Development of a tool to assist in the implementation of world class manufacturing within small to medium size organisations

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Development of a Tool to Assist in Implementation of Agility within Manufacturing Small and Medium Size Organisations

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Abstract

The aim of this research is to study and understand the concept of agility with the aim of providing a methodology for its implementation in small and medium size manufacturing organisations (SMEs).

The objectives of the research are:

1. To provide a comprehensive understanding about agility in manufacturing organisations through a survey of relevant literature.
2. To identify the main elements of the questionnaire assessment tool needed for agility in manufacturing SMEs.
3. To establish a framework to determine the different between actual and required level of agility.
4. Demonstrate the utility of the methodology, in order to assist manufacturing SMEs to adopt agility as a characteristic.

The review of available literature and the work with the collaboration company during the period of the research led to the development of an agility improvement methodology which includes a questionnaire assessment tool for small and medium size manufacturing organisations (SMEs). This assessment tool when used in the case study companies resulted in successful outcomes in each company.

The applications of the methodology in the eight case study companies confirmed the applicability of the tool in measuring the level of agility business environment drivers and the level of agility practices and pinpointed areas for improvement.

The results from applying the assessment tool in the case study companies confirmed the wider utility of the methodology used in this research. Each company confirm a willingness to embark on improvement actions. For each of the eight companies, the results of the improvement actions demonstrated beneficial tactical outcomes to the satisfaction of the companies involved. Demonstrating the effectiveness of the methodology when applied to existing operational activities.

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Glossary of Terms

Agile Enterprise

An agile enterprise is a fast moving, adaptable and robust business. It is capable of rapid adaptation in response to unexpected and unpredicted changes and events, market opportunities, and customer requirements. Such a business is founded on processes and structures that facilitate speed, adaptation and robustness and that deliver a coordinated enterprise that is capable of achieving competitive performance in a highly dynamic and unpredictable business environment that is unsuited to current enterprise practices.

Agility

Assumes the business environment is subject to conditions of continuous change, uncertainty and unpredictability. An Agility approach is the ability to change and reconfigure the internal and external parts of the enterprise - strategies, organisation, technologies, people, partners, suppliers, distributors, and even customers in response to change unpredictable events and uncertainty in the business environment.

Agility Business Environment Drivers

Agility Business Environment Drivers are the forces that drive the manufacturing organisations to move towards agility. These drivers comprise all factors and forces that exist in the environment in which a company lives, and can affect the company's business in any way, a set of forces from the business environment which support manufacturing organisations to reconsider their position and become agile in order to respond to these forces appropriately.

Department for Business, Enterprise and Regulatory Reform (BERR)

The department responsible for international trade policy including the promotion of UK interests in the European Community a well as other international organisations. The BERR under the direction of the British Overseas Trade Board also promotes UK exports and assistance to exporters. The department also promotes the interests of industry; conducts regional policy, inner city initiative, enterprise and deregulation; it also handles competition and consumer protection; research and development; standards and design and the administration of company legislation.

Globalisation

A complex process involving the opening up of world markets to competition, the emergence of new markets, deregulation, the spread of industrial society and the wide variety of company and sector specific responses to this complexity.

Just-in-Time

The principle that the materials used in production should be delivered to the job-site in the correct quantities at the correct time. Ideally this quantity is one-piece, to enable the production and delivery of only what is needed when it is needed in the quantity needed in order to meet the exact demands of the customer in terms of product requirements, timing, volume and variety.

Kaizen

From the Japanese word meaning gradual and orderly, continuous improvement. In business it focuses on eliminating the waste in all systems and processes. As a strategy it involves everyone in the organisation working together to make incremental improvements without the need for large capital investments.

Kanban system

Kanban is a Japanese noun, meaning “visible record”. Kanban works automatically on a pull system (customer orders and inventory withdrawals) to automatically schedule more production without intervention of neither Supervision nor Planning and Scheduling Department personnel.

Large Scale Companies LSCs

Large scale companies which defined as the companies that have over 250 employees and the turnover more than £11.2 m.

Lean Manufacturing

Lean Manufacturing is an operational strategy oriented toward achieving the shortest possible cycle time by eliminating waste. It is derived from the Toyota Production System and its key thrust is to increase the value-added work by eliminating waste and reducing incidental work.

Mass Customisation

Production of individually personalised goods and service at mass production prices. Enabled by concepts such as lean production, IT systems, late configuration, and product modularisation.

Qualitative data

Data that has no quantitative interpretation i.e. they can only be classified into categories (words) such as customer satisfaction.

Quantitative data

Data that represents the quantity or amount of something numerically (Numbers) i.e. the length , size, number of people.

Small and Medium Size Enterprises SMEs

Small and Medium Size Enterprises can be defined as companies that have a number of employees between 1 and 249 employees; and an annual turnover of less than £11.2 m.

Standardisation of Operation (STOPS)

Standardisation supports the fundamental precepts of build-to-order and mass customisation: All parts must be available at all points of use, not just "somewhere in the plant," which eliminates the setup to find, load, or kit parts. As a stand-alone program, standardisation can reduce cost and improve flexibility. Standardisation makes it easier for parts to be pulled into assembly (instead of ordering and waiting) by reducing the number of part types to the point where the remaining few standard parts can receive the focus to arrange demand-pull just-in-time deliveries.

Total Productive Maintenance (TPM)

An evolutionary approach to excellence in maintenance which aims to eliminate breakdowns by the use of the full range of maintenance and housekeeping techniques. TPM builds up the role of the operators and of the maintenance specialists.

Value stream

The irreducible minimum set of activities needed to design, order, manufacture and deliver products or services to the customer.

Workcells

Workcells has the flow production line split into a number of self-contained units. Each team or ‘cell’ is responsible for a significant part of the finished article and, rather than each person only carrying out only one very specific task, team members are skilled at a number of roles, so it provides a means for job rotation. Workcells is a form of team working and helps ensure worker commitment, as each cell is responsible for a complete unit of work. Cells would usually have responsibility for organising work rosters within the cell, for covering holiday and sickness absences and for identifying recruitment and training needs.

World Class Manufacturing (WCM)

Manufacturing organisations that have achieved the highest standards of business performance and are continuously seeking to improve their ability to meet customer needs.

Chapter 1

Introduction

1.1 The Origins of the Project

Changes in the manufacturing environment - such as moving from a local economy towards a global economy, markets moving from mass markets into niche markets, markets asking for products with higher quality at lower costs and highly customised, with short life cycle - leads manufacturing companies to become more flexible and quick to respond in order to satisfy customer and market requirements.

Achieving excellence in responding to changing customer demands has become the first challenge facing manufacturing companies today, customers not only demand high quality products at a low price, they also expect them in the customised variety that gives them exactly what, when and where they want it (Hasan and Shankar, 2007). In other words, customers expect increasing products with lower prices, higher quality and faster delivery, but they also want customised products to match their unique needs.

Manufacturing industry today faces a wide variety of challenges. Manufacturing companies around the world are attempting to improve their profitability, reduce business and manufacturing process complexity and gain better business insight in order to stay on top of their industry. Manufacturers must respond to business demands in real-time, make products in response to customer demand and outsource a wide variety of functions (Saaksvuori and Immonen, 2005).

In these circumstances, the challenge is to adopt a strategy with good capabilities and fast adaptation to cope with environment changes and satisfy customer requirements and needs according to the prevailing or emerging conditions.

Increasingly, environments faced by enterprises today have reduced the time available to prepare and respond to this change. The Agile organisation, characterised by a rapid response to opportunities and threats, is a source of competitive strength for manufacturing enterprises (Sharifi *et al.*, 2001).

The concept of agility represents the ability of a manufacturer to succeed in the face of continuous, unanticipated change (Ilyas *et al.*, 2008). These changes can occur in customer

needs, product markets, technologies and business enterprise relationships (Hasan and Shankar, 2007).

Agility, identified by Goldman as the capability of operating profitably in a competitive environment of continual and unpredictable changing customer opportunities (Goldman *et al.*, 1995), is the ability to market low-cost, high-quality products with short time to market and in varying volumes, providing enhanced value to customers through customisation (Fliedner and Vokurka, 1997).

According to Sharifi and Zhang (2001), agility in manufacturing organisations is the ability to succeed and do well in an environment of constant and unpredictable change and to deal with these changes as opportunities. Sharifi and Zhang see agility as a solution, perceived as an essential characteristic that manufacturing companies need to have in order to maintain their competitive advantage in the new order of business environment, and satisfy the customer expectations and market needs.

Moving towards agility is becoming a main alternative for most existing efforts in managing a manufacturing company in order to gain or maintain competitive advantage (Barclay *et al.*, 1997).

In summary, it could be said that the way to face unanticipated changes of the markets today is to implement a strategy that can deal with such market conditions and is able to cope with unexpected changes.

1.2 Research Problem

All businesses today operate in a marketplace characterised by change. For manufacturers, the challenge is to become agile in order to ensure a flexible response to changing market conditions. Managing planned change is difficult in itself. However, managing unplanned change demands the ability to react faster and use new strategies to match market conditions, and customer demands in a way that maintains or creates competitive advantage. As manufacturing strategies have evolved, the focus has shifted away from being big and stable with complete control, to being small, nimble and more responsive to the market. This evolution reflects the introduction of new technology, new trends and, in particular, new customer behaviour. Agility is the small manufacturer's chance to seize the market by responding faster to customer demands (Agrawal and Hurriyet, 2004). Today's manufacturing world leaders are characterised by their ability to deliver the products that customers want with minimum time to market and maximum capability to improve products to meet market and customer expectations.

Among the greatest challenges facing manufacturers are related to their ability to cope with change, manufacturing small and medium size enterprises or SMEs facing the same challenge and change which have deep impact on SMEs situation in the market (Huff *et al.*, 2002).

Therefore manufacturing SMEs need agility for handling unanticipated change occurring at the early stage of product development cycle (Lee *et al.*, 2005) and to be able to face the continuous and unanticipated change. Manufacturing SMEs need a methodology to adopt agility to stay competitive in the market place and face these changes and challenges.

The review of literature suggests few areas in which the subject of agility in manufacturing organisations can be outlined in order to obtain a realistic, comprehensive and applicable insight into the subject for manufacturing SMEs.

The preliminary investigations in to agility resulted in the recognition of a lack of understanding in the literature as to how individual UK manufacturing SMEs should go about measuring and implementing agility in manufacturing organisations.

Recent research on agility in manufacturing has noted one of the important barriers of implement agility in manufacturing SMEs is the lack of methodologies and frameworks to assist manufacturing SMEs to enhance agility, Hasan and Shankar (2007). There is no available guide and refined methodology to determine how capable manufacturing SMEs are in terms of agility. (Storey *et al.*, 2005, Sharifi and Zhang, 2001)

The need for a new framework for measuring and improving agility level in SMEs is based on identified shortcomings of available literature, models and frameworks. It is argued here that the available literature does not provide adequate support for selecting improvement principles that are applicable at operational level for SMEs.

1.3 Research Hypotheses

These hypotheses were considered at the beginning of the work based on the initial literature review carried out:

1. The manufacturing SME community in the UK is not familiar with the concept of agility.

2. No model, framework or methodology exists currently to specifically bring about an improvement in Agility within a manufacturing SME.

3. The level of competitiveness within manufacturing SMEs is influenced by the extent to which the organisation is agile.

4. A framework capable of identifying the degree to which a manufacturing SME is considered to be agile (within the current environment in which it operates now) and which can pinpoint actions for improvement would, if applied, lead to an increase in competitiveness.

1.4 Aim of the Research

To study and understand the concept of agility with the aim of providing a methodology for its implementation in small and medium size manufacturing SMEs.

1.5 Research Objectives

The specific objectives of this research have been developed from the aim of the project as specified in the above statement. These specific objectives are derived to provide focus for the research activities in order to fulfil the specific aim of the research in a structured and scientific manner. The specific objectives of this research are defined as:

1. To provide a comprehensive understanding about agility in manufacturing organisations through a survey of relevant literature.

2. To identify the main elements of the questionnaire assessment tool needed for agility in manufacturing SMEs.

3. To establish a framework to determine the different between actual and required level of agility.

4. To demonstrate the utility of the methodology, in order to assist manufacturing SMEs to adopt agility as a characteristic.

1.6 Research Methods

The research methods employed were:

1. Desk research of published literature to establish the state of current knowledge and identify potential alternatives for ways of achieving the objectives.

2. Structured and semi-structured interviews with collaborating organisations to understand the opportunities and restrictions.

3. Action research with collaborating organisations to gather data to facilitate the development of approaches to the problem.

4. The questionnaire method, to develop the main factors of the methodology for assisting manufacturing organisation in achieving agility.

5. The conducting of a preliminary validation of the proposed methodology.

6. Testing of wider utility.

1.7 Structure and Outline of the Thesis

In what follows, each chapter will be outlined to show its contribution to the overall argument. This thesis is presented in ten chapters. This chapter has provided an overview of the thesis and its organisation.

Chapter 2 reviews current literature in the broad areas of agility in manufacturing and related topics. The review of literature starts from the importance of SMEs in the market place, comparison between large companies and SMEs, and showing the effect of globalisation on SMEs, characteristics of the business environment today, the definition of agility, and its importance for SMEs, the relation between agility and other manufacturing paradigms and finally the measuring of agility.

Chapter 3 critiques the available models of agility and the relation of these models to manufacturing SMEs and compares of the available models.

Chapter 4 details the research design and presents a description of the approach to data collection for this study.

Chapter 5 describes the design of the questionnaire assessment tool survey.

Chapter 6 shows in detail - tables and graphs - the results and analysis of the questionnaire survey and the interpretation of each data analysis.

Chapter 7 explains the development of the methodology for agility in manufacturing SMEs and shows the results of the application of the methodology in the case studies in details.

Chapter 8 discusses the results of the analysis, comprises a discussion of the findings, achievements and contribution of the research. It also shows the benefit of the proposed methodology, degree to which it is generic, the limitations of the research, main contribution of the research and finally wider finding of the research.

Chapter 9 concludes and identifies the achievements of the aim of the study and final conclusion.

Chapter 10 suggests possible future areas of research to extend or expand upon the findings within this thesis.

Chapter 2

Literature Review

2.1 Introduction

The aim of the literature review in this research is to provide a critical and comprehensive review of research literature on manufacturing SMEs and agility to facilitate the development of a theoretical framework or assessment tool that represents the features of agility that are most likely to be present in the UK's manufacturing SMEs community. The literature survey includes the essential theories, concepts and developments of agility in manufacturing that are relevant to the focus of the research aim.

2.2 Changes and Challenges Facing the Manufacturing Industry

Today's manufacturing industry is not for the passive player, it requires the best in competitiveness, innovation, speed and agility. It is an industry where complexity and competition is ever increasing. As distributors and customers push industrial manufacturers to increase their flexibility, the rules of engagement are altering and the factors upon which companies compete are changing (Yang *et al.*, 2005).

The current business environment today has become more competitive than ever (Khan and Pillania, 2008). Meeting changes in customer demands has also led to a life of continuous product innovation, involving increasingly complex product development and staggeringly short product lifecycles (Yu and Krishnan, 2004).

So in an industry characterised by globalisation, increasing costs, intense competition, and aggressive customer demands, manufacturing companies should know how to manage and compete, the point of differentiation, and the criteria for success (Bernardes and Hanna, 2009). Manufacturing success is increasingly defined by how well the enterprise works, how fast it can act and react. It becomes about the companies ability to execute in the face of today's challenges. (Adeley and Yusuf, 2006).

Success in manufacturing, indeed even survival, has become increasingly difficult, customers today have become more selective in their demands. They have become less reliable, demanding more quality and better service for a lower price (Burke and Gaughran, 2006). At the same time the lifetime of a product has decreased significantly due to

increased competition. New products with additional services continue to appear every day in order to increase market shares and retain customers (Sharifi and Zhang 2000).

These developments in the manufacturing industry, force the producers to have shorter product-life cycles, shorter time-to-market, increased product variety, increased quality of production and service and flexibility in satisfying demands. The challenging point for the manufacturers today is to keep costs within the lowest level possible. These obstacles have give birth to the need for strategy and production systems that are reliable, efficient, and open to sudden changes (Christopher, 2000).

These rapid environmental changes have forced companies to improve their strategy in conditions of increasing uncertainty. Significantly, such changes are occurring faster and more unexpectedly than ever before (Shen and Dunn, 2007). The result is the increasingly rapid evolution of business systems and the creation of new manufacturing and management philosophies. As a result, today's manufacturers are challenged to improve performance and achieve excellence over an ever-expanding range of production and marketing activities.

2.3 Small and Medium Enterprises SMEs

In most countries, SMEs play a significant part in the industrial and commercial infrastructure. SMEs play a very important role in national economies by providing the predominant employment opportunities. In the manufacturing sector, SMEs act as specialist suppliers of components, parts, and sub-assemblies to larger companies because the items can be produced at a cheaper price than the large companies could achieve in-house. Therefore, if economies are aiming to grow, it is essential that SMEs remain competitive in order to meet the international and globalisation challenge and are able to produce high quality outputs (Knight, 2001).

2.3.1 Importance of SMEs in the UK

Most current economies are largely composed of SMEs (Eikebrokk and Olsen, 2007). In the European Union (EU), for instance, SMEs make up 99% of industry and account for more than 70% of employment. Their innovative capability is seen as a key driver of sustainable competitive advantage in today’s rapidly changing markets (Hoffman *et al.*, 1998; Robert and Dallago, 2003).

In the UK**,** manufacturing SMEs play an important role as contributors to the UK’s economic growth and providers of employment opportunities. The importance of SMEs to the economy

of the UK, and the industrialised world as a whole, cannot be over emphasised (Kim *et al.*, 2008, Antony *et al.*, 2008).

A short summary of relevant statistics shows the vital role that SMEs play within the UK:

- There were an estimated 4.3 million business enterprises in the UK at the start of 2006.
- More than 99.8 percent of these enterprises were SMEs.
- More than 97 percent of SMEs employ less than 50 employees, with average turnover less than £2m.
- SMEs employ approximately 58 percent of the total workforce in the UK.
- The SME manufacturing sector alone (which this study is focused on), accounts for over 35 percent of the estimated combined turnover of UK businesses.
- The combined annual turnover of SMEs in the UK is around £1 trillion.

Figure 1 shows the increase of number of SMEs in UK in the last ten years, this increase shows how important this size of companies to the future economic growth of the UK Community (Department for Business, Enterprise and Regulatory Reform1, 2009).

Figure 1 The increase of SMEs during the last ten years

To sustain this role, SMEs need more support in defining their specific technological and organisational needs, and in finding the right approach to respond to these needs (Coronado, 2003).

With such an important place in the UK economy, it is in the best interests of all SME stakeholders, employees, customers or suppliers, to adopt the best management and manufacturing practice in order to compete in today's global marketplace. SMEs should provide high quality products or services at low cost to their customers (Antony, *et al.,* 2008).

2.3.2 The Difference between SMEs and Large Organisations

Before going through the comparison between SMEs and large organisations, it is necessary to define the size of the companies. Definitions of company sizes differ across countries and industry sectors, and can be based on a variety of criteria, such as the number of employees, invested capital and total value of sales. This research will adopt the UK Department for Business, Enterprise and Regulatory Reform (BERR) definition, who classifies the company sizes as follows:

1. Number of employees
    - Small firm: 0-50 employees;
    - Medium firm: 51-250 employees;
    - Large firm: over 250 employees.
2. Turnover
    - Small firm: turnover of not more than £2.8 million
    - Medium firm: turnover of not more than £11.2 million
    - Large firm: over £11.2 million
3. Balance Sheet
    - Small firm: balance sheet total of not more than £1.4 million
    - Medium firm: balance sheet total of not more than £5.6 million;
    - Large firm: over £ 5.6 million

There are many differences between SMEs and large business organisations in terms of structure, policy-making procedures and use of resources.

SMEs are in a more advantageous position in terms of structure because they facilitate faster communication lines, a quick decision-making process, faster implementation and higher contributions as a source of ideas in their operations and innovation and combined culture (Kraipornsak, 2002). The majority of SMEs have simple systems and procedures, which allows flexibility, immediate feedback, better understanding and a quicker response to

customer needs than larger organisations (Kraipornsak, 2002). In addition, SME employees are given the authority and responsibility in their own work areas that can create cohesion and enhance common purposes amongst the workforce to ensure that a job is well done. SMEs have fewer employees and everybody seems to know almost everyone, thus the relationship between employees will better (Jeffcoate, 2002).

On the other hand, SMEs have a number of major weaknesses, which can result in a disadvantageous situation. For instance, the majority of SMEs do not have enough financial resources (Grando and Belvedere, 2006), and have a lack of access to commercial loaning (Deros *et al*., 2006; Kraipornsak, 2002). As a result, SMEs do not have an adequate budget for staff training, which can help in skills improvement. In terms of human resources, SMEs are always faced with the shortage of skilled labour (Chee, 1987). The majority of SME owners have a low level of formal education and limited training in new management principles and practices, which can lead to lack of managerial and technical expertise (Deros , *et al.* 2006; Chee, 1987). SMEs, because of their size, may also lack negotiation power to get good deals with suppliers and customers (Antony *et al*., 2005).

SMEs often depend on one-person management, thus insufficient time and attention is given to the various managerial functions (Deros *et al*., 2006). In SMEs, the owner controls everything which results in poor management; this can be attributed to the owner's lack of business experience and lack of management experience or know-how (Pickle and Abrahamson, 1990; Baumack, 1988).

Furthermore, most SMEs lack appropriate time management and cash flow management systems, which causes high irregularity in work outcome and difficulties in ensuring the efficiency of work (Sun and Cheng, 2002). SMEs are also faced with other problems, such as lack of knowledge in marketing techniques, lack of opportunities at both local and international levels, poor accessibility to the distribution channels and market information, marketing constraints such as pricing or late payment from customers, and an inability to provide high quality products, and a lack of renewing the tools and technology (Kraipornsak, 2002).

The strategic use of improvement activities, such as quality programs and Kaizen, is much higher in large firms than in small firms. This may be related to the knowledge and capacities of SMEs, or it may be that they have neither the financial resources nor people to invest in improving their processes and systems (David, 2003).

The above review can be used to summarise generally the main differences between the SMEs and large organisations as shown in Table 1.

	SMEs	Large Organisations
Capacity and Capability		
Size of company	Small and medium	Large
Financial resources	Low	High
Capital	Low	High
People	Up to 250	More than 250
Technology	General purpose machinery	Specialised dedicated machinery
Access to Distribution channels	Poor	Good
Relationship to suppliers	Weak	Strong
Labour	Doing multi jobs	Narrow job trained
Power in society	Slight power	Considerable power
Management		
Management structure	Less organisational	More organisational
Decision cycle	Short	Long
Knowledge of marketing	Poor	Good
Owner education level	Varying	High
Human recourses		
Employee Relation	Strong	Weak
Labour skills	Low or Medium	High
R&D budget	Low	High
Training budget	Low	High
Training time	Short	Long
Wages	Low or Medium	High
Working conditions & facilities	Poor	Good
Strategy and procedures		
Strategy	Near term	Long term
System and procedures	Simple	Complex
Structure	Simple	Complex
Output products	Vary	High volume
Product quality	Vary	High

Table 1 The differences generally between SMEs and Large organisations

2.3.3 Challenges Facing SMEs

To maintain their current importance in economic terms, SMEs in the manufacturing sectors must ensure that they can compete in areas other than price. It has been argued SMEs can no longer hope to compete on price alone and must now be faster and better, as well as cheaper (Cassell *et al.,* 2001).

It is expected that there will be substantial differences in the adoption of manufacturing technology between firms of difference sizes. There is a considerable body of literature that reports little differences between the manufacturing operations of large companies and SMEs. The difference, however, is in the resources that are available to SMEs compared to larger firms (Cagliano *et al.*, 2001; Chabane, et al, 2003) , where the SMEs usually have low budget to renew and devolve the manufacturing tools and technology according to market needs.

