical flexibility (see Figure 9.2) and strategic flexibility (see Figure 9.3), whereby managers would need to cross-refer to the tables proposed (for example, Tables 9.5, 9.6, 9.8 and 9.9), as highlighted in the checklists, for additional information on the relationships between different organizational attributes. The tables provide managers with useful insights into the types of practices or attributes which their firms may consider to implement or promote in their endeavour to develop and attain specific types of flexibility dimension.

9.6 Summary

Three mathematical models were developed, based on the test results of PLS M2, to predict: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}). New datasets collected from four subject domain experts, by the means of face-to-face interviews, were used to test the robustness of the three mathematical models. To determine the robustness of the models, three equations were adopted: (i) percentage error (PE); (ii) mean percentage error (MPE); and (iii) mean absolute percentage error (MAPE).

The results show that Models Y_{OF} (MAPE = 6.59%) is relatively robust in predicting a firm's operational flexibility potential. On the other hand, Models Y_{TF} and Y_{SF} have not performed satisfactorily in predicting a firm's tactical and strategic flexibility potentials, posing a corresponding mean absolute percentage error of 27.36% and 24.84. This may largely due to the small-sized sample used for model validation (n=4). Furthermore, it is found that the predicted flexibility indices (i.e., flexibility dimensions) are positively correlated with firms' annual turnover.

Table 9.6 Relationship guide 3 for checklists

			Commitment to learning			Competence development			Stress management		Performance management				Intra-organizational relationship management				Customer intimacy initiative			
	Item code/description		Employees training and learning are seen as investment rather than expenses	Performance mistakes are seen as opportunities for learning and development	Our ability to learn is the key towards our firm's success in response to changes within the industry	Providing on-the-job training	Allowing employees to take day off for their continuous professional development	Subsidizing tuition fees of self-upgrading courses and seminars attended by employees	Organizing stress coping and management course	Implementing personal counselling program	Organizing Informal gathering to recognize employees' achievement	Organizing company trips to recognize employees' contribution to firms' performance	Conducting staff performance appraisal exercise	Offering career development and promotion	Encouraging face to face communication among employees	Conducting regular meetings among subordinates and superiors	Implementing survey feedback programme to track the well-being of employees	Conducting induction programme for all recruits	Forming joint-venture with other contractors to serve a group of targeted clients	Forming partnership with clients	Diversifying into different construction business	Following clients abroad
			CL1	**CL2**	**CL3**	**C6**	**C10**	**C13**	**SM2**	**SM4**	**PM1**	**PM3**	**PM4**	**PM5**	**RM1**	**RM2**	**RM3**	**RM4**	**B2**	**B3**	**B4**	**B13**
Employees' skills and behaviour	**ESB1**	Ability to adopt an open-mindset to all alternative		↑	↑	↑								↑	↑	↑	↑	↑				
	ESB2	Ability to work in a team environment	↑	↑	↑	↑	↑				↑	↑	↑	↑		↑					↑	↑
	ESB4	Ability to learn and adapt to different business conditions	↑			↑						↑	↑	↑		↑	↑			↑	↑	
	ESB5	Ability to perform a diverse range of tasks and responsibilities	↑	↑	↑	↑	↑						↑			↑						
	ESB6	Ability to gain customer satisfaction	↑	↑	↑	↑	↑	↑	↑	↑							↑			↑		
	ESB8	Ability to work independently	↑		↑	↑				↑						↑						

Note: ↑ = significant positive correlation between two variables. Results are extracted from Tables 8.22, 8.23, 8.24, 8.25 and 8.37

Table 9.7 Relationship guide 4 for checklists

	Item code/description		Customer intimacy initiative				Cost leadership initiative				Risk leadership initiative		
			Forming joint-venture with other contractors to serve a group of targeted clients	Forming partnership with clients	Diversifying into different construction business	Following clients abroad	Implementing stricter financial management on company cash flow	Setting limits on project size so that any failure of one project would not endanger the firm's operation	Implementing stricter site management to reduce material wastage	Implementing stricter procurement management	Bidding for more projects that are within the firm's capabilities	Creating uncommitted financial resources (e.g., setting aside contingency funds)	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation
			B2	**B3**	**B4**	**B13**	**B9**	**B10**	**B14**	**B15**	**B5**	**B8**	**B11**
Strategic flexibility	**F8**	Ability to operate effectively and profitably in different market conditions	↑	↑		↑					↑		
	F12	Ability to exploit a range of procurement options effectively (e.g., Design & Build and Construction Management)		↑			↑				↑	↑	↑
	F13	Ability to provide a range of construction services (e.g., residential construction and property maintenance)					↑	↑	↑		↑		
	F15	Ability to respond to changes in delivery schedule due to unpredictable changes in client requirements					↑	↑	↑	↑			

Note: ↑ denotes significant positive correlation between two variables. Results are extracted from Tables 8.11, 8.13 and 8.14

Table 9.8 Relationship guide 5 for checklists

			Customer intimacy initiative				Organizational structure			Shared vision and value			
	Item code/description		Forming joint-venture with other contractors to serve a group of targeted clients	Forming partnership with clients	Diversifying into different construction business	Following clients abroad	Our firms operates in a flexible work procedure	Our firm adopts a more decentralized decision making process	Our firm has an open communication channel with flexible access to important information for decision making	Our firm encourages brainstorming sessions among employees to share new ideas	Our firm provides support to employees to reach organizational goals	Employees are constantly informed on the firm's business objectives	Employees' involvement in charting the direction of the firm is the key toward our firm's success
			B2	**B3**	**B4**	**B13**	**OS1**	**OS2**	**OS3**	**SV1**	**SV2**	**SV3**	**SV4**
Technological capabilities	**IT1**	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion		↑	↑	↑				↑	↑		
	IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion		↑	↑				↓	↑			
	IT3	Ability to retrieve information, i.e., regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion		↑	↑					↑			
	IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	↑	↑						↑		↑	
	PT1	Ability to adopt different construction process technologies (e.g., construction methods and materials) to satisfy clients' requirements		↑									
	PT2	Ability to apply different process technology software (e.g. ,estimating and purchasing software) to improve firm's operational process	↑	↑	↑	↑				↑			
	PT3	Ability to lead in process technology innovation (e.g., computer aided program in analyzing indoor thermal condition) to gain competitive advantage		↑	↑								

Note: ↑ denotes significant positive correlation between two variables. Results are extracted from Tables 8.21, 8.27 and 8.36.

Table 9.9 Relationship guide 6 for checklists

			Risk leadership			Open-mindedness		
	Item code/description		Bidding for more projects that are within the firm's capabilities	Creating uncommitted financial resources (e.g., setting aside contingency funds)	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	Our firm encourages participative decision making among employees	Our firm promotes open communication among subordinates and superiors	Our firm adapts freely to changes within the industry without much concern to past practices and management practices
			B5	**B8**	**B11**	**O1**	**O2**	**O3**
Organizational structure	**OS1**	Our firm operates in a flexible work procedure	↑			↑		↑
	OS2	Our firm adopts a more decentralized decision making process				↑		↑
	OS3	Our firm has an open communication channel with flexible access to important information for decision making	↑			↑		
Product leadership initiative	**B7**	Investing on assets that have high liquidity value (e.g., general multiple-usage equipment)						
	B12	Investing in R & D to further explore business opportunities				↑		↑
	B16	Investing surplus funds into financial investments and property development						

Note: ↑ denotes significant positive correlation between two variables. Results are extracted from Tables 8.18, 8.35and 8.38

Also, the interviews revealed that the results derived from PLS M1 and M2 are comprehensive, and provide valuable insights on how construction firms could achieve organizational flexibility. Thereafter, three checklists were developed to help construction firms in assessing, achieving and developing different dimensions of flexibility. Summary and conclusions of this study are presented in the next chapter.

CHAPTER 10

SUMMARY AND CONCLUSIONS

10.1 Summary

A growing need for organizational flexibility arises as a result of changes in the business environment within the construction industry. Although previous construction-related studies have recognized the importance of flexibility for firms to remain viable in the industry, hitherto, no instrument was developed to help construction firms to attain organizational flexibility.

Based on the underlying features of flexibility extracted from previous studies, organizational flexibility is defined in this study as "the ability of an organization to effectively utilize its resources and capabilities to respond or readapt, in a timely and reversible manner to environmental changes, through a continuous learning process" (see Section 3.4). Based on this definition, the aim of this study is to investigate the organizational flexibility management of construction firms in Singapore from an integrative multi-dimensional perspective (see Section 1.4).

Focusing on general contracting operations of construction firms, five specific research objectives are defined accordingly within the context of the Singapore construction industry (see Section 1.4). To fulfil these objectives, this study adopted a three-phase survey research design, combining both the qualitative and quantitative approaches (see Section 5.2). These three phases are: (i) exploratory phase; (ii) questionnaire development phase; and (iii) data collection and analysis phase. The data collection instruments were semi-structured (see Appendix A) and structured questionnaire (see Appendix C) for the exploratory (see Section 5.3) and data collection and analysis phases (see Section 5.5), respectively. Data were collected via face-to-face interviews with construction industry experts. The SmartPLS2.0 M3 statistical software was used for analysing the survey data using the partial least square (PLS) approach (see Section 6.4). Face-to-face interviews were conducted with subject matter experts for validating the models developed (see Section 9.3.1).

10.2 Summary of research findings and validations of hypotheses

This section summarizes the findings of this study. Results corresponding to the research objectives and the research hypotheses are now presented.

10.2.1 Conceptual framework for organizational flexibility

The first objective of this research is to develop and test a conceptual framework for organizational flexibility in construction firms. The conceptual framework is underpinned by the integration of four perspectives of organizational studies: (i) the dynamic contingency view of firms (see Section 3.9.1); (ii) the organizational learning perspective (see Section 3.9.2); (iii) the resource-based view of firms (see Section 3.9.3); and (iv) the complex adaptive system perspective (see Section 3.9.4). The developed conceptual framework postulates that construction firms may attain their flexibility, by engaging in a continuous process of developing and managing resources and capabilities, for their continued existence. This framework was shown to nine experts, within the construction industry, and their views were obtained through semi-structured interviews (see Section 5.3). The resultant framework is shown in Figure 3.2. It shows that organizational flexibility is seen as a multi-dimensional concept that comprises: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}) (see Section 3.6.1). These are further operationalized into 15 flexibility types: (i) modification flexibility (F1); (ii) financial flexibility (F2); (iii) numerical flexibility (F3); (iv) functional flexibility (F4); (v) expansion flexibility (F5); (vi) market flexibility (F6); (vii) operation flexibility (F7); (viii) volume flexibility (F8); (ix) machine flexibility (F9); (x) material flexibility (F10); (xi) process flexibility (F11); (xii) procurement flexibility (F12); (xiii) product flexibility (F13); (xiv) spanning flexibility (F14); and (xv) logistic flexibility (F15) (see Section 3.6.2)

The conceptual framework also shows that flexibility dimensions may, to varying degrees, be influenced by six determinants: (i) organizational learning culture (X1); (ii) organizational structure (X2); (iii) employees' skills and behaviour (X3); (iv) technological capabilities (X4); (v) supply chain capabilities (X5); and (vi) business strategies (X6) (see Section 3.7) .

The conceptual framework was successfully validated using the classical (see Section 7.3) and contemporary (see Section 7.4) procedures. The results show that organizational flexibility is a multi-dimensional concept comprising: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility, at least insofar as in modelling organizational flexibility of construction firms in Singapore is concerned. The results also show that the three flexibility dimensions are distinctive with at least three flexibility types loaded highly on them. Therefore, **Hypothesis $\boldsymbol{H_1}$,** stating that Organizational flexibility (Y) can be characterized by three dimensions: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}), is *supported* (see Section 7.6).

10.2.2 Key determinants of organizational flexibility

The second objective is to identify the key determinants of organizational flexibility. Model PLS M1 was constructed of three organizational flexibility dimensions (i.e., predicted constructs) and six determinants that are operationalized into 11 predictor constructs (see Figure 6.3). They are: (1) commitment to learning ($X1_{CL}$); (2) shared vision and value ($X1_{SV}$); (3) open-mindedness ($X1_{O}$); (4) organizational structure (X2); (5) employees' skills and behaviour (X3); (6) technological capabilities (X4); (7) supply chain capabilities (X5); (8) cost leadership ($X6.1_{CLS}$); (9) risk leadership ($X6.1_{RLS}$); (10) customer intimacy ($X6.2_{CIS}$); and (11) product leadership ($X6.2_{PLS}$). Following a model trimming process to remove the redundant predictor(s) for the respective predicted constructs, the R^2 values for operational flexibility, tactical flexibility and strategic flexibility indicate that the 11 predictor constructs can explain 75.8%, 41.7% and 64.9% of the corresponding variance on operational flexibility, tactical flexibility and strategic flexibility (see Section 8.2.1). Also, the F-test statistics show that the R^2 values have significantly improved after the model trimming process, and that they are statistically significant at $p < 0.05$ level (see Section 8.2.2).

Turning to the path coefficients that describe the 33 relationships among the constructs in PLS M1 (see Section 8.2.3), the test results show that there are 12 statistically significant paths supporting the relationships among the constructs. Of these, six predictor constructs significantly influence (i.e., four positive and two negative path coefficients) firms' operational flexibility. The magnitudes of positive impacts, in order of importance, are: (i) employees' skills and behaviour (X3) (β = 0.332); (ii) open-mindedness ($X1_{O}$) (β = 0.323); (iii) supply chain capabilities (X5) (β = 0.288); and (iv) cost leadership initiative ($X6.1_{CLS}$) (β = 0.195). The findings indicate that the key determinants that improve an organization's flexibility are: (i) employing employees with superior skills; (ii) being open-minded; (iii) having superior supply chain capabilities; and (iv) placing greater emphasis on cost leadership. On the other hand, organizational structure (X2) (β = -0.243) and shared vision and value ($X1_{SV}$) (β = -0.185) are found to have statistically significant negative impact on firms' operational flexibility (see Section 8.3.2).

With regard to firms' tactical flexibility, there are only two predictor constructs with statistically significant impacts: (i) supply chain capabilities (X5) (β = 0.399) (see Section 8.3.3.1), and (ii) product leadership initiative ($X6.2_{PLS}$) (β = -0.284) (see Section 8.3.3.2). The findings indicate that key determinants to enhance firms' tactical flexibility are improving their supply chain capabilities, while lessening their product leadership endeavours.

Lastly, the research found four positive statistically significant predictor constructs influencing firms' strategic flexibility. In order of importance, they are: (i) customer intimacy initiative ($X6.2_{CIS}$) (β =0.426) (see Section 8.3.4.1); (ii) shared vision and value ($X1_{SV}$) (β =0.332) (see Section 8.3.4.2); (iii) cost leadership initiative ($X6.1_{CLS}$) (β =0.312) (see Section 8.3.4.3); and (iv) risk leadership initiative ($X6.1_{RLS}$) (β =0.298) (see Section 8.3.4.4). The findings indicate that firms may improve their strategic flexibility by creating and promoting a shared vision and value work environment, and placing greater emphasis on customer intimacy, cost and risk leadership initiatives.

The above results show that different flexibility dimensions are, to varying degree, influenced by five determinants: (i) organizational learning culture (X1); organizational structure (X2); (iii) employees' skills and behaviour (X3); (iv) supply chain capabilities (X5); and (v) business strategies (X6). It is found that 'technological capabilities (X4)' is the only determinant that does not have statistically significant impact on the three flexibility dimensions. However, this does not imply that technological capability is not important because it might have an impact on other determinants (i.e., organizational attributes) towards achieving different flexibility dimensions.

10.2.3 Inter-relationships of determinants

The third objective of this research is to investigate the effects of inter-relationships among the determinants on organizational flexibility. Model PLS M2 was developed to investigate the inter-relationships among the six key determinants, which have been operationalized into 11 constructs, and the three identified dimensions of organizational flexibility (see Figure 6.4). Following the removal of redundant predictors from their respective predicted constructs, via a model trimming exercise (see Section 8.4.1), the respective predicted constructs have R^2 values ranging from 0.189 to 0.614. Of these, the operational flexibility construct registers the highest R^2 value, having 61.4% of its variance accounted for by its predictor constructs. The supply chain capabilities construct, on the other hand, registers the lowest R^2 value, having only 18.9% of its variance accounted for by its predictor constructs. Nevertheless, all the R^2 values have exceeded the threshold value of 0.10, and are statistically significant at $p < 0.05$ based on the F-test statistics, indicating the satisfactory predictive power of PLS M2 (see Section 8.4.2).

Turning to the assessment of path coefficients, the t-statistics show that a total of 20, out of the 42, proposed paths are statistically significant, supporting the hypothesized relationships among the constructs as set hypotheses, $\mathbf{H_2}$ to $\mathbf{H_{18}}$ (see Section 8.4.3). Following Wang and Li (2007), a hypothesis is considered as *supported* if all hypothesized relationships between relevant constructs (which could be either single-dimensional or multi-dimensional) are statistically significant. However, if only one or some of the hypothesized relationships between the relevant constructs are statistically significant, the hypothesis is considered as *partially supported*. Lastly, a hypothesis is considered as not supported if none of the hypothesized relationships between the relevant constructs is statistically significant. A summary of the results of hypotheses testing is given below.

1. **Hypothesis 2** states that "organizational learning culture (X1) has a significant direct impact on organizational structure (X2)". It is found that an organizational learning culture, characterized only by 'open-mindedness ($X1_O$)' (one out of the three dimensions of the organizational learning culture (X1) construct) has a statistically significant positive impact on 'organizational structure (X2)' (β = 0.511; see Section 8.5.1.1). Therefore, **Hypothesis 2** is *partially supported;* since only one of the three hypothesized relationships is statistically significant. The finding indicates that firms that are open-minded, characterized by their efforts to create an open communication environment and adapt freely to changes within the environment without much concern to past practices and management, are more likely to have a flexible organizational structure.
2. **Hypothesis 3** states that 'organizational learning culture (X1) has a significant impact on employees' skills and behaviour (X3)'. It is found that only 'commitment to learning ($X1_{CL}$)' (i.e., one of the three dimensions of the organizational learning culture (X1) construct) has a statistically significant positive impact on 'employees' skills and behaviour (X3)' (β = 0.571; see Section 8.5.2). Therefore, **Hypothesis 3** is *partially supported;* since only one of the three hypothesized relationships is statistically significant. The finding indicates that firms' commitment to create an environment that promotes learning is important towards developing employees' skills and behaviour.
3. **Hypothesis 4** states that 'organizational learning culture (X1) has a significant impact on technological capabilities (X4)'. It is found that only 'shared vision and value ($X1_{SV}$)' (i.e., one of the three dimensions of the organizational learning culture (X1) construct)) has a statistically significant positive impact on 'technological capabilities (X4)' (β = 0.330; see Section 8.5.3). Therefore, **Hypothesis 4** is *partially supported;* since only one out of the three hypothesized relationships is statistically significant. The finding indicates that firms, which

encourage employees to share new ideas and communicate among themselves towards developing a shared vision and value working environment, are likely to possess superior technological capabilities.

4. **Hypothesis 5** states that 'organizational learning culture (X1) has a significant impact on business strategies (X6)'. It is found that 'commitment to learning ($X1_{CL}$)' has a statistically significant negative impact on 'cost leadership ($X6.1_{CLS}$)' (β = -0.268) and 'product leadership ($X6.2_{PLS}$)' (β = -0.378); two out of the four dimensions of the business strategies (X6) construct (see Sections 8.5.5.1 and 8.5.5.4). Besides this, 'open-mindedness ($X1_{O}$)' is found to positively influence 'product leadership ($X6.2_{PLS}$)', posing a path coefficient of 0.384 (see Section 8.5.5.4). Based on these, **Hypothesis 5** is *partially supported*; since only three out of the 12 hypothesized relationships among the dimensions of the two constructs are statistically significant.
5. **Hypothesis 6** states that 'organizational structure (X2) has a significant impact on business strategies (X6)'. It is found that 'organizational structure (X2)' has a statistically significant positive impact only on 'risk leadership ($X6.1_{RLS}$)' (β = 0.341), among the four dimensions of the business strategies (X6) construct (see Section 8.5.5.2). Therefore, **Hypothesis 6** is *partially supported;* since only one of the four hypothesized relationships is statistically significant. All interviewees recognized that the decision making procedure within a firm's organizational structure is of paramount importance to its risk management endeavours, and added that top management should exercise a certain degree of 'command and control' when making a decision whether to bid or not so as to avoid overstretching resources which may affect project execution.
6. For **Hypothesis 7,** which states that 'organizational structure (X2) has a significant impact on organizational flexibility (Y)', there is insufficient evidence to

establish that an organization's structure will significantly influence its operational, tactical and strategic flexibility potentials. Thus, **Hypothesis 7** is *not supported*.

7. For **Hypothesis 8,** which states that **'**employees' skills and behaviour (X3) have a significant impact on technological capabilities (X4)', there is insufficient evidence to establish that employees' skills and behaviour will significantly influence their technological capabilities. Thus, **Hypothesis 8** is *not supported*.
8. **Hypothesis 9** states that 'employees' skills and behaviour (X3) have a significant impact on supply chain capabilities (X5)'. It is found that 'employees' skills and behaviour (X3)' has a statistically significant positive impact on 'supply chain capabilities (X5)' (β = 0.339; see Section 8.5.4). Therefore, **Hypothesis 9** is *supported*. The finding indicates that employees' skills and behaviour, characterized by their abilities to work in a team environment whereby they learn and adapt to different business conditions towards gaining higher customer satisfaction, are of paramount importance in developing firms' supply chain capabilities.
9. **Hypothesis 10** states that 'employees' skills and behaviour (X3) have a significant impact on business strategies (X6)'. It is found that 'employees' skills and behaviour (X3)' has a statistically significant positive impact only on 'customer intimacy ($X6.2_{CIS}$)' (β = 0.340; see Section 8.5.5.3); one of the four dimensions of the business strategies (X6) construct. Therefore, **Hypothesis 10** is *partially supported;* since only one of the four hypothesized relationships is statistically significant. The finding indicates that employees are important assets towards gaining clients' loyalty; whereby their skills and behaviour could shape the effectiveness of a firm's customer intimacy endeavour**.**
10. **Hypothesis 11** states that 'employees' skills and behaviour (X3) have a significant impact on organizational flexibility (Y)'. The results show that 'employees' skills and behaviour (X3)' has a statistically significant positive

impact only on ‘operational flexibility (Y_{OF})’ (β = 0.419), among the three dimensions of the organizational flexibility (Y) construct. Therefore, **Hypothesis 11** is *partially supported;* since only one of the three hypothesized relationships is statistically significant. It should be noted that ‘employees’ skills and behaviour’ is the predictor with the highest impact among the three predictors of ‘operational flexibility’ (the other two predictors are: (i) ‘supply chain capabilities (X5)’ (β = 0.358), and (ii) ‘product leadership ($X6.2_{PLS}$)’ (β = -0.229)). Also, the results show that ‘employees’ skills and behaviour’ is the primary enabler, both directly and indirectly, of ‘operational flexibility’ (see Figure 8.6 and Section 8.5.6.1). Regarding the indirect influence, employees’ skills and behaviour are found to positively influence firms’ supply chain capabilities in which the latter shapes firms’ operational flexibility (i.e., employees’ skills and behaviour$\rightarrow$ supply chain capabilities$\rightarrow$ operational flexibility).