To maintain or achieve competitiveness and profitability, manufacturing SMEs must respond to a range of challenges, including rapid improvements in technology, declining employment and output and globalisation of markets (Man *et al.*, 2002). Manufacturing SMEs need to have a clear understanding of what their customers want and why customers purchase their products rather than purchase from their competitors. They need to fully understand the aims of the business in terms of its customers, market sectors, product attributes and geographical markets (Muscatello *et al.* 2003).

SMEs may lack sufficient financial and human resources required for the implementation of some improvement activities and technologies, resulting in lower levels of adoption. For example, lack of resources and upper management support is cited as a significant problem in introducing statistical process control into manufacturing SMEs (McAdam and Keogh, 2005).

Another challenge in manufacturing SMEs may be the lack of business experience and knowledge of the business owner (Wang, 2007). Business owners need to be convinced about the introduction of technology (Holden and Jameson, 2002), and manufacturing SMEs managers may also disbelieve consultants who could provide assistance (Hudson *et al.*, 2001).

For example implementation of Just in Time (JIT) in SMEs requires top management commitment as the first requirement in implementing JIT successfully. Since many small firms are family owned, the owner must understand that JIT requires a new way of management thinking and new attitudes toward operations (Lee, 1996). This can be difficult in SMEs as they have only one or two managers who are always busy with daily tasks. They may not have enough time to think about the whole operation and the ways to improve it. Without sufficient understanding about the JIT philosophy from the top management of SMEs, the implementation of JIT will not get the expected results. Another problem in implementation is training. SMEs cannot easily send supervisors to outside training course,

as this means they have to close the factory during the training time. At the same time, most of the SMEs do not have a training department (Szamosi *et al*., 2004).

It has been said that the business climate is especially hard for SMEs (Wilkinson, 1999). It is always difficult to cope with change and especially rapid and ruthless change. Large companies can enjoy certain advantages with more resources and the capacity to respond to emerging demands. For example, with their research and development and marketing departments, they can re-engineer their process and position their products to compete in the new markets. This does not mean SMEs will not have the ability to respond effectively to the challenges ahead. What is critical is how SMEs use the power of their strengths to improve their competitive ability.

The strengths and weaknesses of SMEs that differentiate them from larger companies are mainly determined by their typical characteristics. The most significant ones are ownership, structures and size, which all have positive and negative effects. The major strengths and weaknesses of SMEs can summarise as follows:

Strengths

- Simple structures and less bureaucracy.
- Flexible and shorter reaction times.
- Independently owned.
- Ability to offer customised and specialised goods and services.
- Shorter time-to-market because operations are small and focused.
- Lower labour costs.
- Less formal strategies increase the communication of knowledge and speed of decision.
- Quick realisation of marketable products.

Weaknesses

- Lack of resources.
- Limited access to capital markets.
- Heavily reliant on bank loans.
- Have more difficulties to finance investments or R&D projects.
- Lack the financial resources to hire experienced specialists.
- Lack of capacity in manpower.

2.3.4 Globalisation and its Effect on the SMEs

SMEs are deeply affected by the globalisation of markets, which is forcing all firms to act and think differently about how to manage their business, competing in new areas other than price. The world economy, the increasing globalisation and the internal market of the EU and e-commerce are increasingly shifting the behavioural pattern of SMEs (Eikebrokk and Olsen, 2007).

The forces of globalisation and technology have together created new market opportunities for SMEs. There are now new and better ways to reach out to customers, and to deliver services more effectively and at lower costs. Businesses can transcend geographical boundaries and enter new markets. However, in order to benefit from globalisation, SMEs need to invest in innovation, embrace the strength of entrepreneurship, develop technology and become learning organisations (Department for Business, Enterprise and Regulatory Reform 2, 2008).

David (2003), OECD (2004) and Barkham, *et al.* (1996) identified both internal and external factors that prevent SMEs from engaging in globalisation, these factors can be listed as:

- Competition of local SMEs in foreign markets.
- Lack of government motivations for the internationalisation of SMEs.
- Language barriers and cultural differences.
- Product and service range and usage differences.
- Risks in selling abroad.

2.3.5 Characteristics of Successful and Innovative Manufacturing SMEs

It has been suggested that successful manufacturing SMEs possess several characteristics which separate them from other unsuccessful ones and allow them to survive long-term in the marketplace (Hu and Tsai, 2006). These have been identified a competitive strategy, knowledge and information management, continuous improvement, product quality, customer satisfaction, product development, partnerships and good employee relations.

Competitive Strategy

Limited resources of people, materials and finance must be carefully managed in organisations which seek to develop (Tidd *et al.*, 2005). SMEs have a generic lack of resources and overall resource strategies and action plans.

Gunasakeran *et al.* (1996) state that "overall productivity and quality improvement strategies are lacking in SMEs". Thus rapid decision making by inspired leaders can fail to incorporate innovative practice due to a basic lack of fundamental resources.

SMEs are increasingly turning to strategy in an effort to achieve competitive advantage (Larsen *et al.*, 1998). A number of research studies indicate that SMEs using strategy performed better than non-strategy firms (Kargar and Parnell, 1996). Others found that 'strategic' SMEs were likely to have significant capability to grow, expand, innovate, introduce new products to the market place and achieve greater profitability (Joyce *et al.*, 1996). Strategy is also considered to be one of the most effective ways for firms, regardless of size or sector, to cope with the changes in the business environment (Hart and Banbury, 1994).

However, literature also indicates that many SMEs are inexperienced about the planning and development of strategy (Deakins and Freel, 1998). While there are arguably many reasons for this, it is suggested that SMEs tend to have intuitively derived strategies that reside mainly in the mind of the Managing Director or Chief Executive (Lagace and Bourgault, 2003).

Knowledge and Information Management

Mosey *et al.* (2002) researching innovation in SMEs showed what they called "low growth incremental improvers" made poor use of knowledge and information, especially external customer and market information, in comparison to innovative high growth SMEs .

Knowledge and information management has the potential to be a mechanism for innovation within organisations. Voss *et al.* (1998) considers close customer relationship and hence knowledge of the customer to be a key factor in satisfying the customers in SMEs. This knowledge will inform SMEs about potential product or service changes in their immediate market. When this knowledge is linked to that of rapid decision making then SMEs can make beneficial innovative decisions in a relatively short period of time (Wiele and Brown, 1998).

The main advantages to be gained from information technology for small businesses, in terms of competitiveness and efficiency, are time and cost savings and error reductions (Temtime *et al.*, 2003). Other impacts of Knowledge and information management include increased organisational learning and improved management decisions (Zain *et al.*, 2005). However according to National Research Council (2000) the Internet can be an inexpensive way to meet communications requirements, it also provides opportunities for education and new sales channels for manufacturing companies.

Continuous Improvement

Collins (1994) believes that Continuous Improvement describes an approach to quality assurance which stresses the importance of creating a culture in which concern for quality is an integral part of the product/service delivery.

In innovative organisational change Gunasakeran *et al.* (1996) and Bessant and Cafyn (1997) consider continuous improvement to be a fundamental step along the innovation pathway.

According to Walker and Hampson (2003) Innovation is the most powerful component in the continuous performance improvement required to achieve standards of excellence. Funding for continuous improvement activities is built into the financial plans of innovative firms.

SMEs which have adopted a culture of Continuous Improvement found that they could provide a solid foundation on which to build a culture of effective business innovation. These SMEs were found to have embraced all the different components of innovation, as measured, more readily than those SMEs which did not have a culture of Continuous Improvement (McAdam *et al*,2000).

Product Quality

According to Roth and Miller (1992), successful manufacturing SMEs have formal product quality characterised with continuous improvement and zero defects, when compared to those of the low-performing firms. Successful manufacturing firms normally use an in-process quality assurance system along with pre- and post-process quality assurance (Aziz *et al.*, 2000). Successful companies have process improvement, process control, and employee involvement (Yusof and Aspinwall, 2000).

Customer Satisfaction

Successful manufacturers provide their customers with solutions that make their life easier, keeping them informed of money-saving ideas and industry changes (Chaneski, 2004; Kim *et al.*, 2008). Successful manufacturing SMEs develop a close relationship with their customers and are more capable than larger firms in adjusting to customer preferences (Bentley, 2003). Successful SMEs have a similar competitive advantage factor that allows them to create a niche in the market by changing their product mix to satisfy customer needs (Gadenne, 1998; Vinodh *et al.*, 2009). Pelham (2000) found that market-oriented manufacturing firms were better performers because they respond quickly to negative customer feedback, competitor activities, and customer changes.

In discussing the relative strengths and weaknesses of SMEs, Vossen (1998) identifies the ability to react rapidly, or even to anticipate, market changes as a key element of innovation. For most organisations market changes are reflected in the actions of their main customers (Tidd *et al.*, 2005). They must become closer to the customers.

Product Development

The need for new product development leading to market differentiation is a major opportunity for innovation SMEs in competitive markets (Appiah-Adu and Singh, 1998), new product development is one of the important factors of competitiveness in the market today (Woy and Wang, 2007; Hilletofth, 2009)

The ability of SMEs to meet growing consumer expectations is largely based on their capability to innovate and deliver new products at competitive prices. Innovation is a key driver of sustainable competitive advantage and one of the key challenges for SMEs. The literature suggests that ignoring innovative and creative changes can only lead to failure in the medium to long term (Barkema *et al.,* 2002)

SMEs are famous for their creativity and new product development. This applies in particular to SMEs that have the ability to innovate effectively and develop new products more rapidly than larger firms (Vossen, 1998 and Storey, 1994).

Indeed, Harrison and Watson (1998) contend that there is little doubt that SMEs are capable of effective innovation. However, many SMEs still fail to see the opportunities and advantages that are open to them, such as the flexibility of customising products to the requirements of the consumer, an advantage adopted by larger firms, many authors argue that to develop new products manufacturing companies need to develop different capabilities than those required for improvements to current products (Mosey *et al.*, 2005).

Clearly, the capability to innovate and evolve products quickly is a key factor in the sustainable competitive advantage of any firm (Sun and Cheng, 2002).

Partnerships

Building new strengths, creating new capabilities and developing new and improved products and services are features of innovative firms. Establishing relationships with customers, researchers, suppliers and professional advisors can increase competitiveness and boost the overall performance of all firms. For SMEs competing on a global scale with larger firms, this is particularly important. Establishing alliances and partnerships can help to

reduce costs, lead to new business, speed-up time to market and reduce overall risk (Aldaba, 2008).

Successful SMEs create, implement, and maintain strategic plans for partnerships that enable them to meet customer needs better. These partnerships should be formalised in documents that define roles and responsibilities. Strategic partnerships increase the probability that the customer will use the SME for future business (Wang, 2007).

Good Employee Relations

According to Chaneski, 2004, good employee relations contribute to organisational competitiveness. Employee relationship is seen as important for good business performance (Roth and Miller, 1992). Dossenbach (2005) supported the need for good labour relations and suggested that manufacturing success depends on company-wide commonality, which is achieved through open communication, integrity, and employee empowerment.

SMEs have to exceed customer expectations; they should increase their innovative capabilities to be able to provide the customer's needs in low-cost, high-quality products, effective service and on-time delivery (O'Regan *et al.*, 2006).

In summary to survive and grow SMEs need satisfied customers, they must provide products and services that improve their customers' competitive performance and business results. SMEs should know their customers intimately at all levels in the organisation and provide specific business needs at each level. Effective customer relationships and innovation are the critical business success factors.

2.4 Characteristic of Today's Business Environment

Today's manufacturing environment is increasingly competitive, with customers demanding a wider choice of better products faster. Satisfying this demand requires a greater number of more specialised companies, working together in increasingly complex networks. Today's aggressive business environment further demands that manufacturers lean their processes, create efficient and agile material flow, and have a culture of continuous improvement. Manufacturing companies face an increasingly challenging and complex environment, driven by consumer and competitive trends that influence both growth and profitability (Xing *et al.*, 2006). These changes force decision makers to reassess their views of marketing research and also induce changes in the marketing research processes themselves (Bustelo and Avella, 2005).

Today, customers are more sophisticated and have higher expectations than those in past decades; thus, they demand better products and services, the customers today have access to high quality products of reasonable price from a variety of different sources. This has forced manufacturers to partner with customers and suppliers to create a process that can produce exactly what customers want very quickly and at very low cost. This intense, competitive environment forces companies to operate more efficiently. Investments in technology often play a vital role in retaining and expanding the market shares of growing businesses. Marketing and distribution practices also determine the degree of companies' success (Papke *et al.*, 2006).

All manufacturing sectors are subject to change, some sectors or environments more than others, such as electric and electronic, engineering, automotive and aerospace (Shirif *et al.*, 2001; Elkins *et al.*, 2004,), this is doe to the nature of the products they produce and the speed of development level in these sectors. In the electrical and electronic industry in particular, the products life cycle is significant shorter than in the past (Onuh *et al.*, 2006).

Today's manufacturers are being challenged by a rapidly changing business environment. Even small manufacturers are doing business internationally, both as a production base and to find new markets (Agarwal *et al.*, 2006). This globalisation requires the ability to work, communicate, and innovate across corporate and cultural boundaries. To compete in today's dynamic business environment, global manufacturing organisations must be able to respond to rapidly changing market and operational conditions (Cao and Dowlastshahi, 2005).

Manufacturing SMEs facing a rapidly changing business environment and they need new skills, technologies and business strategies to remain competitive both at home, and globally. They have to adapt their manufacturing systems to changing circumstances such as technology advances and business growth (Moore and manring, 2009). In general terms we can say SMEs today pay more attention to the changes in market conditions and customer demands (Coskun and Altunisk 2002; Abdel-Malek *et al.*, 2000 , Griffiths *et al.*, 2000).

As the business environment changes, it is becoming increasingly important that SMEs engage in business innovation in the widest sense of the term to make the most of their own unique strengths and to develop new markets. These same environments are pushing manufacturing companies to implement new strategies that allow them to face expected and unexpected changes of market demands, and to react to these changes to cope the customer demands (lau *et al.*, 2001).

Nowadays product life cycles are becoming shorter while product features increase in complexity and quality expectations continue to rise. Such product characteristics are becoming increasingly more prevalent and are being documented by studies such as those of Cordero (1991), Hisrich and Perters (1991), Akgun *et al.* (2007), Griffin (1993), Lawrence (1993), Bayus (1994) and Scholefield *et al.* (1999).

In considering the changing market characteristics, Bunce and Gould (1996), Guisinger and Ghorashi (2004), Westkamper (2003), Helaakoski *et al.* (2006), Barutcu (2007) and Zhang and Sharifi (2007) all report at least one of the following product and market characteristics:

- Decreasing concept-to-market.
- Decrease in the introduction time between new products.
- Increasing product variety.
- Increasingly demanding customers.
- Decreasing volumes for identical products.
- Increasing market fragmentation and competition.
- Growth in the need to produce to order.
- Shrinking product life cycles.
- Globalisation of production.
- Simultaneous co-operation and competition between firms.

According to Erande and Alok, (2008), to cope with such characteristics, the concept of agility comes into play. This concept does not refer to a certain method of production or a specific technology; it simply asserts the fact that many changes are occurring to production requirements. Agility became very important condition for the manufacturing SMEs to stay competitive in the today's market.

2.5 Agility in Manufacturing

The term agility has drawn a lot of attention in the world of business. It is now being applied at many levels throughout organisations and in many different industries. In general, agility is the ability of a firm to face and adapt proficiently in a continuously changing and unpredictable business environment (Garbie *et al.*, 2008).

Agility has the key objective of being capable of dealing with turbulent and changing environments (Hoek, 2001). Thus, effective change management and strategic cooperation are the main principles of agility (Prater *et al.*, 2001; Coronado *et al.*, 2004). This is evident

in the infrastructural choices made by an organisation adopting the Agility; for example, integration of production and business information, outsourcing, rapid partnership formation, cooperation and virtual enterprise all of which are mechanisms to cope with the continuous change of the market (Brown, 2003; Bruce and Daly, 2004; Guisinger and Ghorashi, 2004; Hoek, 2001 and Coronado , *et al.* 2004).

Agility in manufacturing emerges most in highly unpredictable and changeable market environment, typical of globalises economy (Guisinger and Ghorashi, 2004; Quintana, 1998; Vastag and Whybark, 1994; Sharifi and Zhang, 2000 and Coronado *et al.*, 2004).

Agility in manufacturing is the measure of a manufacturer's ability to react quickly to expected, sudden, unpredictable change in market and customer demand for its products and services and make a profit. It is a concept of technologies and adjacent management techniques. Where both approaches are closely integrated into one entirety (Hadidi and Rawabdeh, 2008).

However, nowadays technology has become more devolved but the ability to become agile relies not just on the advances in technology but also on the way in which the technology is managed and organised. Thus firms that are agile are those that are able to manage and organised the changes that occur in their environment. Allowing them to be fast and responsive to change in order for them to grow and to maintain or expand profitability (Sharifi and Zhang, 2001; Kumar and Motwani, 1995, Bassant *et al.*, 2002).

Agility is not about how a firm responds to changes only, but it is about having the capabilities and processes to respond to its environment that will often changes in unexpected ways. Kodish *et al.* (1995) refer to agility as the firm's quickness to assemble its technology, employees, and management in a deliberate, effective, and coordinated response to changing customer demands in a market environment of continuous and unanticipated change. Thus, the concept of agility in manufacturing is a combination of two main parts; related firstly to the manufacturing process and secondly to the management and employees and their speed to response to the changes. Effectiveness is how these two parts interact to respond to the market and customer demands.

Manufacturing processes based on agile manufacturing are characterised by integrated processes for designing, manufacturing, production facilities and flexibility of manufacturing. It is characterised by a process that is able to produce effectively, a large variety of products and to be reconfigurable to accommodate changes in the product mix and product designs (Hasan and Shankar, 2007).

Similarly, management processes based on agility in manufacturing are characterised by manufacturing process integrated with marketing, services, decision-making, delivery, supply chain and employees (Abair, 1997; Hasan and Shankar , 2007).

2.5.1 Definitions of Agility in Manufacturing

Agility was first introduced with the publication in the USA of a report entitled “21st Century Manufacturing Enterprise Strategy” by the Iacocca Institute in 1991 in an effort to define a new paradigm which the authors called agile manufacturing. Since then, it has been promoted as a way of gaining competitive advantage in response to increasingly competitive global markets (Lin *et al.*, 2004).

The concept of agility has become one of an evolving philosophy which enables businesses to achieve their goals by allowing reconfiguration of processes.

According to Sharifi and Zhang, (2001), agility means different things to different enterprises in different contexts. As changes and pressures faced by companies may be different, the degree of agility required by individual companies will be different. Moreover, the circumstances for doing business are changing, and the organisation needs to be more agile in order to respond to the changes positively.

During the review of the literature it is clear that some authors are using the term “Agile Manufacturing” as equivalent to the term “Agility in Manufacturing” and they mean by it the agility in the whole company. The substitution of these two terms is clear in some definitions.

According to Christian *et al.*, (2001), agile manufacturing sets out to identify and apply practical tools, methodologies, and best practices that enable companies to achieve manufacturing agility within a changeable business environment.

In this definition Christian *et al.,* are very clear that they are referring to the manufacturing function within the organisation and not extending this to including other business areas. However this distinction is not so clearly stated in the definition provided by Kidd (1994) in which he stated that agility is the ability to thrive and prosper in an environment of constant and unpredictable change. Agility aims not only to accommodate change, but also to relish the opportunities inherent within a turbulent environment.

By implication other areas of the business would need to be able to be equally responsive to the changing needs to satisfy different customer demands. This is encoded by the definition provided by Cheng *et al.,* (1998) in which he states that agile manufacturing is an emerging technology for a company to achieve flexibility and rapid responsiveness to the changing

market and customer's needs, and Radder and Louw, (1999), when they said agile manufacturing focuses on manufacturing highly customised products as and when customers require them. In the opinion of this author, agility in manufacturing implies agility required of all areas of the manufacturing organisation thus, in this research, the term agility in manufacturing can considered as: the processes in the whole company, manufacturing and management that enables the company to achieve agility.

A further definition is provided by Goldman *et al.,* (1996) where agility is described in four organisational dimensions:

1. Enriching the customer: company that configures its products and services into total solutions for its customers, and prices its products and services based on the customer's perceived value (Solution Providers)

2. Co-operating to enhance competitiveness: company that enter into collaboration with qualified partners, both internally and externally, who can quickly and efficiently make their contribution to the development process to bring products to the market as rapidly and cost effectively as possible (Collaborative Operations).

3. Organising to master change and uncertainty: company that is able to rapidly reconfigure the organisation of its resources (personnel and equipment) to meet changing customer demands and produce individualised products and services for its customers (Adaptive Organisations).

4. Leveraging the impact of people and information: company who views the information it possesses (including the skills, knowledge and expertise of the total workforce) as an essential core competency and that uses the information to provide individualised products and services for its customers (Knowledge Driven Enterprise).

Hence agility within manufacturing organisation may included a manufacturing system that is agile, however for this to be translated into effectiveness of competitiveness for organisation as a whole, other areas in the business would need to have the ability to respond quickly to the changing environment and business demands.

2.5.3 The Importance of Agility to Manufacturing SMEs

To become an agile manufacturer, a company should recognise change in the marketplace and then manage and master that change. Agility supports the manufacturing SMEs to deliver lower manufacturing costs, increase their market share, facilitate the speed of

introduction of new products and increase the company competitiveness (Lin *et al.*, 2006). In literature most authors mention to the important of agility to manufacturing companies as key to coping with the changes of the markets and customers demands.

Devor *et al.* (1997) states that agility in manufacturing is an expression that is used to represent the ability of a producer of goods and services to thrive in the face of continuous change. These changes can occur in markets, in technologies, in business relationships and in all facets of the business enterprise.

According to Sharifi, *et al.* (1997) moving towards agility is becoming a main alternative for most existing efforts in managing manufacturing companies in order to gain or maintain the competitive advantage.

Vokurka and Fliedner (1998) suggest the current competitive priority for a world-class firm is agility; agility is the ability to produce and market successfully a broad range of low cost, high quality products with short lead times in varying lot sizes to enhance and satisfy the customers.

Sharifi, *et al.* (2001) argue that agile manufacturing is about the required characteristics for manufacturing companies to respond to the circumstances caused by the changing market environment. Sharifi mentions the newness of the agility concept to the manufacturing sectors in UK, however, he also makes of mention projects conducted with regard to agility which involved electrical /electronic manufacturing companies.

Bessant, *et al.* (2001) defined agility in manufacturing as the ability to respond quickly and effectively to the current configuration of market demand, and also to be proactive in developing and retaining markets in the face of extensive competitive forces. Bessant argue that the importance of agility for manufacturing companies lies in its ability to manage the market situation and changes and how to respond quickly to these changes.

Hormozi (2001) defined agility in manufacturing as methods of manufacturing that will provide a competitive edge for those firms willing to implement it. Agile manufacturing organisations produce a high quality, defect-free product within short lead times.

Hormozi sees the important of agility for the manufacturing companies is the ability to embrace change and adapt it rapidly and easily. Agility means being able to reconfigure operations, processes, and business relationships efficiently while at the same time flourishing in an environment of continuous change.

According to Bessant, *et al.* (2002) agility is the modern tool for manufacturing companies to

face changes in the environment which is routinely shaken by challenges coming from a variety of different directions such increase competition, technological change, globalisation of markets, change of regulation or any other factors.

Ismail, *et al.* (2006) sees agility as the ability to respond to customer requirements both cost effectively as well as on time in an environment of continuous change. Manufacturing companies should adopt agile tools and techniques in strategic parts or throughout the organisation.

Joiner and Josephs (2007) argue that to enjoy sustained success, manufacturing companies need to develop a level of organisational agility that matches the increasing level of change and complexity in their business environment.

According to Hasan and Shankar (2007) the concept of agility represents the ability of a manufacturer of goods and services to thrive in the face of continuous, unanticipated change of the market and customer needs.

Hetherington and Ismail (2007) see the concept of agility has become one of an evolving philosophy which enables businesses to achieve goals by allowing reconfiguration of processes and products to satisfy the customer needs and market demands.

Erande and Alok (2008) see agility as a very important condition for the manufacturing companies to remain competitive in the market. Adding that measurement of agility gives enterprises a measure of its competitiveness and readiness for changes in the market.

According to Adrian and Coronado (2009), Agility means the capability of operating profitably in a competitive environment of continuous and unpredictable changes with information systems regarded as one of its main enablers.

The ability to respond quickly and effectively to produce new products and services has become not so much a method of gaining competitive advantage, but more a means of survival (Poolton *et al.*, 2006). Many companies have seen the need to adopt a whole range of practices that reduce inputs and waste, and allow greater responsiveness to customer needs and the marketplace, Thoburn, et *al.* (1999) argues that this is the role of agility.

The above description shows the important of the agile manufacturing to SMEs, according to the literature information system considered as one enabler of agility in manufacturing within the manufacturing organisations, the next section will explain the importance of information systems to agile manufacturing.

2.6 The Importance of Information Systems to Agile Companies

Information systems have become the backbone of manufacturing organisations, supporting most of their operations and procedures. A number of authors in literature have explored the relationships between information system and manufacturing operations in general. Coronado, *et al.* (2002) however, explored the evolution of Information system in manufacturing and the importance of information systems in supporting agility in manufacturing. Companies are increasingly turning towards integrated systems to help them compete more effectively in today's rapidly changing business environment (Blackwell, *et al.*, 2006).

According to Powel (1992), information systems can assist manufacturing firms in developing their strategic roles. Thus, it is essential for manufacturers to implement information systems strategies that will strengthen the business in the long term. Information systems utilisation enables manufacturers to move to higher value added activities.

According to Devor, *et.al,* (1997) information systems are seen as an important technology for agility in especially in the electrical and electronics industry sector because of the fact moving of technology in this sector. Information systems and technologies enable the company to exchange the information and data between different companies and simplified the manufacturing process during the design, fabrication, assembly and test of for example printed circuit boards.

According to Kassim and Zain (2004) organisation agility requires the company to be quick in the assembly of its technology, employees and management with communication infrastructure in responding to changing customer demands in the marketing environment of continues and unanticipated change. Simply stated, it is a firm ability to generate the required information for management decision making in a changing environment.

An effective information system is regarded as a major enabler and facilitator of the agility in manufacturing (Sharp *et al.,* 1999; Coronado *et al.*, 2002). Sharp et al. (1999) pointed out that information systems help to reduce hierarchical management control and facilitate communication among employees and thus enhance agility.

Information systems applications also support the communication necessary to coordinate activities in manufacturing environments. Agility is gained by reducing hierarchical managerial control, setting up workers in teams, and empowering them to make decisions. Literature suggested that information systems are an essential foundation for the formation

and management of agile companies (Strader and Shaw, 1997; Burn and Barnett, 1999; Kock, 2000 and Khalil and Wang, 2002).

Cheng *et al.*(2002) mention the importance of use information systems and its tools as significant issue to improve the competitiveness and agility of manufacturing SMEs. Manufacturing SMEs have to continuously improve their manufacturing environment through applying new technologies such as using internet associated techniques to support their business operations. Usage of the internet may include:

- Collaboration and development.
- Communication (internally and externally).
- Globalisation via networking.
- Information retrieval and operation.
- Marketing and sales.
- Receiving and transmission of data.

Success in the implementation of agility in manufacturing organisations depends on a number of different enablers such as Virtual enterprise; physically distributed teams and manufacturing; rapid partnership formation tools/metrics; concurrent engineering; integrated business information system; rapid prototyping tools; electronic commerce (Gunasekaran, 1998). Information systems are among those enablers addressed in the literature. Current literature identifies information systems as enablers of the concept of agile manufacturing. Moreover, the introduction of new tools in information systems enables the execution of new ways of work not experienced before. Authors agree that information systems provide competitive advantage to organisations (Sharp *et al.,* 1999 ; Moron and Swierczek, 2009 and Coronado *et al.*, 2002,).

Agility in manufacturing relies heavily on the quality of information that organisations have and on their ability to organise and reuse it. A constant inflow of information and knowledge is the fuel of agility in manufacturing companies. In the process of forming agility in manufacturing, organisations have to be equipped with information systems that integrate their present technology and improve upon it. Information systems make it possible to improve organisational efficiency and effectiveness, which can provide competitive advantage (Coronado *et al.,* 2002).

In agility, the central contribution of the technology would be the acquisition, management, communication and reuse of information. Most companies turn to new technologies, in

particular information systems that will provide them with a competitive edge, or that will allow them to become agile.

2.7 Relation between Agility and Manufacturing Paradigms

In the literature agility is often confused with Lean production and flexibility. Agility is a business concept and its aim is to place the company ahead of its competitors and being able to rapidly respond to changes occurring in the market environment. The next subsections will define the relationship of the above systems to agility.

2.7.1 Agility and Leanness

Leanness or lean production is a different concept to agility. Sometimes the terms lean and agility are used interchangeably. In literature many of articles that focus on lean production and agility as strategic approaches to manufacturing. As manufacturing firms strive to improve plant-level performance in the face of increasing competition, the relevance of understanding how to become lean or agile has become even greater than before. Given the resource constraints within which most manufacturing firms have to operate today, it is useful, if not critical, to develop a good understanding of how these paradigms differ and what their constituent dimensions are. Such an understanding is also essential for developing and testing theories relating to leanness and agility (Hormozi, 2001).

Agility has been shown to differ from a lean, agility means that the whole manufacturing organisation is re-organised as frequently as needed to enable adaptation or anticipation of changes in business environment. However the lean production system is a focus on immediate solutions and changes (Bunce and Gould, 1996). Lean is used because lean production is concerned with doing everything with less. In other words, the excess of wasteful activities, unnecessary inventory and long lead times are cut away through the application of just-in-time manufacturing, concurrent engineering, overhead cost reduction, improved supplier and customer relationships and total quality management.

The adoption of lean production which focus primarily on production efficiency does not address the total requirements demanded by the current market, which include a simultaneous focus on efficiency and quality, as well as flexibility and new product development (Cave, 2009).

There are a number of difficulties and barriers faced by SMEs to implement Lean practices and techniques. These include the lack of understanding of the lean concept, and statements about the approach not being often applicable, the education level of mangers,

also, becoming lean and staying that way requires focus, commitment and time. All this could make the implementation of Lean practices in some manufacturing SMEs challenging.

The findings from literature suggest there is confusion between lean and agile performance and practice concepts (Trzcielinski, 2007). It is important to distinguish between leanness and agility as performance capabilities, and lean and agile as manufacturing systems that include both performance capabilities and practices. The literature does consistently suggest that leanness and agility are identifiable, distinct, operational performance capabilities that explain fundamental differences in plant operational performance. Secondly, literature indicates that there may be temporal relationships between lean and agile, with the predominant view being that lean manufacturing is a performance/practice state that is antecedent to agility (Prince and Kay, 2003). Therefore the extent to which an organisation is lean or has adopted lean production practices will be a factor in the agility the organisation.

2.7.2 Agility and Flexibility

Flexibility and agility are also used interchangeably. Flexibility has been defined as "the ability to change or react with little penalty in time, effort, cost or performance" (Nordlund *et al.*, 2008). Flexibility is the ability of a manufacturing organisation to effectively organise and reorganise its resources, responding to the changing conditions of its environment to operate profitably at different output levels, it's the capacity to deploy or re-deploy production resources efficiently as required by changes in the environment (Sethi and Sethi 1990).

The competitive environment should determine the type of flexibility a firm should emphasise. According to (Tachiziwa and Gimenez, 2007), flexibility to respond correctly to changes in the competitive environment is an imperative to remain competitive in the global marketplace. Flexibility can be seen both as internal "capability" or external "competitive edge" (Nordlund *et al.*, 2008).

Flexibility in general is a very important issue for SMEs today; SMEs must be flexible enough in adjusting and adapting to changes in business environment. They also need to be agile in order to capture market opportunities before competitors. This agility permits SMEs to widen market opportunities as they quickly respond to the changing demand of market. Along with flexibility and agility, networking is the most viable way to ease resource constraints. All definitions of agility highlight the speed and flexibility as principal attributes of agile organisation (Sherehiy *et al.*, 2007; Ganguly *et al.*, 2009).

Baker (1996) explains the real difference between flexibility and agility. Flexibility is usually associated with the operational level, agility places greater focus on the strategic levels

which implies ability to embrace change and respond quickly and effectively to cope with market and customer demands, therefore agility and flexibility are different things.

One of the main differences between "agility" and "flexibility" is in the business context. In manufacturing terms, flexibility refers to product(s) range using certain (production) strategies, while agility refers to quick movement (change) of the whole enterprise in a certain direction.

2.8 Measuring Agility

In reviewing existing agility measures, there does not exist a direct, adaptive and holistic treatment of agility components (Erande and Alok, 2008). For example, in Goldman *et al.* (1995), the overall problem of measurement is limited to three simple, yet fundamental questions: what to measure, how to measure it, how to evaluate the results. Furthermore, there is no "synthesis method" to combine measurements and determine agility (Ramesh and Devadasan, 2007).

In literature there are a number of different measures of agility used. This can lead to confusion since how is one measure selected. Moreover some times different measures that purport to measure the same issue may conflict (Giachetti *et al*., 2003).

Krajewski and Ritzman (2001) defined competitive priorities as: quality, cost, time, and flexibility as the four dimensions of agility measures. Kumar and Motwani (1995) identified five major factors as agility measures that influence the ability of an enterprise to respond; material and information flow discipline, state of technology, specialised functions, quality, and flexibility. These factors were then delineated into 23 sub-factors that also reflect the firm's agility. These factors/ subfactors were further used in a strategic framework, which they developed to evaluate effectiveness on the dimension of agility. Yusuf *et al.* (1999) suggests a set of 32 attributes in 10 different domains: integration, competence, teambuilding, technology, quality, change, partnership, market, education and welfare.

Tsourveloudis *et al.* (1999) break-down manufacturing agility into four divisions or infrastructures in order to measure it. Overall agility is calculated by applying fuzzy logic to individual agility scores in production infrastructure, market infrastructure, people infrastructure and information infrastructure.

Rameshash *et al.* (2001) suggest a quantitative framework to explore the value of agility in financial terms, the Net Present value (NPV) of all relevant cash flows being the measure of agility. Lomas *et al.* (2006) give a method to measure design process agility for a single

company product development process. Key Agility Index (KAI) is calculated to measure agility of a process.

Bessant, *et al.* (2001) suggests a model to implement agility in manufacturing companies with four major dimensions; strategy, processes, linkages and people as agility measures. Sharifi *et al.*, (2001) suggests that the agility of manufacturing companies can be measured through four dimensions; responsiveness, competency, flexibility and quickness. Gunasekaran *et al.*, (2002) framework measures agility through people, strategy, technology and organisation. Bustelo and Avella (2006) present a conceptual model to implement agility in Spanish manufacturing companies according to ; cost, flexibility, delivery, quality and services as measures of agility.

As already described in early in this chapter Goldman *et al.*, (1995), see agility measured through the capabilities of the company considering four strategic dimensions that underlie the strategic process of any company seeking to achieve agile capabilities, regardless of size and industry, enriching the customer, cooperation to enhance competitiveness, mastering change and uncertainty and leverages the impact of people and information.

The above dimensions provide general information on how to achieve agility; the dimensions offer a platform for translating the macro characteristics and concepts of agility into a form suitable for the needs of individual companies (McCarthy and Tsinopoulos, 2003).

Literature has shown that companies in different sectors will respond differently to change through the consideration of strategic capabilities which suit them and correlate to their specific circumstances. This being the case, the measure of agility will also differ by sector. For example, given that production processes are extensive and complex and product life - cycles are long, agility in the aerospace sector is focused on the design process and on the area of product development where competitiveness is the ability to recognise and react to changes in the market for the products. By contrast within the automotive sector, agility is measured in the speed and effectiveness of the manufacturing process.

In summary, the classification of dimensions and capabilities helps in the understanding of how the concepts of agility can be measured within a particular company.

2.9 Summary

The aim of studying the literature behind agility in manufacturing is to understand the concept of agility and how it is important for the manufacturing SMEs, and to defined the specific benefits of moving towards agility, and thus what benefit it can bring to an organisation.

The review of the literature can be summarised in the following points:

- Agility in manufacturing refers to the manufacturing function within the organisation and all other business areas. Agility in manufacturing is a term applied to whole organisation that has created the processes, tools and training to enable it to respond quickly to customer needs and market changes, whilst still controlling costs and quality.

- Agility for manufacturing companies became necessary to cope with the changing environment to satisfy the need of the markets today. Change and pressure drive any manufacturing company to be agile. However, it is impossible to derive a definitive list of drivers which are applicable to all manufacturing companies. This chapter concludes potential drivers which are reasonably broad and are common to companies within different manufacturing sectors:

  - Change in customer needs: today's customers focus on unique products, they are less willing to accept mass-marketed goods and are rejecting products that fit all.

  - Change in Technology: technological innovation continues to accelerate, technology is becoming cheaper, faster and better. Manufacturers of all types and levels have access to technology that can help them to respond faster and operate from smaller plants, using more flexible production methods.

  - Development in internet and information tools: the Internet and information tools such as intranet, business to business and different communication tools have opened up a worldwide market to every manufacturer, and it has enabled customers to source products and services from any supplier, anywhere.

  - Response to change and uncertainty: the market requires low volume, high quality custom or specific products with very short life cycle, and short development and production lead times. Products and services today with high information and value-adding content more than before.

  - Competition: the competition between companies can move into new marketplaces more easily than ever before because there are now fewer political and tariff borders and therefore barriers to entry.

  - Responsiveness to social and environmental issues such as environmental pressures, changes in political legal issues and social and cultural changes

- The measure of agility focuses on two main areas of the organisations:
    - Agility drivers: the forces that push the manufacturing company to be an agile company.
    - Agility capabilities: the capabilities that allow the company to respond quickly to the changes in the environment and market place.

The next chapter, three, will critique existing agility models or frameworks, discuss the relationship between them and consider their applicability to manufacturing SMEs.

Chapter 3

Critique of the Existing Models of Agility

3.1 Introduction

There are a large number of publications on agility concerned with specific strategies, techniques, and manufacturing and/or management practices. There are also a number and variety of strategies, techniques, and manufacturing and/or management practices described as a part of the agile manufacturing company. Only a few studies address the conceptualisation and development of an integrated view of the agility concept in manufacturing. Although, some agility frameworks make an attempt to present a more integrated and holistic model, they still present a view mostly focused on production and the technological aspects of enterprise. Moreover, most agility related publications are focused on the theoretical descriptions of agility and agility frameworks. Few metrics and frameworks are grounded in empirical research.

Since the emergence of agility a significant amount of attention from both the academic and industrial communities has produced a large body of published work in research and development related to this topic. With contributions tackling different aspects of this field. The previous chapter identified the important of agility for SMEs and demonstrate agility in manufacturing as one of the approaches to cope with the changes in market environment. This Chapter represents a critique of existing models and frameworks for agility and assesses their applicability for SMEs reviews.

3.2 Reported Models and Frameworks of Agility in Manufacturing

Most of the literature on agility discusses only strategies and techniques. Few papers address the development of a practical methodology for implementing agility in manufacturing. However, several agility frameworks based on the different definitions and approaches can be found in the literature (Conboy and Fitzgerald, 2004; Ramesh and Devadasan, 2007; Hasan and Shankar, 2007).

From the literature review it was clear that the characteristics of the model which can satisfied the needs of SMEs to assist them in the implementation of agility is different from that of large companies. Furthermore, the criteria of an agility model for SMEs, should meet the needs of the SMEs and at the same time, it should be applicable to the resource

limitations of the SMEs. Characteristics of model specific to SMEs can be concluded in the following points:

- Low cost of implementation.
- Short time for implementation.
- Simplicity of use.
- Low expertise level required to use effectively.
- Leads to measurable outcomes in a reasonable period of time.

The above characteristics make the model easy and applicable to use within the SMEs, however six such models have been identified and this will be critique within this chapter according to the above characteristics.

3.2.1 Model A

Proposed by Yusuf, *et al.* (1999) who suggested 32 attributes of agile company, as shown in Table 2. He identified the competitive foundations of agility as: speed, flexibility, innovation, proactivity, quality, and profitability, then claimed that the proposed competitive foundations are the absolutely essential characteristics of an agile company that must be achieved in synergy. In the proposed framework three aspects of agility were relating to different levels of the enterprise; elemental agility refers to individual resources (people, machinery and management), and micro-agility refers to the enterprise, and macro-agility to the inter-enterprise level. This framework includes four core concepts of agility in manufacturing: Core competence management, Virtual enterprise formation, Capability for re-configuration and Knowledge driven enterprise.

Core competence management: Core competences are associated with the corporation's workforce and products that are identified at the individual and firm level. The enterprise core competences are derived from a corporate-wide learning process, integration of diverse skills and technologies, work organisation, and capability for inter-organisational cooperation.

Virtual enterprise formation: the framework presents three levels of cooperation among enterprises culminating in virtual partnership. The first stage represents enterprises that have operated as isolated islands. In stage two Interactions between companies at the corporate level with little or no relationship to the operational levels. In stage three, agile

organisations form virtual enterprises and cooperate both at the corporate and operational levels. Agile teams work across the company partners. This is the high point of cooperative venturing. It allows resources and diverse skills which are spread across disparate organisations to be harnessed and coordinated for manufacturing products, simple or complex, very quickly in accordance with customer specifications.

Table 2 Attributes of Agility (Yusuf, *et al.*, 1999)

Capability for re-configuration: This type of organisation is well positioned to take advantage of speed, by getting to the market before competitors with new products, and proactivity, by providing the products that will be required by customers just before the need arises. Operational reconfiguration is necessary to capitalise on the strategic architecture. Management must invest in technologies that confer operational flexibility at the plant level.

Knowledge driven enterprise: Organisations which intend to become agile should include the development of a well trained and motivated workforce, with the right set of skills, expertise and knowledge, as an essential element of their strategies. Such organisations are driven by knowledge and information possessed by and available to, the work force.

According to Yusuf *et al.* (1999), the development of a strategic architecture that presents a corporate wide map of core skills may allow the organisation to make rapid changes in focus and afford reconfiguration of the business when the window of opportunity appears.

Within this model Yusuf did not show any mechanism of application, also he did not pay much attention to the development and description of the measures of agility attributes considered in the research. Also this model did not provide any practical actions for improvement. Finally, there is no evidence in the literature or through case study that any testing of this model has been carried out.

3.2.2 Model B

In this model Bessant *et al.,* (2001) seeks to explain and guide the development of agility within a manufacturing enterprise. The major dimensions of the model are; agile strategy, agile processes, agile linkages and agile people. These are shown in Figure 2, and discussed below.

Agile Strategy involves the process for understanding the firm's situation within its sector, committing to an agile strategy, aligning the company to a fast moving market, and communicating and deploying the company effectively.

The agile strategy contains four sub factors:

1. Wide-deep scanning: focussing on tracing and understanding what is going outside the company, to define the essential changes for the company, these changes are considered as agility drivers.

2. Strategic commitment: these routines concern the commitment behaviour exhibited in support of the goal of agility, to speed of change and optimum technology utilisation necessitated by an agile approach.

3. Full deployment: is concerned about the integration level of different parts, departments, functions, teams and individuals, how the human resource is focussed to be fast moving and effective.

4. Agile metrics: measuring the operation performance of the whole company.

Figure 2 Reference Model for Agile Manufacturing Practices (Bessant *et al.,* 2001)

Agile Processes is the provision of the actual facilities, systems and procedures, and manufacturing processes to allow the organisation to functioning in an agile manner.

The agile process contains four sub factors:

1. Flexible facilities: measures the flexibility and capability of all aspects of the structure and infrastructure, how to rapid reconfiguration and change.

2. Fast new product acquisition: concerned with how important the development of new products is to the sector the company belongs to and acquiring it as appropriate to the organisations needs.

3. Rapid problem solving: the speed of the company management to solve and respond to problems.

4. Rich information system: measuring the speed of the decisions of the company.

Agile Linkages refer to the working intensively with, and learning from, others outside the company, especially with customers and suppliers.

The agile linkages contain four sub-factors:

1. Extensive benchmarking: measures where the company's position is in relation to the competitors in terms of; market position, technological innovation, application of technology and human resources.

2. Full customer insight: measures customer satisfaction.

3. Aligned suppliers: measures the reliability of suppliers in terms of quality, cost, and customer focus.

4. Performing partnership: measures the company's capability to cooperate with customers, suppliers and other companies.

Agile People is the development of a flexible and multi-skilled workforce, creating a culture which allows initiative, creativity and supportiveness to thrive throughout the organisation.

Agile people contain four sub-factors:

1. Adaptable structure: measures the adaptive ability of the company in terms of technology and methods of production.
2. Multi skilled people: measures the skills level and knowledge of the workforce and the training in the company.
3. Rapid able decision making: measures the integration level inside the organisation and the amount and the speed of information flow through the company.
4. Continuous learning: measures the rate at which the organisation learns and educates.

This model has been developed by building upon established organisational development experiences, using (survey-feedback) principles within the company to help identify and facilitate change.

Bessant *et al.,* suggested that developing agility involves working on three linked areas: the strategy which is described as the path, the core competence which is described as position and the behavioural capability of the organisation which is described by Bessant *et al.,* as the processes within the organisation.

However, the work is followed further to introduce a practical and factual approach in three case studies, each of them manufacturing SMEs, the results of applying the model produced general comments on each dimension without mention of any actions for improvement. The model was applied in the case studies to identify the areas that need improvement. No published evidence exists that there were any specific results.

3.2.3 Model C

Sharifi, *et al.,* (2001) proposed a methodology for helping organisations to understand better what is required in order to assess the degree of uncertainty the organisation is facing. The main components of the model proposed are: agility drivers, agility capabilities and agility providers as shown in Figure 3.

Figure 3 The Proposed Methodology to Achieve Agility (Sharifi, *et al*., 2001)

Agility drivers are the changes in the business environment that drive the company to a new position in running their business and searching for competitive advantage.

Agility capabilities are the second part that proposes the essential headlines of abilities that would provide the required strength for responding to changes such as responsiveness, competency, flexibility and quickness. Responsiveness is considered as the ability to identify changes and respond quickly to them, reactively or proactively, and to recover from them. Competency is defined as an extensive set of abilities that provide a basis for productivity, efficiency, and effectiveness of a company's activities. Flexibility is an ability to process different products and achieve different objectives with the same facilities. Quickness is the ability to carry out tasks and operations in the shortest possible time.

Finally Sharifi *et al.,*defined agility providers that are the means by which the agility capabilities could be achieved and are sought from four major areas of the manufacturing environment. These areas are organisation, people, technology, and innovation.

According to Sharifi *et al.,* the methodology was applied in two case studies (both of them large companies). The model did not target SME companies as its main focus. The

methodology used to identify the level of agility for each company refers to general practices to improve agility in the company without showing any specific results achieved.

The Sharifi *et al.,* model ignores the importance of information systems as a factor for agility, the agility here was measured by means of the responsiveness, Competency, Flexibility and Quickness of the company as a whole.

3.2.4 Model D

Gunasekaran, *et al.,* (2002) undertook a manufacturing agility review on an aerospace company in the United Kingdom. He presents a framework for measuring the discrepancy between the current agility level and the required agility level, in order for the aerospace company to continue to compete successfully in a global market.