11. **Hypothesis 12** states ‘technological capabilities (X4) have a significant impact on organizational structure (X2)’. It is found that ‘technological capabilities (X4)’ has a statistically significant negative impact on ‘organizational structure (X2)’ (β = -0.352) (see Section 8.5.1.2). Therefore, **Hypothesis 12** is *supported*. The phenomenon can partly be explained in relation to the ownership of the majority of interviewees’ firms (see Section 8.3.2); where the firms have placed a certain degree of restrictions on employees’ access to company information and records as part of their risk management endeavour.
12. For **Hypothesis 13**, which states that “technological capabilities (X4) have a significant impact on supply chain capabilities (X5)”, there is insufficient evidence to establish that firms’ technological capabilities will significantly influence their supply chain capabilities. Thus, **Hypothesis 13** is *not supported*.
13. **Hypothesis 14** states that ‘technological capabilities (X4) have a significant impact on business strategies (X6)’. The results show that ‘technological

capabilities (X4)' exerts a statistically significant positive impact only on 'customer intimacy ($X6.2_{CIS}$)' (β = 0.491; see Section 8.5.5.3); one of the four dimensions of the business strategies (X6) construct. Thus, **Hypothesis 14** is *partially supported;* since only one of the four hypothesized relationships is statistically significant. The finding indicates that firms with superior technological capabilities are likely to possess a better capability in pursuing their customer intimacy initiative.

14. For **Hypothesis 15,** which states that 'technological capabilities (X4) have a significant impact on organizational flexibility (Y)', there is insufficient evidence to establish that a firm's technological capabilities will significantly influence its organizational flexibility. Therefore, **Hypothesis 15** is *not supported*.
15. **Hypothesis 16** states that 'supply chain capabilities (X5) have a significant impact on business strategies (X6)'. The results show that 'supply chain capabilities (X5)' exerts a statistically significant positive impact on 'cost leadership ($X6.1_{CLS}$)' (β = 0.447) and 'risk leadership ($X6.1_{RLS}$)' (β = 0.431) (see Section 8.5.5.1), among the four dimensions of the business strategies (X6) construct. Thus, **Hypothesis 16** is *partially supported;* since only one of the four hypothesized relationships is statistically significant. The findings indicate that a firm with superior supply chain capabilities is likely to possess enhanced capacity to pursue its cost and risk leadership initiatives.
16. **Hypothesis 17** states that 'supply chain capabilities (X5) have a significant impact on organizational flexibility (Y)'. The results show that 'supply chain capabilities (X5)' exerts statistically significant positive impacts on both 'strategic flexibility (Y_{SF})' (β = 0.358; see Section 8.5.6.3) and 'tactical flexibility (Y_{TF})' (β = 0.415; see Section 8.5.6.2). Therefore, **Hypothesis 17** is *partially supported;* since two out of the three hypothesized relationships are statistically significant. The findings indicate that firms' supply chain capabilities are of paramount

importance towards achieving organizational flexibility. This phenomenon may be partly explained by the extensive use of subcontracting in construction; whereby having good relationships with supply chain parties could improve a firm's responsiveness to marketplace changes.

17. **Hypothesis 18** states that 'business strategies (X6) have a significant impact on organizational flexibility (Y)'. The results show that three out of the four dimensions of the business strategies (X6) construct exert statistically significant positive impacts on 'strategic flexibility (Y_{SF})'. In order of importance, the three dimensions are: (i) 'customer intimacy ($X6.2_{CIS}$)' (β = 0.384); (ii) 'cost leadership ($X6.1_{CLS}$)' (β = 0.339); and (iii) 'risk leadership ($X6.1_{RLS}$)' (β = 0.324) (see Section 8.5.6.3). Also, 'product leadership ($X6.2_{PLS}$)' is found to have a statistically significant negative impact on 'operational flexibility (Y_{OF})' (β = -0.229) (see Section 8.5.6.1). Based on these, **Hypothesis 18** is *partially supported*; since four out the 12 hypothesized relationships among the dimensions of the two constructs are statistically significant.

10.2.4 Moderating roles of market and technological conditions

The fourth objective of this research is to investigate the moderating effects of market and technological conditions on the relationships between the determinants and organizational flexibility. Three sets of structural models were developed using the PLS product-indicator approach (see Section 6.5.2) to examine the moderating effects (see Sections 8.6) following a two-stage hierarchical process (see Section 6.5.3). The models were built using the test results of PLS M2 (see Section 8.4.3), in which only the respective statistically significant predictor constructs of: (i) operational flexibility (Y_{OF}); (ii) tactical flexibility (Y_{TF}); and (iii) strategic flexibility (Y_{SF}), were included.

Based on the results obtained, no moderating effects of market and technological conditions were found to be statistically significant on the relationships between the determinants and organizational flexibility. Therefore, **Hypothesis 19** is *not supported*.

However, other findings were detected when examining the moderating effects. They are:

1. 'Market conditions (Z_{MC})' has a statistically significant negative impact (β = -0.28) on 'operational flexibility (Y_{OF})' in the respective 'main effect' model (see Section 8.6.1). This means that high market volatility will weaken a firm's operational flexibility potential.
2. 'Technological conditions (Z_{TCn})' has a statistically significant negative impact (β = -0.24) on 'strategic flexibility (Y_{SF})' in the respective 'main effect' model (see Section 8.6.3). This means that high technological volatility is likely to restrict a firm's ability to be strategically flexible.

10.2.5 Flexibility indices

The last objective of this research is to design and test flexibility indices that measure construction firms' flexibility potential. Three mathematical models were developed based on the test results of PLS M2: (i) Eq. 9-1 for operational flexibility (Y_{OF}) (see Section 9.2.1); (ii) Eq. 9-2 for tactical flexibility (Y_{TF}) (see Section 9.2.2); and (iii) Eq. 9-3 for strategic flexibility (Y_{SF}) (see Section 9.2.3). These equations were tested with four new datasets in an effort to assess their robustness (see Section 9.3.2).

The results show that Models Y_{OF} (mean absolute percentage error = 6.59%) is robust in predicting a firm's operational flexibility potential. On the other hand, Models Y_{TF} and Y_{SF} did not perform satisfactorily in predicting a firm's tactical and strategic flexibility potentials with a corresponding mean absolute percentage error of 27.36% and 24.84%, respectively. This may largely due to the small sample size used (n= 4) for model validation.

To further ascertain whether the flexibility indices are valid measures, correlations between the three predicted flexibility dimensions (i.e., Y_{OF}, Y_{TF} and Y_{SF}) and firms' annual turnover were investigated. It is found that the three flexibility dimensions have statistically significant positive correlations with firms' annual turnover (i.e., sales volume). The finding indicates that the higher the level of contractors' flexibility potential, the higher will be their annual turnover (see Sections 9.3.3).

10.3 Contribution to theory

This study contributes to knowledge in construction business management by developing and successfully testing the theoretical framework of organizational flexibility that emphasizes the collective efforts of firms' resources, capabilities and strategies towards achieving organizational flexibility, in a business environment fuelled by market and technological forces. Previous construction-related studies investigated flexibility as a single-dimensional construct. This is the first known quantitative study in construction management research that investigates the concept of organizational flexibility from a multi-dimensional perspective. The study provides empirical evidence that organizational flexibility is a multi-dimensional concept comprising: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility. Also, the study empirically demonstrates the influence of inter-relationships among organizational resources, capabilities and strategies towards achieving different flexibility dimensions. It offers a new plausible explanation for the factors influencing organizational flexibility management in construction. These do not only broaden the focus of firms' flexibility practices but also enhances the understanding of the nature and constitution (i.e., flexibility types) of the respective flexibility dimensions.

Another contribution to theory is that this study applied and tested the theories of organizational learning (Cyert and March, 1963) (see Section 3.9.2) and dynamic capabilities (Teece et al., 1997) (see Section 3.9.3.2) on the concept of organizational flexibility by examining the effects of different dimensions of organization learning culture on construction firms' resources and capabilities in attaining flexibility. First, it establishes empirical evidence to support the claim that learning-orientation is important towards developing contractors' dynamic capabilities; given that dimensions of organizational learning culture are found to have statistically significant direct impacts on firms' resources and capabilities (see Figure 8.6 and Table 8.17). Second, this study discovered that a firm's commitment to learning ($X1_{CL}$) positively influences employees' skills and behaviour (X3), in which the latter is an important organizational asset that influences other organizational attributes (for example, supply chain capabilities (X5) and customer intimacy endeavour ($X6.2_{CIS}$)). It follows that the Teece et al.'s (1997) dynamic capabilities theory, which emphasized the influence of organizational processes on a firm's 'asset position' (for example, technological and structural assets) and path dependencies (for example, business development) towards attaining competitive advantage (see Section 3.9.3.2), should be modified by considering the role of 'employees' skills and behaviour' in the 'asset position' category in construction-related research.

The next contribution is that this study examined Thompson's (1967) dynamic contingency theory (see Section 3.9.1) on organizational flexibility, by exploring the moderating effects of two environmental conditions (i.e., market and technological conditions) on the relationships between construction firms' resources, capabilities, strategies (i.e., determinants) and organizational flexibility. Although no significant moderating effects of market and technological conditions were found on the relationships concerned, the findings show strong evidence concerning the direct impact of market and technological conditions on firms' operational and strategic flexibilities, respectively (see Section 8.6). From another perspective, these findings may suggest that the dynamic contingency theory is no longer sufficient to explain how Singapore construction firms behave flexibly in a changing business environment. Instead, contractors would need to engage themselves in a continuous learning process for improved responsiveness to environmental changes. This phenomenon may partly be explained in relation to the business conditions of the Singapore construction industry, where construction firms had undergone eight years of unprecedented economic downturn from 1997-2005, followed by an unstable market condition, from 2006-2007, due to the increasing prices of raw materials and soaring construction demand (see Section 2.5).

Lastly, this study examined the complexity theory (Prigogine and Stengers, 1984) (see Section 3.9.4) on organizational flexibility, and proved that construction firms could be seen as complex adaptive systems comprising many interrelated elements (i.e., resources, capabilities and strategies), which learn and adapt to their environment in their efforts to remain viable. Hence, further work on construction business management should consider these elements in the development of theoretical frameworks.

10.4 Implications for practice

The empirical findings of this study have implications for managerial actions in construction firms. These are now presented.

1. The empirical findings show that it is important for firms to foster a learning culture (X1) that emphasizes: (i) commitment to learning ($X1_{CL}$); (ii) shared vision and value ($X1_{SV}$); and (iii) open-mindedness ($X1_{O}$); given that each of these dimensions has a varying impact on other organizational attributes. For example, firms have to foster a shared vision and value environment in order to improve their technological capabilities, whereby employees are able to share information and communicate efficiently. This is consistent with Project Management Institute's (PMI, 2004) recommendation that managers should be proactive in creating a shared vision and value environment, improving the feelings of trust and cohesiveness among team members, in their attempts to raise productivity through greater teamwork. Likewise, firms have to be open-minded, in terms of encouraging employees to generate new ideas and adapt freely to changes without being restrained by past practices and routines, in their product leadership endeavours. Nevertheless, it is necessary for them to recognize the constructive and destructive impact of their commitment to learning on business operations (see Section 10.3). It follows that firms must continually assess their commitment to learning, and more importantly, differentiate the destructive and constructive learning behaviour of employees.

2. The study found that 'employees' skills and behaviour (X3)' is one key determinant that influences other determinants and organizational flexibility. The former influences supply chain capabilities (X5), and in turn, these two determinants collectively influence business strategies (X6) towards achieving organizational flexibility. It follows that construction firms may consider implementing various human resource management practices, suggested in Table 10.1, in their continuous efforts to monitor, develop and nurture their employees' skills and behaviour. Some of these highlighted practices have been highlighted by PMI (2004), emphasizing that managers should continually

monitor and develop the skills of their team members, by implementing appropriate human resource management practices, in order to improve their competencies to complete allocated activities for better project performance. Also, firms should recognize that individual practices should be collectively considered and implemented for better realization of behaviour change and skill improvement of their employees. For example, firms may provide on-the-job training to improve employees' skills, while conducting performance appraisal to identify employees' training need and offering career opportunities and promotion, in their efforts to improve the firms' employees' skills and gain behavioural commitment.

3. As highlighted in item 2, firms' supply chain capability (X5) is also an important determinant of business strategies (i.e., cost leadership ($X6.1_{CLS}$) and risk leadership ($X6.1_{RLS}$); see Sections 8.5.5.1 and 8.5.5.2) and organizational flexibility (i.e., operational flexibility (Y_{OF}) and tactical flexibility (Y_{TF}); see Sections 8.5.6.1 and 8.5.6.3). Of these, a firm's tactical flexibility is solely dependent on its supply chain capabilities. Therefore, contractors could place greater emphasis on building their supply chain capabilities, by: (i) providing prompt after-sales services to clients; (ii) organizing training for supply chain parties; (iii) organizing informal gatherings among supply chain parties; and (iv) keeping constant contact with clients (e.g., end users and consultants) to keep track of their needs (see Section 8.5.4). An important implication is that, although the development of supply chain capabilities involves relationship building with external parties (for example, clients and subcontractors) (see Section 4.6.2), this study found that contractors cannot capitalize on their supply chain capabilities to pursue a customer intimacy initiative ($X6.2_{CIS}$). Instead, it is the firms' employees' skills and behaviour (X3) and technological capabilities (X4) that influence their customer intimacy endeavour.

Table 10.1 Recommendations for developing employees' skills and behaviour

1. Competence development
a. Providing on-the-job training to improve employees' skills
b. Allowing employees to take days off for their continuous professional development and professional qualification courses
c. Subsidizing tuition fees of self-upgrading courses and seminars attended by employees
2. Stress management
a. Organizing stress coping and management courses
b. Implementing personal counselling programs
3. Performance management
a. Organizing informal gatherings to recognize employees' achievements
b. Organizing company trips to reward employees' contributions to firms' performance
c. Conducting staff performance appraisal exercises as a formal means of discussing, identifying and recording their training needs
d. Offering career development and promotion
4. Intra-organizational relationship management
a. Encouraging face to face communication among employees
b. Conducting regular meetings among subordinates and superiors
c. Implementing survey feedback programme to track the well-being of employees
d. Conducting induction programme for all new recruits

Note: Findings were extracted from Section 8.5.2

4. The findings show that contractors' cost, risk and resource management are important towards achieving their strategic flexibility (see Section 8.5.6.3). This is consistent with PMI (2004), suggesting that cost, risk and resource management are key practices towards better project performance, which in turn affect a firm's operation. Contractors should learn from their counterparts who were forced out of the industry, mainly due to: (i) under-pricing projects; (ii) overlooking environmental influences and risks within their business environment; and (iii) overstretching firms' resources and capabilities. They should be more prudent and vigilant against threats, bid rationally for projects and expand business ventures within their limits of available resources and capabilities. In addition, they may place greater emphasis on their cost control endeavours, and consider it as a proactive response, rather than a reactive strategy, to any foreseen or

unforeseen disturbance, by establishing, monitoring and reviewing their cost control protocols regularly. Other cost-related practices are summarized in Table 10.2.

Table 10.2 Recommendations for cost-related practices

1. Site waste management a. Adopting just-in-time delivery scheme to minimize material wastage; b. Implementing materials recycling programmes; c. Implementing profit-sharing scheme by rewarding employees for the amount of materials they saved; and d. Delegating responsibility of material inventory management to respective site managers.
2. Cash flow management a. Establishing a project milestones monitoring system to compare project cash flow with estimated project budget based on pre-determined milestones; b. Requiring project directors/managers to submit monthly progress reports; c. Implementing an Unbilled Receivable (UBR) system to monitor unbilled project receivables against project procurement expenses; and d. Engaging or appointing a company project cost auditor.
3. Procurement management a. Implementing a stricter purchase orders system – purchase orders are to be endorsed by at least three parties; b. Requiring project managers/directors to review and reconfirm the approximate quantity of materials and amount of work required in respective projects; and c. Procuring the required materials and services in bulk volume to realize the value of economies of scale.

Note: Findings were extracted from Section 8.5.6.3

5. The findings show that product leadership initiative has negative impact on operational flexibility and tactical flexibility (see Sections 8.3.3.2 and 8.5.6.1). It follows that firms need to recognize the risks involved in product or business development, and be ‘disciplined aggressive’ in their business ventures and learn how to stay adequately lean in managing their business in order to be flexible and responsive to changes in the environment. Rather than venturing into unfamiliar business areas, contractors should focus on the fundamentals of their business and stick to the basics (Drucker, 1980). As such, when engaging in a cycle of building and developing their resources and capabilities within

existing markets, contractors should plan strategically and iteratively in line with the business environment taking into account opportunities and threats in potential markets. Upon identifying their target, they should familiarize themselves with and invest incrementally into the targeted market. To further mitigate risks, contractors may consider forming partnerships with previous clients in their product development endeavours.

6. The study shows that contractors' good relationship with clients and established reputation play important roles in shaping their firms' ability to obtain sufficient jobs to tide over an economic downturn (see Sections 8.3.4.1 and 8.5.6.3). This is especially applicable in the private sector contracting where the established relationships and firms' reputation could often present contractors with contracting opportunities to bid for projects. Also, it is found that some contractors formed partnerships with their clients to undertake residential developments, in their endeavour to keep their resources occupied and sustain business operation during a downturn. All these further imply the importance for contractors to proactively and continuously engage themselves in relationship and reputation management regardless of whether times are good or bad.

7. The findings indicate that organizational flexibility management comprises three distinct but interrelated dimensions (i.e., operational flexibility, tactical flexibility and strategic flexibility; see Section 7.6), in which each has unique constituents (i.e., flexibility types) and configuration of determinants (see Section 8.5.6 and Figure 8.6). Therefore, firms should not only include them in decision making on the development and management of organizational flexibility, but also differentiate them and set specific objectives for each dimension. They may use the checklists developed (see Section 9.4), as instruments, in their strategic

planning for the type of resources and capabilities desired towards building and strengthening their organizational flexibility potential.

8. The study found that firms should consider the effects of market and technological conditions on their organizational flexibility development (see Sections 8.6.1 and 8.6.3). Failure to consider the market and technological conditions may undermine the firms' flexibility potential, which may, in turn, result in slow response and inability to react to marketplace changes.

10.5 Limitations of the study

The study presented empirical evidence that contribute to knowledge about organizational flexibility management in construction. However, the research findings need to be interpreted within the limitations of this study which is exploratory in nature; especially since the majority of measurement items of the respective constructs were borrowed from cross-discipline studies and then re-contextualized into construction context. The limitations of this study are now discussed.

1. The study used the key informant retrospective reporting approach (i.e., self-reporting) whereby all questions, relating to both independent and dependent variables, were assessed by one key personnel from each of the targeted group of firms. It follows that the strength of reported relationships between predictor and predicted constructs may be inflated by common method variance, and furthermore, the results may be susceptible to social desirability bias (i.e., informant bias) and distorted self-reporting error. Measures were taken to minimize the possibility of social desirability bias and common method variance problems: (i) questions relating to independent and dependent variables were structured and arranged in the way that interviewees were not aware of the proposed relationships (see Section 5.4.5), and (ii) assurances of anonymity

were provided in the cover letter and highlighted to the interviewees during the interview surveys (see Section 5.5.5). Besides these, the Harman's (1967) one-factor test results (see Section 6.4.1.1) and the respectable degree of reliability and validity obtained (see Sections 7.3 and 7.4) for respective constructs indicate that common method variance is not a significant problem in this study. Despite all these efforts, it is acknowledged that the results may be contaminated by common method variance. This limitation leads to the future research possibility discussed in Section 10.7.

2. The sample size of this research was not as large. The data were obtained from 41 executives of large and medium-sized Singapore construction firms, representing a response rate of 45%. This relatively small sample size placed restrictions on the ability to detect significant effects. However, the use of the PLS approach allows for statistical modelling of the structural models (see Section 6.3.2), and furthermore, the analysis shows that the response rate did not affect the validity of the results. Despite this evidence, it is acknowledged that the insignificant moderating effects of market and technological conditions may be due to the small sample size obtained in this study.

3. The study developed and tested the structural models, based on six key determinants (for example, organizational learning culture, organizational structure and supply chain capabilities) for achieving organizational flexibility, which were specified based on the review of the literature (see Chapter 4). The results show that the six determinants have, either direct or indirect, impacts on organizational flexibility. Despite these findings, it is acknowledged that the models could be: further refined by: (i) considering other organizational attributes, and (ii) exploring the other possible relationships among the six determinants, and between the determinants and the three flexibility dimensions,

which were not tested in this study. This limitation leads to the future research possibility discussed in Section 10.7.

4. The measurement models developed in this study have considered complex constructs (for example, organizational learning culture, employees' skills and behaviour, business strategies and organizational flexibility) that are intangible, dynamic and 'soft' assets of a construction firm. Although the results showed an acceptable level of construct reliability and validity, it is acknowledged that measurement items of respective constructs should be continuously updated for improved understanding about achieving organizational flexibility.

5. The structural model (PLS M2) was developed based the perception of 41 large and medium-sized construction firms which survived the 1997-2005 economic downturn in Singapore. It follows that the form and strength of the proposed relationships between constructs are likely to differ in different industry contexts. Though the findings of this study provide valuable insights into organizational flexibility management in construction, its application could have limitations in countries with different cultural and economic background from Singapore. Also, the model developed has not been further tested on Singapore construction firms that had gone into liquidation during the economic downturn, due to the difficulties encountered in contacting and persuading the relevant personnel of those firms. Besides this, the study did not consider the small-sized Singapore contractors and the construction firms that were established after the economic downturn. All these limitations lead to future research possibilities discussed in Section 10.7.

6. The study found that supply chain capabilities (X5) is the only significant determinant of tactical flexibility (Y_{TF}). It is acknowledged that a firm's tactical

flexibility might be affected by other determinants that have excluded included in the study. Therefore, this limitation leads to the future research possibility discussed in Section 10.7.

7. The study found that the three flexibility dimensions (i.e., operational flexibility, tactical flexibility and strategic flexibility) are significantly correlated with firms' annual turnover (i.e., sales volume). It is acknowledged that correlation is not equals to causation, and that firms' annual turnover could also be affected by other relevant variables such as environmental conditions and competitive priorities.

10.6 Conclusions

This research addresses the key questions of organizational studies as to "why do contractors need to be flexible?" and "how can contractors become flexible?" in the context of the construction industry. The need for construction firms to be flexible, via the effective utilization of organizational resources and capabilities for improved responsiveness, is important because of the increasing rate of changes in the business environment within which they operate. Achieving organizational flexibility is also important because it has a significant correlation with a firm's turnover.

In addressing the second question, it is essential for academics and practitioners to recognize that the attainment of organizational flexibility involves different dimensions, namely: (i) operational flexibility; (ii) tactical flexibility; and (iii) strategic flexibility, whereby each dimension requires different configurations of determinants (i.e., resources, capabilities and strategies). The findings indicate that relationships do exist among determinants, representing the collective functioning of firms' resources, capabilities and strategies towards achieving organizational flexibility.

Construction firms should consider these relationships and implement appropriate management practices for developing and configuring the right kind of resources, capabilities and strategies towards achieving different flexibility dimensions.

10.7 Directions of future research

This study lays the groundwork for future research concerning flexibility management in construction. As highlighted in Section 10.5, there are several areas of interest which can be further explored. Directions of future research are now presented.

1. The study is based on perceptions of 41 large and medium-sized contractors, who have survived the 1997-2005 economic downturn in Singapore. Future research could replicate the principle features of this study with a larger sample within different industries, regions or countries. Such comparative studies would be useful to test and refine the developed models, and to identify the differences in the constituents of organizational flexibility and their differentiated contributions to firms' performance. This may offer a new insight for researchers and practitioners into the effects of organizational culture and other specific factors on organizational flexibility.

2. Small-sized contractors were found to be unsuitable in this study (see Section 5.5.4) since they may not have enough resources and capabilities, compared to the large and medium-sized counterparts, for developing organizational flexibility in a more comprehensive scale. This however does not mean that small-sized contractors are not flexible, but rather, they tend to exhibit a different configuration of the organizational attributes for achieving organizational flexibility. It follows that future studies could examine how small-sized contractors attain organizational flexibility and then conduct a comparative study in exploring the differences and similarities of these two

groups of contractors in achieving organizational flexibility. Likewise, future studies could conduct a comparative study involving public listed and non-public listed contractors, extending the scope of the developed models and identifying the difference and similarity on the determinants of achieving organizational flexibility.

3. Given that this study focuses on the periods from 1997 - 2007, a direction for future research is to validate and extend the empirical findings by collecting and analyzing longitudinal data. It is strongly believed that the longitudinal studies may provide a better understanding of how the determinants and organizational flexibility change over time and their resultants dynamically influence firms' performance. Indeed, the importance of longitudinal studies can be supported by the increasing level of environmental turbulence.