The framework presents the main dimensions of agility as; people, strategy, technology and organisation as shown in Figure 4.

Figure 4 A generic Framework for Agile Manufacturing (Gunasekaran, *et al.,*2002)

The framework is intended to provide a general overview of some of the things that every company can look at to improve its overall effectiveness, and hence, its competitive advantage. The framework shows the following possible links between the key components strategy, technology, organisation and people of a manufacturing company:

Business process re-engineering is a link between the technology of the organisation and its overall strategy.

Information technology and electronic commerce is the ability to communicate with customers, suppliers, employees, and machines; i.e. it is essential both inside and outside the company limits. Information technology (IT) and electronic commerce (EC) can facilitate better communication links between the technology of the firm and the rest of the organisation.

Quality function deployment (QFD) is used to improve the communication link between people and the organisation, and can be used to communicate the customer requirements into real manufacturing data for the organisation.

Training, education and incentive schemes aimed at making workers become more agile in the business sense will improve people by empowering them and by keeping them motivated, which ties well with the overall business strategy.

Within the framework an agility questionnaire is used to assess the agility level of the company (sample questions of the questionnaire in appendix 1). The case study of the agility manufacturing experience is reported, including a list of recommendations for improving manufacturing competitiveness.

It can be seen in this framework that different enablers of agile manufacturing are overlapping each other. Therefore, all the enablers/tools should be integrated to achieve an effective integration and management of firms in agile manufacturing as mentioned previously the framework targets the large scale companies.

In this model Gunasekaran, *et al.,* did not take the drivers of agility as well as their measurement in to consideration, the model focuses on one sector (aerospace) which is considered as one of the sectors subject to change more than others, furthermore Gunasekaran, *et al.,* did not consider if the company actually required agility in view of the environment in which the company operated.

The results of applying this model within an aerospace company concluded a number of recommendations to improve the overall business competitiveness. The author leaves the recommendations with the management to decide when and how to apply them. This framework has been applied in one case study only and concluded without any published results with respect to improvement in agility.

3.2.5 Model E

Bustelo and Avella (2006) present a conceptual model for the analysis of agile manufacturing using three fundamental elements: motivators (environment), facilitators (agility practices) and results (agility results), shown in Figure 5.

Figure 5 The Agility Conceptual Model (Bustelo and Avella, 2006)

According to Bustelo and Avella the model consists of three main elements which are business environment, agility practices, and agility results that can be explained in detail:

Business environment

Bustelo and Avella considered business environment the source of change and generator of uncertainty, business environment considered as the main motivator of agility, these drivers of agility split in to two types , dynamism and hostility drivers which help the firm to develop and adopt practices linked to this new production model.

Agility practices

Five practices are defined:

Human resources practices that enable the development and application of highly trained,

motivated and empowered employees working in teams.

Practices related to information systems and technologies, which entail the use of advanced design, manufacturing and administrative technologies which are systematically implanted and fully integrated.

Practices related to the internal organisation and external relations, that contemplate the development of mechanisms of integration and coordination of the value chain, based on the cooperation and integration of operations between the firm's departments or areas and between the firm and external agents (suppliers, clients, allies, interest groups).

Practices related to the organisation for the development of new products and/or processes tending to the application of concurrent engineering.

Practices related to knowledge management and learning.

Agility results

It is suggested that the development of the previously mentioned agile manufacturing practices have repercussions on the attaining of a manufacturing strength, enabling the concurrent improvement of each of the five competitive priorities of this area (cost, quality, flexibility, delivery and service). In addition, the achievement of greater capabilities in the different manufacturing competitive priorities leads to higher levels of operational, financial and market performance, thus increasing the firms' level of competitiveness.

In this model the link between the three elements (business environment, agility practices and agility results) is not clear, Bustelo and Avella did not show how to measure the turbulence in the environment, and how this could lead to improve agility practices. At the same time, the model did not show how these improvements in the agility practices leads to measurable improvements in manufacturing strengths and then to improvements in company performance. Also, this model did not indicate any mechanism for measuring improvements in agility practices and strengths such as quality delivery and flexibility.

The model was studied by using a sample of Spanish manufacturers of different sizes (one medium and three large companies). The selection criteria of the case studies were built on the assumption that all the case studies have certain level of agility. The aim of using case studies was to define the main elements of the agile manufacturing model; it was studied the practices of each company towards agility and linked them to the model elements.

Furthermore, this model focuses on training and advanced technology as main elements of the model. According to literature, these items are more suitable for the large companies

more than for SMEs, because of the resource limits of SMEs. The model was delivered and built using the case study companies. However there is no evidence of the application of this model to any case study.

3.2.6 Model F

The final model identified is that of Ismail, *et al.,* (2006) who present a framework for the implementation of agile manufacturing. The framework (Figure 6. Agile Road Map) incorporates a detailed assessment of the level of business environment turbulence and the impact of this turbulence on the enterprise.

The Agile Road Map framework measures the level of change, level of control and level of impact on the company. According to the model agility performance indicators: products, people, operation and organisation. The proposed framework is basically a preliminary explanation of the way in which the model could be set into practice, using standard forms.

The analysis begins by identifying business threats and opportunities, and then proceeds to highlight organisations' weaknesses and strengths in relation to threats.

Figure 6 The Agility Road Map Process (Ismail, *et al.,* 2006)

The four key areas that the framework is concerned with are:

- Business strategy
- Business environment
- Organisation and how it performs

- Manufacturing methods

The process steps of the road map framework as shown in figure 6 are:

The first task of the agility road map involves eliciting information concerning the current business strategy and company aims. Subsequently, these are used to guide the selection of agility tools, methodologies and measures, and redefining strategies where this is appropriate.

The next task of the agility road map framework identifies the business environment and the degree to which the company is experiencing 'turbulence' and measures the impact of the turbulence factors and identifies those that are critical.

The next step is identifying and prioritising the attributes required in addressing critical turbulence factors based on degree of alignment or threat to business strategy.

The next stage within the agility road map framework focuses on linking the identified critical turbulence factors to those agility strategies required to overcome the identified turbulence. Agility capabilities of companies are defined in terms of five overlapping sections. These are; product, process, people, operations and organisation. Each section consists of a set of attributes or agility capability indicators that further define and shape its focus in terms of manufacturing agility.

The final step of the roadmap framework is an interactive process around the development, implementation and evaluation of its manufacturing strategy.

The approach can be viewed as a three-stage agile process. First, companies undergo the transformation of improving the weak areas related to change. Second, companies become responsive to change via the integration of improvement operations and activities. Finally companies must become proactive, (innovative) thereby taking more charge of their business environment, and effecting their environment so that it is more positive for their development and continued growth.

The model uses a complicated mathematical approach, which needs expertise in this framework to complete the result analysis of applying the framework. The application of this model in SMEs requires an expert person to apply and collect the results of the framework. These results need to be analysed to identify the new strategy for the company. According to Ismail, *et al.,* this process may take long time for SMEs mangers to see results. Addition there is the cost of applying this model for SMEs to consider.

3.3 The Main Important Factors of Agility Models and Frameworks

The study of the available models, frameworks and methodologies give full idea about the main component and factors of agility for manufacturing SMEs that considered as essential for agility in manufacturing, these elements may differ in definition from author to another, but in general it's common in the majority of them, it can be defined as follows:

Business strategy: is the strategy of the company, how this strategy support the strategic capabilities of agility which are necessary for responding to changes. Capabilities such responsiveness for change, competency, flexibility and speed in production, delivery and services, customer satisfaction, product and service quality and variety, innovative products and customised products are the most important items according to the literature (Ismail, *et al.*, 2006, Sharifi, *et al.,* 2001, Bunce and Gould, 1996) These capabilities are the most essential for any organisation that needs to define by the strategy of the company.

Business environment: agility is the ability of a business to adapt rapidly and cost efficiently in response to changes in the business environment. The changes are the forces, which drive the manufacturing organisations to move towards agility. These drivers include all factors and forces that exist in the environment in which a company lives, and can affect the company's business in a way. Factors such as changes in marketplace, competition and competitors, customers and suppliers, technology, and social factors are the most important factors that can effect on the company according to the literature (Sharifi, 2001; Bustelo and Avella, 2006; Ismail, *et al.*, 2006; Sherehiy, *et al.*, 2007; Hillegersberg, *et al.*, 2005; Yusuf, *et al.*, 2004; Kettunen, 2008).

Business Practices: agility is the set of capabilities that an organisation needs to thrive and prosper in a continuously changing and unpredictable business environment. The capabilities are a set of practices that an organisation needs in order to be able to respond to the agility drivers, these practices can be defined as actions that improve the capabilities of the company, these improvement actions can be related to different aspects of the company such: people, technology, manufacturing process, information systems, flexibility, competency, innovation, tools, knowledge, products, speed, finance, recourses, management, marketing, operation and infrastructure (Sharifi, *et al.*, 2001; Bustelo and Avella, 2006, Ismail, *et al.*, 2006, Lin, *et al.*, 2004, Yusuf, *et al.*, 2004, Brown and Bessant, (2003)) .

The analysis of the available models found that most of the current models of agility contain of the above elements, they follow almost the same thinking to devolving their models or

frameworks, the different between these models or frameworks is how they define the sub-elements or components of the above elements and the measuring system and how measure the level of each element.

In order to devolve new model for agility, the new model should be able to define the above elements in order to assist the SMEs to implement and measure agility. These elements can be readdressed and defined to produce model or framework to assist in implementing of agility in manufacturing SMEs according to their recourses and capabilities.

In summary, it can be concluded that the current available models of agility have shortcomings in their applicability for SMEs. As shown in table 3, a comparison was made between the current models of agility according to the following factors: cost of implementation, time needed for implementation, the simplicity of use, expertise level required for implementation, the inclusion of a measuring system, whether the model has been applied to an SME case study in practices and if so whether the application of the model led to any empirical results being published.

	Yusuf 1999	Bessant 2001	Sharifi 2001	Gunasekaran 2002	Bustelo 2006	Ismail 2006	Needed Model
Cost of implementation	Unknown	Low	Low	High	Unknown	High	Low
Time for implementation	Unknown	Unknown	Short	Short	Short	Long	Short
simplicity of use	Unknown	Easy	Easy	Difficult	Difficult	Difficult	Easy
Expert level required	No	No	No	Yes	Yes	Yes	No
Measuring System included	No	Yes	Yes	Yes	No	Yes	Yes
Applied to SMEs	No	Yes	No	No	No	Yes	Yes
Empirical results	No	No	No	No	No	Yes	Yes

Table 3 Comparison between the available models of agility

As can be seen from Table 3 above Bessant *et al.,* (2001) and Sharifi, *et al.*, (2001) models are closest to that which would be appropriate for use within SMEs. Indeed, empirical results exist from the use of Bessant *et al.,* model however these are not linked to practical outputs leading to change, and within the model itself no extension to the framework is provided in order for the SME to apply this subsequent step in the methodology. The model can therefore be considered as a benchmark tool to determine current level of agility rather than a model or framework to improve agility.

Similarly with Sharifi, *et al.*, (2001), the model proposed has features which are appropriate to an SME however, there is no published evidence provided to establish the utility of this model where it has been applied to an SME company and therefore no results are available to confirm this.

The above comparison between models shows that there are weaknesses present in each of the current models which make them less applicable to use for SMEs in the implementing of agility.

3.4 Summary

This chapter reviewed the available models and frameworks related to agility in order to identify the essential elements of agility assessment tool for SMEs.

As mention in the previous chapters, one of the important barriers of implement agility in manufacturing SMEs is lake of the methodologies or frameworks to enhance agility. As a result of the findings, the preliminary investigations in the subject resulted in the recognition of a lack of understanding in the literature as to how individual UK manufacturing SMEs should go about implementing agility.

The majority of the literature regarding agility was either conceptual or exploratory with limited managerial implications. Most of the studies lacked theoretical foundation, empirical evidence, or rigorous analysis. Current models do not meet the needs and demands of SMEs as frameworks towards agility.

The need for a new framework to measure and improve agility levels within manufacturing SMEs is based on identified shortcomings of available literature, models and frameworks. It is argued here that the available literature does not provide adequate support for selecting improvement principles that are applicable at operational level to the target companies in this research.

From the critique of existing models and frameworks of agility it can be concluded that no single model exist currently which meets the requirements identified for the SME to successfully apply the model and for it to result in measurable change in agility to improve competitiveness.

The next chapter will present the methodology adopted to achieve the aim and objectives of the research.

Chapter 4

The Research Approach Adopted

4.1 Introduction

This chapter explains and justifies the research approach adopted, methodology and data collection, and explains the purpose of using the adopted methodology. Finally the selection criteria of the survey sample are discussed.

4.2 Research Approaches

Research approaches are generally categorised as either quantitative or qualitative (Creswell, 2003; Neuman, 2000). These two approaches are known as the scientific empirical tradition and the naturalistic phenomenological approaches, respectively (Burns, 2000). The appropriateness of using quantitative or qualitative approaches depends on a particular research paradigm or a set of assumptions (Sale *et al.*, 2002; Yauch and Steudel, 2003).

On the other hand, Crotty (1998) sees that the difference between qualitative and quantitative approaches occurs at the level of methods, or type of data employed. It does not occur at the level of epistemology, or theoretical perspectives. He also contends that method is a technique or procedure used to gather and analyse data. Similarly, in view of the data presentation (Yauch and Steudel, 2003), quantitative methods such as surveys or other measurements produce data in the form of numbers, whereas qualitative methods such as interviews, focus groups or participant observation collect individual words.

This study follows pluralism, and is therefore a mix of quantitative and qualitative. A combination of research methods both quantitative and qualitative will produce the most objective results (Collis and Hussey 2009). Quantitative research is viewed as confirmatory and deductive in nature whilst qualitative research is exploratory and inductive in nature (Collis and Hussey ,2009).

In the following sections, quantitative and qualitative approaches will be discussed in detail, as they are used at different stages in this study.

4.2.1 The Quantitative Approach

The quantitative approach is based on a scientific method for data collection and analysis in numerical form. The quantitative approach typically tends to learn 'what', 'how much' and 'how many' (Pinsonneault and Kraemer, 1993), and determines the frequency and percentage, or proportion, of responses. In other words, the quantitative approach involves collecting objective or numerical data that can be charted, graphed, tabulated, and analysed using statistical methods. When taking a quantitative approach, samples should be large enough to be representative of an entire population, so that the results can be generalised and may be replicated or repeated elsewhere (Black, 1999).

The quantitative approach enables a researcher to draw conclusion about the quantity of attributes of an entire population from a sample. In doing so, a researcher uses tools drawn from descriptive and inferential statistics.

The quantitative approach was selected for this research. The questionnaire survey was conducted via post with the aim of providing the researcher with required information about the survey sample.

4.2.2 The Qualitative Approach

In contrast to a quantitative approach, the qualitative approach is characterised by an emphasis on the collection and analysis of non-numerical data. The nature of this approach concentrates on investigating subjective data (Davies, 2007).

The qualitative approach usually involves small groups of people or organisations, but provides rich and holistic descriptions of complex phenomena through a variety of techniques including detailed interviewing, observation and documentary analysis.

The qualitative approach of this research was the semi-structure interview with a sample of case studies to provide additional information to that of the survey.

4.3 The Data Collection Instrument

Survey research has been the most common means by which researchers in any subject area collect data (Tull and Hawkins 1987). The survey method allows the investigation of intangible phenomena that cannot be observed directly by the researcher (Bagozzi 1996). Three major survey research methods are commonly suggested in literature: the questionnaire, the personal interview, and the telephone survey. Each has its own

advantages and disadvantages, which have to be evaluated in order to suit the context in which each method is employed.

In this research, a questionnaire was chosen as the data collection instrument because it offered a feasible solution to the problem of distance between subjects and researcher. Beside, the questionnaire is self-administering, and easy to classify and analyse.

The questionnaire is a structured technique for collecting primary data for the survey. It is a series of written or verbal questions for which the respondent provides answers. A well-designed questionnaire motivates the respondent to provide complete and accurate information (Saks and Allsop, 2007).

The main advantage of this method is the ability to reach a large sample of respondents in a wide geographic area at the same time and at a reasonable cost (Gay, 2005; Sekaran, 2002). Respondents also have time to think about answers without the influence of an interviewer. Weiers (1988) adds that this flexibility allows a respondent to gather information that may not be immediately available at the time when an interview would take place.

The main reasons for selecting the questionnaire as a research instrument for this research were the advantages this method offers which, according to Oppenheim (1994) and Chisnall (2001) are**:**

- The cost of distributing mailed questionnaires is relatively low considering the geographical area that need to cover.
- A questionnaire provides reliable information.
- The analysis and interpretation of the data results in better appreciation of the problem.
- The analysis of the data is relatively uncomplicated.
- It is confidential.
- It is possible to survey a large number of companies in a short period of time.
- Respondents enjoyed a high degree of freedom in completing the questionnaires.

On the other hand the disadvantages with questionnaires are primarily the low response rate (Collis and Hussey, 2009, Brannick and Roche 1997, Adam and Healy 2000). Bogen (1996) mentions that the length of the questionnaire can effect negatively on the response rate Malhotra (2003) points out that response rate can be very low in some cases. Malhotra also

suggests that researchers should not assume that respondents provide accurate or reasonable answers to all questions. Respondents can misunderstand questions, have limited skills, or may be uninformed. Smith *et al.,* (2003) suggest the response rates varied from one research to another for SMEs surveys.

4.3.1 The Questionnaire Design

The business environment surrounding the organisation and the changes in it, which are defined as the agility business environment drivers, are the genesis when considering the matter of agility. These drivers define the boundaries of the subject of agility for an organisation. A major and first step towards the determination of current levels of agility is the evaluation and assessment of the business environment to determine the need within the organisation for greater agility. An analysis based on this assessment would lead the organisation to refine or redefine its strategy for agility, identify the required and missing capabilities and practices of agility, implement the practices determined as necessary requirements, and finally evaluating the outcomes to examine the agility position for the organisation. This process would be repeated in a recursive movement towards greater agility.

As discussed in chapter three, agility in manufacturing companies is a combination of three different elements; the business environment, business strategy and business practices .The purpose of the questionnaire and its design is to provide an instrument to assess current levels of agility within an organisation. The developed questionnaire assessment tool defines two main analysis processes of the company; one for its level of need for agility and one for its current level of ability or agility drivers that are the inputs to the 'agility need' level analysis. The first part of the assessment tool is designed to assess specifically the company's business environment to determine the degree of its turbulence and hence the level of the company's need for agility.

A further assessment must be made to determine the current level of a company's agility. Measuring the level of an organisation's current agility, which in fact is the ability of the organisation in responding to the changes in its business environment, should be interpreted in relation with the degree of turbulence and changes in the company's business environment. This measurement is also related to the agility capabilities and practices in the main four dimensions of agility; Solution Providers, Collaborative Operations, Adaptive Organisations and Knowledge Driven Enterprise which are the main components of the agility capabilities considered in this research, and represent the reference points with which the company's abilities (current agility level) should be measured.

Accepting the purpose of the questionnaire the specific objectives were determined to be to:

1. Examine the level the various changes that could happen in the business environment of the company. This will help in the process of recognising the type of change and the capabilities required for recovering them.

2. Examine the current level of strategic capabilities that would be required and are vital in responding to changes. The capabilities that an agile organisation should have to be able to make appropriate response to changes taking place in its business environment.

3. Examine the current level of agility practices that help in defining the initiatives and methods for improving the required capabilities. This would provide guidance for choosing the practices and put them in the company's action plan.

A well-designed questionnaire is important, the clarity and the language use to construct the questionnaire must be carefully considered.

Descriptions in the literature exist to show how a questionnaire should be constructed and provide the reasons for this. In considering the questionnaire within this research reference was made to the work of (Ian, 2004; Saris and Gallhofer, 2007; Gillham, 2008; Collis and Hussey , 2009, Diliman, 2000; Malhotra,2003; Brace, 2004 and Fink, 2002).

4.3.2 The Purpose of Asked Questions

According to literature, in order to provide a measure by which a company would need to improve, the current level of agility would need to be understood, and the environment in which they operate (the extent to which agility is required for organisation).

The questionnaire is the quantitative element of this research. The main aim behind using questionnaire in this research is to:

- Obtain a substantial amount of information at a reasonable cost from many manufacturing SMEs in the UK.
- Enabled the researcher to get contact with companies.
- Enable the researcher to develop meant of a preliminary understanding of the situation of how the SME community regards the agility concept and its practices of the tested sample of SMEs.
- Investigate the level of knowledge of agility in the tested sample of SMEs.

- Test the relationship between agility model elements.
- Examine the level of agility business environment drivers for tested sample of SMEs.
- Examine the current level of agility within the tested sample of SMEs.
- Identify the relation between the finding of literature review and analysis results of the tested companies.
- Test the validity of the questionnaire as a research assessment tool.

4.3.3 Questions Design

Rensis Likert provided a way by which researchers can measure the degree of agreement or disagreement of the respondents to a question (Fink, 2002). The respondents must indicate how closely their feelings match the question or statement on a rating scale. The Likert scale converts the feeling of respondents to numerical data, which facilitates analysis. This type of question is known as a Closed-ended question. The benefit of closed-ended questions is that they are easy to standardise, and data gathered from closed-ended questions lend themselves to statistical analysis (Fink, 2002).

The advantages of a Likert-style questions and closed-ended questions are that carefully chosen response options allow for the same frame of reference for all participants when choosing an answer. The answers to a close-ended question are pre-determined, and as a result, they are both more specific than open-ended questions and are more likely to promote consistency among respondents in terms of understanding both the question and responses.

Close-ended questions provide a variety of possible responses for the respondent to choose from. Close-ended questions are very popular because they provide a uniformity of answers and it is very easy to code those answers and produce some forms of statistical analysis on the results (Fink, 2002).

The designing of the questions is important in order to avoid confusion. In this survey questionnaire the type of question design was a mixture of close-ended questions. Respondents were required to select either one answer he or she thought was appropriate for questions asked in the questionnaire (Collis and Hussey, 2009).

In order to obtain the required information, the questionnaire was composed of seven main sections. Questionnaire items were developed in accord with the research aim. The structure of the questionnaire was including all the essential elements of agility model in addition to

general information section and lean practices section, respondents were welcomed to comment or give their suggestions in the end of the questionnaire.

4.4 Piloting of the Questionnaire

Adopting the recommends of Ian, (2004) the questionnaire was piloted to discover any possible problem related to the design in terms of the degree of clarity or its applicability. The questionnaire was sent to the collaborating company (LabFurniturings Ltd.) as the piloting step for the questionnaire.

As a result of this exercise minor revisions were made to develop the final form of the questionnaire (Copy of the questionnaire assessment tool in appendix 3).

4.4.1 Self-Addressed Stamped Envelope SASE

Mathews *et al.* (2001) suggested that including a cover letter and self-addressed stamped envelope in the package survey could increase the response rate. The main disadvantage of using the questionnaire method is the low rate of response. Therefore the author decided to send SASE with the survey package, along with a covering letter, (appendix 2).

4.5 Identifying the Appropriate Organisations

It was decided to make use of a commercially available data base of companies within the UK, Applegate, 2006 website, as this was regarded as up-to-date and was readily available. Companies were selected form this database based on the following criteria:

- Company size: the target size in this research was small and medium size manufacturing companies as defined in chapter two.
- Manufacturing sector: the research targets all the manufacturing sectors according to availability of companies from each sector.
- Location of the company: the target location in this research was the companies located within the UK.

4.6 Administering the Questionnaire

The survey was conducted between 1st and 10th of October 2006. Survey packages were mailed to 2178 companies in the UK. The survey package included a covering letter asking for their participation, a self-addressed stamped envelope and a copy of the questionnaire with an introductory letter.

As the subject of agility does not related to a specific department or section in the company, it was considered appropriate if one of either the managing director, manufacturing director, production manager, plant manager or business development manager complete the questionnaire. Questionnaires were therefore addressed by name to one of the above positions in each company, depending on the availability of these on the database.

Approximately two weeks after the initial mailing, a reminder e-mail (Appendix 4) was sent to those companies who had not responded by the due date. If subsequent to this there was still no response, a follow-up telephone call was made.

From the questionnaires posted, 179 responses were received, from which 103 responses were selected as appropriate to this study.

The response rate was less than 9%, which was less than expected, however on a statistical basis, the number of responses can be considered satisfactory for the purposes of this research.

4.7 Summary

This chapter focused on the research design and methodology used to accomplish the study objectives. The structure of the research method employed in this study was discussed, and the considerations that were taken into account in adopting the research methodology were presented. A description of the questionnaire assessment tool design will be presented in the next chapter.

Chapter 5

Questionnaire Assessment Tool Design

5.1 Introduction

Based upon the literature review, previous authors have adopted different strategies and assumptions in order to build agility models and tools, what is clear however, is that no model or framework currently exists to satisfy the hypotheses put forward and, restated here for clarity:

1. The manufacturing SME community in the UK is not familiar with the concept of agility.

2. No model, framework or methodology exists currently to specifically bring about an improvement in Agility within a manufacturing SME.

3. The level of competitiveness within manufacturing SMEs is influenced by the extent to which the organisation is agile.

4. A framework capable of identifying the degree to which a manufacturing SME is considered to be agile (within the current environment in which it operates now) and which can pinpoint actions for improvement would if applied lead to an increase in competitiveness.

The major issues with regard to agility in manufacturing, which were discussed in chapter 2 and 3, are briefly recollected, organised and discussed here to identify the basic elements of the questionnaire assessment tool.

5.2 Creating the Questionnaire Assessment Tool for Agility

The purpose of the questionnaire assessment tool as mention in detail in chapter one is to assess the extent to which agility is perceived as important and the extent to which a company pays attention to the importance of the application of agility in manufacturing and its application and actions across the organisation. It is expected that use of the questionnaire assessment tool will pinpoint areas of weakness within the organisation and assist in the development of operational actions for improvement.

The resulting understanding from literature is articulated into elements within the questionnaire and used to establish a basis for defining agility in manufacturing organisations.

The outcome of the literature suggests that the measuring of agility in manufacturing companies can be seen as a combination of three main parts. Firstly, the agility business environment drivers which are the changes in the business environment which drive the company to a new position in running their business and searching for competitive advantage.

These drivers will vary from one sector to another, from one company to another and from one situation to another, and therefore the way they affect a company will vary as well. According to the literature this can be expected to influence the company to revisit the company's strategy and to reconstruct it giving greater consideration to the development of agility as a more important issue for the company. The agility strategic capabilities are the second part of this relationship that proposes the essential headlines of abilities that would provide the required ‘strength’ for responding to the changes. And finally the relationship of these to the agility practices where existing, or developed competencies, will underpin those practices that are the means by which the capabilities of the company can be developed to achieve the required levels of agility across the four main dimensions of agility discussed previously.

The relationship between these three elements is shown in figure 7. Any change in any one of these elements can lead to changes in the other elements, the changes that occurs in the business environment, for example changes in the market or customer demand will lead the company to restructure their strategy as a response to these changes. This action will lead to changes in the capabilities and practices of operations of the company to responds to and deal with the above changes. The changes in business practices can be seen as increasing the capability level of the main dimensions of agility as action taken in the face of changes in the business environment.

Therefore there is an established relationship between the drivers of the business environment, the business strategy and the strategic responses to them via the changes in business practices as a result of the business needs and reciprocity through an improved capability providing increased strategic opportunity to deliver within the business environment.

According to a definition of agility dimensions, the capability practices of each company can

be measured within the four dimensions of agility for each company. So measuring the level of these dimensions can be a means by which to measure a company's capabilities and practices of operation and accordingly measure the level of agility existing within the organisation.

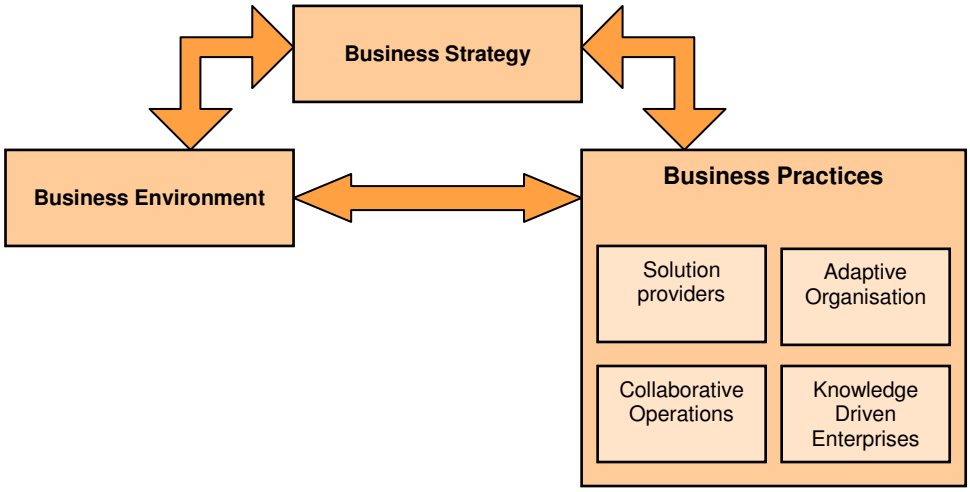

Figure 7 The relationship between main agility elements

In order to link the above main elements of agility, the questionnaire survey, should include three main sections as a mechanism to measure strategic capabilities, drivers of business environment and agility practices. Additionally the design of the questionnaire survey will assist the author to obtain the required information needed for contextual research purposes from and about the organisations themselves.

Therefore the questionnaire needs to include all of these sections to satisfy the research aim. The sections are: Company's profile, Agility strategic capabilities, Information systems practices, Lean manufacturing practices, Agility business environment drivers, Agility practices and a section covering Additional information.

Each of these sections has been expanded to provide the level of detail necessary to provide for further evaluation to take place.

5.2.1 Company's profile

This section seeks to obtain general information about the surveyed companies:

- The company's characteristics, sector, size, turnover, type of production and number of products.
- New product introduction rate per year.

- The level of familiarity of the company (respondents) with the subject (agility).
- The self-confidence level of the company; whether they consider themselves a World-Class Manufacturing Company.

The aim of this section was to give the author a more complete profile of the companies, to test the first hypothesis of the research: The manufacturing SME community in the UK is not familiar with the concept of agility, and to help the author in the second phase to select the organisations to further case study.

5.2.2 Agility Strategic Capabilities

According to literature agility strategic capabilities are the capabilities that are necessary for the company or the organisation to response to change. The nine capabilities that are used in the questionnaire are the main capabilities related to agility according to literature as mentioned in section 3.3 these capabilities were included to determine which strategic capabilities have not received attention by the company when their strategy was developed.

In order to aspire to a certain level of agility, manufacturing companies need to pay attention to their strategic capabilities with respect to agility when they prepare their strategy. These capabilities if present or if they can be developed will allow them to take tactical actions and deliver measurable improvements. Developing the ability to do so will help to increase the level of agility. It is seen therefore as important to measure the levels of these capabilities as the genesis to measuring the extent to which a manufacturing organisation can be considered to be agile.

To determine the importance of these capabilities to the company, each company was asked to rate the following nine capabilities:

a. Focusing on Customer Satisfaction.
b. Focusing on Producing Innovative Products.
c. Focusing on Product Quality.
d. Increasing Product Variety.
e. Increasing Competency of the Company
f. Increasing Flexibility in Production and Services.
g. Increasing Responsiveness to Change.
h. Increasing Speed of Production and Delivery.
i. Producing Customised Products.

5.2.3 Information systems Practices

In the literature, a number of authors discuss the importance of the information system and its application to the manufacturing companies as a factor in agility (as discussed in chapter 2).

If for example, agility is required within the manufacturing process particularly then in order to become more agile, the company will need to work towards the development of a flexible and speedy manufacturing system that can provide better customer service, better logistics, better planning and scheduling and a quicker response to customer needs.

In this situation the role of an 'information system' would be in providing a robust and effective management information system to support the manufacturing function; one able to gather and track information on for example; purchasing, goods received, inventory levels, despatch, invoicing and payment and interface with planning and control data to provide accurate and timely management information for decision making. Similarly if design and product development were areas of agility required for competitiveness then relational databases on product structures and bill of materials would be needed to provide support in these areas of the business.

This part of the survey was aimed at collecting data on the information system capabilities and resources of respondent companies. In this part of the survey, respondents were asked to rate the elements related to information systems tools, practices and applications for their business.

Questions were created in order to draw out the current level of use of information systems in these companies.

5.2.4 Lean Manufacturing Practices

In literature there is some confusion between Lean and Agility with the terms being used by many authors interchangeably. There can be little doubt that for a number of manufacturing sectors Lean practises underpin competitiveness however, within literature the question remaining unanswered is; whether or not Lean is a necessary requirement of Agility.

Thus, in order to determine the current relationship between Lean and Agility within the tested sample of SMEs, it was important to know the level of leanness in the tested companies and which of the lean practices are more used especially in the companies that already have high level of agility practices, as a means by which the importance of Lean practices for implementing agility within the SMEs can be better evaluated.

This section was included in the questionnaire to find out the level of lean practices, and which of these practices are more used and is of benefit for manufacturing SMEs, and to assess the current level of leanness within the company according to the use of the following widely accepted lean techniques or practices:

- Just in time (JIT).
- Cellular manufacturing of organisation.
- Standardisation of Operations (STOP's).
- Kanban control systems.
- Kaizen.
- Value Stream Mapping (VSM).
- Total Productive Maintenance (TPM).

5.2.5 Agility Business Environment Drivers

According to the finding from literature companies are different in the way they face changes and the consequences of these changes. So it can be deduced that there are likely to be differences in the way companies will respond to these changes. Within these researches this is defined as the 'agility needed level' or how agile the company needs to be. According to literature, this level is a result of different factors including; turbulence of the business environment, the environment that the company competes in and the characteristics of the company itself.

Literature suggests a series of factors as measures that could be used to assess the turbulence of the environment of the company. These factors are used to determine the importance and urgency of developing particular capabilities for becoming agile. These factors will be assessed and scored based on the turbulence and/or the impact they would have on the company's performance,

The scoring of each factor represents a proportional rate of the factor with regard to the highest possible level in that specific area. This provides the opportunity to take the average score of the total items as a measure of the 'agility needed level'.

One of the factors is the pressure from the external environment on an internal element that makes the circumstances more harsh and severe for the company.

Consequently, measuring the needed level of agility or defining the pressure level of the outside environment is one of the important functions of the questionnaire assessment tool

in providing the opportunity for the company to recognise how to deal with the market conditions before deciding which of the many actions they could take to increase or improve agility.

The most important factors identified from literature can be listed as:

- Changes in market environment (growth of the niche market, change in products models, decreasing of product lifecycle).
- Changes in competition criteria (rapidly changing market, increasing pressure on cost and rate of innovation, global market competition, decreasing time to market).
- Changes in customer requirements (demand for individualised products, speed of delivery time, increase of quality expectation, changes in order quantity and specification).
- Changes in technology (introduction of new production facilities, software and hard technologies).
- Changes in social factors (environmental /legal/political pressures, cultural problems, workforce/workplace expectations).

To evaluate each of the above factors, the author proposed a series of questions according the literature and the above attributes of each driver, these questions were asked to rate the above drivers to defined the extent of the pressure on the companies move toward agility.

5.2.6 Agility Practices

Agile practices as mention in chapter 3 are a set of actions that relate to the capabilities that an organisation needs in order to be able to respond to the agility business environment drivers and these practices, as described in current literature, were discussed.

In order that the extent of these practices can be tested it was considered necessary to identify, define and classify practices with similar attributes.

Once the company has recognised the level of its agility needs, it should be able to assess itself for the level of agility it has already. This can be done by measuring the level of agility capabilities and practices in the main four dimensions of agility; measured by considering the level of practices in each attribute of each dimension. The agility dimensions are structured upon the work of Goldman *et al*. (1996) who both elicited and described comprehensively agility as falling into one of four dimensions:

Solution Provider

This refers to the company's ability to deliver customer adapted services, including the ability to incorporate service and future services into a given product. The agile company offers a complete solution to the customer, including both physical products and services. Thus the agile company puts great emphasis on having continual contact with its customers. Customer satisfaction is regularly measured, and a deliberate effort is put into identifying future customer needs.

An important aspect here is the establishment of continues connection to the customer. In other words the company must be able to continue to service the customer long after the product has been delivered.

The traditional view of products is changing from only focusing on a physical product to also including information and services in relation to the product. In traditional mass production, the customer buys a product and uses it until it is worn out or out of date, after which a new standard product is bought from a supplier selected more or less at random.

According to literature the most related attributes to solution providers can be summarised as follows:

- High Product Variety.
- High Product Introduction Rate.
- Frequent Model Changes.
- Rapid Concept to Cash.
- Cost-Effective Low Volume Producer.
- Production to Order.
- Tailor Made Solutions (Products/Services).
- Product and Customer Support.
- High Information Products.
- Long Lasting Customer Relationship.
- Consumer Demand Changes.
- High Quality Standards.
- Customers Satisfaction.

Collaborative Operations

This refers to the company's ability to collaborate in a manner involving several internal functions, and its ability to collaborate with external partners.

The increasing collaboration both internally and between companies contributes to the transfer of technology between different organisations and at the same time leads to a considerable increase in the resources which are available in the individual development projects. An important condition for being able to establish this type of collaboration is however that the individual participants are technically capable of exchanging product information, and that the company's top management accepts that such product information is shared with external partners.

Two or more companies that have different core competencies and that cooperatively use these competencies to produce individualised products and services. Also, a business environment characterised by a close, cooperative, integrated relationship between companies, or between organisations within companies.

As the time available for developing and launching new products for example, gets shorter and shorter. Less time is available for the manufacturer to discover everything alone. Thus collaborating on a development process supports the reduction in individual development cost, reduces throughput time and spreads the risk.

In an agile company, cooperation among companies is seen as the key to achieving a competitive advantage. Cooperation with external sources is critical in an agile competitive environment, yet it is only possible if cooperation first exists within the organisation.

According to the literature review the most related attributes to Collaborative Operations can be summarised as follows:

- Cooperation strategy.
- Product Integration and Process Development.
- Integrated Enterprise Processes.
- Customer-Supplier Interactive Relationships.
- Organisation Virtual Partnership.
- Electronically Commerce organisation.
- Short Operation Cycle.
- Information Sharing Strategy.

Adaptive Organisation

This refers to the company's ability to adapt to unexpected changes, i.e. the organisation's ability to respond, to changing of the markets including the ability to enter into alliances with other companies. Important aspects of this are the use of knowledge and information, so that they become available to everyone in the organisation, and establishing a training program by means of which the organisation's staff will obtain new qualifications, so that the individual employees within the organisation will be able to deal with the new tasks which occur.

Individual employees are given greater freedom and thus also a greater responsibility for the work carried out. Employees are motivated to show initiative, and are rewarded in relation to their contribution to the individual tasks.

The company works continually to develop the existing business processes, and the organisation of the company is changed frequently. Management has a positive view of changes, and works purposely to establish an organisational culture in which changes are received positively and are viewed as an opportunity for growth.

The key to mastering change and uncertainty lies in an enabling infrastructure that promotes interoperability, adaptability, reconfigurability, and flexibility. In an agile enterprise, the rapid response to environmental change is one of the agility keys.

According to the literature review the most related attributes to Adaptive Organisation can be summarised as follows:

- Capable and Ready for Change.
- Monitoring of Competitors.
- Management Leadership.
- High Response for Change.

Knowledge Driven Enterprises

This refers to the company's ability to use and circulate knowledge, both internally within the organisation and externally. An important aspect of this is the possibilities offered by information technology for using knowledge and information. Knowledge is made open and can thus be shared between different employees, both internally within the organisation and externally, in a more operational manner.

Specialist knowledge is expressed openly and thus becomes available to more members of the organisation. This contributes to increasing the level of learning within the organisation.

Another important aspect of this is that the individual employees have the necessary abilities, at the same time as showing flexibility with respect to performing changing tasks. This last requirement in particular makes it necessary to build up a culture in which the individual employee is constantly being trained, and where getting trained is rewarded, to that the employee is able to deal more effectively with multiple tasks.

The individual employees' knowledge and ability, together with their ability to absorb new knowledge and to deal with new tasks, are the essential requirements if an organisation wants to be able to exploit the possibilities which are present in an ever more dynamic market. It is also necessary for the employees to be innovative and able to take new initiatives.

People are critical resources of an organisation in respect of; what they know, the skills that they possess, the initiative they display, and the information to which they have access. In an agile environment, management provides resources, rewards innovation, distributes authority, and promotes an industrial culture that leverages the impact of people and information on operations.

According to the literature review the most related attributes to Knowledge Driven Enterprises can be summarised as follows:

- Dynamic Competency Testing.
- High Communication Level.
- Innovative and High-skilled Workforce.
- Knowledge and Training-based Organisation.
- Active in Societal Activities.

The definition of each of the attributes of each dimension can be found in appendix 12.

Within this research this classification has been used to assess the agile practices within an organisation. The questions of this section of the questionnaire have been developed from literature (Ren, *et al.*, 2005; Jackson and Johansson, 2003; Aitken, *et al.*, 2002; Crocitto and Youseff, 2003; Kinnie, *et al.*, 1999; Yusuf, *et al.*, 2003; Gunasekaran, 1998; Christopher and Towill, 2000, langerak and Hultink , 2008; Gunasekaran and Yusuf, 2002; Devadasan, *et al.*, 2005; Li, 2000; Yusuf, *et al.*, 1999; Ren, *et al.*, 2003; Maskell, 2001; Parkinson, 1999

and Sherehiy, *et al*., 2007). In measuring the level of each dimension according to the attributes of each dimension. The distribution of the questions in this section is as follows:

- Questions from 1 to 34 related to Solution Providers dimension.
- Questions from 35 to 52 related to Collaborative Operations dimension.
- Questions from 53 to 65 related to Adaptive Organisations dimension.
- Questions from 66 to 76 related to Knowledge Driven Enterprise dimension.

These are the main elements of the questionnaire assessment tool which are subsequently further sub-divided into a number of questions. A series of questions were asked for each of the above elements of the questionnaire assessment tool to allow the author to measure the level of each element and sub-element. Within each element, there are further sub-divisions into detailed questions that total 122 for the complete questionnaire assessment tool.

Through for respondent the relationship of questions to dimensions is not visible.

The initial evaluation of the company's 'agility level needed' and its current agility level provide a benchmark of agility. Though this benchmarking in itself is useful without intervention being taken in the systems, processes and procedures within the organisation no improvement will actually be realised. Thus, the information the analysis of the questionnaire provides when taken in association with the other management information, experience and intuition present within most SMEs needs to be linked to a second stage within the improvement methodology where each organisation will determine what actions they will instigate.

5.2.7 Additional Information

In this final section of the questionnaire the respondents were asked simply whether they had decided either to be a part of the next phase of the research (as a case study), or not. The respondents were also asked to indicate if they were interested in receiving a copy of the analysis results or not. A contact telephone number and e-mail were made available if participants required further information. The basic objective of this section was to help the author in selection of the case study companies in the next phase of the research, seeking additional information related to the subject, or to find out if there were any comments which may help in this research that can be obtained from the respondents.

In order that the responses to each question within the questionnaire can be adequately analysed or interpreted it was for necessary to translate the qualitative responses in to

quantitative ratings in order to allow benchmarking and comparison to be under taken. The Likert scale was utilised for this purpose as described in detail in appendix 5.

Responses to the questions related to each element (except those in the first and final sections of the questionnaire) are limited to five points score between 0 and 4. The response scores for each element once collated can be used to provide an average score for each of the elements of the questionnaire assessment tool.

The results for the main elements of the questionnaire assessment tool can also be used to provide an average for each element out of 4 and, according to the measuring scale (appendix 6) adopted in this study; the results will show the current level of the organisation in each element of the questionnaire assessment tool.

In interpreting the results, the level of agility business environment drivers reflects the degree of turbulent of the company environment, i.e. the level of agility needed for the company to face these forces or drivers of change.

High scores in Agility Strategic Capabilities, Information Systems practices, and Agility Practices would imply that good organisational practices have been adopted and that these are being consistently practised throughout the organisation. A low score would represent a weakness and would indicate an area for improvement.

5.3 Summary

This chapter has illustrated the design steps of the questionnaire assessment tool, and describes the elements of the questionnaire assessment tool.

An analysis and interpretation of the empirical data collected through these methods will be presented in the next chapter.

Chapter 6

The Questionnaire Survey Analysis

6.1 Introduction

This chapter presents the data collected from 103 manufacturing SMEs responding to the survey, it consists of a comprehensive discussion of the analysis of the results from the questionnaire survey as a further phase of the research.

6.2 Statistical Analysis Technique

A number of criteria are proposed by Tabachnick and Fidell (2006) to select an appropriate statistical technique, two of which are the appropriateness of the technique to the research questions, and the characteristics of data. Accordingly, two statistical techniques were used in the analysis based on their relevance to the research questions. They were frequency analysis and cross-tabulation analysis.

Frequency analysis produces a table of frequency counts and percentages for the value of an individual variable. It was used in this research to provide descriptive information of the data such as frequency, and distribution of the responses, and to summarise the responses to each question.

The second statistical technique used was cross-tabulation. Cross-tabulation allows researchers to see whether or not there is a relationship between two variables. To say that there is a relationship between two variables means that the distribution of values on one of the variables is in some way linked to the distribution of values on the second variable (Walstad and Robson, 1997).
The scale is an ordered system that provides an overall rating representing the intensity felt by a respondent to a particular attitude, value, or characteristic. While several types of scales are used in questionnaires, the most common in the literature is the Likert scale. In this type of questions a series of statements or questions expressing a viewpoint are listed, and the respondents are asked to select a ranked response that reflects the level with which they agree or disagree with the statement. The Likert Scale allows a participant to provide feedback that is slightly more expansive than a simple close-ended question, but that is much easier to quantify than a completely open-ended response. In this type of research

and within this kind of data it most appropriate to use five-point Likert scales questions (Tabachnick and Fidell, 2006).

Statistical Package for Social Sciences (SPSS) software was used to analyse the data. The reason for this was the familiarity of the author with the software and the features of the software that allow the data to be articulated in different ways. Having decided that all data collected would be analysed using SPSS, the questionnaire was prepared in a manner that facilitated the analysis of the data.

6.3 Validating the Questionnaire Survey Finding

In order to be confident that the findings were relevant it was felt necessary to validate them. This was proposed in three ways:

Firstly, having developed the questionnaire from the reviewing of literature the finding were compared to those that might reasonably be expected to result if the companies participating in the survey were indeed representative of those described in the literature in respect of the environment in which they operate and the necessity for agility.

Secondly, having produced results for each company surveyed, each company was approached where they had indicated that they were be willing to undertake a further phase of the research and implement changes as result of the finding, and asked for further comment on their findings. This resulted in a number of companies (20) who were still interested in undertaking the second phase research, thus indicating their acceptance of the finding presented as a realistic representative of the level of agility within each of their organisations.

Thirdly, eight companies were eventually selected to undertake the second phase and actions identified and, agreed actions plans committed as a part of this phase. This commitment to change, on the basis of the findings of the survey, represents a validity of the research at this stage.

In the following section the findings are presented and comparison made between the questionnaire finding and expected results from the review of literature.