4. Although this study provides a useful insight into the functioning of firms' resource-based determinants in attaining organizational flexibility, a direction for future research might be to explore the value creation and delivery process of organizational flexibility such as how to build, leverage and upgrade a firm's flexibility potential with limited or minimum resources in order to realize the full potential advantages of organizational flexibility. This emphasizes the dynamics of organizational flexibility in response to the increasing level of environmental turbulence.

5. Considering the exploratory nature of this study, another possible direction for future research is a thorough exploration of how the determinants, organizational flexibility and environmental conditions interact effectively among each other, and in turn determine a firm's performance. For example, future studies could explore whether and which determinants are

indispensable to achieve organizational flexibility in different environmental settings, and in turn affect a firm's performance. Furthermore, studies may explore the weight ratio of different flexibility dimensions corresponding to firms' performance (as highlighted in Section 9.4.1.1). This may in turn lead to the development of a single flexibility index for construction firms.

6. This study developed the structural model based on the six key resources and capabilities identified from the literature (see Section 3.7) and preliminary interviews (see Section 5.3.3.2). Future studies could explore the effect of other resources and capabilities (for example, management leadership, financial resources, firms' reputation and firms' size) on organizational flexibility.

7. As mentioned in Section 10.5, there may be a problem of common method variance due to the use of the key informant retrospective reporting and subjective data approaches in this study. Future studies could adopt the following methods to overcome this limitation: (i) the complementary use of more objective data; (ii) the use of multiple informants that involves the cross-checking of reported information; and (iii) the use of the multitrait-multimethod matrix technique that involves application of different data collection methods in collecting a similar set of data.

Bibliography

Aaker, D.A. and Mascarenhas, B. (1984) The need for strategic flexibility. *The Journal of Business Strategy*, **5**(2), 74–82.

Adler, P.S. (1988) Managing flexibility automation. *California Management Review*, **30**(3), 34-56.

Agapiou, A., Flanagan, R. Norman, G. and Notman, D. (1998) The changing role of builders merchants in the construction supply chain. *Construction Management and Economics*, **16**(3), 351-351.

Ahmed, P.K., Hardaker, G. and Carpenter, M. (1996) Integrated flexibility- key to competition in a turbulent environment. *Long Range Planning*, **29**(4), 562-571.

Aibinu, A.A., Ofori, G. and Ling, F.Y.Y. (2008) Explaining cooperative behaviour in building and civil engineering projects' claims process: interactive effects of outcome favourability and procedural fairness. *Journal of Construction Engineering and Management,* **134**(9), 681-691.

Aiken, M. and Hage, J. (1968) Organizational interdependence and intra-organizational structure. *American Sociological Review*, **33**(6), 912-930.

Akintoye, A., McIntosh, G., Fitzgerald, E. (2000) A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing & Supply Management*, **6**(3-4), 159-168.

Aldrich, H.E. and Preffer, J. (1976) Environments of organizations. *Annual Review of Sociology*, **2**(1), 79-105.

Allayannis, G., Ihrig, J. and Weston, J.P. (2001) Exchange-rate hedging: financial versus operational strategies. *The American Economic Review*, **91**(2), 391-395.

Amit, R. and Schoemaker, P. (1993) Strategic assets and organizational rents. *Strategic Management Journal*, **14**(1), 33-46.

Amoroso, D.L. and Cheney, P.C. (1991) Testing a casual model of end-user application effectiveness. *Journal of Management Information system,* **8**(1), 63-89.

Anderson, J.C. and Gerbing, D.W. (1988) Structural equation modelling in practice: a review and recommended two-step approach. *Psychological Bulletin*, **103**(3), 411-423.

Anderson, P. (1999) Complexity theory and organization science. *Organization Science*, **10**(3), 216–232.

Andrew, C.J. and Krogmann, U. (2009) Explaining the adoption of energy-efficient technologies in U.S. commercial buildings. *Energy and Buildings*, **41**(3), 287-294.

Annett, A. (2001) Social fractionalization, political instability, and the size of government. *IMF Staff Papers*, **48**(3), 561-592.

Ansoff, H.I. (1965) *Corporate Strategies*. New York: McGraw-Hill.

Arditi, D. and Chotibhongs, R. (2005) Issues in subcontracting practice. *Journal of Construction Engineering and Management*, **131**(8), 866 – 876.

Argyris, C. and Schon, D.A. (1978) *Organizational Learning: A Theory of Action Perspective*. Reading: Addison-Wesley.

Athey, R. (2008) It's 2008: do you know where your talent is? Connecting people to what matter? *Journal of Business Strategy*, **29**(4), 4-14.

Atkinson, J. (1984) Manpower strategies for flexible organizations. *Personnel Management*, **16**(8), 28–31.

Avison, D.E., Powell, P.L., Keen, J., Klein, J.H. and Ward, S. (1995) Addressing the need for flexibility in information system. *Journal of Management Systems*, **7**(2), 43-60.

Avolio, B.J. and Bass, B.M. (1991) Identifying common methods variance with data collected from a single source: an unresolved sticky issue. *Journal of Management*, **17**(3), 571–587.

Bagozzi, R.P., Yi, Y. And Phillips, L.W. (1991) Assessing construct validity in organizational research. *Administrative Science Quarterly*, **36**(3), 421-458.

Bahrami, H. (1998) The emerging flexible organization: perspectives from Silicon Valley. In Mabey, C., Salaman, G. and Storey, J. (eds.), *Strategic Human Resource Management: A Reader*. London: Sage.

Baker, W.E. and Sinkula J.M. (1999) The synergistic effect of market orientation and learning orientation on organizational performance. *Journal of Academic Marketing Science*, **27**(4), 411–427.

Ball, M. (1988) *Rebuilding Construction: Economics Change and the British Construction Industry*. London: Routledge.

Barley, S.R. (1983) Semiotics and the study of occupational and organizational cultures. *Administrative Science Quarterly*, **28**(3), 393-413.

Barlow, J. and Jashapara, A. (1998) Organizational learning and inter-firm "partnering" in the UK construction industry. *The Learning Organization: An International Journal*, **5**(2), 86-98.

Barney, B.J. (1996) *Gaining and Sustaining Competitive Advantage*. New York: Addison-Wesley.

Barney, J.B. (1986) Organizational culture: can it be a source of competitive advantages? *Academy of Management Review*, **11**(3), 656-665.

Barney, J.B. (1991) Firm resources and sustained competitive advantage. *Journal of Management*, **17**(1), 99–120.

Barney, J.B. (1995) Looking inside for competitive advantage. *Academy of Management Executive*, **9**(4), 49-61.

Barney, J.B. (2001) Is the resource-based 'view' a useful perspective for strategic management research? Yes. *Academy of Management Review*, **26**(1), 41-56.

Barney, J.B. and Wright, P.M. (1998) On becoming a strategic player: the role of human resources in gaining competitive advantage. *Human Resource Management*, **37**(1), 31-46.

Barratt, M. and Oke, A. (2007) Antecedents of supply chain visibility in retail supply chains: a resource based theory perspective. *Journal of Operations Management*, **25**(6), 1217-1233.

BCA (2000) *Construction Economic Report: Fourth Quarter 1999.* Singapore: Building and Construction Authority.

BCA (2002) *Contracts Awarded by Sector and Type of work*, as at 30th August January 2002. Singapore: Building and Construction Authority.

BCA (2003) *First Private Developer in Singapore Obtains ISO14000 and OHSMS Certification* - press release, downloaded from http://www.bca.gov.sg/newsroom /others/pr191103.pdf <100608>.

BCA (2005) *Construction Project Listing,* as at 30th December 2005, Singapore: Building and Construction Authority.

BCA (2007) *Green Mark Incentive Scheme*, Singapore: Building and Construction Authority, downloaded from: http://www.bca.gov.sg/GreenMark/ GMIS.html, <130308>.

BCA (2008a) *Directory of BCA Registered Contractors and Licensed Builders*, Building and Construction Authority of Singapore, downloaded from: http://dir.bca.gov.sg/bca/AdvSearchList.asp?actual_pg=1&ListAbsolutePage=1 <200608>.

BCA (2008b) *Design & Build Trend*, Building and Construction of Singapore, downloaded from http://www.bca.gov.sg/DesignBuild/design_build_statistics_fig2.html <301108>.

BCA (2008c) *Construction Project Listing,* as at 26th December 2008. Singapore: Building and Construction Authority.

BCA (2008d) *Green Mark Project*, Building and Construction Authority of Singapore, available at: http://www.bca.gov.sg/GreenMark/ green_mark_ projects.html <130308>.

BCA (2009a) *Contracts Awarded by Sector and Type of work*, as at 14th January 2009. Singapore: Building and Construction Authority.

BCA (2009b) *Market Price of Construction Material*, as at 14th January 2009. Singapore: Building and Construction Authority.

BCA (2009c) *BCA Registered Contractors – Terms of Registration,* as at July 2009. Singapore: Building and Construction Authority.

BCA (2009c) 2nd Green Building Materplan, Building and Construction Authority of Singapore, downloaded from: http://www.bca.gov.sg/GreenMark/others/gbmp2.pdf <100709>

Beach, R., Muhlemann, A.P., Price, D.H.R., Paterson, A. and Sharp, J.A. (2000) A review of manufacturing flexibility. *European Journal of Operational Research*, **122**(1), 41–57.

Bennett, J. (1991) *International construction project management*. Oxford: Butterworth-Heinemann.

Bergkvist, L. and Rossiter, J.R. (2007) The predictive validity of multiple-item versus single-item measures of the same constructs. *Journal of Marketing Research*, **44**(2), 175-184.

Bernard, H.R. (2000) *Social Research Methods: Qualitative and Quantitative Approaches*. California: Sage Publication Inc.

Betts, M. (1991) Achieving and measuring flexibility in project information retrieval. *Construction Management and Economics*, **9**(3), 231–245.

Betts, M. and Brown, P. (1992) Construction tender bid variability in Singapore. *AACE Transactions*, **2**, 6.1-6.12.

Betts, M. and Ofori, G. (1994) Strategic planning for competitive advantage in construction: the institutions. *Construction Management and Economics*, **12**(3), 203-217.

Beugelsdijk, S., Koen, C.I. and Noorderhaven, N.G. (2006) Organizational culture and relationship skills. *Organization studies*, **27**(6), 833-854.

Bevan, R. (2008) Cliques and mortar: Public-private partnerships sound so dinky, but their very foundation is flawed. *Architecture, Australian Financial Review*, June 13-15, p. L19-L21.

Bhattacharya, M., Gibson, D.E. and Doty, D.H. (2005) The effects of flexibility in employee skills, employees behaviours, and human resource practices on firm performance. *Journal of Management*, **31**(4), 622-640.

Blau, P.M. (1974) *On the Nature of Organizations*. New York: John Wiley and Sons, Inc.

Blau, P.M. and Schoenherr, R.A. (1971) *The Structuring of Organizations*. New York: Basic Books.

Blazevic, V. and Lievens, A. (2004) Learning during the new financial service innovation process: antecedents and performance effects. *Journal of Business Research*, **57**(4), 374-391.

Bogner, W.C. and Thomas, H. (1994) Core competences and competitive advantage: a model and illustrative evidence from pharmaceutical industry. In Hamel, G. and Heene, A. (eds.), *Competence- Based Competition*. New York: John Wiley, pp. 111–148.

Boisot, M. and Child, J. (1999) Organizations as adaptive systems in complex environment: The case of china. *Organization Science*, **10**(3), 237–252.

Bollen, K.A and Lennox, R. (1991) Conventional wisdom on measurement: a structural equation perspective. *Psychological Bulletin*, **110**(2), 305-314.

Bollen, K.A and Paxton, P. (1998) Interaction of latent variables in structural equation models. *Structural Equation Modelling*, **5**(3), 267-293.

Bollen, K.A. (1989) *Structural Equations with Latent Variables*. New York: Wiley.

Bon, R. (1989) *Building as an Economic Process*. New Jersey: Prentice-Hall

Bon, R. and Crosthwaite, D. (2000) *The Future in International Construction*. London: Thomas Telford.

Bone, P.F., Sharma, S. and Shimp, T.A. (1989) A bootstrap procedure for evaluating goodness-of-fit indices of structural equation and confirmatory factor models. *Journal of Marketing Research*, **26**(1), 105-111.

Boon, J. (1996) Survival strategies for small professional firms in a volatile market. In Langford, D.A. and Retik, A. (eds.) *The Organization and Management of Construction: Shaping Theory and Practices (Volume 1)*. London: E&FN Spoon, pp.87–96.

Bourgeois, L.J.III. (1980) Performance and consensus. *Strategic Management Journal*, **1**(3), 227-248.

Bourgeois, L.J.III. and Brodwin, D.R. (1984) Strategic implementation: five approaches to an elusive phenomenon. *Strategic Management Journal*, **5**(3), 241-264.

Bourgeois, L.J.III. and Eisenhart, K.M. (1988) Strategic decision process in high velocity environments: four cases in the microcomputer industry. *Management Science*, **34**(7), 816-835.

Bowman, E.H. and Hurry, D. (1993) Strategy through the option lens: an integrated view of resource investments and the incremental-choice process. *Academy of Management Review*, **18**(4), 760-782.

Boyd, B.K. and Fulk, J. (1996) Executive scanning and perceived uncertainty: a multidimensional model. *Journal of Management*, **22**(1), 1-21.

Boyle, T.A. (2006) Towards best management practices for implementing manufacturing flexibility. *Journal of Manufacturing Technology Management*, **17** (1), 6-21.

Briscoe, G.H. (2009) The impact of fiscal, monetary and regulatory policy on the construction industry. In Ruddock, L. (ed.), *Economics for the Modern Built Environment*. New York: Taylor and Francis, pp. 113-129.

Brochner, J. (2009) The changing nature of the built environment. In Ruddock, L. (ed.), *Economics for the Modern Built Environment*. New York: Taylor and Francis, pp. 11-33.

Brown, A. (1998) *Organizational culture*, 2nd Ed. London: Financial Times Pitman Publishing.

Brown, S.L. and Eisenhardt, K.M. (1995) Product development: past research, present findings, and future direction. *Academy of Management Review*, **20**(2), 343-378.

Browne, J., Dubois, D., Rathmill, K., Sethi, S.P. and Stecke, K.E. (1984) Classification of flexible manufacturing systems. *The Flexibility Manufacturing System Magazine*, **2**(2), 114–117.

Bucki, J and Pesqueux, Y (2000) Flexible workshop: about the concept of flexibility. *International Journal of Agile Management System,* **2**(1), 62–70.

Buckley, A. (1997) Valuing tactical and strategic flexibility. *Journal of General Management*, **22**(3), 74-91.

Buckley, P.J. and Casson, M.C. (1998) Models of the multinational enterprise. *Journal of International Business Studies*, **29**(1), 21-44.

Burawoy, W. (1991) *Unbound: Power and Resistance in the Modern Metropolis*. California: University of California Press.

Burns, T. and Stalker, G.M. (1961) *The Management of Innovation*. London: Tavistock Publication.

Burton, R.M. and Obel, B. (2004) *Strategic Organizational Diagnosis and Design: The Dynamics of Fit*, 3rd Ed. New York: Springer Science.

Burton, R.M., DeSanctis, G. and Obel, B. (2006) *Organizational Design: A Step-By-Step Approach*. Cambridge: Cambridge University Press.

Cadogan, J.W., Cui, C.C. and Li, E.K.Y. (2003) Export market-orientated behaviour and export performance: the moderating roles of competitive intensity and technological turbulence. *International Marketing Review*, **20**(5), 493-513.

Calantone, R.J., Cavusgil, S.T. and Zhao, Y. (2002) Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, **31**(6), 515-524.

Cameron, E. and Green, M. (2004) *Making Sense of Change Management*. London: Kogan Page.

Campbell, D.T. and Fiske, D.W. (1959) Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, **56**(2), 81-105.

Campell, D. (1969) Variation, selection and retention in soci-cultural evolution. *General Systems*, **16**(1), 69-85.

Carlsson, B. (1989) Flexibility and the theory of the firm. *International Journal of Industrial Organization*, **7**(2), 179–203.

Carlsson, B. (1992) Management of flexible manufacturing: an international comparison. *Omega*, **20**(1), 11-22.

Carroll, T. and Burton, R.M. (2000) Organizations and complexity: searching for the edge of chaos. *Computational and Mathematical Organization Theory*, **6**(4), 319–337.

Cartlidge, D. (2004) *Procurement of Built Assets*. Oxford: Butterworth Heinemann.

Chaffee, E.E. (1985) Three models of strategy. *Academy of Management Review*, **10**(1), 89-98.

Chakravarthy, B.S. (1982) Adaptation: a promising metaphor for strategic management. *Academy of Management Review*, **7**(1), 34-44.

Chan, K. (2007) Integrating traditional commercial buildings with intelligent building concepts. *Cost Engineering*, **49**(3), 25-36.

Chandler, A.D. (1962) *Strategy and structure*. Cambridge: MIT Press.

Chandler, A.D. (1997) Strategy and structure. In Foss, N.J. (Ed.), *Resources, Firms and Strategies*. New York: Oxford University Press, pp. 40–51.

Chang, S.C, Yang, C.L., Cheng, H.C. and Sheu, C. (2003) Manufacturing flexibility and business strategy: an empirical study of small and medium sized firms. *International Journal of Production Economics*, **83**(1), 13-26.

Chang, S.C., Chen, R.H., Lin, R.J., Tien, S.W. and Sheu, C. (2006) Supplier involvement and manufacturing flexibility. *Technovation*, **26**(10), 1136-1146.

Chen, M. and Hambrick, D.C. (1995) Speed, stealth, and selective attack: how small firms differ from large firms in competitive behaviour. *Academy of Management Journal*, **38**(2), 453–482.

Cheng, E., Li, H., Drew, D. and Yeung, N. (2001) Infrastructure of Partnering for Construction Projects. *Journal of Management in Engineering*, **17**(4), 229–237.

Cheng, E.W.L., Li, H. and Love P.E.D. (2000) Establishment of Critical Success Factors for Construction Partnering. *Journal of Management in Engineering*, **16**(2), 84 – 92.

Chiang, Y.H. (2009) Subcontracting and its ramifications: a survey of the building industry in Hong Kong. *International Journal of Project Management*, **27**(1), 80-88.

Child, J. (1972) Organizational structure, environment and performance: the role of strategic choice. *Sociology*, **6**(1), 1-22.

Child, J. (1984) *Organization: A Guide to Problems and Practices*, 2nd Ed. London: Harper & Row.

Chin, W.W. (1998a) The partial least squares approach to structural equation modelling. In Marcoulides, G.A. (ed.), *Modern Methods for Business Research*. New Jersey: Lawrence Erlbaum Associates Publisher, pp. 295–335.

Chin, W.W. (1998b) Commentary: issues and opinion on structural equation modelling. *MIS Quarterly*, **22**(1), vii-xvi.

Chin, W.W. and Newstead, P.R. (1999) Structural equation modelling analysis with small samples using partial least squares. In Hoyle, R.H. (ed.), *Statistical Strategies for Small Sample Research*. Thousands Oaks: Sage Publication, pp. 308– 337.

Chin, W.W., Marcolin, B. and Newstead, P.R. (1996) A partial least square latent variable modelling approach for measuring interaction effects: results from a Monte Carlo simulation study and voice mail emotion/adoption study. *Proceedings of the Seventeenth International Conference on Information systems*, pp. 21-41.

Chin, W.W., Marcolin, B. and Newstead, P.R. (2003) A partial least squares latent variables modelling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic mail emotion/adoption study. *Information System Research*, **14**(2), 189–217.

Cho, M.C.T. and Fellows, R. (2000) Intelligent building systems in Hong Kong offices. *Facilities*, **18**(5), 225-234.

Christopher, M. (1992) *Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Strategies*. London: Pitman.

Chua, D.K.H., Wang, Y. and Tan, W.T. (2003) Impacts of obstacles in East Asian cross-border construction. *Journal of Construction Engineering and Management*, **129**(2), 131-141.

Chung, W. and Hui, Y,V, (2009) A study of energy efficiency of private office buildings in Hong Kong. *Energy and Buildings*, **41**(6), 696-701.

Church, M. (1999) Organizing simply for complexity: beyond metaphor towards theory. *Long Range Planning*, **32**(4), 425-440

Churchill, G.A. (1979) A paradigm for developing better measures for marketing constructs. *Journal of Marketing Research*, **16**(1), 64–73.

Churchill, G.A. and Iacobucci, D. (2005) *Marketing Research: Methodological Foundations*, 9th Ed. Ohio: Thomson/South-Western.

Cohen, J. (1988) *Statistical Power Analysis for the Behavioural Science,* 2nd Ed. New Jersey: Lawrence Erlbaum.

Collin, P.H. (2004) *Dictionary of Business*. London: Bloomsbury.

Collis, D.J. and Montgomery, C.A. (1999) Competing on resources: strategy in the 1990s. In Zack, M.H. (Ed.), *Knowledge and Strategy*. Boston: Butterworth-Heinemann, pp. 25–40.

Compeau, D.R. and Hinggins, C.A. (1995) Application of social cognitive theory to training for computer skills. *Information Systems Research*, **6**(2), 118-143.

Comrey, A.L. (1973) *A First Course in Factor Analysis*. New York: Academic Press.

Construction 21 Steering Committee (1999) *Reinventing Construction*. Singapore: Ministry of Manpower and Ministry of National Development.

Construction Industry Institute (1993) *Competing in the Global MKarket*. Austin: The Construction Industry Institute.

Cooper, M.C., Lambert, D.M. and Pagh, J.D. (1997) Supply chain management: more than a new name for logistics. *International Journal of Logistics Management,* **8**(1), 1-14.

Correa, H.L. (1994) The flexibility of technological and human resources in automotive manufacturing. *Integrated Manufacturing System*, **5**(1), 33–40.

Cox, A. and Ireland, P. (2002) Managing construction supply chains: the common sense approach. *Engineering, Construction and Architectural Management*, **9**(5/6), 409–418.

Cox, A. and Thompson I. (1997) ‘Fit for purpose’ contractual relations: determining a theoretical framework for construction projects. *European Journal of Purchasing and Supply Management*, **3**(3), 127 – 135.

CPG (2005) *Published tender reports*, available at www.cpgcorp.com.sg <100606>.

Crocitto, M. and Youssef, M. (2003) The human side of organizational agility. *Industrial Management and Data Systems*, **103**(6), 388–397.

Crocker, L. and Algina, J. (1986) *Introduction to Classical and Modern Test Theory*. New York: Rinehart and Winston.

Cronbach, L.J. (1970) *Essentials of Psychological Testing*, 3rd Ed. New York: Harper & Row.

Cronbach, L.J. (1987) Statistical tests for moderator variables: flaws in analyses recently proposed. *Psychological Bulletin*, **102**(3), 414-417.

Crozier, M. and Thoening, J.C. (1976) The regulation of complex organized systems. *Administrative Science Quarterly*, **21**(4), 547-570.

Cudeck, R. (2000) Exploratory factor analysis. In Tinsley, H.E.A and Brown, S.D. (eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modelling*. California: Academic Press, pp. 265-296.

Cunha, M.P. and Cunha, J.V. (2006) Towards a complexity theory of strategy. *Management Decision*, **44**(7), 839-850.

Cyert, R.M. and March J.G. (1963) *A Behavioural Theory of Firm*. New Jersey: Prentice Hall.

D’Souza, D.E. and Williams, P.E. (2000) Toward a taxonomy of manufacturing flexibility dimensions. *Journal of Operations Management*, **18**(5), 577-593.

Daft, R.L. (1992) *Organization theory and design*, 4th Ed. Minnesota: West Publishing.

Daft, R.L. and Marcic, D. (2007) *Management: The New Workplace*. Ohio: Thomson South Western.

Dainty, A.R.J., Briscoe, G. and Millett, S. (2001) Subcontractor Perspectives on supply chain alliances. *Construction Management and Economics*, **19**(8), 841-848.

Dalton, D.R., Todor, W.D., Spendolini, M.J., Fielding, G.J. and Porter, L.W. (1980) Organization structure and performance: a critical review. *Academy of Management Review*, **5**(1), 49-64.

Das, S.K. and Elango, B. (1995) Managing strategic flexibility: key to effective performance. *Journal of General Management*, **20**(3), 60-75.

Das, S.K. and Patel, P. (2002) An audit tool for determining flexibility requirements in a manufacturing facility. *Integrated Manufacturing Systems*, **13**(4), 264 – 274.

Davis Langdon and Seah International (2000) *Spon's Asia Pacific Construction Costs Handbook*, 3rd Ed. London: E & F.N. Spon.

Dawes, J. (2007) Do data characteristics change according to the number of scale points used?. An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research*, **50**(1), 61-78.

Day, G.S. (1991) *Learning about Markets*, Marketing Science Institute Report. Cambridge: Marketing Science Institute.

Day, G.S. (1994) The capabilities of market-driven organizations. *Journal of Marketing*, **58**(4), 37-52.

Debrah, Y.A. and Ofori, G. (1997) Flexibility, labour subcontracting and HRM in the construction industry in Singapore: can the system be refined? *The international Journal of Human Resource Management*, **8**(5), 690–709.

Denton, J. (1998) *Organizational learning and effectiveness*. London: Routlege.

Department of Statistics (1998) *Formation and Cessation of Companies and Businesses 1997* - Singapore statistics newsletter. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (1999) *Formation and Cessation of Companies and Businesses 1998* - Singapore statistics newsletter. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2001) *Economics Surveys of Singapore*, *2000*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2002) *Economics Surveys of Singapore*, *2001*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2004) *Economics Surveys of Singapore*, *2004*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2006) *Economics Surveys of Singapore*, *2005*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2007) *Economics Surveys of Singapore*, *3rd Quarter 2007*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2008a) *Yearbook of Statistics Singapore*, *2008*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Department of Statistics (2008b) *Population Trends 2008, June*. Republic of Singapore: Department of Statistics, Ministry of Trade and Industry.

Desarbo, W.S., Benedetto, C.A.D., Song, M. and Sinha, I. (2005) Revisiting the Miles and Snow strategic framework: Uncovering interrelationships between strategic types, capabilities, environmental uncertainty, and firm performance. *Strategic Management Journal*, **26**(1), 47–74.

Dess, G.G. and Beard, D.W. (1984) Dimensions of organizational task environments. *Administrative Science Quarterly*, **29**(1), 52-73.

Dickson, P.R. (1996) The static and dynamic mechanisms of competition: a comment on Hunt and Morgan's comparative advantage theory. *Journal of Marketing*, **60**(4), 102-106.

Dijkstra, T. (1983) Some comments on maximum likelihood and partial least squares methods. *Journal of Econometrics*, **22**(1-2), 67-90.

Dikmen, I., Birgonul, M.T. and Kizitas, S. (2005) Prediction of organizational effectiveness in construction companies. *Journal of Construction Engineering and Management*, **131**(2), 252–261.

Dilalla, L.F. (2000) Structural equation modelling: uses and issues. In Tinsley, H.E.A and Brown, S.D. (eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modelling*. California: Academic Press, pp. 440-462.

Dill, W.R. (1958) Environment as an influence on managerial autonomy. *Administrative Science Quarterly*, **2**(1), 409-443.

Dillman, D.A. (1978) *Mail and Telephone Surveys: The Total Design Method*. New York: John Wiley & Sons.

Dillman, D.A. (2007) *Mail and Internet Surveys: The Tailored Design Method*, 2nd Ed. New Jersey: John Wiley & Sons.

Dixon, N.M. (1992) Organizational learning: a review of the literature with implications for HRD professionals. *Human Resource Development Quarterly*, **3**(1), 29–49.

Dodgson, M. (1991) Technological learning, technology strategy and competitive pressure. *British Journal of Management*, **2**(1), 3-10.

Dodgson, M. (1993) Organizational learning: a review of some literatures. *Organization Studies*, **14**(3), 375-394.

Donaldson, L. (2001) *The Contingency Theory of Organizations*. California: Sage Publications.

Dosi, G. (1984) *Technical Change and Industrial Transformation*. New York: St. Martin's Press.

Dreyer, B. and Gronhaug, K. (2004) Uncertainty, flexibility and sustained competitive advantage. *Journal of Business Research*, **57**(5), 484-494.

Drucker, P.F. (1980) *Managing in Turbulent Times*. New York: Harper & Row.

Drucker, P.F. (1999) Knowledge-worker productivity: the biggest challenge. *California Management Review*, **41**(2), 79-94.

Duclos, L.K., Vokurka, R.J. and Lummus, R.R. (2003) A conceptual model of supply chain flexibility. *Industrial Management and Data Systems*, **103**(6), 446–456.

Dulaimi, M.F. and Hong, G.S. (2002) The factors influencing bid mark-up decisions of large- and medium-size contractors in Singapore. *Construction Management and Economics*, **20**(7), 601–610.

Dulaimi, M.F. and Tan, (2001) Developing world class construction companies in Singapore. *Construction Management and Economics*, **19**(6), 591-599.

Dulaimi, M.F., Nepal, M.P. and Park, M. (2005) A hierarchical structural model of assessing innovation and project performance. *Construction Management and Economics,* **23**(6), 565–577.

Duncan (1972) Characteristics of organizational environment and perceived environmental uncertainty. *Administrative Science Quarterly*, **17**(3), 313–327.

Eccles, R.G. (1981) Bureaucratic versus craft administration: the relationship of market structure to the construction firm. *Administrative Science Quarterly*, **26**(3), 449-469.

Economic Department Board (EBD) (2009) *Industries,* Economic Department Board of Singapore, available at: http://www.edb.gov.sg/edb/sg/en_uk/index/industry_sectors/pharmaceuticals.html <130509>

Efron, B. (1979) Bootstrap methods: another look at the jacknife. *Annals of Statistics*, **7**(1), 1-26.

Efron, B. (1982) *The Jacknife, the Bootstrap and Other Sampling Plans*. Philadelphia: Society for Industry and Applied Mathematics.

Efron, B. (1987) Better bootstrap confidence intervals. *Journal of the American Statistical Association*, **82**(397), 171-185.

Egan J. (1998) *Rethinking Construction*. London: Development of the Environment, Transport and the Regions.

Eijnatten, F.M. (2004) Chaordic systems thinking: some suggestions for a complexity framework to inform a learning organization. *The Learning Organization: An International Journal,* **11**(6), 430-449.

Eijnatten, F.M. and Putnik, G.D. (2004) Chaos, complexity, learning and the learning organization: towards a chaordic enterprise. *The Learning Organization: An International Journal*, **11**(6), 418-429.

Eisenhardt, K.M. and Martin, J.A. (2000) Dynamic capabilities: what are they? *Strategic Management Journal*, **21**(10-11), 1105-1121.

Ekanayake, L.L. and Ofori, G. (2004) Building waste assessment score: design-based tool. *Building and Environment*, **39**(7), 851-861.

Elmuti, D. (2002) The perceived impact of supply chain management on organization effectiveness. *Journal of Supply Chain Management*, **38**(3), 49–57.

Englehardt, C.S. and Simmons, P.R. (2002) Organizational flexibility for a changing world. *Leadership & Organizational Development Journal*, **23**(2), 113–121.

Eppink, D.J. (1978) *Managing the Unforeseen: A Study of Flexibility.* Dissertation thesis. Ermelo: Administratief Centrum.

European Construction Technology Platform (ECTP) (2005) *Strategic Research Agenda for the European Construction Sector – Achieving a Sustainable and Competitive Construction Sector by 2030*, The European Construction Technology Platform, downloaded from: http://cordis.europa.eu/technology-platforms/ pdf/ectp2.pdf <100608>.

Evans, J.S. (1991) Strategic flexibility for high technology manoeuvres: a conceptual framework. *Journal of Management Studies*, **28**(1), 69–89.

Fahey, L. and Christensen, H.K. (1986) Evaluating the research on strategy content. *Journal of Management*, **12**(2), 167-183.

Falk, R.F. and Miller, N.B. (1992) *A Primer for Soft Modelling*. Ohio: University of Akron Press.

Fiegenbaum, A. and Karnani, A. (1991) Output flexibility– competitive advantages for small firms. *Strategic Management Journal*, **12**(2), 101-114.

Figueiredo, P.N. (2002) Learning processes features and technological capabilities accumulation: explaining inter-firm difference. *Technovation*, **22**(11)685-698

Finkel, G. (1997) *The Economics of the Construction Industry*. New York: ME Sharpe Inc.

Fiol, C. And Lyles, M. (1985) Organizational Learning. *Academy of Management Review*, **10**(4), 803-813.

Flamholtz, E. and Randle, Y. (2008) *Leading Strategic Change: bridging theory and practice*. Cambridge: Cambridge University Press.

Flanagan, R. (1994) The features of successful construction companies in the international construction market. In Warzawki, A. and Navon, R. (eds.), *Strategic Planning in Construction*, Proceedings of the A. J. Etkin International Seminar on Strategic Planning in Construction Companies, 8-9 June, Haifa, Israel, pp. 304 - 318.

Ford, D.N. and Bhargav, S. (2006) Project management quality and the value of flexible strategies. *Engineering, Construction and Architectural Management*, **13**(3), 275-289.

Ford, D.N., Lander, D.M. and Voyer, J.J. (2002) A real options approach to value strategic flexibility in uncertain construction projects. *Construction Management and Economics*, **20**(4), 343–351.

Ford, J.D. and Slocum, J.W. (1977) Size, technology, environment and the structure of organizations. *Academy of Management Review*, **2**(4), 561-569.

Fornell, C. and Bookstein, F.L. (1982) Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, **19**(4), 440-452.

Fornell, C. and Cha, J. (1994) Partial least squares. In Bagozzi, R.P. (ed.), *Advanced Methods of Marketing Research*. Cambridge: Blackwell Business, pp. 52-78.

Fornell, C. and Larcker, D.F. (1981) Evaluating structural equation models with unobserved variables and measurement error. *Journal of Marketing Research*, **18**(1), 39-50.

Fornell, C., Lorange, P. and Roos, J. (1990) The cooperative venture formation process: a latent variable structural modelling approach. *Management Science*, **36**(10), 1246-1255.

Fredericks, E. (2005) Infusing flexibility into business-to-business firms: a contingency theory and resource-based view perspective and practical implications. *Industrial Marketing Management*, **34**(6), 555-565.

Frenken, K. (2006) Technological innovation and complexity theory. *Economics of Innovation and New Technology*, **15**(2), 137–155.

Fynes, B. de Burca, S. and Marshall, D. (2005) Environmental uncertainty, supply chain relationship quality and performance. *Journal of Purchasing and Supply Management*, **10**(4-5), 179-190.

Galbraith, C.S. (1990) Transferring core manufacturing technologies in high-technology firms. *California Management Review*, **32**(4), 56-70.

Galbraith, J.R. (1973) *Designing Complex Organizations*. Reading: Addison-Wesley.

Galbreath, J. (2005) Which resources matter the most to firm success? An exploratory study of resource based theory. *Technovation*, **25**(9), 979–987.

Gann, D.M. (1994) Innovation in the construction sector. In Dodgson, M. and Rothwell, R. (eds.), *The Handbook of Industrial Innovation*. London: Edward Elgar, pp. 202-212.

Garavelli, A.C. (2003) Flexibility configurations for supply chain management. *International Journal of Production Economics*, **85**(2), 141–153.

Gefen, D. and Straub, D. (2005) A practical guide to factorial validity using PLS-graph: tutorial and annotated example. *Communications of the Association for Information Systems*, **16**(1), 91-109.

Genus, A. (1995) *Flexible Strategic Management.* London: Chapman & Hall.

Gerbing, D.W. and Anderson, J.C. (1988) An update paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research*, **25**(2), 186-192.

Gerwin, D. (1987) An agenda for research on the flexibility of manufacturing process. *International Journal of Operations and Production Management*, **7**(1), 38–49.

Gerwin, D. (1993) Manufacturing flexibility: a strategic perspective. *Management Science*, **39**(4), 395-410.

Gil, N., Tommelein, I.D., Stout, A. and Garrett, T. (2005) Embodying product and process flexibility to cope with challenging project deliveries. *Journal of Construction Engineering and Management*, **131**(4), 439–448.

Gill, J. and Johnson, P. (1997) *Research Methods for Manager*, 2nd Ed. London: Paul Chapman Publishing Ltd.

Glick, W.H., Jenkins, G.D. and Gupta, N. (1986) Method versus substance: how strong are underlying relationships between job characteristics and attitudinal outcomes? *Academy of Management Journal*, **29**(3), 441-464.

Gold, A.H., Malhotra, A. and Segars, A. (2008) Knowledge management: an organizational capabilities perspective. *Journal of Management Information System*, **18**(1), 185-214.

Golden, B.R. (1992) The past is the past – or is it? The use of retrospective accounts as indicators of past strategy. *Academy of Management Journal*, **35**(4), 848-860.

Golden, W. and Powell, P. (2000) Towards a definition of flexibility: in search of the Holy Grails? *Omega*, **28**(4), 373-384.

Goldman, S.L., Nagel, R.N. and Preiss, K. (1994) *Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer*. New York: Van Nostrand Reinhold.

Goudling, J.S. and Alshawi, M. (2002) Generic and specific IT training: a process protocol model for construction. *Construction Management and Economics*, **20**(6), 493–505.

Graetz, F., Rimmer, M., Lawrence, A. and Smith, A. (2002) *Managing Organizational Change*. Queenland: John Wiley and Sons Australia Ltd.

Grant, R.M. (1991) The resource based theory of competitive advantage: implications of strategy formulation. *California Management Review*, **33**(3), 114–135.

Green, P.E. and Carroll, J.D. (1976) *Mathematical Tools for Applied Multivariate Analysis*. New York: Academic Press.

Green, S., Newcombe, R., Fernie, S. and Weller, S. (2004) *Learning Across Business Sectors: Knowledge Sharing between Aerospace and Construction*, The University of Reading, downloaded from http://icrc-reading.org/projects/publications.asp?projectid=77&pubid=77 <010606>.

Green, S.D., Larsen, G.D. and Kao, C. (2008) Competitive strategy revisited: contested concepts and dynamic capabilities. *Construction Management and Economics*, **26**(1), 63-78.

Griego, O.V., Geroy, G.D. and Wright, P.C. (2000) Predictors of learning organizations: a human resource development practitioner's perspective. *The Learning Organization: An International Journal*, **7**(1), 5-12.

Gruneberg, S.L (2009) Construction markets in a changing world economy. In Ruddock, L. (ed.), *Economics for the Modern Built Environment*. New York: Taylor and Francis, pp. 153-167.

Gruneberg, S.L and Ive, G.J. (2000) *The Economics of the Modern Construction firms*. Basingstoke: Macmillan Press Ltd.

Gudergan, S.P., Ringle, C.M., Wende, S. and Will, A. (2008) Confirmatory tetrad analysis in PLS path modelling. *Journal of Business Research*, **61**(12), 1238-1249.

Guenzi, P., Georges, L. and Pardo, C. (2008) The impact of strategic account managements' behaviours on relational outcomes: an empirical study. *Industrial Marketing Management*, article in press, doi:10.1016/j.indmarman.2007.09.011

Gupta, Y.P. and Goyal, S. (1989) Flexibility of manufacturing systems: concepts and measurement. *European Journal of Operational Research*, **43**(2), 119–135.

Gupta, Y.P. and Somers, T.M. (1996) Business strategy, manufacturing flexibility and organizational performance relationships: a path analysis approach. *Production and Operations Management*, **5**(3), 204-233.

Hair, J.F., Anderson R.E., Tatham, R.L. and Black, W.C. (1998) *Multivariate Data Analysis with Readings,* International Ed. New Jersey: Prentice Hill.

Hair, J.F., Bush, R.P. and Ortinau, D.J. (2003) *Marketing Research: Within a Changing Information Environment*, 2nd Ed. Boston: McGraw-Hill.

Hall, D. and Saias, M. (1983) Strategy follows structure! *Strategic Management Journal*, **1**(2), 149-163.

Hall, R.H. (1987) *Organizations: Structures, Processes, and Outcomes*, 4th Ed. New Jersey: Prentice-Hall Inc.

Hambrick, D.C. (1980) Operationalizing the concept of business strategy in research. *Academy of Management Review*, **5**(4), 567-575.

Hambrick, D.C. and Snow, C. (1977) A contextual model of strategic decision making in organizations. *Academy of Management Proceedings*, 109-112.

Hamel, G. and Prahalad, C.K. (1994) *Competing for the Future*. Boston: Harvard Business School Press.

Handa, V. and Adas, A. (1996) Predicting the level of organizational effectiveness: a methodology for the construction firm. *Construction Management and Economics*, **14**(4), 341–352.

Handfield, R.B. and Nichols, E.L. (1999) *Introduction to Supply Chain Management.* New Jersey: Prentice-Hall Inc.

Hannan, M.T. and Freeman J. (1977) The population ecology of organizations. *The American Journal of Sociology*, **82**(5), 929-964.

Hannan, M.T. and Freeman J. (1984) Structural inertia and organizational change. *American Sociological Review*, **49**(2), 149-164.

Hannan, M.T. and Freeman, J. (1989) *Organizational Ecology*. Cambridge: Harvard University Press.

Hanvanick, S., Sivakumar, K. and Hult, G.T.M. (2006) The relationship of learning and memory with organizational performance: the moderating role of turbulence. *Journal of the Academy of Marketing Science*, **34**(6), 600-612.

Harman, H.H. (1967) *Modern Factor Analysis*. Chicago: University of Chicago Press.

Harrigan, K.R. (1985) *Strategic Flexibility: A Management Guide for Changing Times*. Boston and Toronto: Lexington Books.

Harrison, J.S. and John, C.H. (1998) *Strategic Management of Organizations and Stakeholder*, 2nd Ed. Ohio: South-Western College publishing.

Hassan, T., Mitrovic, D., Gayoso, A. and Hunter, I. (1998) *The Future LSE Industry*. Loughborough: European Construction Institute.

Hawk, D. (2006) Conditions of success: a platform for international construction development. *Construction Management and Economics*, **24**(7), 735-742.

Hayes, R.H. and Pisano, G.P. (1994) Beyond world-class: the new manufacturing strategy. *Harvard Business Review*, **72**(1), 77-87.

HDB (2007) *Housing & Development Board Annual Report 2006/2007*. Singapore: Housing & Development Board

Hedberg, B. (1981) How organizations learn and unlearn. In Nystrom, P.C. and Starbuck, W.H. (eds.), *Handbook of Organizational Design*. Oxford: Oxford University, pp. 3-27.

Hedberg, B., Nystrom, P.C. and Starbuck, W.H. (1976) Camping on seesaws: prescriptions for a self-designing organization. *Administrative Science Quarterly*, **21**(1), 41-65.

Helfat, C.E. and Peteraf, M.A (2003) The dynamic resource based view: capabilities lifecycles. *Strategic Management Journal*, **24**(10), 997–1010.

Herdberg, B. and Jonsson, S. (1978) Designing semi-confusing information systems for organizations in changing environments. *Accounting, Organizations and Society*, **3**(1), 47-64.

Hill, C.W.L (1988) Differentiation versus low-cost or differentiation and low-cost: a contingency framework. *Academy of Management Review*, **13**(3), 401-412.

Hillebrandt, P.M. (2000) *Economic Theory and the Construction Industry*, 3rd Ed. London: Macmillan Press Ltd.

Hillebrandt, P.M. and Cannon, J. (1990) *The Modern Construction Firm*. London: Macmillan Press Ltd.

Hillebrandt, P.M. Cannon, J. and Lansley, P. (1995) *The Construction Company in and Out Recession*. London: Macmillan Press Ltd.

Hinze, J. and Tracey, A. (1994) The contractor-subcontractor relationship: the subcontractor's view. *Journal of Construction Engineering and Management*, **120**(2), 274-287.

Hitt, M.A., Keats, B.W. and DeMarine, S.M. (1998) Navigating in the new competitive landscape: building strategic flexibility and competitive advantage in the 21st century. *Academy of Management Executive*, **12**(4), 22-42.

Ho, S.P. and Liu, L.Y. (2003) How to evaluate and invest in emerging A/E/C technologies under uncertainty. *Journal of Construction Engineering and Management*, **129**(1), 16–24.

Hofer, C.W. and Schendel, D.E. (1978) *Strategy Formulation: Analytical Concepts*. Minnesota: West Publication.

Hofstede, G., Neuijen, B., Ohayv, D.D. and Sanders, G. (1990) Measuring organizational cultures: a qualitative and quantitative study across twenty cases. *Administrative Science Quarterly*, **35**(2), 286-316.

Holt, G. (1998) *A Guide to Successful Dissertation Study for Student of the Built Environment,* 2nd Ed. Wolverhampton: University of Wolverhampton Print Services.

Hong Kong (HK) Buildings Department (2004) *Joint Practice Notes on Protection and Improvement of the Built and Natural Environment* by Buildings Department, Lands Department and Planning Department, available at: http://www.bd.gov.hk/ english/documents/index_joint.html <200608>.

Hong, T. (2009) A close look at the China design standard for energy efficient of public buildings. *Energy and Buildings*, **41**(4), 426-435.

Hoopes, D.G., Madsen, T.L. and Walker, G. (2003) Guest editors' introduction to this special issue: why is there a resource based view? Toward a theory of competitive heterogeneity. *Strategic Management Journal*, **24**(10), 889–902.

Houlihan, J.B. (1985) International supply chain management. *International Journal of Physical Distribution and Logistics Management*, **15**(1), 22-38.

Houston, F.S. (1986) The marketing concept: what it is and what it is not. *Journal of Marketing*, **50**(2), 81-87.

Hoyle, R.H. (2000) Confirmatory factor analysis. In Tinsley, H.E.A. and Brown, S.D. (eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modelling*. New York: Academic Press.

Hsu, S.H., Chen, W.H. and Hsieh, M.J. (2006) Robustness testing of PLS, LISREL, EQS and ANN-based SEM for measuring customer satisfaction. *Total Quality Management*, **17**(3), 355-371.

Huber, G.P. and Power, D.J. (1985) Retrospective reports of strategic level managers: guidelines for increasing their accuracy. Strategic *Management Journal*, **6**(2), 171-180.

Huff, A.S., Huff, J. O. and Thomas, H. (1992) Strategic renewal and the interaction of cumulative stress and inertia. *Strategic Management Journal*, **13**(special issue), 55–75.

Hughes, W.P. (1989) Identifying the environments of construction projects. *Construction Management and Economics*, **7**(1), 29-40.

Hulin, C.L. and Roznowski, M. (1985) Organizational technologies: effects on organizations' characteristics and individuals' response. In Cummings, L.L. and Staw, B.M. (eds.), *Research in Organizational Behaviour,* Vol. 7. Connecticut: JAI Press.

Hulland, J. (1999) Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal*, **20**(2), 195-204.

Hult, G.T.M. (1998) Managing the international strategic sourcing process as a market-driven organizational learning system. *Decision Science*, **29**(1), 193–216.

Inkson, J.H., Pugh, D.S. and Hickson, D.J. (1970) Organization context and structure: an abbreviated replication. *Administrative Science Quarterly*, **15**(3), 318-329.

International Enterprise Singapore (2007) *Singapore's FTA Network: Expanding Markets, Connecting Partners*, available at: http://www.fta.gov.sg/ <200608>.

Ireland, R.D. and Hitt, M.A. (1999) Achieving and maintaining strategic competitiveness in the 21st century: the role of strategic leadership. *Academy of Management Executive*, **13**(1), 43–57.

Islam, M.B.M. and Faniran, O.O (2005) Structural equation model of project planning effectiveness. *Construction Management and Economics*, **23**(2), 215-223.

Itami, H. and Numagami, T. (1992) Dynamic interaction between strategy and technology. *Strategic Management Journal*, 1**3**(special issue, winter), 119-135.