6.4 Analysis of the Questionnaire Survey

The questionnaire used in this research was carefully analysed to ensure that the data gathered was presented clearly with the aid of tables, percentages and graphs, where possible. The following sections will present and show the questionnaire data analysis and

findings from 103 manufacturing SMEs, and how the results of the analysis links to the finding from literature (sample of returned questionnaire assessment tool survey can be found in appendix 7).

6.4.1 Profile of Respondent Companies

In the first part of the survey, respondents were requested to indicate general information about the company: number of employees, annual turnover, ownership type, industry sector, type of products, main customer, production process type, number of products and the new products introduction rate of the company. The aim of asking such questions was to get information about the tested companies that may help the researcher to select different case studies companies for the next phase of the research.

Size of Companies

The size of the tested companies was indicated by two measures, the number of employees and the annual turnover. The size of the surveyed companies is depicted in Figures 8 and 9 respectively.

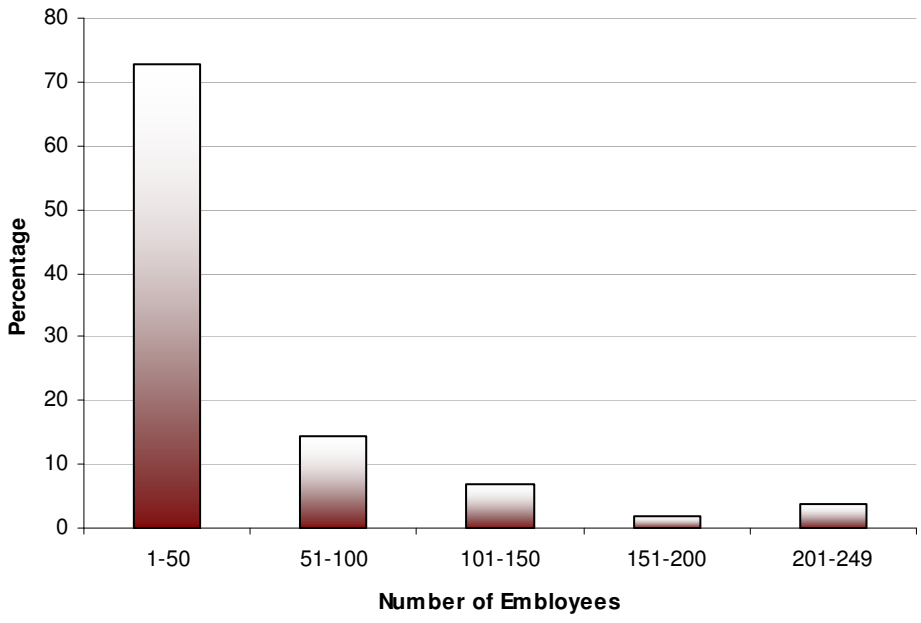

Figure 8 Size Of Surveyed Companies - Number Of Employees

As shown in the above figure, more than (70%) of the surveyed companies are micro or small companies according to the number of employees.

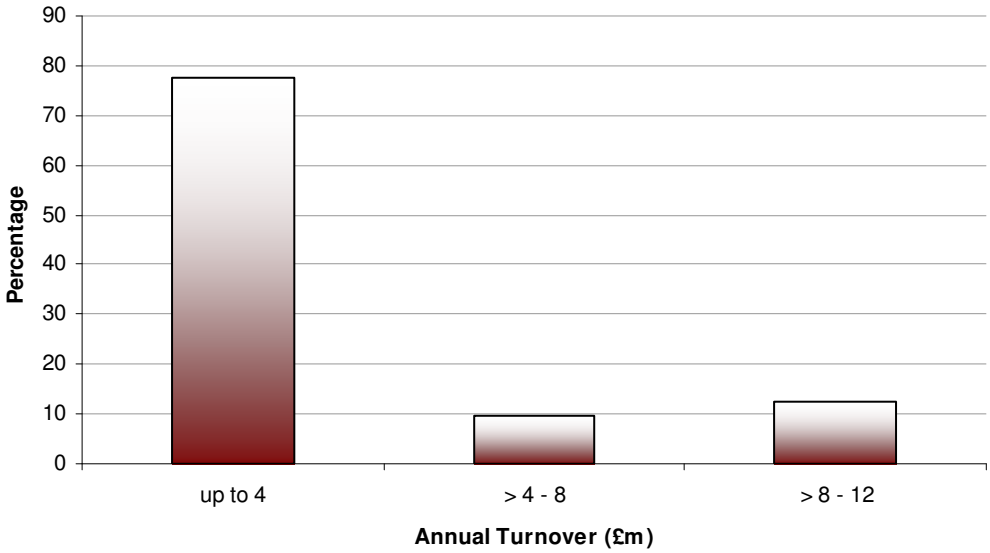

Figure 9 Size of Surveyed Companies- Annual Turnover (£m)

As shown in above figure more than (70%) of the respondent companies are located in the category of 1-50 employees.

		Annual Turnover (£m)			Total
		up to £4m	>£4 - 8 m	>£8 - 12 m	
Number of employee	**1- 50**	**72**	6	1	**79**
	51-100	1	6	5	**12**
	101-150	0	2	4	**6**
	151-200	0	0	2	**2**
	201-250	0	1	3	**4**
Total		**73**	**15**	**15**	**103**

Table 4 Number of Employees and Annual Turnover Cross Tabulation

The above figures and the cross tabulation table show more than 70% of the tested companies are micro or small companies, with a small number of employees (1-50) and a limited turnover (up to £4m), although different in proportion, the trend never the less supports the finding from the literature review which, identified that more than 90% of manufacturing SMEs are micro or small companies.

Studied Sectors

The surveyed companies were chosen from 15 industry sectors. These sectors were targeted by the survey in order to determine which of these sectors is subject to change more than the others.

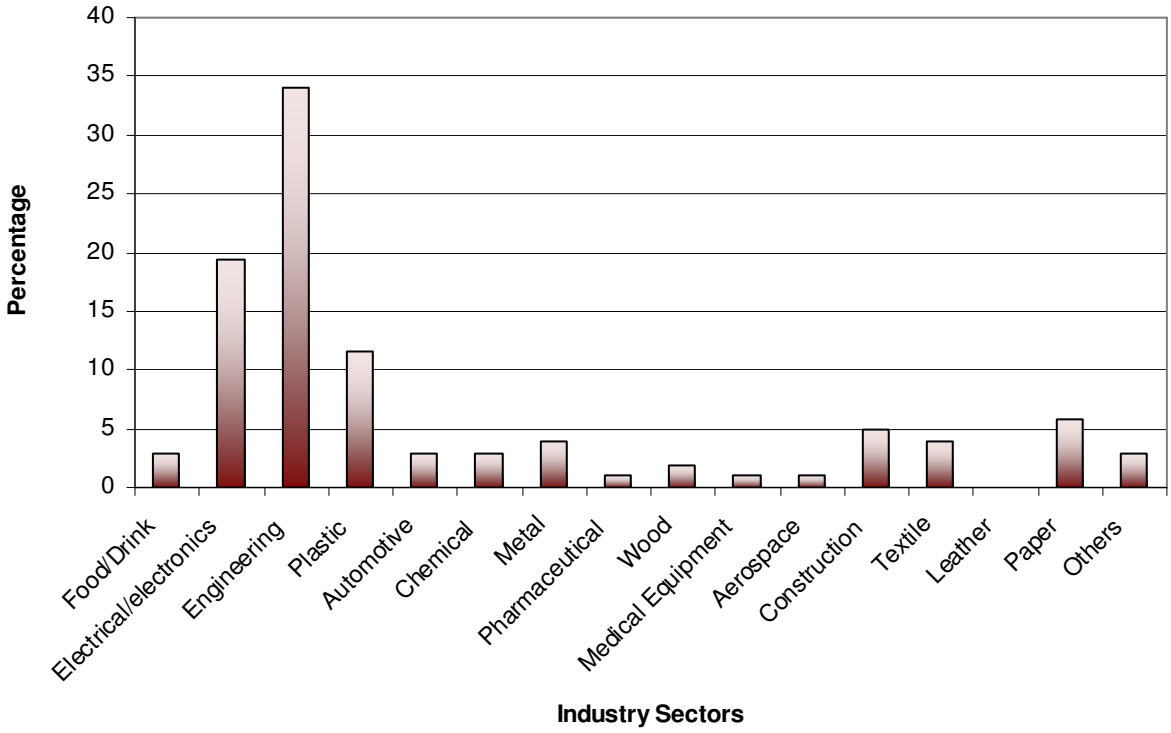

Figure 10 Distribution of Surveyed Companies in Different Sectors

Figure 10 shows the breakdown of the sectors in which the participating companies operate. As can be seen they come predominately from three sectors; electrical/electronic, engineering and plastics. The aim of this section was to do a full study about the agility needs for all sectors, but according to the number of replies from each sector, which in some sectors is very low (or zero), it was decided that any further phase of testing of the sectors analysis would be confined to these three sectors to allow for inter firm comparison to be achieved.

Awareness of Agility Concept

The research initially was based on the perception that the agility concept is still new to the UK's manufacturing SME community. This perception was examined by asking the respondents to identify the extent to which they are familiar with the subject of agility.

Findings on respondent's awareness of the concept of agility are shown in Figure 11. This shows that more than (70%) of the surveyed companies are not familiar with the concept, and about (10%) are acquainted with concept but do not fully understand what it really means. This finding supports the view in literature that manufacturing SMEs in UK are not familiar with the concept of agility.

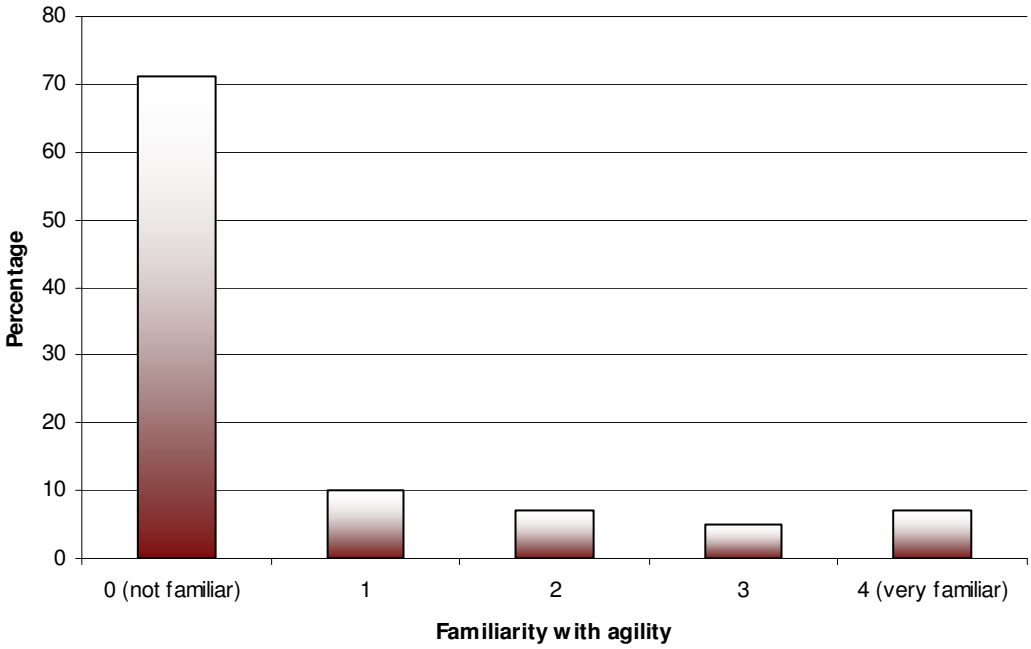

Figure 11 Familiarity with the Agility Concept

However, this does not necessarily mean that the companies are not alert, or do not know their business environment and circumstances, or are not aware of the importance of responding to change; they simply may not regard themselves as agile.

6.4.2 Strategic Capabilities

Strategic capabilities were included to indicate the level of how important these capabilities are to the company when developing their strategy.

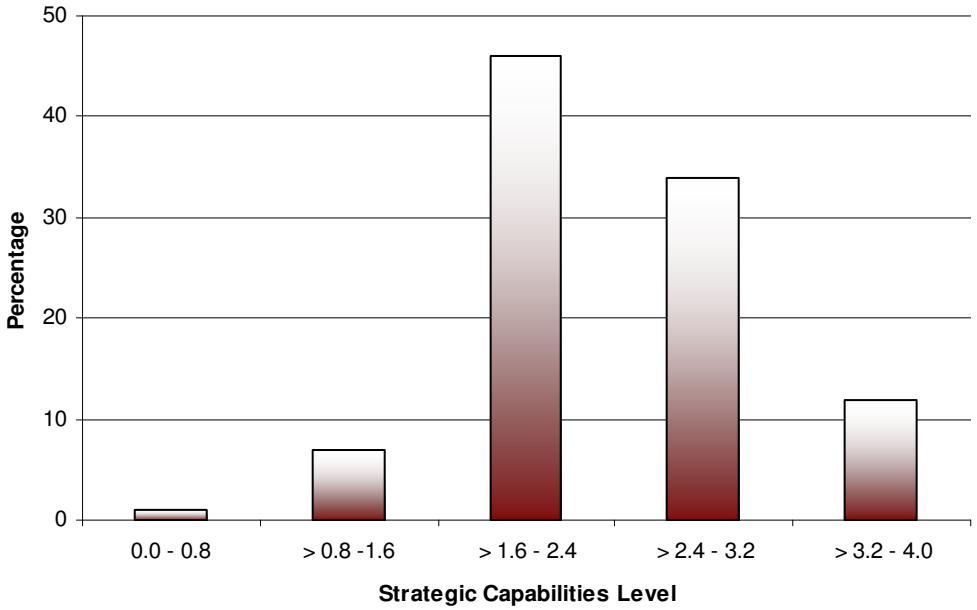

Figure 12 Strategic Capabilities in the Surveyed Companies

Figure 12 shows the classification of the answers according to the strategic capabilities level of respondent companies. It is apparent that most of the respondent companies had acceptable level of these capabilities. As can be seen, more than 90% (in average or above) of respondent companies identified acceptable level of concern about strategic capabilities allowing them to be prepared for change. This supports the finding from literature that manufacturing SMEs today are more prepared for the changing market conditions.

6.4.3 Information Systems

Information systems and tools are considered as a very important competitive factor for SMEs. Therefore, the level of use of information systems and related tools in the company is seen as an important issue for agility.

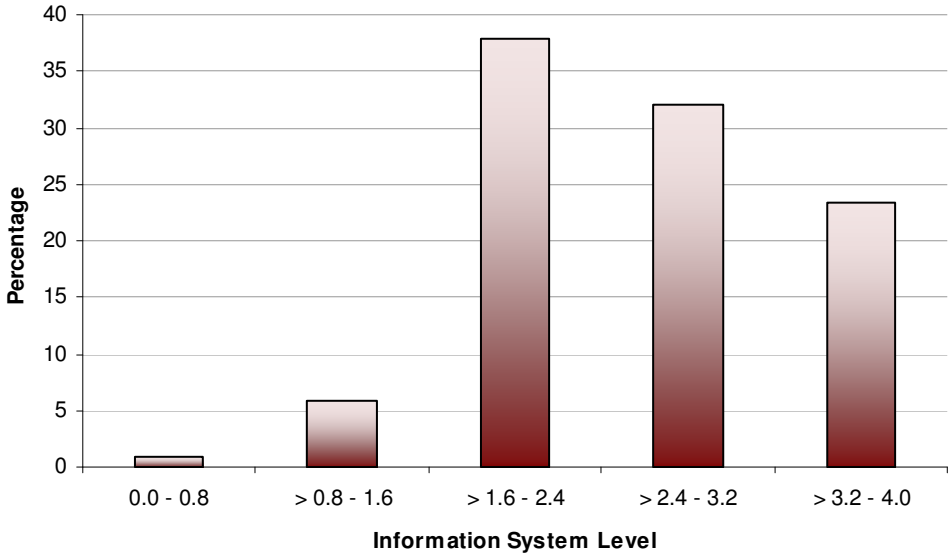

Figure 13 Levels of Use Information Systems

Figure 13 shows that more than 80% of the surveyed companies attached average or greater than average importance to the use of information systems, which mean that the surveyed companies can be considered to be agile companies with respect to availability and validity of information systems, supporting the finding from the literature review.

6.4.4 Lean Manufacturing Practices

This part of the survey was designed to determine the extent to which companies have adopted lean manufacturing practices.

Analysis of the replies identified that more than (75%) of companies within the survey employed few, if any lean manufacturing practices (75% with low or very low level of leanness) as shown in Figure 14.

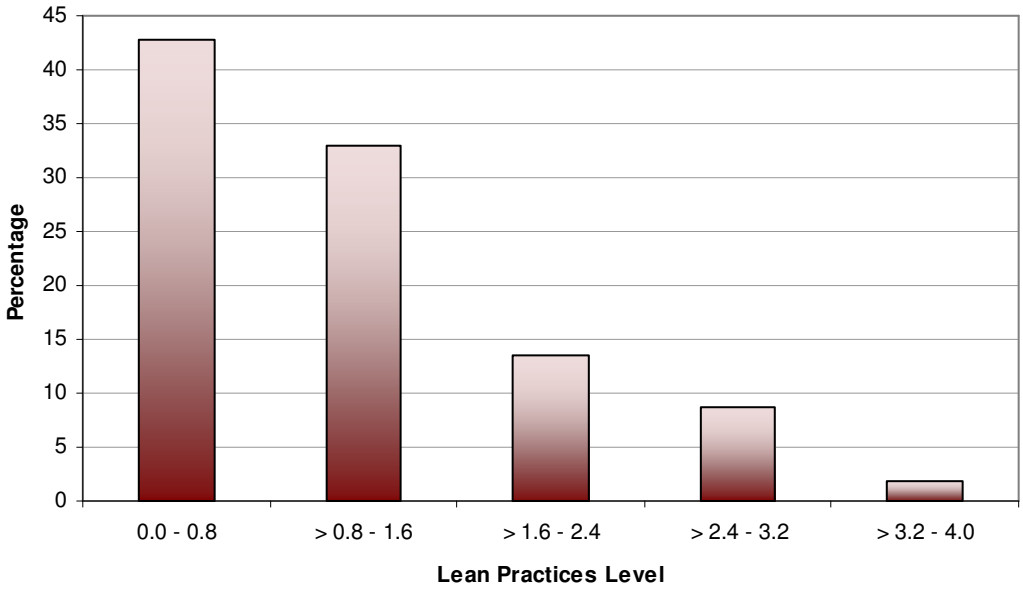

Figure 14 Lean Manufacturing Practices Level

The above figure shows that the overall use of lean manufacturing practices within SMEs is very low. Thus the majority of the tested companies do not use lean practices. This is the finding from literature that would be expected, as in literature the barriers of implementation of lean practices for SMEs is specifically identified.

6.4.5 Agility Business Environment Drivers

Agility Business Environment Drivers were examined to determine the extent to which they are perceived by manufacturing organisations as changing and turbulent. The levels of these drivers indicate the level of need for agility for the surveyed companies. These drivers, or the pressures from the business environment, were categorised under five main titles:

- Turbulence of the marketplace environment.
- Various changes in competition bases and criteria.
- Ever-changing customer requirements.
- Fast changes and improvement in technology.
- Changes in social factors.

Findings show that more than 65% of companies surveyed as shown in Figure 15 are under high or very high level of agility business environment drivers, i.e. more than (65%) of the tested companies work in a high or very highly turbulent environment.

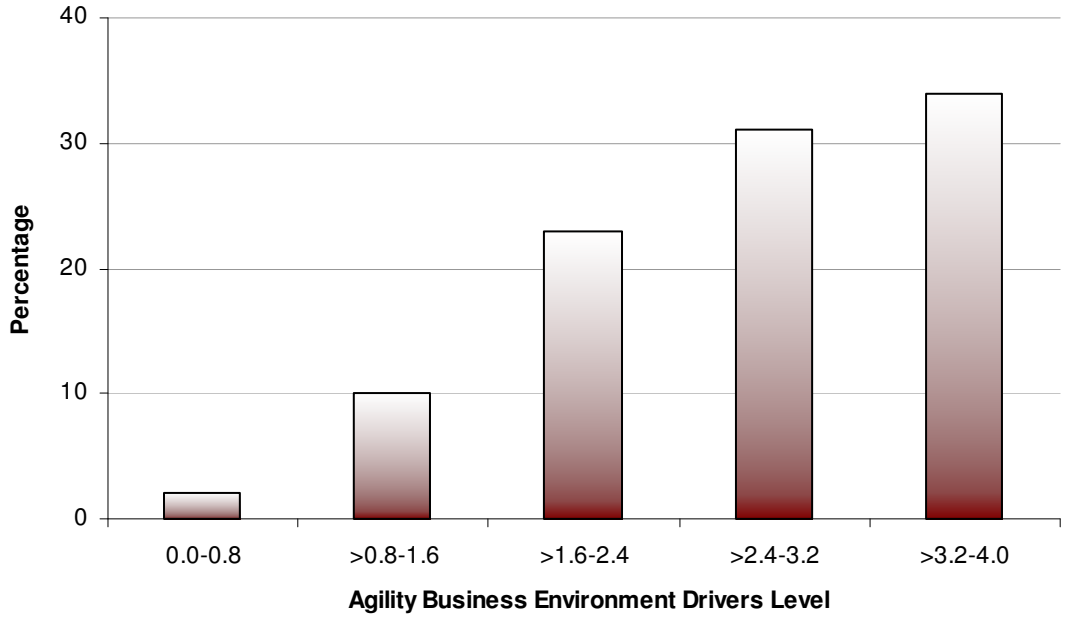

Figure 15 Agility Business Environment Drivers among the Surveyed Companies

This supports the finding from the literature review that the environment for manufacturing companies today is very changeable and uncertain, an environment which pressure the companies to be more agile to face the changes in the environments.

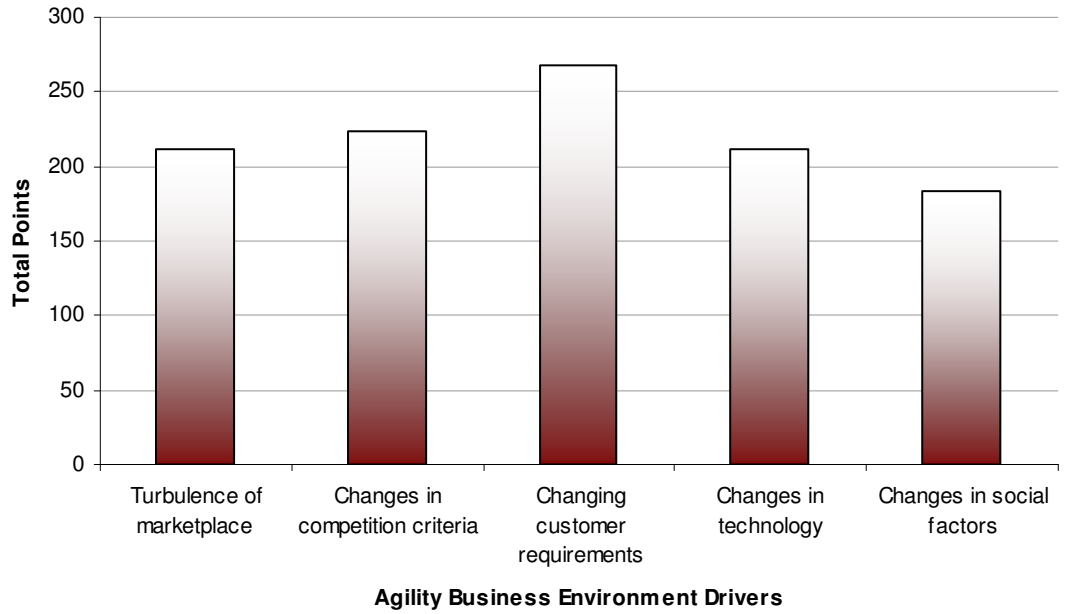

Figure 16 Levels of Agility Business Environment Drivers

Figure 16 shows the level of each driver. According to the analysis of the surveyed companies, all the drivers appears to be important to the SMEs, the most important driver for the change according to the analysis is the change in customer requirements, as was mention in the literature review. The aim of moving towards agility is to able companies to

respond to customer requirements and to cope with the changes in the market place by producing and providing the customers and markets with products according to their needs and demands.