Ive, J.G. and Gruneberg, S.L. (2000) *The Economics of the Modern Construction Industry*. Basingstoke: Macmillan Press Ltd.

Jaillon, L. and Poon, C.S. (2009) The evolution of prefabricated residential building systems in Hong Kong: a review of the public and the private sectors. *Automation in Construction*, **18**(3), 239-248.

Jaunch, L. R. and Kraft, K. L. (1986) Strategic management of uncertainty. *Academy of Management Review*, **11**(4), 777–790.

Jaworski, B.J. and Kohli, A.K. (1993) Market orientation: antecedents and consequences. *Journal of Marketing*, **57**(3), 53-70.

Jayachandran, S. and Varadarajan, R. (2006) Does success diminish competitive responsiveness? Reconciling conflicting perspectives. *Journal of the Academy of Marketing Science*, **34**(3), 284-294.

Jensen, M.B. (2008) Online marketing communication potential: priorities in Danish firms and advertising agencies*. European Journal of Marketing*, **42**(3/4), 502-525.

Jin, X.H., Doloi, H. and Gao, S.Y. (2007) Relationship-based determinants of building project Performance in China. *Construction Management and Economics*, **25**(3), 297-304.

Johnson, J.L., Lee, R.P., Saini, A. and Grohmann, B. (2003) Market-focused strategic flexibility: conceptual advances and an integrative model. *Journal of the Academy of Marketing Science*, **31**(1), 74-89.

Johnson, R.E. and Clayton, M.J. (1998) The impact of information technology in design and construction: the owner's perspective. *Automation in Construction*, **8**(1), 3–14.

Jones, C., Hesterly, W.S. and Borgatti, S.P. (1997) A general theory of network governance: exchange conditions and social mechanisms. *Academy of Management Review*, **22**(4), 911-945.

Joreskog, K.G (1973) A geneal method for estimating a linear structural equation system. In Golderger, A.S. and Duncan, O.D. (eds.), *Structural Equation Models in the Social Sciences*. New York: Seminar Press, pp. 85-112.

Joreskog, K.G. and Sorbom, D. (1978) LISREL IV: Analysis of Linear Structural Relationships by the Method of Maximum Likelihood. Chicago: National Educational Resources.

Joreskog, K.G. and Wold, H. (1982) The ML and PLS technique for modelling with latent variables: Historical and comparative aspects. In Joreskog, K. G. and Wold, H. (eds.), S*ystem under Indirect Observation: Causality, Structure, Prediction - Part 1*. Amsterdam: North Holland, pp. 263 – 270.

Joyce, T. (2008a) Construction Sector in for Tough Times. *The Strait Times*, October 22, p.B24. Singapore: The Singapore Press Holdings Publication.

Joyce, T. (2008b) Murkier Outlook for Construction Sector. *The Strait Times*, October 28, p.B18. Singapore: The Singapore Press Holdings Publication.

Kaiser, H.F. (1960) The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, **20**, 141-151.

Kale, S. (1999) *Competitive Advantage in the Construction Industry: Firm-Specific Resources and Strategy*. Unpublished PhD thesis, The Graduate College of the Illinois Institute of Technology.

Kale, S. and Arditi, D. (1998) Business failure: liabilities of newness, adolescence, and smallness. *Journal of Construction Engineering and Management*, **124**(6), 458–464.

Kale, S. and Arditi, D. (2001) General contractors' relationships with subcontractors: a strategic asset. *Construction Management and Economics*, **19**(5), 541–549.

Kale, S. and Arditi, D. (2002) Competitive positioning in United States construction industry. *Journal of Construction Engineering and Management*, **128**(3), 238–247.

Kale, S. and Arditi, D. (2003) Differentiation, conformity, and construction firm performance. *Journal of Management in Engineering*, **19**(2), 52–59.

Kalleberg, A.L. (2001) Organizing flexibility: the flexible firm in a new century. *British Journal of Industrial Relations*, **39**(4), 479–504.

Kanter, R.M. (1983) *The Change Masters: Corporate Entrepreneurs at Work*. London: Unwin Paperbacks.

Kanter, R.M. (1989) *When Giants Learn to Dance: Mastering the Challenge of Strategy, Management, and Careers in the 1990s*. New York: Simon and Schuster.

Kara, S. and Kayis, B. (2004) Manufacturing flexibility and variability: an overview. *Journal of Manufacturing Technology Management*, **15**(6), 466–478.

Katz, D. and Kahn, R.L. (1978) *The Social Psychology of Organizations*. New York: Wiley.

Kaynak, H. (2003) The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management*, **21**(4), 405-435.

Keats, B.W. and Hitt, M.A. (1988) A causal model of linkage among environment dimensions, macro organizational characteristics, and performance. *Academy of Management Journal*, **31**(3), 570-598.

Kenny, D.A. and Judd, C.M. (1984) Estimating the nonlinear and interactive effects of latent variables*. Psychological Bulletin*, **96**(1), 201-210.

Kenny. J. (2006) Strategy and the learning organization: a maturity model for the formation of strategy. *The Learning Organization: An International Journal*, **13**(4), 353-368.

Khandwalla, P.N. (1977) *The Design of Organizations*. New York: Harcourt Brace Jovanovich.

Kline, R. B. (1998) *Principles and Practice of Structural Equation Modelling*. New York: The Guildford Press.

Knight, K. (1977) *Matrix Management: A Cross-functional Approach to Organization*. Singapore: Gower.

Kohli, A. and Jaworski, B.J. (1990) Market orientation: The construct, research propositions. *Journal of Marketing*, **54**(2), 1–17.

Kor, Y.Y and Mahoney, J.T. (2004) Edith Penrose's (1959) contributions to the resource-based view of strategic management. *Journal of Management Studies*, **41**(1), 183-191.

Koste, L.L. (1999) *Measurement of Manufacturing Flexibility and its Implications for Supply Chain Management*. Unpublished PhD Thesis, University of South Carolina.

Koste, L.L. and Malhotra, M.K. (1999) A theoretical framework for analyzing the dimension of manufacturing flexibility. *Journal of Operations Management*, 1**8**(1), 75–93.

Koste, L.L. and Malhotra, M.K. (2000) Trade-offs among the elements of flexibility: a comparison from the automotive industry. *Omega*, **28**(6), 693-710

Krause, D.R. (1997) Supplier development: current practices and outcomes. *International Journal of Purchasing and Materials Management*, **33**(2), 12-19.

Krijnen, H.G. (1979) The flexible firm. *Long Range Planning*, **12**(2), 63–75.

Kumaraswamy, M.M., Rahman, M.M., Ling, Y.Y.F. and Phng, S.T. (2005) Reconstructing cultures for relationship contracting. *Journal of Construction Engineering and Management,* **131**(10), 1065–1075.

La Londe, B.J. (1998) *Supply Chain Management: An Opportunity for Competitive Advantage*. Department of Transport and Logistics, The Ohio State University.

Laborde, M. and Sanvido, V. (1994) Introducing new process technologies into construction companies. *Journal of Construction Engineering and Management*, **120**(3), 488–508.

Lamber, R. and Peppard, J. (1993) Information technology and new organizational forms: destination but no road map? *Journal of Strategic Information Systems*, **2**(3), 180-205.

Langford, D.A. and Male, S.P. (2001) *Strategic Management in Construction*, 2nd Ed. London: Blackwell Science Ltd.

Lansley, P., Quince, T. and Lea, E. (1979) *Flexibility and Efficiency in Construction Management*, the final report on a research project with financial support of the DoE. Building Industry Group, Ashridge Management Research Unit (unpublished).

Lansley, P.R. (1983) A practical approach to auditing organizational flexibility. *Construction Management and Economics*, **1**(2), 145–156.

Lansley, P.R. (1987) Corporate strategy and survival in the UK construction industry. *Construction Management and Economics*, **5**(2), 141–155.

Lansley, P.R. (1994) Analyzing construction organization. *Construction Management and Economics*, **12**(4), 337–348.

Lansley, P.R., Sadler, P. and Webb, T. (1974) Organization structure, management style and company performance. *Omega*, **2**(4), 467-485.

Lansley, P.R., Sadler, P. and Webb, T. (1975) Organization structure, management style and company performance: some recent results. *Omega*, **3**(5), 615-617.

Lau, R.S.M. (1996) Strategy flexibility: a new reality for world class manufacturing. *S.A.M. Advanced Management Journal*, **61**(2), 11-19.

Lawrence, P. and Dyer, D. (1981) *Towards a theory of organizational and industrial adaptation.* Working Paper No. HBS80-57, Gradudate School of Business Administration. Boston: Harvard University.

Lawrence, P. and Lorsch, J.W. (1967) *Organization and Environment*. Boston: Harvard Business School Press.

Lee, H.L. and Billington, C. (1994) Managing supply chain inventory: pitfalls and opportunities. *Sloan Management Review*, **33**(3), 65–73.

Lenard, D.J. (1999) Future challenges in construction management: creating a symbiotic learning environment. *Journal of Construction Procurement*, **6**(2), 164-183.

Lencioni, P. (2007) *The Five Dysfunctions of a Team: Facilitator's Guide: The Officical Guide to Conducting the Five Dysfunctions Workshop*. San Francisco: Pfeiffer.

Lengnick-Hall, C.A. and Lengnick-Hall, M.L. (1988) Strategic human resource management: a review of the literature and a proposed typology. *Academy of Management Review,* **13**(3), 454-470.

Leping, J.A., Colquitt, J.A. and Erez, A. (2000) Adaptability to changing task contexts: effects of general cognitive ability, conscientiousness, and openness to experience. *Personnel Psycholog*y, **53**(3), 563-594.

Leung, M.Y., Olomolaiye, P., Chong, A. and Lam, C.C.Y. (2005) Impacts of stress on estimation performance in Hong Kong. *Construction Management and Economics*, **23**(9), 891–903.

Levitt, B. and March, J.G. (1988) *Organizational learning*. *Annual review of Sociology*, **14**(1), 319-340.

Li, B. and Tiong, L.K. (1999) Risk management model for international construction joint ventures. *Journal of Construction Engineering and Management*, **125**(5), 377–384.

Li, F., Harmer, P., Duncan, T.E., Duncan, S.C., Acock, A. and Boles, S. (1998) Approaches to testing interaction effects using structural equation modelling methodology. *Multivariate Behavioural Research*, **33**(1), 1-39.

Lientz, B.P. and Rea, K.P. (2003) *International Project Management*. Boston: Academic Press.

Lim, J.N., Ofori, G. and Park, M. (2006) Stimulating construction innovation in Singapore through the national system of innovation. *Journal of Construction Engineering and Management,* **132**(10), 1069-1082.

Lim, L.Y. and Low, S.P. (1992) *Just-In-Time Productivity for Construction*. Singapore: SNP Publishers Pte Ltd.

Lim, S.S. and Wang, H. (2007) The effect of financial hedging on the incentives corporate diversification: the role of stakeholder firm-specific investments. *Journal of Economic Behaviour & Organization*, **62**(4), 640-656.

Lin, F., Huang, S. and Lin, S. (2002) Effect of information sharing on supply chain performance in electronic commerce. *IEEE Transactions on Engineering Management*, **49**(3), 258-268.

Ling, F.Y.Y. and Chong, C.L.K. (2005) Design-and-build contractors' service quality in public projects in Singapore. *Building and Environment*, **40**(6), 815-823.

Ling, F.Y.Y. and Liu, M. (2004) Using neural network to predict performance of design-build projects in Singapore. *Building and Environment*, **39**(10), 1263-1274.

Ling, F.Y.Y. and Poh, B.H.M. (2008) Problems encountered by owners of design-build projects in Singapore. *International Journal of Project Management*, **26**(2), 164-173.

Ling, F.Y.Y., Ibbs, C.W. and Cuervo, J.C. (2005) Entry and business strategies used by international architectural, engineering and construction firms in China. *Construction Management and Economics*, **23**(5), 509-520.

Llorens, F.J., Molina, L.M. and Verdu, A.J. (2005) Flexibility of manufacturing systems, strategic change and performance. *International Journal of Production Economics*, **98**(3), 273–289.

Lohmoller, J.B. (1989) *Latent Variable Path Modelling with Partial Least Squares*. Heidelberg: Physica-Verlag.

Longman Dictionary (2001) *Longman Dictionary of Contemporary English*, 3rd Ed. Essex: Pearson Education Ltd.

Loosemore, M., Dainty, A. and Lingard, H. (2003) *Human Resources Management in Construction Projects: Strategic and Operational Approaches*. New York: Spon Press.

Lopez-Cabrales, A., Valle, R. and Herrero, I. (2006) The contribution of core employees to organizational capabilities and efficiency. *Human Resource Management,* **45**(1), 81-109.

Love, P.E.D., Irani, Z. and Edwards, D.J. (2004) A seamless supply chain management model for construction. *Supply Chain Management: An International Journal*, **9**(1), 43-56.

Love, P.E.D., Irani, Z. and Edwards, D.J. (2005) Researching the investment of information technology in construction: an examination of evaluating practices. *Automation in Construction*, **14**(4), 569-582.

Love, P.E.D., Li, H. and Mandal, P. (1999) Rework: a symptom of a dysfunctional supply-chain. *European Journal of Purchasing & Supply Management*, **5**(1), 1–11.

Low, S.P. and Lim, N.H. (1999) Outlook for construction in Singapore. *SES Journal*, January, 19–22 & 68.

Low, S.P. and Lim, N.H. (2000) The strategic responses of construction firms to the Asian financial crisis in 1997–1998. *International Journal of Construction Marketing,* **1**(2), 1–12.

Lucas, H.C. and Olson, M. (1993) *The Impact of Information Technology on Organization Flexibility*. Center for Digital Economy Research, Stern School of Business, Working Paper IS-93-49, 1-46, downloaded from: https://archive.nyu.edu/handle/2451/14316 <280207>.

Lukas, B.A., Hult, G.T.M. and Ferrell, O.C. (1996) A theoretical perspective of the antecedents and consequences of organizational learning in marketing channels. *Journal of Business Research*, **36**(3), 233– 244.

Lutzkendorf, T. and Lorenz, D. (2005) Sustainable property investment: valuing sustainable buildings through property performance assessment. *Building Research and Information*, **33**(3), 212-234.

MacDuffie, J.P. (1995) Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world of auto industry. *Industrial and Labor Relations Review*, **48**(1), 197-221.

Mah, B.T. (2007) *Keynotes address by Mr. Mah Bow Tan, Minister for National Development, at the opening of the 1st Asia Pacific Housing Forum,* Ministry of National Development, Singapore, 24th September 2007, downloaded from http://www.mnd.gov.sg/newsroom/Speeches/speeches_2007_M_24092007.htm <050608>.

Major, D.A., Davis, D.D., Germano, L.M., Fletcher, T.D., Sachez-Hucles, J. and Mann, J. (2007) Managing human resources in information technology: best practices of high-performing supervisors. *Human Resource Management*, **46**(3), 411-427.

Male, S.P. (1991a) Strategic management and competitive advantage in construction. In Male, S. P. and Stocks, R. K. (eds.), *Competitive Advantage in Construction*. Oxford: Butterworth Heinemann, pp. 45–104.

Male, S.P. (1991b) Strategic management in construction: conceptual foundations. In Male, S. P. and Stocks, R. K. (eds.), *Competitive Advantage in Construction*. Oxford: Butterworth Heinemann, pp. 5–43.

Malerba, F. (1992) Learning by firms and incremental technical change. *The Economic Journal*, **102**(413), 845-859.

Manseau, A. (2005a) Construction – a challenging industry challenging current innovation models. In Manseau, A. and Shields, R. (eds.), *BuildingTomorrow: Innovation in Construction and Engineering*. Aldershot: Ashgate Publishing Limited, pp. 23-42.

Manseau, A. (2005b) Redefining innovation. In Manseau, A. and Shields, R. (eds.) *BuildingTomorrow: Innovation in Construction and Engineering.* Ashgate Publishing Limited, Aldershot, 43-55.

Marsh, R.M (1992) A research note: centralization in decision-making in Japanese factories. *Organization Studies*, **13**(22), 261-270.

Marsh, R.M. and Mannari, H. (1981) Technology and size as determinants of the organizational structure of Japanese factories. *Administrative Science Quarterly*, **26**(1), 33-57.

Mascarenhas, B. (1982) Coping with uncertainty in international business. *Journal of International Business Studies,* **13**(2), 87-98

Matusik, S.F. and Hill, C.W.L. (1998) The utilization of contingent work, knowledge creation and competitive advantage. *Academy of Management Review*, **23**(4), 680-697.

Matzler, K., Renzl, B. and Faullant, R. (2007) Dimensions of price satisfaction: a replication and extension. *The International Journal of Bank Marketing*, **25**(6), 394-405.

McGregor, W. (2000) Preparing for an uncertain future. *Facilities*, **18**(10-12), 402–410.

Metcalfe, L. (1981) Designing precarious partnership. In Nystrom, P.C. and Starbuck, W.H. (eds.), *Handbook of Organizational Design*. Oxford: Oxford University, pp. 503-530.

Miles, R.E. and Snow, C.C. (1978) *Organizational Strategy, Structure and Process*. New York: McGraw-Hill

Miles, R.E., Snow, C.C and Pfeffer, J. (1974) Organization-environment: concepts and issues. *Industrial Relations*, **13**(3), 244-264.

Miller, C.C., Cardinal, L.B. and Glick, W.H. (1997) Retrospective reports in organizational research: a re-examination of recent evidence. *Academy of Management Journal*, **40**(1), 189-204.

Miller, D. (1987) The structural and environmental correlates of business strategy. *Strategic Management Journal*, **8**(1), 55-76.

Miller, D. (1988) Relating Porter's business strategies to environment and structure: analysis and performance implications. *Academy of Management Journal*, **31**(2), 280-308.

Miller, D. (1992) The generic strategy trap. *Journal of Business Strategy*, **13**(1), 37-41.

Milliken, F.J. (1987) Three types of perceived uncertainty about environment: state, effect and response uncertainty. *Academy of Management Review*, **12**(1), 133–143.

Ministry of Community Development, Youth and Sport (MCYS) (2008) *Singapore Social Statistics in Brief, 2008*, downloaded from: http://www.singstat.gov.sg/stats /themes/people/social.html <101008>

Ministry of Finance (2005) *Contracts and purchasing procedures*. Singapore: Ministry of Finance.

Ministry of Finance (2008) *Public Private Partnerships*, available at: http://www.mof.gov.sg/policies/ppp.html <200608>.

Minzberg, H. (1979) *The Structuring of Organizations: A Synthesis of the Research. New Jersey*: Prentice-Hall.

Mitropoulos, P. and Tatum, C.B. (2000) Forces driving adoption of new information technologies. *Journal of Construction Engineering and Management*, **126**(5), 340–348.

Ministry of Environment (2006) *The Singapore Green Plan 2012*. Singapore: Ministry of Environment and Water Resources, download from: http://www.mewr.gov.sg/sgp2012/ about.htm <190308>.

Ministry of Environment (2007). *Key Environmental Statistics 2007*, Singapore: Ministry of Environment and Water Resources, download from: http://app.mewr.gov.sg/ data/ImgUpd/KESDATA.pdf <130308>.

Moffat, J. (2003) *Complexity Theory and Network Centric Warfare*. CCRP Publication Series, downloaded from: http://www.dodccrp.org/files/Moffat_Complexity.pdf <200107>.

Mone, M.A., McKinley, W. and Barker, V.L. (1998) Organizational decline and innovation: a contingency framework. *Academy of Management Review*, **23**(1), 115–132.

Montanari, J.R. (1979) Strategic choice: a theoretical analysis. *Journal of Management*, **17**(2), 202-221.

Moore, G.C. and Benbasat, I. (1991) Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, **2**(3), 192-222.

Moorman, C. and Miner, A.S. (1998) Organizational improvisation and organizational memory. *Academy Management Review*, **23**(4), 698–723.

Morash, E.A. (2001) Supply chain strategies, capabilities, and performance. *Transportation Journal*, **41**(1), 37-54.

Morgan, G. (1986) *Images of Organizations.* Beverly Hills: Sage Publications.

Morgan, R.E. and Turnell, C.R. (2003) Market-based organizational learning and market performance gains. *British Journal of Management*, **14**(3), 255-274.

Myers, D. (2004) *Construction Economics: A New Approach*. New York: Spon Press.

Nagarur, N. (1992) Some performance measures of flexible manufacturing systems. *International Journal of Production Research*, **30**(4), 799–809.

Nam, C.H. and Tatum, C.B. (1997) Leaders and champions for construction innovation. *Construction Management and Economics*, **15**(3), 259-270.

Narasimhan, R., Jayaram. J. and Carter J.R. (2001) An empirical examination of the underlying dimensions of purchasing competence. *Production and Operations Management*, **10**(1), 1–15.

Narasimhan, R., Talluri, S. and Das, A. (2004) Exploring flexibility and execution competencies of manufacturing firm. *Journal of Operations Management*, **22**(1), 91–106.

National Research Council (2000) *Surviving Supply Chain Integration: Challenges for Smaller Manufacturing*. Washington: National Academy Press.

Neilsen, E.H. (1974) Contingency theory applied to small business organizations. *Human Relations*, **27**(4), 357–379.

Nelson, R.R. (1991) Why do firms differ, and how does it matter? *Strategic Management Journal*, **12**(special issue, winter), 61-74.

Neter, J., Wasserman, W. and Kutner, M.H. (1990) *Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs*, 3rd Ed. Homewood: Richard D. Irwin

Neuman, G.A. and Wright, J. (1999) Team effectiveness: beyond skills and cognitive ability. *Journal of Applied Psychology*, **84**(3), 376-389.

New, S.J. and Payne, P. (1995) Research frameworks in logistics: three models, seven dinners and a survey. *International Journal of Physical Distribution and Logistics Management*, **25**(10), 60–77.

Newcombe, R. (1990a) The evolution and structure of the construction firm. In Ireland, V. and Cheetham, C. (eds.), *Building Economics and Construction Management of the Building Firm, Vol. 6*. The International Council for Building Research Studies and Documentation, CIB W-55/65, Sydney, pp. 358 – 369.

Newcombe, R. (1990b) *Construction Management 1: Organization Systems*. London: Mitchell.

Ng, S.T. and Tang, Z. (2008) Delineating the predominant criteria for subcontractor appraisal and their latent relationships. *Construction Management and Economics*, **26**(3), 249–259.

Nikas, A., Poulymenakou, A. and Kriaris, P. (2007) Investigating antecedents and drivers affecting the adoption of collaboration technologies in the construction industry. *Automation in Construction*, **16**(5), 632–641.

Nohria, N. and Gulati, R. (1997) What is the optimum amount of organizational slack? A study of the relationship between slack and innovation in multinational firms. *European Management Journal*, **15**(6), 603-611.

Nonaka, I. And Takeuchi, H. (1995) *The Knowledge-Creating Company*. Oxford: Oxford University Press.

Norman, R. (1985) Developing capabilities for organizational learning. In Pennings, J.M. (Ed.), *Organizational strategy and Change*, San Francisco: Jossey-Bass.

Norusis, M.J. (2007) *SPSS16.0 Statistical Procedures Companion*. New Jersey: Prentice Hall.

Nunnally, J.C. (1967) *Psychometric Theory*. New York: McGraw-Hill.

Nunnally, J.C. (1978) *Psychometric Theory*, 2nd Ed. New York: McGraw-Hill.

O'Leary-Kelly, S.W. and Vokurka, R.J. (1998) The empirical assessment of construct validity. *Journal of Operations Management*, **16**(4), 387-405.

Ofori, G. (1988) Construction industry and economic growth in Singapore. *Construction Management and Economics*, **6**(1), 57-70.

Ofori, G. (1992) The environment: the fourth construction project objective? *Construction Management and Economics*, **10**(5), 369–395.

Ofori, G. (2003) Frameworks for analyzing international construction. *Construction Management and Economics*, **21**(4), 379–391.

Ofori, G. and Debrah, Y.A. (1998) Flexible management of workers: review of employment practices in the construction industry in Singapore. *Construction Management and Economics*, **16**(4), 397–408.

Oke, A. (2005) A framework for analyzing manufacturing flexibility. *International Journal of Operations & Production Management*, **25**(10), 973 – 996.

Olsson, N.O. (2006) Management of flexibility in projects. *International Journal of Project Management*, **24**(1), 66–74.

Oo, B.L. (2007) *Modelling Individual Contractors' Bidding Decisions in Different Competitive Environments*. Unpublished PhD thesis, The Hong Kong Polytechnic University.

Oo, B.L., Drew, D. and Lo, H.P. (2007) Modelling contractors' mark-up behaviour in different construction markets. *Engineering, Construction and Architectural Management*, **14**(5), 447-462.

Orosa, J.A. and Oliveira, A.C. (2009) Energy saving with passive climate control methods in Spanish office buildings. *Energy and Buildings*, **41**(8), 823-828.

Oxford Reference Online (2009) *A Dictionary of Business and Management*, Oxford University Press, downloaded at: http://www.oxfordreference.com.ezproxy2.library.usyd.edu.au/views/ENTRY.html?subview=Main&entry=t18.e2590 <100309>.

Pagell, M. and Krause, D. R. (2004) Re-exploring the relationship between flexibility and the external environment. *Journal of Operations Management*, **21**(6), 629–649.

Papadopoulos, A.M., Oxizidis, S. and Papandritsas, G. (2008) Energy, economic and environmental performance of heating system in Greek Buildings. *Energy and Buildings*, **40**(3), 224-230.

Parker, R.P. and Wirth, A. (1999) Manufacturing flexibility: measures and relationships. *European Journal of Operational Research*, **118**(3), 429–449.

Parsons, T. (1960) *Structure and Process in Modern Societies.* New York: Free Press.

Pascale, R.T. (1990) *Managing on the Edge: How the Smartest Companies Use Conflict To Stay Ahead*. London: Simon and Schuster.

Pearson, A. (1999) Chain reaction. *Building*, 12 March, 54 – 55.

Pedhazur, E.J. and Schmelkin, L.P. (1991) *Measurement, Design and Analysis: An Integrated Approach*. New Jersey: Lawrence Erlbaum Associates.

Pedler, M., Boydell, T. and Burgoyne, J. (1989) Towards the learning company. *Management Education and Development*, **20**(1), 1-8.

Pedler, M., Burgoyne, J. and Boydell, T. (1991) *The Learning Company: A Strategy for Sustainable Development*. London: McGraw Hill.

Pelton, L.E., Strutton, D. and Lumpkin, J.R. (1997) *Marketing Channels: A Relationship Management Approach*. Chicago: Irwin.

Pennings, J.M. (1987) Structural contingency theory: a multivariate test. *Organization Studies*, **8**(3), 223-240.

Penrose, E. T. (1959) *The Theory of the Growth of the Firm*. Oxford: Basil Blackwell.

Penrose, E. T. (1995) *The Theory of the Growth of the Firm*, 3rd Ed. Oxford: Oxford University Press.

Perrow, C. (1967) A framework for the comparative analysis of organizations. *American Sociological Review*, **32**(2), 194-208.

Perrow, C. (1986) *Complex Organizations: A Critical Essay*, 3rd Ed. New York: Random House.

Peter, J.P. (1979) Reliability: a review of psychometric basics and recent marketing practices. *Journal of Marketing Research*, **16**(1), 6-17.

Peter, J.P. and Churchill, G.A. (1986) Relationships among research design choices and psychometric properties of rating scales: a meta-analysis. *Journal of Marketing Research*, **23**(1), 1-10.

Peteraf, M.A. (1993) The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal*, **14**(3), 179-192.

Peteraf, M.A. and Barney, J.B. (2003) Unraveling the resource-based tangle. *Managerial and Decision Economics*, **24**(4), 309–323.

Peters, T.J. and Waterman, R.H.Jr. (1982) *In Search of Excellence*. New York: Warner Books.

Pfeffer, J. (1982) *Organizations and Organization Theory*. Boston: Pitman.

Pfeffer, J. (1997) *New Directions for Organization Theory: Problems and Prospects.* New York: Oxford University Press.

Pfeffer, J. and Salancik, G.R. (1978) *The External Control of Organizations: A Resource Dependence Perspective*. New York: Harper & Row.

Pferffer, J, (1994) *Competitive Advantage through People: Unleashing the Power of the Workforce*. Boston: Harvard Business School Press.

Phillips, L.W. (1981) Assessing measurement error in key informant reports: a methodological note on organizational analysis in marketing. *Journal of Marketing Research*, **18**(4), 395-415.

Pisik, B. (2007) Singapore 'already make green choice' *The Straits Times*, March 14. Singapore: The Singapore Press Holding Publication, p.H2.

Podsakoff, P.M. and Organ, D.W. (1986) Self-reports in organizational research: problems and prospects. *Journal of Management*, **12**(4), 531-544.

Porter, M.E. (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: The Free Press.

Porter, M.E. (1985) *Competitive Advantage: Creating and Sustaining Superior Performance.* New York: The Free Press.

Porter, M.E. and Millar, V.E. (1985) How information gives you competitive advantages. *Harvard Business Review*, **63**(4), 149–174.

Prahalad, C.K. and Hamel, G. (1990) The core competence of the corporation. *Harvard Business Review*, **68**(3), 79–91.

Prigogine, I. and Stengers, I. (1984) *Order out of Chaos*. London: Heinemann.

Project Management Institute (PMI) (2004) *A Guide to Project Management Body of Knowledge: PMBOK Guide*, 3rd Ed. Newtown Square, PA

Pugh, D.S. and Hickson, D.J. (2007) *Great Writers on Organizations*. Aldershot: Ashgate Publishing Limited.

Pugh, D.S., Hickson, D.J., Hinings, C.R. and Turner, C.C. (1968) The dimensions of organization structure. *Administrative Science Quarterly*, **13**(1), 65-105.

Pulakos, E.D., Arad, S., Donovan, M.A. and Plamondon, K.E. (2000) Adaptability in the workplace: development of a taxonomy of adaptive performance. *Journal of Applied Psychology*, **85**(4), 612-624.

Quinn, J. B. and Hilmer, F. G. (1996) Core competencies and strategic outsourcing. In Mintzberg, H. and Quinn, J.B. (eds.), *The Strategy Process: Concepts, Contexts, Cases*, 3rd Ed. Upper Saddle River: Prentice Hall, pp. 63-74.

Quinn, J.B. (1980) *Strategies for Change – Logical Incrementalism*. Homewood: Irwin.

Quinn, J.B. (1985) Managing Innovation: controlled Chaos. *Harvard Business Review*, **63**(3), 73- 84.

Quinn, J.B. (1992) *Intelligent Enterprise: A Knowledge and Service Based Paradigm for Industry*. New York: The Free Press.

Radjou, N. (2003) U.S. manufacturers' supply chain mandate. *World Trade*, **16**(12), 42-46.

Raftery, J., Pasadilla, B., Chiang, Y., Hui, E. and Tang, B. (1998) Globalization and construction industry development: Implications of recent development in the construction sector in Asia. *Construction Management and Economics*, **16**(6), 729–737.

Rahman, M.M. and Kumaraswamy, M.M (2005) Relational selection for collaborative working arrangements. *Journal of Construction Engineering and Management*, **131**(10), 1087-1098.

Raiden, A.B. and Dainty, A.R.J. (2006) Human resource development in construction organizations: an example of a "chaordic" learning organization? *The Learning Organization: An International Journal*, **13**(1), 63-79.

Raiden, A.B., Dainty, A.R.J. and Neale, R.H. (2004) Current barriers and possible solutions to effective project team formation and deployment within a large construction organization. *International Journal of Project Management*, **22**(4), 209–316.

Ranson, S., Hinings, B. and Greenwood, R. (1980) The structuring of organizational structures. *Administrative Science Quarterly*, **25**(1), 1-17.

Reed, R. and DeFilippi, R. (1990) Causal ambiguity, barriers to imitation and sustained competitive advantage. *Academy of Management Review*, **15**(1), 88-102.

Ringle, C.M., Wende, S. and Will, a. (2005) *SmartPLS 2.0 (beta)*, University of Hamburg, Germany, available at: www.smartpls.de

Robbins, S.P. (1983) *Organization Theory: the Structure and Design of Organizations*. Englewood Cliffs: Prentice-Hall.

Robbins, S.P. and Coulter, M. (1996) *Management*, 5th Ed. New Jersey: Prentice-Hall.

Robson, C. (2002) *Real World Research: A Resource for Social Scientists and Practitioner – researchers*, 2nd Ed. Oxford: Blackwell Publisher Ltd.

Rothwell, R. (1992) The 5th generation innovation process. *R&D Management*, **22**(3), 221-239.

Royal Institution of Chartered Surveyors (2004) *Contracts in Use: A Survey of Building Contractors in Use during 2004*, downloaded from: www.rics.org <200608>.

Rubin, H. and Rubin, I. (1995) *Qualitative Interviewing: The Art of Hearing Data*. California: Sage Publications.

Rumelth, R.P. (1994) Core competence in strategic thinking – Forward. In Hamel, G. and Heene, A. (eds), *Competence-Based Competition*. West Sussex: John Wiley & Sons Ltd.

Runeson, G. (2000) *Building Economics*, Victoria: Deakin University Press.

Runeson, G. and de Valence, G. (2009) The new construction industry. In Ruddock, L. (ed.), *Economics for the Modern Built Environment*. New York: Taylor and Francis, pp. 199-211.

Runeson, G. and Skitmore, M. (1999) Tendering theory revisited. *Construction Management Economics*, **17**(3), 285–296.

Russell, J.S. and Stouffer, B. (2000) Globalization: the new reality. *Journal of Construction Engineering and Management*, **16**(6), 3.

Salaman, G. and Asch, D. (2003) *Strategy and Capability: Sustaining Organizational Change*. Oxford: Blackwell Publishing.

Sanchez, A.M. and Perez, M.P. (2005) Supply chain flexibility and firm performance: a conceptual model and empirical study in the automotive industry. *International Journal of Operations and Production Management*, **25**(7), 681-700.

Sanchez, R. (1995) Strategic flexibility in product competition. *Strategic Management Journal*, **16**(Summer-special issue), 135–159.

Sanchez, R. (1997) Preparing for an uncertain future: managing organizations for strategic flexibility. *International Studies of Management and Organizations*, **27**(2), 71-94.

Schmidt, F.L. and Hunter, J.E. (1992) Development of causal models of processes determining job performance. *Current Directions in Psychological Science*, **1**(3), 89-92.

Schmitt, N.W. and Stults, D.M. (1985) Factors defined by negatively keyed items: the results of careless respondents? *Applied Psychological Measurement*, **9**(4), 367-73.

Schuler, R.S. and Jackson, S.E. (1978) Linking competitive strategies with human resource management practices. *The Academy of Management Executive*, **1**(3), 207-219.

Schutt, R.K. (2005) Sampling. In Grinnell. Jr. and Unrau, Y.A. (eds.), *Social Work Research and Evaluation: Quantitative and Qualitative Approaches*, 7th Ed. Oxford: Oxford University Press, pp. 149 – 170.

Schwab, D.P. (1980) Construct validity in organizational behaviour. *Research of Organizational Behaviour*, **2**(1), 3-43.

Scott, C. and Westbrook, R. (1991) New strategic tools for supply chain management. *International Journal of Physical Distribution and Logistics*, **21**(1), 23–33.

Scott, W.R. (1992*) Organizations: Rational, Natural and Open Systems*. New Jersey: Prentice-Hall.

Scott, W.R. and Davis, G.F. (2007) *Organizations and Organizing: Rational, Natural and Open System Perspectives*. New Jersey: Pearson Education, Inc.

Seidler, J. (1974) On using informants: a technique for collecting quantitative data and controlling measurement error in organizational analysis. *American Sociological Review*, **39**(6), 816-831.

Senge, P.M. (1990) *The Fifth Discipline: the Art and Practice of the Learning Organization*. New York: Doubleday.

Sethi, A.K. and Sethi, P.S. (1990) Flexibility in manufacturing: a survey. *International Journal of Flexible Manufacturing System*, **2**(4), 289 – 328.

Shankari, U. (2008) Rattled contractors give project a Miss. *The Business Times*, October 21. Singapore: The Singapore Press Holdings Publication, p.1.

Sharifi, H. and Zhang, Z. (1999) A methodology for achieving agility in manufacturing organizations: an introduction. *International Journal of Production Economy*, **62**(1-2), 7–22.

Sharma, S. (1996) *Applied Multivariate Techniques*. New York: John Wiley and Sons, Inc.

Shash, A. (1998) Subcontractors' bidding decisions. *Journal of Construction Engineering and Management*, **124**(2), 101-106.

Sheth, J.N. (2007) *The Self-destructive Habits of Good Companies:... and how to break them.* New Jersey: Wharton School Publishing.

Shirazi, B., Langford, D.A. and Rowlinson, S.M. (1996) Organizational structures in the construction industry. *Construction Management and Economics*, **14**(3), 199–212.

Shrivastava, P. (1983) A typology of organizational learning systems. *Journal of Management Studies*, **10**(1), 7-28

Sillars, D.N. and Kangari, R. (1997) Japanese construction alliances. *Journal of Construction Engineering and Management*, **123**(2), 146-152.

Simon, H.A. (1996) *The Sciences of the Artificial*, 3rd Ed. Cambridge: MIT Press.

Sinkula, J.M. (1994) Market information processing and organizational learning. *Journal of Marketing*, **58**(1), 35-45.

Sinkula, J.M., Baker, W.E. and Noordewier, T. (1997) A framework for market-based organizational learning: linking values, knowledge, and behaviour. *Academy of Marketing Science*, **25**(4), 305-318.

Slack, N. (1983) Flexibility as a manufacturing objective. *International Journal of Operations and Production Management*, **3**(3), 5–13.

Slack, N. (1987) The flexibility manufacturing systems. *International Journal of Operations and Production Management*, **7**(4), 35–45.

Slack, N. (2005) The changing nature of operations flexibility – update. *International Journal of Operations and Production Management*, **25**(12), 1201–1210.

Slack, N. and Lewis, M. (2002) *Operations strategy*. New York: Prentice-Hall.

Slater, S.F. and Narver, J.C. (1994) Does competitive environment moderate the market orientation-performance relationship? *Journal of Marketing*, **58**(1), 46-55.

Smircich, L. and Stubbart, C. (1985) Strategic management in an enacted world. *Academy of Management Review*, **10**(4), 724-736.

Smiricich, L. (1983) Concepts of culture and organizational analysis. *Administrative Science Quarterly*, **28**(3), 339-358.

Smith, K.W. and Sasaki, M.S. (1979) Decreasing multicollinearity: a method for models with multiplicative functions. *Sociology Methods and Research*, **8**(1), 35-56.

Smith, R.C. (1986) *Estimating and Tendering for Building Work*. New York: Longman.

Snow, C. and Snell, S. (1992) Staffing as strategy. In Schmitt, N. and Borman, W. (eds.), *Personnel Selection in Organization*. San Francisco: Jossey-Bass.

Snyman, J. (2009) From the short to the long term: history and development of leading indicators and building cycles. In Ruddock, L. (ed.), *Economics for the Modern Built Environment*. New York: Taylor and Francis, pp. 130-152.

Spekman, R.E., Kanauff, J. and Spear, J. (1999) Towards more effective sourcing and supplier management. *European Journal of Purchasing and Supply Management*, **5**(2), 103–116.

Spencer, N.C. and Winch, G. (2002) *How Buildings Add Value for Clients*. London: Thomas Telford.

Srivannaboon, S. and Milosevic, D.Z. (2006) A two-way influence between business strategy and project management. *International Journal of Project Management*, **24**(6), 493–505.

Stacey, R.D. (2001) Complex Responsive Processes in Organizations: Learning and Knowledge Creation. London: Routledge.

Starkey, K. Wright, M. and Thompson, S. (1991) Flexibility, hierarchy, markets. *British Journal of Management*, **2**(3), 165–176.

Stewart, R.A., Mohamed, S. and Daet, R. (2002) Strategic implementation of IT/IS projects in construction: a case study. *Automation in Construction*, **11**(6), 681–694.

Stewarts, T.A. and Warner, M. (1996) 3M fight back. *Fortune*, 133(2), 94-99.

Stigler, G.J. (1939) Production and distribution in the short run. *Journal of Political Economy*, **47**(3), 305–327.

Strandholm, K., Kumar, K. and Subramanian, R. (2004) Examining the interrelationships among perceived environmental change, strategic response, managerial characteristics, and organizational performance. *Journal of Business Research*, **57**(1), 58-68.

Streiner, D.L. (2005) Finding our way: an introduction to path analysis. *Canadian Journal of Psychiatry*, **50**(2), 115-122.

Styhre, A., Josephson, P. and Knauseder, I. (2004) Learning capabilities in organizational networks: case studies of six construction projects. *Construction Management and Economics*, **22**(9), 957-966.

Suarez, F.F., Cusumano, M.A and Fine, C.H. (1995) An empirical study of flexibility in manufacturing. *Sloan Management Review*, **37**(1), 25-32.

Suarez, F.F., Cusumano, M.A. and Fine, C.H. (1996) An empirical study of manufacturing flexibility in printed circuit board assembly. *Operations Research*, **44**(1), 223–240.

Subramony, M. (2006) Why organizations adopt some human resource management practices and reject others: an exploration of rationales. Human Resource Management, 45(2), 195-210.

Sull, D.N. (1999) Why good companies go bad. *Harvard Business Review*, **77**(4), 42-50.

Sull, D.N. (2005) *Why Good Companies Go Bad and How Great Managers Remake Them*. Boston: Harvard Business School Press.

Swafford, P.M., Ghosh, S. and Murthy, N. (2006) The antecedents of supply chain agility of a firm: scale development and model testing. *Journal of Operations Management*, **24**(2), 170–188.

Szulanski, G. and Amin, K. (2001) Learning to make strategy: balancing discipline and imagination. *Long Range Planning*, **34**(5), 537-556.

Tam, V.W.Y. and Tam, C.M. (2006) Evaluations of existing waste recycling methods: a Hong Kong study. *Building and Environment*, **41**(12), 1649-1660.

Tan, J. and Peng, M.W. (2003) Organizational slack and firm performance during economic transitions: two studies from an emerging economy. *Strategic Management Journal*, **24**(13), 1249-1263.

Tan, K.C. (2001) A framework of supply chain management literature. *European Journal of Purchasing and Supply Management*, **7**(1), 39–48.

Tan, K.C. (2002a) Supply chain management: practices, concerns and performance issues. *The Journal of Supply Chain Management*, **38**(1), 42–53.

Tan, W. (1995) *Research Methods in Real Estate and Construction*. Singapore: National University of Singapore.

Tan, W. (2002b) *Practical Research Methods*, 2nd Ed. Singapore: Pearson Education South Asia.

Tatum, C.B. (1987) Process of innovation in construction firms. *Journal of Construction Engineering and Management*, **113**(4), 648–663.

Tatum, C.B. (1988) Technology and competitive advantage in civil engineering. *Journal of Professional Issues in Engineering, Education and Practices*, **114**(3), 256–264.

Tatum, C.B. (1989) Organizing to increase innovation in construction firms. *Journal of Construction Engineering and Management,* **115**(4), 602-617.

Tay, L. and Morgan, N.A. (2002) Antecedents and consequences of market orientation in chartered surveying firms. *Construction Management and Economics,* **20**(4), 331-341.

Teare, R. (1997) Enabling organizational learning. *International Journal of Contemporary Hospitality Management*, **9**(7), 315-324.

Teece, D.J. Pisano, G. Shuen, A. (1997) Dynamic capabilities and strategic management. *Strategic Management Journal*, **18**(7), 509–533.

Temme, D., Kreis, H. and Hildebrandt, L. (2006) *PLS Path Modelling – A Software Review*, SFB 649 Discussion Paper, downloaded from: http://sfb649.wiwi.hu-berlin.de/papers/pdf/SFB649DP2006-084.pdf <200507>.

Teo, E.A.L., Ling, F.Y.Y., Chong, A.R.W (2005) Framework for project managers to manage construction safety. *International Journal of Project Management*, **23**(4), 329-341.

Tetenbaum, T.J. (1998) Shifting paradigms: from Newton to chaos. *Organizational Dynamics*, **26**(4), 21–32.

The Business Times (2004) *L&M poised to report loss in FY2004*, Singapore Press Holdings Limited, 8 November, downloaded from: http://global.factiva.com.libproxy1.nus.edu.sg/ha/default.aspx. <281206>

The Contractor (1998) SCAL members respond to economic changes. *The Contractor*, **15**(5), 1&3.

The Straits Times (2004) Budget terminal: 28 firms bid for job. *The Straits Times*, 6 October. Singapore: The Singapore Press Holdings Publication.

The Straits Times (2006) *How it all came tumbling down for big time construction firm*, Singapore Press Holding Limited, 6 August, downloaded from: http://global.factiva.com.libproxy1.nus.edu.sg/ha/default.aspx. <281206>

Theoharakis, V. and Hooley, G. (2003) Organizational resource enabling service responsiveness: evidence from Greece. *Industrial Marketing Management*, **32**(8), 695-702.

Thompson, J.L. (1993) *Strategic Management: Awareness and Change*. London: Chapman and Hall.

Thompson. J.D. (1967) *Organizations in Action*. New York: McGraw-Hill.

Thornhill, A., Lewis, P., Millmore, M. and Saunders, M. (2000) *Managing Changes: A Human Resource Strategy Approach*. Essex: Pearson Education Limited.

Tinsley, H.E.A. and Brown, S.D. (2000) Multivariate statistics and mathematical modelling. In Tinsley, H.E.A and Brown, S.D. (eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modelling*. California: Academic Press, pp. 3-36.

Tiong, R. and Yeo, K.T. (1993) Project financing as a competitive strategy in winning overseas jobs. *International Journal of Project Management*, **11**(2), 79-86.

Tomer, J.F. (1996) Strategy and structure in the human firm: beyond hierarchy, towards flexibility and integration. *Journal of Socio-Economics*, **24**(3), 411–431.

Treacy, M. And Wiersema, F. (1993) Customer intimacy and other value disciplines. *Harvard Business Review*, **71**(1) 84–93.

Underhill, T. (1996) *Strategic Alliances: Managing the Supply Chain*. Oklahoma: Penn Well Publishing Company.

Upton, D.M. (1994) The management of manufacturing flexibility. *California Management Review,* **36**(2), 72–89.

Upton, D.M. (1995a) Flexibility as process mobility: the management of plant capabilities for quick response manufacturing. *Journal of Operations Management*, **12**(3-4), 205–224.

Upton, D.M. (1995b) What really makes factories flexible? *Harvard Business Review*, **73**(4), 74-84.

Upton, G. and Cook, I. (2006) *A Dictionary of Statistics*, 2nd Ed. Oxford: Oxford University Press.

Usdiken, B., Sozen, Z. and Enbiyaoglu, H. (1988) Strategies and boundaries: subcontracting in construction. *Strategic Management Journal*, **9**(6), 633-637.

Vakharia, A.J. (2002) E-business and supply chain management. *Decision Sciences*, **33**(4), 495-504.

Van de Ven, A.H. (1976) A framework for organization assessment. *Academy of Management Review,* **1**(1), 64-78.

Van de Ven, A.H. (1986) Central problems in the management of Innovation. *Management Science*, **32**(5), 590-607.

Van de Vorst, J.G.A.J. and Beulens, A.J.M. (2002) Identifying sources of uncertainty to generate supply chain redesign strategies. *International Journal of Physical Distribution and Logistics Management*, **32**(6), 409–430.

Vance, A., Cosaque, C.E.D. and Straub, D.W. (2008) Examining trust in information technology artifacts: the effects of system quality and culture. *Journal of Management Information Systems*, **24**(4), 73-100.

Venkatraman, N, and Ramanujam, V. (1986) Measurement of business performance in strategy research: a comparison of approaches. *Academy of Management, Review*, **11**(4), 801-814.