6.4.6 Agility Practices

This part of the questionnaire provides an evaluation of the current level of an organisation's agility practices in the main four areas of agility previously detailed in chapter 5:

- Solution Providers.
- Collaborative Operations.
- Adaptive Organisations.
- Knowledge Driven Enterprise.

The resulting data provides an image of the company's ability to respond to the changes in the business environment and hence its agility, i.e. the current level of agility of the responding companies in each area.

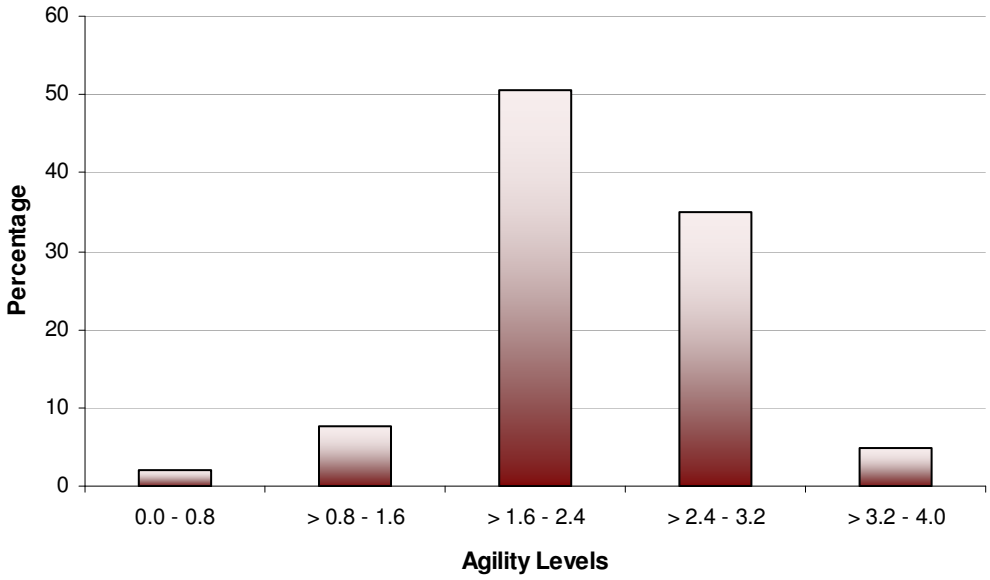

Figure 17 Classifications According to General Level of Agility

Figure 17 shows that the current average level of agility practices of the tested sample varies; in general we can say more than (40%) of the companies have a high or very high level of agility and the other (60%) between a low and medium level. This mean 60% of the sample have a wide area to work with in order to improve their level of agility.

As mention before a familiarity with agility does not mean a level of agility in practice, This is supported by the above analysis as we can see here more than 40% of the tested companies have a high or very high level of agility, while about 70% of the same sample are not familiar with the concept. This means even through SMEs are not familiar with agility, but at the same time they are aware of the business conditions.

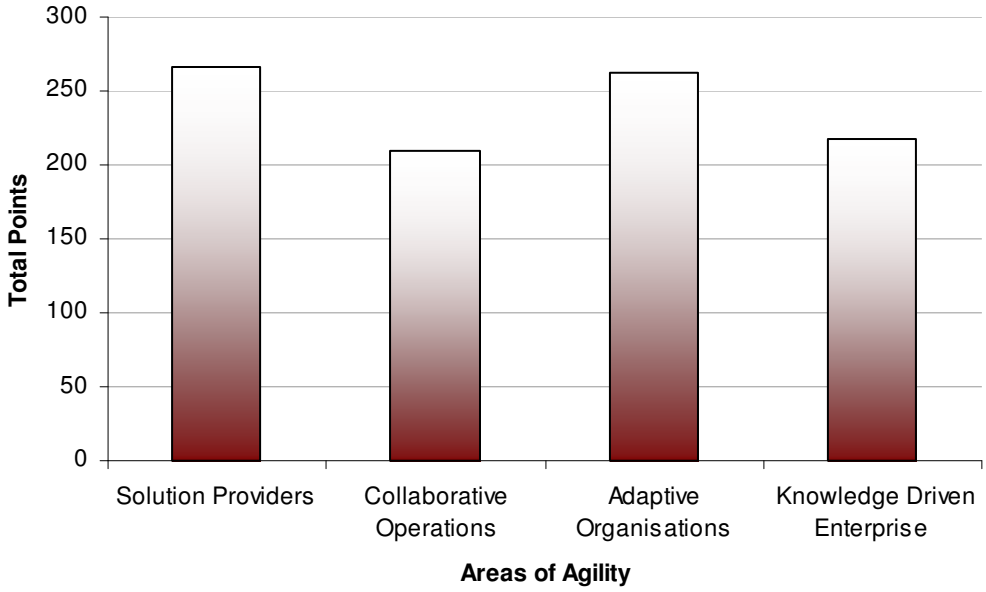

Figure 18 Classifications According to High Level of Agility Area

As can be seen from Figure 18, although manufacturing SMEs appear more active as solution providers and adaptive organisations, rather than developing as collaborative operation or knowledge driven organisations, the differences are not great and thus, the finding are as would be predicted from a reviewing literature.

6.5 Analysis by Sectors

Different companies in different sectors possess characteristics that are specific or perhaps unique to them. The same could be said for the circumstances they face in succeeding in the market. These particular circumstances could define the way that the company may be treated when it enters the field of competition, is threatened by competitors, offered opportunities or evaluated by markets and customers and hence the way it has to respond to these environmental pressures. This uniqueness cannot be excluded from companies in a sector, though members of each sector are expected to share some characteristics, show similar behaviour and maintain a similar competitive environment.

This is also more evident with the increasing formation of niche markets, and also with the sophistication and complication of technologies. Therefore, agility, as a way of responding to

changes in the business environment, can be thought of as a characteristic that relates to the specific situations and circumstances a company is engaged in.

Thus, the sectors with the three highest replies were chosen; electrical/electronic, engineering and plastics, comparisons between the three studied sectors were made to find out to what degree the sectors are different according to the measures considered in this research.

6.5.1 Familiarity with Agility

The electric and electronic sector seems to be more aware of agility than the other two sectors; this can be reasoned to be type and life cycle of products produced and the development in the technology related to this sector as mention in literature. The engineering sector and plastic sector follow the electrical and electronic sector in the matter of awareness respectively, though the difference between these two sectors is not very significant, as shown in Figure 19.

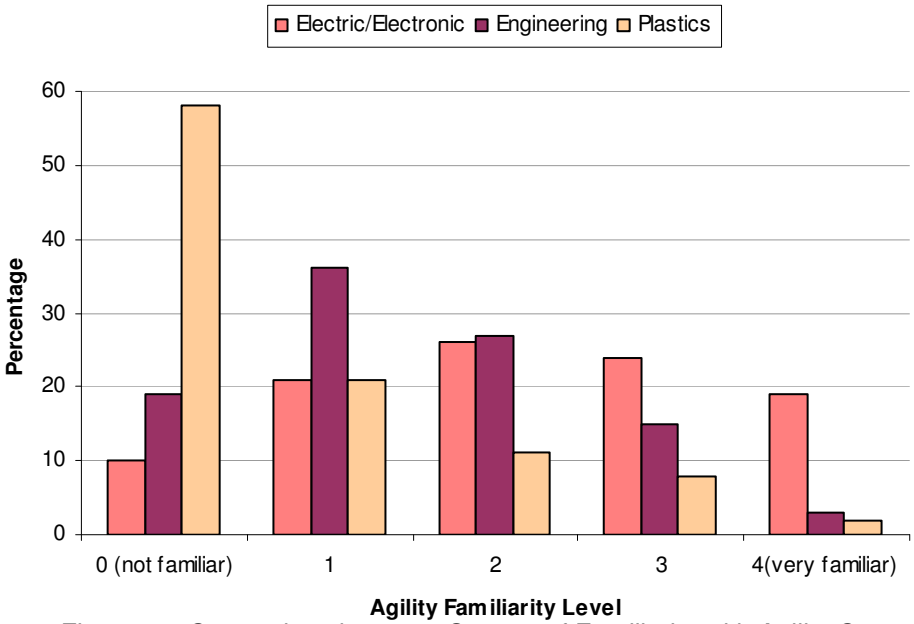

Figure 19 Comparison between Sectors of Familiarity with Agility Concept

6.5.2 Information Systems Level

Comparisons are made between the three sectors in terms of the extent of the importance of information systems and its uses in the surveyed companies.

The electrical and electronics sector is found to be most concerned about information systems and its practices. With a higher percentage than other sectors, (70%) of the companies in this sector had an average score of high or very high in the level of information systems as shown in Figure 20.

This was expected, according to the findings of literature, information systems is more important for the electrical and electronic sector, the information systems and technologies play an important role in the manufacturing process.

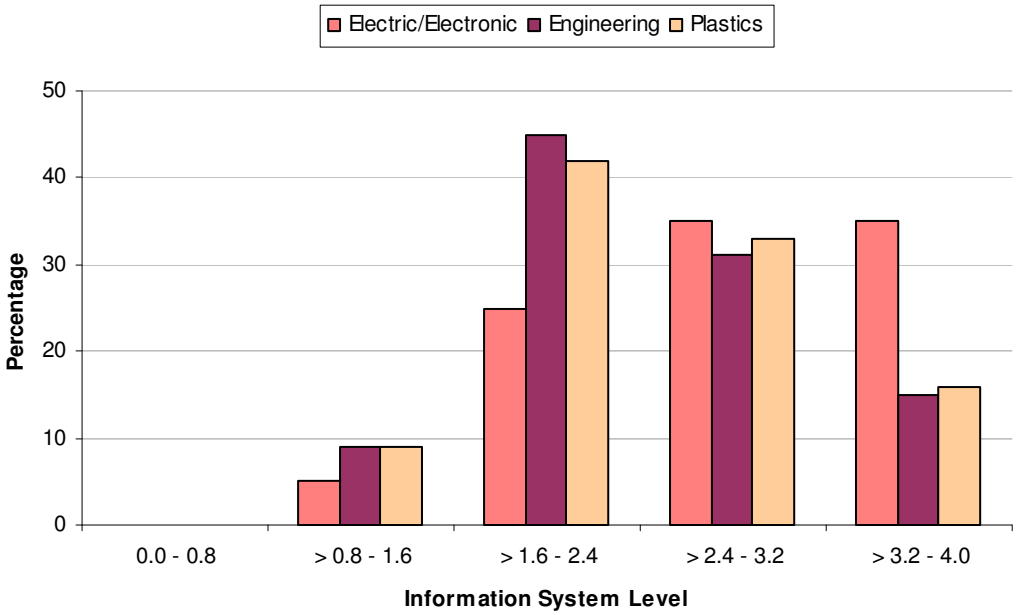

Figure 20 Comparison between Sectors of Current Level of Information Systems

6.5.3 Agility Business Environment Drivers Level

From within the surveyed companies the electrical and electronic sector has indicated a higher level of agility business environment drivers. 47 % identify the need to be agile with a very high level, which is followed by the engineering sector with 40%, and the plastic sector with 28% as shown in figure 21. This support the finding from the literature review that electrical and electronic and engineering sectors are subject to much faster change in their business environment.

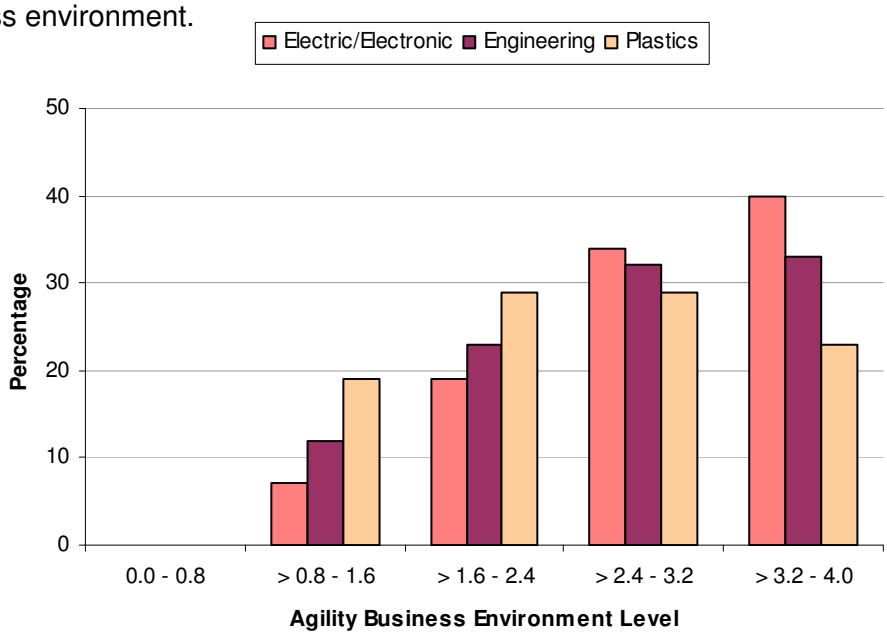

Figure 21 Comparison between Sectors of agility business environment drivers

6.5.4 Agility Practises

The analysis of the finding of this survey shows the average level of agility practices in the electrical and electronic sector is higher than the other two sectors. More than 30% of the companies in this sector had very high level of agility practices. The engineering sector had a level of 20%, and it seems that the plastic sector, (with 5%), had the lowest level of agility when compared to the other two sectors, as shown in Figure 22.

These results support the findings from the literature, that the electrical and electronic and engineering sectors in UK are more engaged in agility practises more than the other sectors.

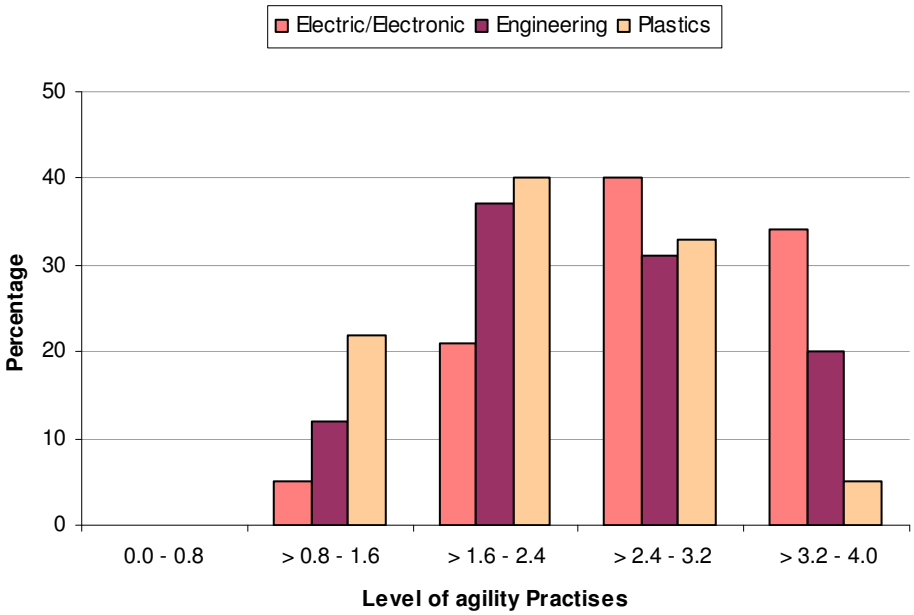

Figure 22 Comparison between Sectors of Current Level of Agility

6.6 Relationship of Finding to the Stated Hypotheses and Objectives

This chapter reported results form the survey phase of the research. The survey was designed in seven sections to fulfil the second objective, of studying the research hypotheses, identifying the main factors of the questionnaire assessment tool and verifying the validity of the proposed questionnaire assessment tool.

The resulting data was analysed using SPSS for Windows and this analysis was based on statistical tests to examine different aspects of the questionnaire and to identify the importance of the assessment tool factors.

Various aspects of the surveyed sample were examined in accordance with the concept of agility and the proposed questionnaire assessment tool. For instance:

1. While the awareness of SME manufacturing companies is low with regard to agility, the indicated level of need for agility is very high. This supports the validity of the first hypothesis of the research: The manufacturing SME community in the UK is not familiar with the concept of agility.

2. Companies in the three main sectors of the surveyed sample i.e., electrical and electronics, engineering and plastics, were compared statistically to find out to what degree the sectors are different, according to measures considered in the research and the questionnaire assessment tool. As a result, there is little significant difference between different aspects of agility among the three studied sectors. The only difference is the electrical and electronic and engineering sectors aware of agility more than that of the plastic sector.

3. The findings show that lean manufacturing practices are, in general, not very well used within SMEs.

4. According to the level of agility needed by the tested companies, the results show that agility is more urgently needed by the electrical and electronic and engineering sectors than the plastics sector which, supports the finding of the literature review.

5. The questionnaire assessment tool was studied during the research's empirical study phases, which received support and approval for being meaningful and relevant to manufacturing organisations.

6.7 Summary

In order to develop the methodology to achieve agility it was considered necessary to validate the questionnaire assessment tool by comparing the finding of the survey to literature.

The resulting findings confirm that the companies sampled can be regarded as representative of the SME community. Further, it can be stated that the application of the questionnaire tool is capable of identifying current levels of agility and needed level of agility thus providing validity for its application.

The next chapter will show the results of creating an improvement methodology and the application through case studies as validation of the assessment tool utility at this stage of the research.

Chapter 7

Creating an Improvement Methodology

7.1 Introduction

This chapter represents the formation and formulation of a methodology for the implementation of agility in manufacturing SMEs to establish a framework to determine the different between actual and required level of agility and create and apply an improvement methodology.

The proposed methodology is the result of the conducted review of literature and questionnaire survey results.

The purpose of the methodology is to assess the extent to which a company pays attention to the importance of the application of agility in manufacturing and its application and actions across the organisation. It is expected that using of the questionnaire assessment tool will pinpoint areas of weakness within the organisation and assist in the development of actions for improvement.

7.2 Creating Improvement Methodology

The review of the literature provided the author with a fuller understanding of the concept of agility. This led to the production of the questionnaire assessment tool survey which included all the elements of the agility model in addition to other sections which related to specific information about the responding company.

The main sections covered by the questionnaire were seen as important to explore as the start point to evaluate the initial situation of the tested sample of SMEs regard agility. These sections were: Company profile, agility strategic capabilities, information system practices, lean manufacturing practices, agility business environment drivers, agility practices and additional information section.

The questionnaire has been devolved into a number of questions related to each of the above sections to evaluate the current situation of each section.

Using the collaborating company (Labfurniture Ltd) helped to identify the applicability and simplicity of using the questionnaire as assessment tool. It provided also a comparison to

how much the gathered information from the questionnaire match the real situation of the company. Working with the collaborating organisation on the development of the questionnaire confirmed the validity and simplicity of using the questionnaire assessment survey tool as a data collection instrument for the research.

Confidence in the wider validity of the questionnaire assessment tool comes from the results of the statistical analysis of the survey data. A comparison of the analysis results with the finding from the literature review confirmed a degree of consistency in actual output with the expected output according to aggregated literature sources. Thus, the results of the statistical analysis of the survey data confirmed the validity of the assessment tool in identifying agility needs and levels and the ability for it in use, to discriminate between these, for different organisations.

Completing the questionnaire provides an organisation with the opportunity to benchmark their current level of agility with the level needed. The process of analysis provides an objective 'score' in each dimension and factor of agility. Thus, low scoring areas can be pinpointed from the further analysis of the survey results. These low scoring areas can be compared to other available sector, company or local management information in order to correlate the results.

SMEs are characterised in literature as having limited resources typically; time, capacity, capability, and money. Thus, the prioritisation of which areas to improve is an obvious requirement however, the methodology recognises that in this area a regulatory approach would not be suitable as each organisation will have its own reference framework for dealing with priorities. These could be quite crude with few dimensions considered e.g. cost or speed of solution or alternatively they could be relatively sophisticated and consider many dimensions and use recognised methods e.g. financial appraisal or risk analysis. They would also use metrics existing already within the organisation to measure particular performance and gauge improvement potential and these could be expected to vary from company to company and indeed sector to sector.

The improvement methodology has therefore been developed with this in mind and presents an 'open' approach to companies at this stage (step 6 in the methodology). Thus, in the case study examples that follow, each company will have determined, using their own criteria which, if any, of the weak areas identified they wish to prioritise for improvement and how best to address the underlying cause or causes (factors) influencing this weakness.

A nine-step process was developed:

1. Identify individual manager.

   The company needs to be able to identify a manager who has the potential for completing the questionnaire assessment tool and implementing change consistent with these objectives. This individual manager must be able to contribute to improved company performance. Another consideration is the availability of time, as both the organisation and the individual manager will need to ensure that sufficient time is available to execute the change activities identified.

2. Identify the level of Agility business environment.

   Before completing the assessment tool the company needs to identify the level of agility business environment drivers. This level indicates to the company the level of turbulence of the market and the level of the reaction needed of the company against these drivers. These drivers comprise all factors and forces that exist in the environment in which a company operates, and affect the company's business operations.

   In this step the company can identify the level of Agility Business Environment Drivers by completing the first part of the assessment tool, and comparing the results. According to the results obtained the company can defined the needed level to move towards improving agility. The scoring system of this part of the questionnaire is shown in appendix 8.

3. Complete the other sections of the Questionnaire Assessment Tool :

   This element of the methodology is the completing of the other sections of questionnaire assessment tool according to the company situation, which are:

   a. Agility Strategic Capabilities.

      This part assesses the company to identify the level of company capabilities regarding agility strategic and defines the low scoring capabilities in this area (Scoring system of this part in appendix 9).

   b. Information Systems.

      This part of the methodology assesses the information system level of the company and defines the possible improvement areas to help the company to improve the overall level of the information system of the company (Scoring system of this part in appendix 10).

c. Agility Practices.

   This part of the methodology assesses the level of agility practices, and which of these practices needs more improvement. The overall level of these areas defines the level of agility in the company (Scoring system of this part in appendix 11).

4. Questionnaire Assessment Tool Results.

   In this step the results of each part of the questionnaire assessment tool are calculated by using excel worksheet scoring systems as shown in appendixes (8, 9, 10, and 11).

5. Identify the low scores areas.

   The company can now identify the low scoring areas according to the results of the previous step of the methodology.

6. Prioritising Areas of Improvement.

   The company now should be able to prioritise the areas of improvement according to the score of each area and strategy objectives of the company.

7. Identify improvement actions will be done.

   The company is now able to define the improvement actions, these actions can be defined according to the potential returns, cost, benefit, time effectiveness and ability of the company for implementation. These actions can be selected by management to find which one is appropriate for the improvement. A ranking of opportunities can be created using, for example, cost-benefit analysis and Pareto analysis or other tools, commonly in use within the organisation.

8. Apply the agree improvement actions.

   In this step the company needs to apply improvement actions identified and start the implementation process.

9. Evaluate and monitor assessment tool output:

   The final step of the methodology is to evaluate the results of applying the questionnaire assessment tool by determines the effect of applying the tool in the company according to the measures they use.

The nine-step improvement methodology is depicted in Figure 23.