Venkatraman, N. (1989) Strategic orientation of business enterprises: the construct, dimensionality, and measurement. *Management Science*, **35**(8), 942-962.

Verona, G.A. (1999) A resource-based view of product development. *Academy of Management Review*, **24**(1), 132-142.

Vickery, S., Calantone, R and Droge, C. (1999) Supply chain flexibility: An empirical study. *Journal of Supply Chain Management*, **35**(3), 16–24.

Vokurka, R.J. and O'Leary-Kelly, S.W. (2000) A review of empirical research on manufacturing flexibility. *Journal of Operations Management*, **18**(4), 485–501.

Volberda, H.W. (1992) *Organizational Flexibility: Chance and Preservation: A Flexibility Audit & Redesign Method*. Groningen: Wolters-Noordhoff.

Volberda, H.W. (1996) Towards the flexible forms: how to remain vital in hypercompetitive environments. *Organization Science*, **7**(4) 359–374.

Volberda, H.W. (1997) Building flexible organizations for fast-moving markets. *Long Range Planning*, **30**(2), 169-183.

Volberda, H.W. (1998) *Building the Flexible Firm: How to Remain Competitiveness*. New York: Oxford University Press Inc.

Volberda, H.W. and Cheah, H. (1993) A new perspective on entrepreneurship: a dialectic process of transformation within the entrepreneurial mode, type of flexibility and organizational form. In Klandt, H. (ed.), *Entrepreneurship and Business Development*. Aldershot: Avebury, pp. 261-286.

Voordijk, H., Hann, J.D and Joosten, G. (2000) Changing governance of supply chains in the building industry: a multiple case study. *European Journal of Purchasing and Supply Chain Management,* **6**(3-4), 217-225.

Wainwright, C.E.R. and Bateman, N. (1998) Auditing system flexibility in the context of manufacturing strategy information. *International Journal of Physical Distribution & Logistics Management*, **28**(9/10), 724–740.

Waldrop, M.M. (1992) Complexity*: The Emerging Science at the Edge of Chaos and Order*. New York: Simon & Schuster.

Walker, D.H.T. and Loosemore, M. (2003) Flexible problem solving in construction project on the National Museum of Australia project. *Team Performance Management: An International Journal*, **9**(1-2), 5-15.

Walker, D.H.T. and Shen, Y.J. (2002) Project understanding, planning flexibility of management action and construction performance: two Australian case studies. *Construction Management and Economics*, **20**(1), 31–44.

Wang, Y.G. and Li, H.R. (2007) *Marketing Competences and Strategic Flexibility in China*. New York: Palgrave Macmillan.

Watt, C. Hahn, C. and Sohn, B. (1993) Manufacturing flexibility: Concept and management. *Operations Management Review*, **9**(4), 33 – 44.

Weick, K.E. (1979) *The Social Psychology of Organizing*, 2nd Ed. Reading: Addison-Wesley.

Wernerfelt, B. (1984) A resource based view of firm. *Strategic Management Journal*, **5**(2), 171-180.

Wernerfelt, B. and Karnani A. (1987) Competitive strategy under uncertainty, *Strategic Management Journal*, **8**(2), 187–194.

Wikinson, L. and Task Force on Statistical Inference (1999) Statistical methods in psychology journals: guidelines and explanations. *American Psychologist*, **54**(8), 594-604.

Williams, L.J., Cote, J.A. and Buckley, M.R. (1989) Lack of method variance in self-reported affect and perception at work: Reality or artifact? *Journal of Applied Psychology*, **74**(3), 462-468.

Winch G. M. (2002) *Managing Construction Projects: An Information Processing Approach*. Oxford: Blackwell Science Ltd

Winch, G.M. (2000) Institutional reform in British construction: partnering and private finance. *Building Research and Information*, **28**(1), 141 – 155.

Wixom, B.H. and Watson, H.J. (2001) An empirical investigation of the factors affecting data warehousing success. *MIS Quarterly*, **25**(1), 17-41.

Wold, H. (1966) Estimation of principle components and related models by iterative least square. In Krishnaiah, P.R. (ed.), *Multivariate Analysis: Proceedings of An International Symposium Held in Dayton*, Ohio, June 14-19. New York: Academic Press, pp. 391-420.

Wold, H. (1975) Path models with latent variables: the NIPALS approach. In Blalock, H.M. et al. (eds.), *Quantitative Sociology: International Perspectives on Mathematical and Statistical Model Building*. New York: Academic Press, pp. 307-357.

Wold, H. (1982) Soft modelling: the basic design and some extension. In Joreskog, K.G. and Wold, H. (eds.), *Systems under Indirect Observations: Causality, Structure, Prediction - Part 2*. Amsterdam: North-Holland, pp. 1-54.

Womack, J., Jones, D. and Roos, D. (1990) *The Machine that changed the World*. New York: Rawson Ass.

Woodward, J. (1965) *Industrial Organization: Theory and Practice*. London: Oxford University Press.

Wright, P.M. and Snell, S.A. (1998) Toward a unifying framework for exploring fit and flexibility in strategic human resource management. *Academy of Management Review,* **23**(4), 756-772.

Wright, P.M., Dunford, B.B. and Snell, S.A. (2001) Human resources and the resource-based view of the firm. *Journal of Management*, **27**(6), 701-721.

Wright, P.M., Knoll, M., Caddie, B., Pryingle, C. (1990) Strategic profiles, market share and business performance. *Industrial Management*, **32**(3), 23-28.

Wright, P.M., McMahan, G.C. and McWilliams, A. (1994) Human resources and sustained competitive advantage: a resource-based perspective. *International Journal of Human Resource Management*, **5**(2), 301 – 326.

Wu, F., Yeniyurt, s. Kim, D. and Cavusgil, S.T. (2006) The impact of information technology on supply chain capabilities and firm performance: a resource-based view. *Industrial Marketing Management*, **35**(4), 493-504.

Yadav, R.N., Narain, R., Sarkis, J. and Cordeiro J.J. (2000) The strategic implications of flexibility in manufacturing systems. *International Journal of Agile Management System*, **2**(3), 202-213.

Yamin, S., Gunasekaran, A. and Mavondo, F.T. (1999) Relationship between generic strategies, competitive advantage and operational performance: an empirical analysis. *Technovation*, **19**(8), 507-518.

Yates, J.K. (1994) Construction competition and competitive strategies. *Journal of Management in Engineering*, **10**(1), 58-69.

Yin, R.K. (2003) *Case Study Research: Design and Methods*, 3rd Ed. London: Sage Publications Ltd.

Yisa, S.B., Ndekugri, I. and Ambrose, B. (1996) A review of changes in the UK construction industry: their implications for the marketing of construction services. *European Journal of Marketing*, **30**(3), 47-64.

Young-Ybarra, C. and Wiersema, M. (1999) Strategic flexibility in information technology alliances: the influence of transaction cost economics and social exchange theory. *Organization Science*, **10**(4), 439 – 459.

Yukl, G. and Lepsinger, R. (2004) *Flexible Leadership: Creating Value by Balancing Mulitple Challenges and Choices*. San Francisco: Jossey-Bass.

Yusuf, Y.Y., Gunasekaran, A., Adeleye, E.O. and Sivayoganathan, K. (2004) Agile supply chain capabilities: determinants of competitive objectives. *European Journal of Operational Research*, **159**(2), 379-392.

Zahra, S.A. (1996) Technology strategy and new venture performance: a study of corporate-sponsored and independent biotechnology venture. *Journal of Business Venturing*, **11**(4), 289-321.

Zahra, S.A. and Covin, J.G. (1993) Business strategy, technology policy and firm performance. *Strategic Management Journal*, **14**(6), 451–478.

Zhang, Q.Y., Vonderembse, M.A. and Lim, J.S. (2003) Manufacturing flexibility: defining and analyzing relationships among competence, capability and customer satisfaction. *Journal of Operation Management*, **21**(2), 173–191.

Zikmund, W.G. and Babin, B.J. (2007) *Essentials of Marketing Research*, 3rd Ed. Ohio: Thomson/South-Western.

Zou, P.X.W. and Lim, B.T.H. (2006) An empirical study in subcontractor selection and long term alliance relationship between main-contractor and subcontractor. *International Journal of Construction Management*, **6**(1), 1-13.

Appendix A – Interview guide questions

S/No.		Authors	Objectives
1	Please could you briefly describe your company background and your personal profile? (for example, the number of employees, annual turnover and range of services offered, your working experience in the construction industry and your tenure in this firm).		It seeks to provide general background information for the company and interviewee.
2	What are the significant external and internal changes that have affected your company's business operations over the last 10 years?	Das and Patel 2002	These questions seek to explore the range of changes that have occurred over the years that may not have been covered in the literature. They form the opening questions before going into more specific questions of how organizations respond flexibly to these changes.
3	What are the consequences of these changes on your firm's operation?		
4	What are the causes to these changes? What are the environmental factors that caused these changes?		
5	Could you please provide the various attempts/ strategies adopted by your organization to respond and manage these changes?		
6	Do you agree on the definition of flexibility: "the ability of an organization to effectively utilize its resources and capabilities to respond or readapt, in a timely and reversible manner to environmental changes via a continuous learning process"		These questions seek to extract interviewees' understanding of the term 'flexibility'. In addition, it gauges the appropriateness of the flexibility concept in the construction industry.
7	Based on the previous question, do you think the ability of being flexible is necessary in the construction industry? Why?		
8	How important do you think that a construction firm needs to be flexible in response to the environmental changes? What are the driving forces?		
9	Is the ability of being flexible necessary for general contracting business of a construction firm? Or it is only useful in dealing with uncertain circumstances? E.g. recession markets	Slack 1987	

S/No.		Authors	Objectives
10	Does a firm's flexibility enhance its competitiveness (e.g. turnover, winning rate, reputation) within the changing business environment which it operates?		This seeks to examine whether interviewees perceive proper management of flexibility will increase their competitiveness in the construction market.
11	What are the types of flexibility possessed by your firm? Or what are the top five flexibility types which your firm desires to possess? Why? Do you agree with the definitions of the flexibility types proposed on the list?		These questions seek to explore the range of flexibility types that interviewees perceive as practical and important.
12	Which flexibility types does your firm perceive as being the most important for the construction business operation? Why?	Slack 1987	
13	What are the key determinants (for example, human resource, information and process technologies and organization structure) that will help a construction firm to attain organizational flexibility?		These questions seek to identify: (i) the key determinant of organizational flexibility and (ii) the practices in supporting these enablers to achieve flexibility
14	Please could you kindly describe the characteristics of these key determinants?		
15	What are the practices or strategies adopted by your firm to ensure that these key determinants will support the attainment of organizational flexibility?		

Appendix B – List of proposed flexibility types and their definitions

Code	Terms	Proposed definitions
F1	Modification/changeover flexibility	The ability to modify its operational structure without major restructuring in the face of environmental changes.
F2	Financial flexibility	The ability to integrate, construct and re-shape those financial resources in the face of environmental changes.
F3	Labour flexibility	The ability to change number of workers, tasks and responsibilities performed by workers.
F4	Expansion flexibility	The ability to add and expand business capacity as and when it is needed without incurring high transition costs or major investment.
F5	Market flexibility	The ability to operate in different market conditions.
F6	Operation/Routing/ Production flexibility	The ability to adopt a range of alternative routes or options in response to environmental changes and clients' needs.
F7	Volume flexibility	The ability to operate efficiently, effectively and profitability in response to current market demand.
F8	Machine flexibility	The ability of equipments or machines to perform or modify to suit variety of operations without incurring high transaction penalties or large charges in performance outcomes.
F9	Material flexibility	The ability to make or produce products using alternative compositions and dimensions of raw materials.
F10	Process flexibility	The ability to change procedures and technologies in response to changes in clients' need or the business environment.
F11	Procurement flexibility	The ability to effectively exploit a range of purchasing processes or options in response to changes in clients' need and/or the business environment.
F12	Product /mix/new product flexibility	The ability to effectively provide a range of products and services aligned with changes in clients' needs or the business environment.
F13	Program flexibility	The ability of an organization to upgrade its technological system without incurring high transaction penalties.
F14	Spanning flexibility	The ability to integrate different business units (i.e., internal functions and external firms) in producing and delivering value added products and services for clients.
F15	Logistic/ Delivery/Material handling flexibility	The ability to effectively respond to changes in the delivery schedule due to unpredictable changes in clients' requirements or the business environment.

Appendix C – Interview survey structured questionnaire

School of Design and Environment
Department of Building

NUS National University of Singapore

Instructions for completing the questionnaire

Dear Sir/Mdm,

Below are some guidelines for completing the questionnaire.

1. Please note that there is no right or wrong answer to respective questions;
2. Please answer respective questions based the factual situations rather than the strategic intent of your organization;
3. Please make every effort to provide complete and accurate information. This helps us to develop a more reliable assessment model; and
4. Please note that the term “employees” refers to supervisory staff and above.

Many thanks for your kind participation.

Survey on Flexibility Management in Construction Business

Part 1: General Information of Your Firm

1.1 **Your firm's workhead** (Pls tick all that applies):

☐ General Building/ Financial Classification: Grade _____

☐ Civil Engineering/ Financial classification: Grade _____

☐ Others, please specify: Workhead _____ Financial Classification _____

1.2 **Age of your firm**: ______

1.3 **Type of your firm**:

☐ Public Listed Firm ☐ Private Limited Firm: Sole proprietorship/ Partnership/Family business

1.4 **What is your firm's average annual financial turnover during the periods stated below?**

Year 1997 – 2000 S$_____/year **Year 2001 – 2005** S$_____/year **Year 2006 - now** S$_____/year

1.5 **What is your firm's average revenue from projects outside Singapore during the periods stated below?**

Year 1997 – 2000 S$_____/year **Year 2001 – 2005** S$_____/year **Year 2006 - now** S$_____/year

1.6 **What is the average tendering success rate of your firm during the periods stated below?**
(E.g. if you bid 10 projects and were successful twice, the success rate is 20%)

Year	*Success rate, %*							
	0 – 5%	6 – 10%	11 – 20%	21 – 30%	31 – 40%	41 – 50%	51 – 60%	Other, Pls state
1997 – 2000	☐	☐	☐	☐	☐	☐	☐	_____%
2001 – 2005	☐	☐	☐	☐	☐	☐	☐	_____%
2006 - now	☐	☐	☐	☐	☐	☐	☐	_____%

1.7 **What are your firm's business focuses during the periods stated below?** (Pls tick the relevant boxes)

	1997 - 2000	**2001 - 2005**	**2006 – now**
a Private residential construction	☐	☐	☐
b Public residential construction	☐	☐	☐
c Office & shopping construction	☐	☐	☐
d Hotel construction	☐	☐	☐
e Factory construction	☐	☐	☐
f School construction	☐	☐	☐
g Industrial building construction	☐	☐	☐
h Renovation and alteration	☐	☐	☐
i Civil engineering & piling	☐	☐	☐
j Mechanical and electrical engineering	☐	☐	☐
k Manufacturing building products	☐	☐	☐
l Supply of building products	☐	☐	☐
m Property maintenance	☐	☐	☐
n Property development	☐	☐	☐
o Others (Please specify)	_____	_____	_____

Part 2: Human Resources

2.1 **How often does your firm provide the following for its employees annually?**

	Competence Development	(No. of times/year) 0	1	2	3	4	5	≥ 6
C1	Organizing training on current issues (e.g. change in regulations and safety requirements) that have direct impact on firm's operational processes	☐	☐	☐	☐	☐	☐	☐
C2	Organizing training to upgrade employees' knowledge and skills in using IT equipment and application (e.g. email)	☐	☐	☐	☐	☐	☐	☐
C3	Organizing training to upgrade employees' knowledge and skills in using IT software (e.g. Microsoft Project, AutoCAD and accounting software)	☐	☐	☐	☐	☐	☐	☐
C4	Organizing training to upgrade employees' knowledge and skill on application of different procurement options (e.g. Design & Build)	☐	☐	☐	☐	☐	☐	☐
C5	Organizing training to upgrade employees' knowledge and skills on application of different construction methods and technologies	☐	☐	☐	☐	☐	☐	☐

2.2 **How often does your firm practise the following for its employees?**

	Competence Development	Seldom 1	2	⟵ 3	4	5 ⟶	Often 6	7
C6	Offering on-the-job training	☐	☐	☐	☐	☐	☐	☐
C7	Offering job rotation programme	☐	☐	☐	☐	☐	☐	☐
C8	Offering job enrichment programme (e.g. taking on higher responsibility)	☐	☐	☐	☐	☐	☐	☐
C9	Offering day release scheme to attend part-time courses in institutions	☐	☐	☐	☐	☐	☐	☐
C10	Allowing employees to take day-off for their continual professional development and professional qualifications courses	☐	☐	☐	☐	☐	☐	☐
C11	Implementing mentoring scheme to support new recruits and recently promoted employees	☐	☐	☐	☐	☐	☐	☐
C12	Collaborating with management institutes to provide training for employees	☐	☐	☐	☐	☐	☐	☐
C13	Subsidizing tuition fees of self-upgrading courses and seminars attended by employees'	☐	☐	☐	☐	☐	☐	☐

2.3 **To what extent does your firm adopt the following practices?**

	Stress Management	Seldom 1	2	⟵ 3	4	5 ⟶	Often 6	7
SM1	Allowing employees to take time-off as and when it is necessary	☐	☐	☐	☐	☐	☐	☐
SM2	Organizing stress coping and management courses	☐	☐	☐	☐	☐	☐	☐
SM3	Implementing buddy scheme among employees	☐	☐	☐	☐	☐	☐	☐
SM4	Implementing personal counselling program	☐	☐	☐	☐	☐	☐	☐

2.4 **To what extent does your firm adopt the following practices?**

	Performance Management	Seldom 1	2	⟵ 3	4	5 ⟶	Often 6	7
PM1	Organizing informal gatherings to recognize employees' achievements and to foster team building	☐	☐	☐	☐	☐	☐	☐
PM2	Providing flexible compensation plans (e.g. performance bonuses and profit sharing)	☐	☐	☐	☐	☐	☐	☐
PM3	Organizing company trips to reward employees' contributions to the firm's business performance	☐	☐	☐	☐	☐	☐	☐
PM4	Conducting staff performance appraisal exercise as a formal means of discussing, identifying and recording their training need	☐	☐	☐	☐	☐	☐	☐
PM5	Offering career development and promotion opportunities	☐	☐	☐	☐	☐	☐	☐

2.5 **To what extent does your firm adopt the following practices?**

Relationship Management	Seldom 1	2	3	4	5	6	Often 7
RM1 Encouraging regular face-to-face communications among employees	☐	☐	☐	☐	☐	☐	☐
RM2 Conducting regular meetings among subordinates and superiors	☐	☐	☐	☐	☐	☐	☐
RM3 Implementing survey feedback programme to track the well-being of employees	☐	☐	☐	☐	☐	☐	☐
RM4 Encouraging regular meetings among employees and parties in the supply chain	☐	☐	☐	☐	☐	☐	☐
RM5 Implementing induction programme for all new recruits	☐	☐	☐	☐	☐	☐	☐
RM6 Providing subcontractors/suppliers the flexibility to plan their delivery schedule	☐	☐	☐	☐	☐	☐	☐
RM7 Offering incentive scheme to suppliers and subcontractors (e.g. early payment)	☐	☐	☐	☐	☐	☐	☐
RM8 Providing after-sales services to clients	☐	☐	☐	☐	☐	☐	☐
RM9 Organizing training for other parties in the supply chain (e.g. seminar)	☐	☐	☐	☐	☐	☐	☐
RM10 Keeping constant contact with clients to keep track of their business need	☐	☐	☐	☐	☐	☐	☐
RM11 Organizing informal gatherings among other parties in the supply chain	☐	☐	☐	☐	☐	☐	☐

2.6 **Please rank & rate the desired skills and behaviour of your firm's employees.**

	Rank (1= most important to 8 least important)	Low 1	2	3	4	5	6	High 7
ESB1 Ability to adopt an open mindset to all alternatives	_____	☐	☐	☐	☐	☐	☐	☐
ESB2 Ability to work in a team environment	_____	☐	☐	☐	☐	☐	☐	☐
ESB3 Ability to travel overseas on assignments for an extended period	_____	☐	☐	☐	☐	☐	☐	☐
ESB4 Ability to learn and adapt to different business conditions	_____	☐	☐	☐	☐	☐	☐	☐
ESB5 Ability to perform a diverse range of tasks and responsibilities	_____	☐	☐	☐	☐	☐	☐	☐
ESB6 Ability to gain customer satisfaction	_____	☐	☐	☐	☐	☐	☐	☐
ESB7 Ability to perform highly sophisticated tasks	_____	☐	☐	☐	☐	☐	☐	☐
ESB8 Ability to work independently	_____	☐	☐	☐	☐	☐	☐	☐

2.7 **What is the size of your firm's workforce (supervisory staffs and above)?**

No. of employees

0 – 5	6 - 10	11 - 50	51 - 100	101 - 150	151 - 200	201 - 300	301 - 400	401 - 500	>500
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

2.8 **What percentage of your firm's workforce is employed based on contract basis?**

% of contract-based employees

0%	1%	2 - 3%	4 - 5%	6 - 8%	9 - 10%	11 - 15%	16 - 20%	
☐	☐	☐	☐	☐	☐	☐	☐	Other_____%

Part 3: Organizational Culture

3.1 **To what extent do the following best describe your firm's culture?**

		Strongly disagree 1	2	3	4	5	6	Strongly agree 7
CL1	Employees' training and learning are seen as investment rather than expenses	☐	☐	☐	☐	☐	☐	☐
CL2	Performance mistakes are seen as opportunities for learning and development	☐	☐	☐	☐	☐	☐	☐
CL3	Our ability to learn is the key toward our firm's success in response to changes within the industry	☐	☐	☐	☐	☐	☐	☐
O1	Our firm encourages participative decision making among employees	☐	☐	☐	☐	☐	☐	☐
O2	Our firm promotes open communication among subordinates and superiors	☐	☐	☐	☐	☐	☐	☐
O3	Our firm adapts freely to changes within the industry without much concern to past practices and management practices	☐	☐	☐	☐	☐	☐	☐
SV1	Our firm encourages brainstorming sessions among employees to share new ideas	☐	☐	☐	☐	☐	☐	☐
SV2	Our firm provides support to employees to reach organizational goals	☐	☐	☐	☐	☐	☐	☐
SV3	Employees are constantly informed on the firm's business objectives	☐	☐	☐	☐	☐	☐	☐
SV4	Employees' involvement in charting the direction of the firm is the key toward our firm's success	☐	☐	☐	☐	☐	☐	☐

Leadership

3.2 **Please <u>tick one</u> of the following that best describes your firm's top management directing and collaborating behaviour.**

- a Specifying a rigid process of what must be done and accurately controlling the business performance ☐
- b Asking for contributions from employees in decision making and closely following their task performance ☐
- c Joint decision making with employees and direct support in their task execution ☐
- d Leaving decisions about tasks as well as the responsibility for these decisions to employees ☐

Planning attitude

3.3 **Please <u>tick one</u> of the following that best describes your firm's planning strategy.**

- a Establish <u>stable goals</u> and develop <u>integrated plans</u> to achieve them ☐
- b Establish <u>broad goals</u> and plan incrementally with <u>short-term aim</u> to achieve them ☐
- c Plan iteratively in accordance with the business environment – <u>keeping all options open</u> ☐

3.4 **If possible, please provide a copy of your firm's mission and vision statement.**

Part 4: Organizational Structure

4.1 **How many hierarchical levels are there in your firm's organizational structure?** (*If possible, please provide a copy of your firm's organization chart)*

2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ Other_______

4.2 **How many times have your firm changed its organizational structure during the stated periods below?**

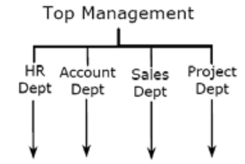
Years	*No. of times*								
1997 – 2000	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Other _______
2001 – 2005	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Other _______
2006 – now	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Other _______

4.3 **To what extent does your firm adopt the following system during the periods stated below?**

(**N.A** – Not applicable, **R–** Rarely practised, **S** – Sometimes practised, **O–** Often practised)

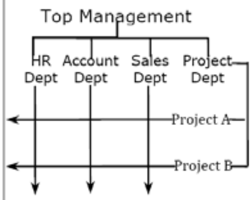
	Simple configuration				*Functional configuration*				*Divisional configuration*				*Matrix configuration*			
Year	**N.A**	**R**	**S**	**O**	**N.A**	**R**	**S**	**O**	**N.A**	**R**	**S**	**O**	**N.A**	**R**	**S**	**O**
1997 – 2000	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2001 – 2005	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2006 – now	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

One man show system where decisions are made by a single person



Interdependent functional departments (Dept) have their own distinctive processes

Divisional units can be separated based on type of different services or markets



Departments operate in a dual hierarchy of authority. It forms a project-centred arrangement

4.4 **To what extent do the following best reflect your firm's decision making and communication procedure?**

Stronger emphasis on left-hand expression ←			Equal emphasis			→ *Stronger emphasis right hand expression*
4	3	2	1	2	3	4

		4	3	2	1	2	3	4	
OS1	Following the formally laid down procedures	☐	☐	☐	☐	☐	☐	☐	Getting things done even if the methods used disregard the formal procedures
OS2	Centralization: most operating decisions made by top management	☐	☐	☐	☐	☐	☐	☐	Decentralization: most operating decisions made by lower management
OS3	Structured communication channel and restricted access to important information for decision making	☐	☐	☐	☐	☐	☐	☐	Open communication channel with flexible access to important information for decision making
OS4	Tight and formal control: most operations are governed by means of sophisticated control	☐	☐	☐	☐	☐	☐	☐	Loose and informal control: dependent on informal relationships and norms of cooperation for getting work done

Part 5: Organizational Supply Chain

5.1 **To what extent do the following best reflect your firm's supply chain capabilities (compared to your closest competitors)?**

		Low ←→ High						
		1	2	3	4	5	6	7
SC1	Ability to obtain more competitive price from suppliers/subcontractors	☐	☐	☐	☐	☐	☐	☐
SC2	Ability to procure materials on a global basis	☐	☐	☐	☐	☐	☐	☐
SC3	Ability to improve the quality of construction services and products	☐	☐	☐	☐	☐	☐	☐
SC4	Ability to attract repeat business from clients	☐	☐	☐	☐	☐	☐	☐
SC5	Ability to improve construction delivery speed	☐	☐	☐	☐	☐	☐	☐
SC6	Ability to coordinate delivery requirement to meet clients' need on a global basis	☐	☐	☐	☐	☐	☐	☐
SC7	Ability to assemble effective business teams (including suppliers & subcontractors) to provide one-stop services for clients	☐	☐	☐	☐	☐	☐	☐

5.2 **How responsive are your preferred suppliers and subcontractors in response to your request for:**

	Response time (Working Day(s))						
	1	2 - 3	4 - 5	6 -7	8 - 14	15 - 28	≥29
R1 Basic information, e.g. product specification	☐	☐	☐	☐	☐	☐	☐
R2 Proposal for minor work	☐	☐	☐	☐	☐	☐	☐
R3 After-sales service (e.g. rectification works)	☐	☐	☐	☐	☐	☐	☐
R4 Delivery of urgent but routine services and products	☐	☐	☐	☐	☐	☐	☐
R5 Overseas assignment when their services are needed	☐	☐	☐	☐	☐	☐	☐

Part 6: Business Practices

6.1 **To what extent does your firm adopt the following practices in response to changes within the industry over the last 10 years?**

(**R–** Rarely practised, **S** – Sometimes practised, **A** – Averagely practised, **O–** Often practised)

		1997 - 2000				2001 - 2005				2006 - now			
		R	S	A	O	R	S	A	O	R	S	A	O
B1	Adopting merger and acquisition strategies	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B2	Forming joint-venture with other contractors to serve a group of targeted clients	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B3	Forming partnership with clients	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B4	Diversifying into different construction business	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B5	Bidding for more projects that are within the firm's capabilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B6	Bidding for projects with low tender prices and tiny/zero margins	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B7	Investing on assets that have high liquidity value (e.g. general multiple-usage equipment)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B8	Creating uncommitted financial resources (e.g. setting aside contingency funds)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B9	Implementing stricter financial management on company cash flow	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B10	Setting limits on project size so that any failure of one project would not endanger the firm's operation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B11	Entering into forward contracts with suppliers & subcontractors to protect the firm against cost escalation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B12	Investing into R & D to further explore business opportunities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B13	Following clients abroad	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B14	Implementing stricter site management to reduce material wastage	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B15	Implementing stricter procurement management	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B16	Investing surplus funds into financial investment and property development	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6.2 **What is the average percentage of subcontracted work for your firm's existing/past projects?**

Market	% of work							
Singapore Market	0% ☐	1 - 5% ☐	6 - 15% ☐	16 - 30% ☐	31 - 50% ☐	51 - 70% ☐	71 - 85% ☐	86 - 100% ☐
Overseas Market(s)	0% ☐	1 - 5% ☐	6 - 15% ☐	16 - 30% ☐	31 - 50% ☐	51 - 70% ☐	71 - 85% ☐	86 - 100% ☐

6.3 **How many overseas countries does your firm operate in during the period stated below?**

Year 1997 – 2000 ______countries **Year 2001 – 2005** ______countries **Year 2006 - now** ______countries

Part 7: Information Technology (IT)

7.1 **What percentage of your firm's annual financial turnover is spent on development of its IT?**

0% ☐ ≤0.5 % ☐ 0.6 - 1% ☐ 2% ☐ 3% ☐ 4 - 5% ☐ 6 - 7% ☐ 8 - 10% ☐ Other______%

7.2 **What percentage of your firm's employees is equipped with basic IT skills, e.g. use of email?**

0% ☐ 1 - 5% ☐ 6 - 15% ☐ 16 - 30% ☐ 31 - 50% ☐ 51 - 70% ☐ 71 - 85% ☐ 86 - 100% ☐

7.3 **What percentage of your firm's documents, i.e. past or existing project information, is electronically stored in your firm's database?**

0% ☐ 1 - 5% ☐ 6 - 15% ☐ 16 - 30% ☐ 31 - 50% ☐ 51 - 70% ☐ 71 - 85% ☐ 86 - 100% ☐

7.4 **What percentage of your firm's employees has directly access to the firm's IT system to retrieve existing/past records?**

0% ☐ 1 - 5% ☐ 6 - 15% ☐ 16 - 30% ☐ 31 - 50% ☐ 51 - 70% ☐ 71 - 85% ☐ 86 - 100% ☐

7.5 **To what extent do the following best reflect your firm's IT capabilities?**

		Low 1	2	3	4	5	6	High 7
IT1	Ability to communicate and share real time information among supply chain parties regardless of geographic dispersion	☐	☐	☐	☐	☐	☐	☐
IT2	Ability to communicate and share real time information among all decision makers and employees regardless of geographic dispersion	☐	☐	☐	☐	☐	☐	☐
IT3	Ability to retrieve information, i.e. regarding past/existing projects, from the company database in a timely manner regardless of geographic dispersion	☐	☐	☐	☐	☐	☐	☐
IT4	Ability to disseminate information and link similar information, providing decision makers with the most up-to-date and accurate information regarding changing environmental contingencies	☐	☐	☐	☐	☐	☐	☐

Part 8: Construction Process Technology (CPT)

8.1 **What percentage of your firm's annual financial turnover is spent on development of its CPT?**

0% ☐ ≤0.5 % ☐ 0.6 - 1% ☐ 2% ☐ 3% ☐ 4 - 5% ☐ 6 - 7% ☐ 8 - 10% ☐ Other______%

8.2 **What percentage of your firm's employees is equipped with basic CPT programme (e.g. AutoCAD and Microsoft Project software)?**

0% ☐ 1 - 5% ☐ 6 - 15% ☐ 16 - 30% ☐ 31 - 50% ☐ 51 - 70% ☐ 71 - 85% ☐ 86 - 100% ☐

8.3 **What percentage of your firm's employees is equipped with advanced CPT knowledge (e.g. using computer-aided program in analyzing indoor thermal condition and air flow analysis)?**

0%	1 - 5%	6 - 15%	16 - 30%	31 - 50%	51 - 70%	71 - 85%	86 - 100%
☐	☐	☐	☐	☐	☐	☐	☐

8.4 **To what extent do the following best reflect your firm's CPT capabilities?**

		Low 1	2	3	4	5	6	High 7
PT1	Ability to adopt different construction process technologies (e.g. construction methods and materials) to satisfy clients' requirements	☐	☐	☐	☐	☐	☐	☐
PT2	Ability to apply different process technology software (e.g. estimating and purchasing software) to improve firm's operational process	☐	☐	☐	☐	☐	☐	☐
PT3	Ability to lead in process technology innovation (e.g. computer aided program in analyzing indoor thermal condition) to gain competitive advantage	☐	☐	☐	☐	☐	☐	☐

Part 9: Environmental Conditions

9.1 **To what extent have the following conditions affected your business operation and performance during the periods stated below?**

(**M -** Minimal impact, **A –** Average impact, **Q –** Quite a high impact, **H –** Highest impact)

		1997 - 2000				2001 - 2005				2006 - now			
Market conditions		M	L	Q	H	N	L	Q	H	N	L	Q	H
MC1	Fluctuation of demand for constructed facilities	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MC2	Changes of clients' need	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MC3	Unpredictable actions of competitors	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MC4	Price competition in the construction market	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MC5	Intense competition in the construction market	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MC6	Fluctuation of supply of construction resources	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Technological conditions													
TCn1	Rapid emergence of new information technology on business operations	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TCn2	Rapid emergence of new construction process technology on business operations	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TCn3	Demand for advanced technological constructed facilities (e.g. intelligent building)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Part 10: Organization's flexibility capabilities

10.1 **To what extent do the following reflect your firm's flexibility capabilities in response to the environmental conditions?**

		Low 1	2	3	4	5	6	High 7
F1	Ability to modify your firm's operational structure	☐	☐	☐	☐	☐	☐	☐
F2	Ability to integrate, construct and reshape your firm's financial resources	☐	☐	☐	☐	☐	☐	☐
F3	Ability to change the number of employees in your business operation	☐	☐	☐	☐	☐	☐	☐
F4	Ability of your firm's employees to handle multiple responsibilities	☐	☐	☐	☐	☐	☐	☐

		Low 1	2	3	4	5	6	High 7
F5	Ability to add and expand your business capacity efficiently	☐	☐	☐	☐	☐	☐	☐
F6	Ability to operate effectively in both local and overseas markets	☐	☐	☐	☐	☐	☐	☐
F7	Ability to adopt a range of alternative logistics supports to operations	☐	☐	☐	☐	☐	☐	☐
F8	Ability to operate effectively and profitably in different market conditions	☐	☐	☐	☐	☐	☐	☐
F9	Ability of your firm's construction equipment to be modified to suit different operational needs	☐	☐	☐	☐	☐	☐	☐
F10	Ability to construct facilities using different construction methods and materials	☐	☐	☐	☐	☐	☐	☐
F11	Ability to make decisions on non-routine and significant events which cannot be anticipated in advance	☐	☐	☐	☐	☐	☐	☐
F12	Ability to exploit a range of procurement options effectively (e.g. Design & Build and Construction Management)	☐	☐	☐	☐	☐	☐	☐
F13	Ability to provide a range of construction services (e.g. residential construction and property maintenance)	☐	☐	☐	☐	☐	☐	☐
F14	Ability to integrate your internal functions with external firms in providing value-added services to clients	☐	☐	☐	☐	☐	☐	☐
F15	Ability to respond to changes in delivery schedule due to unpredictable changes in clients' requirements	☐	☐	☐	☐	☐	☐	☐

Part 11: Demographic Characteristic

1. Your designation/job title: ____________________________
2. Number of years you have practiced in the construction industry:______________________ years
3. Your name (optional):______________________________
4. Name of your firm (optional):_______________________________

Thank you very much for your kind participation!

Appendix D – Example of invitation letter

School of Design and Environment
Department of Building

NUS National University of Singapore

Tel: 65163513 Fax: 63867893

3rd October 2007

The Managing Director
XXX Co. PTE LTD
100 Bukit Merah Lane 1, #00-145
Singapore 150120

Dear Sir/Mdm,

INTERVIEW SURVEY ON FLEXIBILTY MANAGEMENT IN CONSTRUCTION

We are researching into the practices that construction firms adopt to attain flexibility in response to the changing business environment. This research involves development of a system that evaluates organizational flexibility of construction firms. Your firm has been identified as one of the elite companies operating successfully in the Singapore construction industry and which grew over the past decade. Your knowledge of business management in the construction industry would be very valuable to this research.

This research involves interviews with experts in the Singapore construction industry. As a senior management of your firm with extensive experience in the firm's business operation, we would like to humbly request for an interview with your goodself. The interview will take about 45 minutes.

You can be assured that all information that you provide will be treated in strictest confidentiality and used for research purpose only. Your name and your firm's name would not appear in the report. A complimentary copy of the results and the developed evaluation system will be provided to you upon the completion of this research project.

We look forward to receiving your response. Should you have any queries with regard to this research project, please do not hesitate to contact the undersigned at 9004 8694.

Thank you.

Yours sincerely,

Lim Teck Heng, Benson
PhD Candidate
Email: g0500825@nus.edu.sg

Please tick and fax this page to Benson Lim at: (65) 63867893

☐ I would like to participate in this research

________________	________________	________________
Name	Email address	Date

Appendix E – Model validation instrument

School of Design and Environment
Department of Building

NUS
National University of Singapore

Introduction

Our research seeks to develop flexibility indices to help contractors to determine their ability to respond and react to changes within the business environment. Six determinants of organizational flexibility were identified in this research. They are (1) organizational learning culture (X1); (2) organizational structure (X2); (3) employees' skills and behaviour (X3); (4) supply chain capabilities (X4); (5) technological capabilities (X5); and (6) business strategies (X6). These determinants were used to test against different flexibility dimensions identified (i.e. operational flexibility; tactical flexibility; and strategic flexibility). These dimensions represent different flexibility indices of a contractor.

Models were developed from the dataset obtained from the early survey result conducted. Your feedback concerning the practicability and comprehensiveness of these models is important.

Your kind participation at this validation stage is greatly appreciated to bring this research to a conclusion. We thank you very much indeed for your participation in this research. You can be assured that all of the information that you provide will be treated in *STRICTEST* confidence and use for research purposes only.

Many thanks.

Yours sincerely,

Lim Teck Heng, Benson
PhD Candidate
Email: g0500825@nus.edu.sg

Interview Guide Questions

1. Do you think the three dimensions identified within our model (operational flexibility, tactical flexibility and strategic flexibility) should be combined into one single dimension?

2. Out of the three dimensions, which dimension do you think has the largest impact on firms' performance? Please assess the weight of each dimension on firms' performance. For example, **0.5**:**0.2**:**0.3.** If you think that they carry equal weight, please indicate: **0.33:0.33:0.33**

   Operational flexibility: ____; Tactical flexibility: ____; strategic flexibility: _____

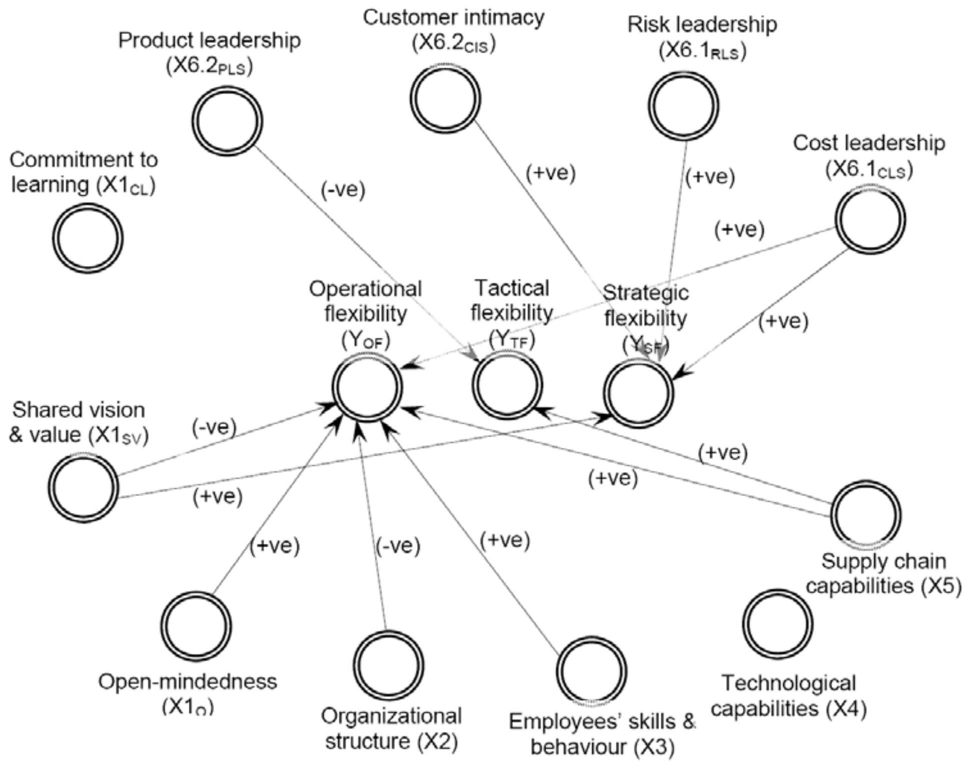
3. Do you think that a firm need to balance itself among these three flexibility dimensions? If yes/no, why?

4. What do you think about the practicability of the model for the Singapore construction industry?

5. Any other factors or enablers (e.g. human resource and technological capabilities) that are not included in the model that you think would help to improve contractors' responsiveness to changes within the business environment?

6. Do you think that it would be helpful and viable to develop a Decision Support System (DSS), a computer program, to help contractors to determine their flexibility potential? What would you like to see in this program (e.g. functions)?

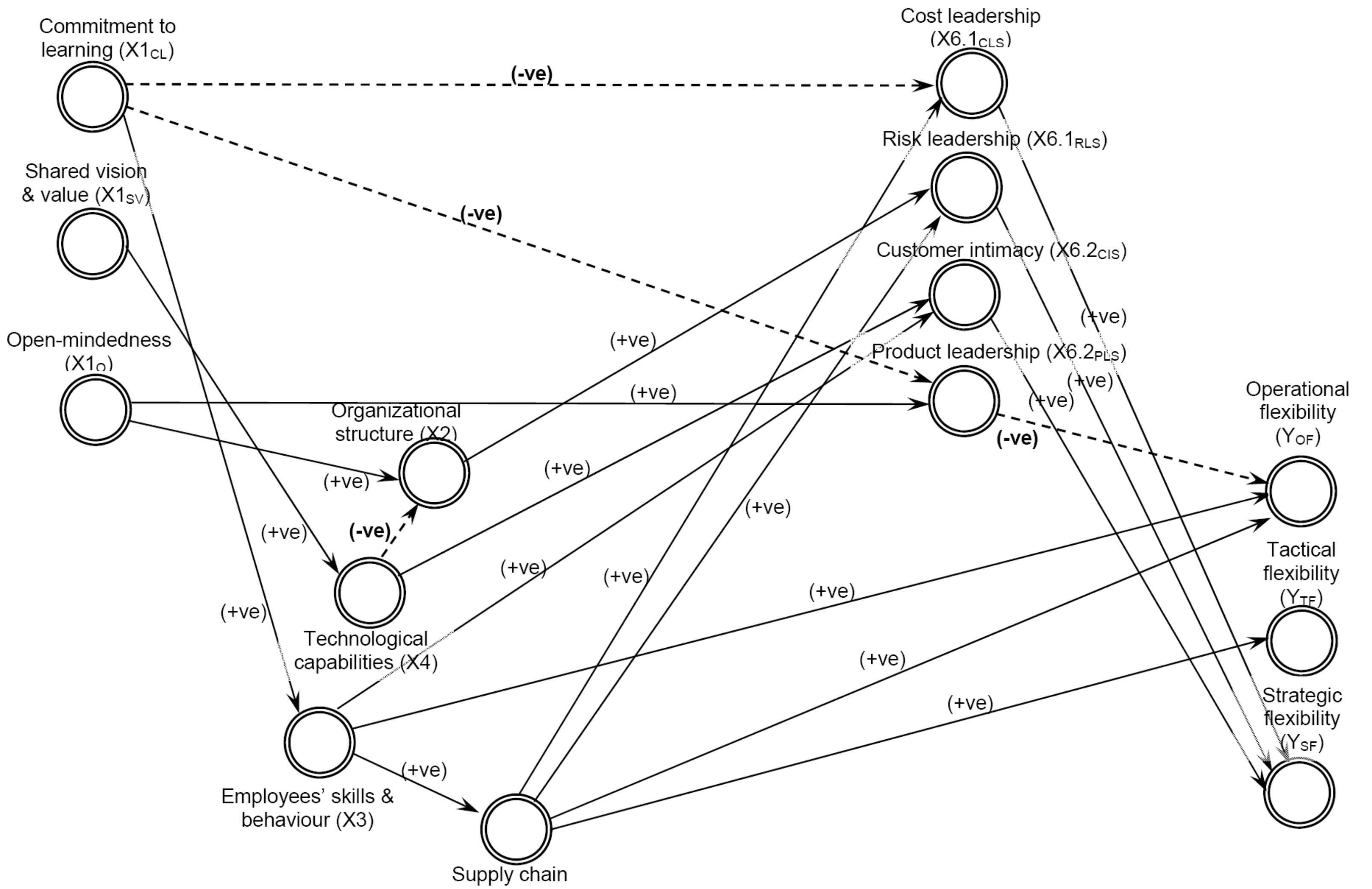
PLS M1 Organizational flexibility model



(-ve) and (+ve) denote negative and positive relationships, respectively

Description	Determinants	
	Positive influence	**Negative influence**
Operational flexibility (Y_{OF})	Open-mindedness ($X1_{O}$) Employees' skills and behaviour (X3) Supply chain capabilities (X5) Cost leadership initiative (6.1_{CLS})	Shared vision and value ($X1_{SV}$) Organizational structure (X2)
Tactical flexibility (Y_{TF})	Supply chain capabilities (X5)	Nil
Strategic flexibility (Y_{SF})	Shared vision and value ($X1_{SV}$) Cost leadership initiative ($X6.1_{CLS}$) Risk leadership initiative ($X6.1_{RLS}$) Customer intimacy initiative ($X6.2_{CIS}$)	Nil

PLS M2 Organizational flexibility model



Description	Determinants	
	Positive influence	Negative influence
Organizational structure (X2)	Open-mindedness ($X1_O$)	Technological capabilities (X4)
Employees' skills and behaviour (X3)	Commitment to learning ($X1_{CL}$)	Nil
Technological capabilities (X4)	Shared vision and value ($X1_{SV}$)	Nil
Supply chain capabilities (X5)	Employees' skills and behaviour (X3)	Nil
Cost leadership initiative ($X6.1_{CLS}$)	Supply chain capabilities (X5)	Commitment to learning ($X1_{CL}$)
Risk leadership initiative ($X6.1_{RLS}$)	Organizational structure (X2) Supply chain capabilities (X5)	Nil
Customer intimacy initiative ($X6.2_{CIS}$)	Employees' skills and behaviour (X3) Technological capabilities (X4)	Nil
Product leadership initiative ($X6.2_{PLS}$)	Open-mindedness ($X1_O$)	Commitment to learning ($X1_{CL}$)
Operational flexibility (Y_{OF})	Employees' skills and behaviour (X3) Supply chain capabilities (X5)	Product leadership initiative ($X6.2_{PLS}$)
Tactical flexibility (Y_{TF})	Supply chain capabilities (X5)	Nil
Strategic flexibility (Y_{SF})	Cost leadership initiative ($X6.1_{CLS}$) Risk leadership initiative ($X6.1_{RLS}$) Customer intimacy initiative ($X6.2_{CIS}$)	Nil