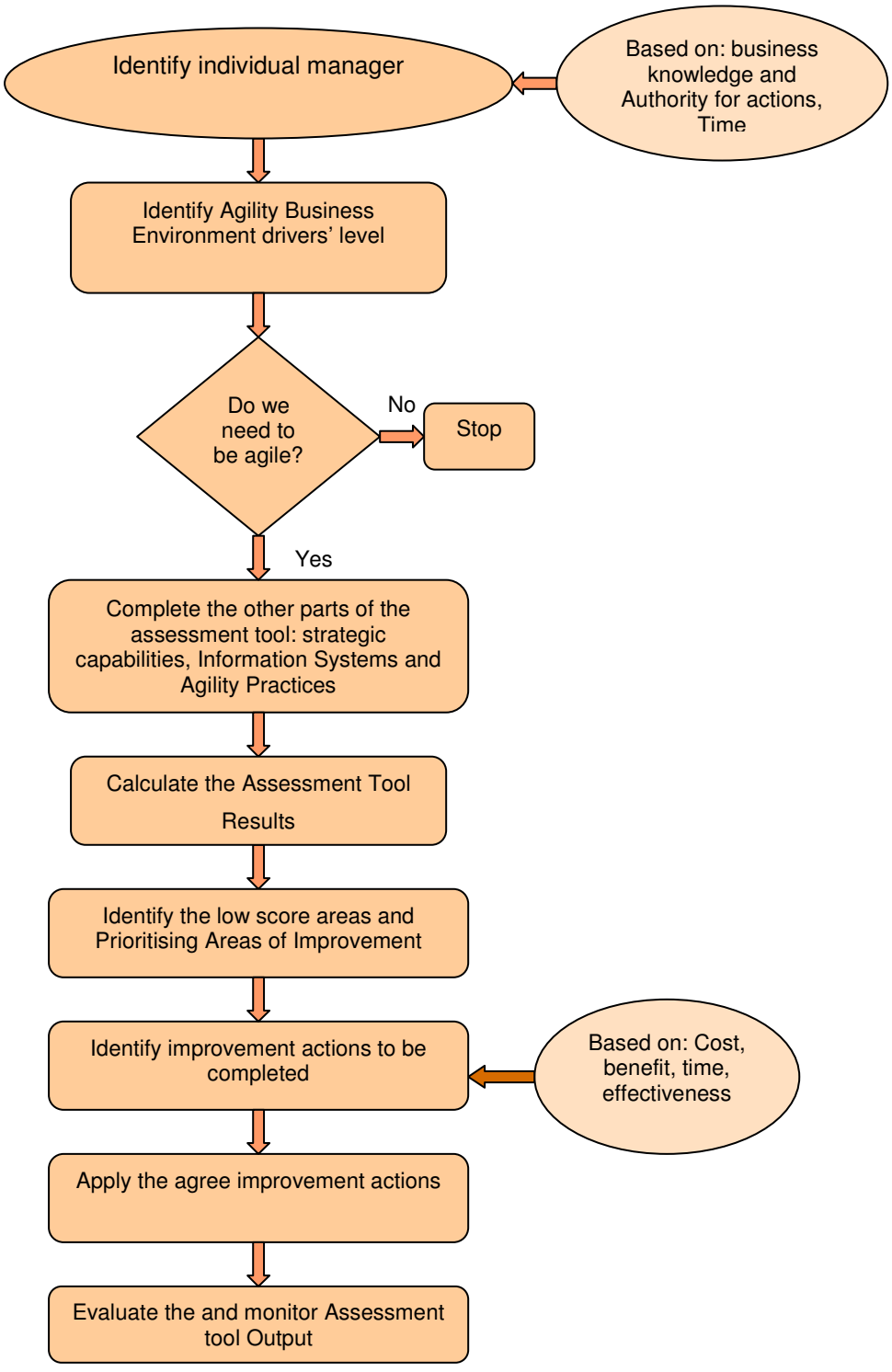

Figure 23 Agility improvement methodology

A methodology for measuring manufacturing organisations need for and achievement of agility has been developed as a result of the previous phases of the research, represented by the first five steps in the methodology.

In order to assess the extent to which this knowledge once acquired could be used to drive change and improvement, and validate the remaining steps (6 - 9 inclusive) of the

methodology, eight organisations were selected to provide case study data and confirm the wider utility of the methodology.

7.3 Selection Approach of Case Studies

It was seen as necessary to put the methodology under examination by applying it to manufacturing SMEs and studying the results. When the questionnaire was sent to the companies in the first phase, all the companies were asked if the they would be prepared to participate in the second phase of the research, twenty (20) of the surveyed companies agreed to take part in the further phase of the research. This covered two important industrial sectors of the tested companies electrical and electronic and engineering.

In order to use this opportunity in the best way, criteria were identified in selecting the case study companies. These included:

1. A willingness to take part in the second phase.
2. Operating in one of the main four sectors (electric and electronic, engineering, automotive and aerospace).
3. An ability to provide company management time and staff to support the intervention process.
4. Demonstrate that the organisation is ready to work with the author in the second phase of the research and apply the improvement actions according to the assessment tool results.
5. Identified a high level of agility business environment drivers according to the analysis of the questionnaire survey results of the first phase of the research.
6. The ability to identify opportunities to generate business improvement within the time-frame of the research (12 months).

Eight companies were selected from the companies who had responded to the previous assessment work.

7.4 The Practical Application of the Methodology

This section shows the steps followed through the application of the methodology:

1. Producing the questionnaire assessment tool according to the finding from the review of the literature, this includes all the elements of the assessment tool that need to be tested in SMEs sample.

2. Selected the population sample of manufacturing SME inside UK from different sectors, according to selection criteria of the research.

3. Sending the questionnaire survey to the selected sample of manufacturing SMEs by mail, and follow up process to get the required number of respondents for the research.

4. Analyse the respondent replays of the questionnaire survey by using the appropriate software, and link the survey analysis results to the finding of the literature.

5. Select the case study companies to participate in the case study phase according to the selection criteria.

6. Contact the selected companies to arrange for company visit and discuss the results with the management of each company.

7. The individual reports for each of the participating company were prepared according to the results analysis of the questionnaire survey of each company.

8. The next step was a visit by the author to each case study company discusses the individual report results and agrees areas for improvement.

9. The author contacted the case study companies again to confirm which of the improvement actions they had decided to implement in the company, and how these changes or improvements would be measured.

10. The management to undertake the improvement actions within the organisation according to their selection of improvement actions.

11. The evaluation of the completed process through a comparison of the tactical outputs with the last year.

12. After a further period approximately of 12 months, the companies were again contacted to collect the results and feedback on the results of the improvement actions.

In the following section the results of each case study are detailed. The first case study illustrated is developed in detail. The other case studies summarised.

7.4.1 Engineering Services Management Ltd. (ESM)

Company Profile

Engineering Services Management Limited (ESM), is based in Harlow, Essex. It was established in July 1997 and is a privately owned company dedicated to the turnkey design and construction of optical fibre manufacturing facilities, together with all the associated environmental control plants. ESM offers specialised product and service to support the manufacturing industry.

ESM is focusing on providing equipment and services to: fibre optic product manufacturers, network equipment manufacturers, test equipment manufacturers, field installation contractors and custom assembly manufacturers.

The company operates in a competitive market and supports a wide range of customers globally. The number of employees in the company is 15 and the annual turnover is £1.8m. The company is totally UK owned and belonged to engineering sector.

Products Range

ESM offers full range of Optical Fiber solutions and has a manufacturing facility for the following optical fibre equipment:

- Optical Fibre Draw towers.
- Cane drawing towers.
- MCVD Equipment (Modified Chemical Vapour Deposition).
- Optical Fibre Rewinders and strain testers.
- Fibre Samplers.
- Fibre concentricity monitors.
- Graphite furnaces –Resistance heating type.
- Tube Pressure Controllers.
- Cleanroom access controllers .

The company products can be used in many different fields such:

- Factories.
- Laboratories.
- Universities.

- Research centres.
- Start up companies in optical filed.

The company also has expertise in the fields listed below:

- **Cleanrooms Design and Construction**
  Building clean rooms from class 100,000 to class 100 with sizes vary from 3 m high to 20 m high.
- **Optical Fiber Production Support Services**
  Specify supply and install equipment such as Chlorine delivery systems with full auto purging facility, Oxygen demethanators, Nitrogen driers, water purifiers and quartz glass tube washers.
- **Environmental Services**
  Specified and installed a variety of environmental gas and particulate scrubbing equipment so that all gas emissions are kept to the legally permissible limits. These devices include packed scrubbing towers, and the latest venturi fluidic high efficiency gas and particulate scrubbing system.
- **Fibre Production Equipment Installation**
  Specifying, installing and commissioning of MCVD equipment, pulling towers, proof testers equipment.
- **Process Chilled Water**
  Designing, building and commissioning several chilled water plants for furnace and process cooling with range from 50Kw to 250Kw cooling capacity complete with run/ standby/ and emergency dc pumps for power failure.

The company supports a wide range of customers internally and globally, the most active markets for the company are: UK, France, Germany, Denmark and Slovenia.

Assessment Tool Results

This company was chosen to be the one of the case study companies to apply the methodology of this research. A meeting was held on 25 January 2007 in the meeting room at the ESM Company, and was attended by the Researcher and the Managing Director of ESM Ltd. After an initial introduction outlining the nature, purpose, scope and use of the results, and a brief time for the Managing Director to ask questions for clarification, the author undertook the review process of the individual results of ESM, the purpose of the meeting was to review the results shown in the analysis report for the company and to agree actions for improvement (copy of a full report of one case study in appendix 13).

The calculated results of the questionnaire assessment tool in ESM shows the current level of the main four elements of the questionnaire assessment tool, therefore the analysis of each element shows the weak points in each, and defines the areas that needed further development. This allows the company management to identify the improvement action to improve the low level scores of the assessment tool results.

The analysis process considers the low score of the results as 2 or less than 2 and the high score results there are more than 3.

Results of the four elements of the questionnaire assessment tool are listed below. They are reported in detail so that the process by which the questionnaire assessment tool result have been translated into benefits to the organisation is demonstrated:

Strategic Capabilities

The results of the questionnaire assessment tool identified four particular capabilities of concern, which with score 2 or less as shown in Figure 24.

- Speed of production and delivery.
- Product variety.
- Innovation of products.
- Responsiveness for change.

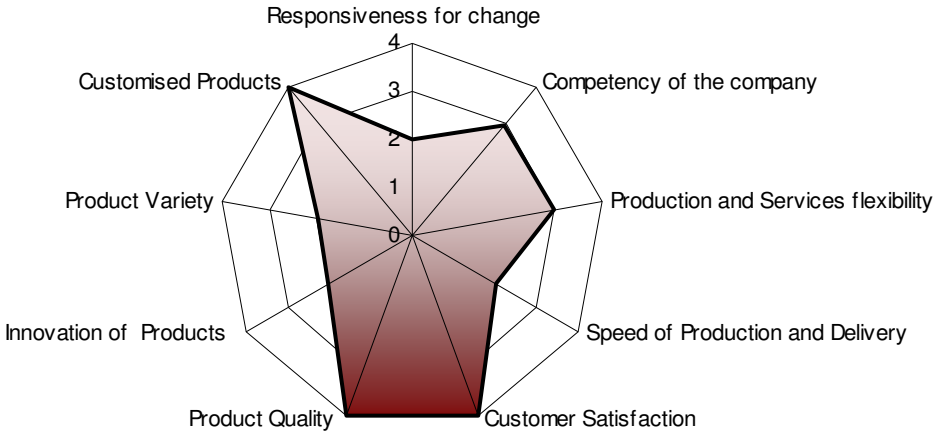

Figure 24 ESM Strategic Capabilities Level

Strategic capabilities as mention in the literature review, is considered as the main capabilities for an agile company, where the current level of strategic capabilities of the company is relatively high (2.9 out of 4), thus the recommendation to ESM is to consider the

low score capabilities when they next consider the strategy of the company, in order to keep the company in a strong position in this sector, and to be ready to react to market changes.

Information Systems

As mention in literature the level of information system of manufacturing companies is very important for companies that aim to be agile. The information systems level of this case study scored 3.3 out of 4, as shown in Figure 25, which is at a very high level according to the tool measuring scale (see appendix 6).

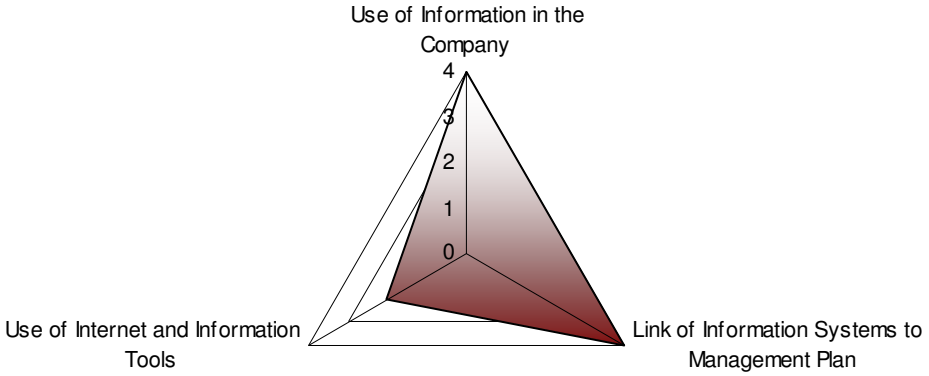

Figure 25 ESM Information System Level

The analysis of the calculated results shows that the company in the current circumstance has one area which is lower than the others:

- Use of internet and information tools.

Discussion of the questionnaire assessment tool results with ESM why they rate this item less than to others, they identified the following points of concern:

- Lack of web presence (company website very basic and needs to improve).
- Shortage of using the E- commerce.
- Age of information systems technology (software and hardware).

Agility Business Environment Drivers

The analysis of the results of the questionnaire assessment tool shows that the average agility business environment driver's score in this case study was 3.3 out of 4, as shown in Figure 26. According to this result, the company recognises the turbulent environment and needs a very high level of agility according to the definition of agility levels (appendix 6).

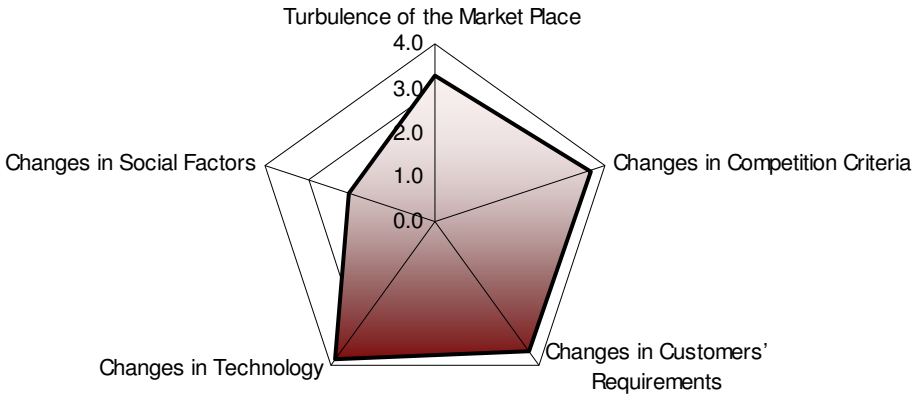

Figure 26 ESM Agility Business Environment Drivers

The above figure shows the areas where the company faces the pressure of change; the factors where the turbulence level is more than 3 are:

- Changes in technology.
- Changes in customer requirements.
- Turbulence of the market place.
- Changes in competition criteria.

According to the analysis of questionnaire assessment tool results, the above drivers are considered as the pressures that require ESM to be more agile and ready for change. This level gives the company an indication about the level of environment forces that can affect the company competitiveness.

Agility Practices Levels

The analysis of the calculated results of the questionnaire assessment tool indicated the current levels of agility practises in the main four dimensions of agility for ESM, as shown in Figure 27:

- The Solution Provider area got an average score of 2.8.
- The Collaborative Operation area got an average score of 2.6.
- The Adaptive Organisation area got an average score of 2.1.
- The Knowledge Driven Enterprise area got an average score of 2.3.

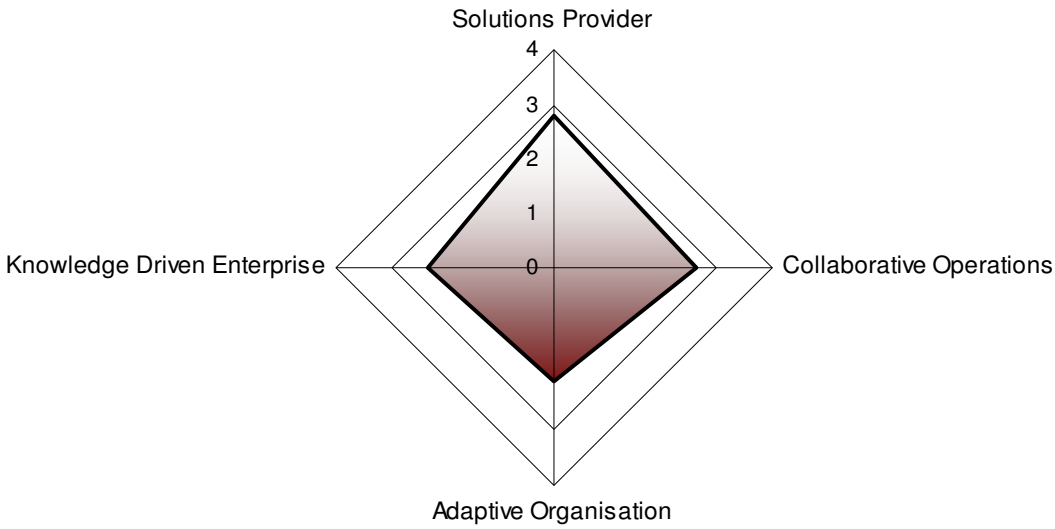

Figure 27 ESM Agility Practices Levels

The analysis shows that the overall scores of agility dimensions is relatively low according to the level of agility business environment drivers, more specifically some attributes in each dimension are very low. The company can increase the agility level by improving the low score attributes in each area. The attributes which achieved very low scores are:

Solution Providers area

- Rapid concept to cash.
- Cost-Effective Low Volume Producer.

Collaborative Operation Area

- Electronic commerce organisation.
- Short Operation Cycle.
- Information Sharing Strategy.

Adaptive Organisation Area

- Capable and Ready for Change.
- High Response for Change.

Knowledge Driven Enterprise Area

- Knowledge and training based organisation.
- Active in societal activities.

Suggestions for Improvement Actions

The analysis of the questionnaire assessment tool results for the low score attributes, guides management to suggest the following actions as improvement actions to improve some of the low scores of the questionnaire assessment tool results. The suggested actions were:

- Renew the old equipments of IS to improve performance.
- Investment in new technology and equipment to support the manufacturing process to improve quality and reduce cost.
- Change the factory layout to decrease the need for product movements and remove bottlenecks.
- Improve supplier delivery performance by sharing information, measuring, monitoring and scoring the suppliers performance and inform them with the results.
- Reduce order process time by simplifying or using computer systems.
- Use 'e-commerce' for orders to reduce transaction costs.
- Improving the procedures for ordering and stocking.
- Communicate openly with employees and encourage them to openly communicate with each other.
- Upgrade employee skills through job rotation and cross-functional training.

Identification of the Tactical Responses Taken by the Company

The decision of what and when to implement changes was made by the company themselves and was not based simply on the finding from survey questionnaire but on other intelligence within and available to the organisation and with the regard for both the prevailing strategic aim and operational constraints. The agreed actions were:

Improve Information systems facilities

IS tools and equipment of the company plays an important role in the agility of manufacturing companies, one of the shortages related to the information systems in ESM Ltd was the age of the PCs, especially the PCs of the design engineers which were not considered suitable for the modern software of design. The improvement action was to replace five of the company PCs with new ones and up-to-date software required.

Implement new technology

The welding process was one of the most important operations for producing good quality and high purity stainless steel pipe work for the optical machines. To reduce the welding time, decrease waste and improve the quality of the product; it was considered necessary to change this operation from manual to automatic. To achieve this, it was necessary to purchase new automated welding machine to improve processing time, quality and save money.

Improve shop floor layout

Factory layout has a dramatic effect on the productivity of a manufacturing company. An effective factory layout improves workflow, highlights bottlenecks, reduces production time and makes production management more visible and much easier. The layout of the shop floor of ESM indicated a bottleneck point that caused congestion in manufacturing operations. This congestion had a negative effect on the production flow and cycle time. A simple by re-organising the shop floor layout made the product flow more visible and easier to understand. The change was made by moving the production of the electric control cabinets to the left corner of the factory which made the flow of the operation process so easy.

Improve supplier's relationships

Suppliers' relationships are critical to cycle time reduction and overall delivery performance. Suppliers need to know the company goals and needs, and have production and business processes that can support these needs. On-time delivery of quality materials is essential to reducing cycle time, decreasing inventories and lowering costs.

One of the most important challenges that ESM faced was poor relationships with suppliers, and accordingly this affected the overall delivery performance of the company. So the improvement action here was to increase the amount of information shared with the suppliers, and schedule for regular meetings with them to inform them of the importance of their effect on the company products, and discuss the opportunities of reducing the cost and improve the quality and delivery of products.

Improve Quality

One of the main problems related to the quality was the design of the optical fibre draw towers. A specific training program was provided for two engineers on AutoCAD software, aimed at improving the design process of the optical fibre draw towers.

Improve employee's skills

One of the problems facing ESM in this area was the specialised engineering skills needed in order to multi-task during peak work load or holiday periods. This problem was solved by rotating critical tasks between the engineers so that during the absence of any engineer, a trained engineer in that task can take over temporarily. The engineers were given a programme of multi-task training where an engineer would take on a task of another engineer for a period of two weeks under the supervision of the competent engineer. Such

tasks included operation of orbital welder and operation of the high integrity helium leak detector.

Tactical Output

The effectiveness of the agreed actions was measured using matrices already in place within the company and reflects the company's view on the benefits gained. In the case of ESM these were:

- As result of using new automated welding machine the Right First Time of stainless steel welded pipes increased up to 99%.
- The increase the amount of information shared between ESM and suppliers has positive effect on improve the Percentage of suppliers delivering on time by 30%.
- According to the improvement in the delivery of the suppliers als the Work-in-progress reduced by 67%.
- Setting training program for the ESM employees and improving information technology facilities has clear effect on improve their skills during the period of research.
- According to the above results and the improvements made in the shop floor the Overall productivity increased by 5%.

As previously indicated the remaining seven (7) case studies have been summarised in the remainder of this chapter.

7.4.2 London Electronics Ltd.

The company is based in Shefford, Bedfordshire, and belongs to the electrical and electronic sector, with expertise in designing and manufacturing digital panel meters and displays of different sizes.

The number of employees in the company is 20 and the annual turnover is £1.2m. The company is totally UK-owned and is a specialist OEM in the electrical and electronic sector, producing finished, marketed products and selling them to the end user. The production processes used by this company was determined to be low batch and customised production. The number of total product types the company produces is approximately 20.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 5 and displayed graphically on the accompanying radar plot in figures 28, 29, 30and 31.

		level	Areas of Focus
Strategic Capabilities		**3.1**	• Responsiveness for change • Production and service flexibility • Product variety
Information Systems		**3.7**	• Use of Internet and Information Tools
Agility Business Environment Drivers		**3.2**	• Turbulence of marketplace • Changes in competition criteria • Changing customer requirements • Changes in technology
Agility levels	**Solution Provider**	**2.7**	• Product introduction rate • Frequent model change • Rapid concept to cash
	Collaborative Operations	**2.4**	• Cooperation strategy • Short operation cycle • Customer supplier interactive relationship • Information sharing strategy
	Adaptive Organisation	**2.4**	• Management leadership
	Knowledge Driven Enterprises	**2.6**	• Innovation and high skilled work force • Knowledge & training-based organisation

Table 5 Calculated questionnaire assessment tool results for London Electronic Ltd

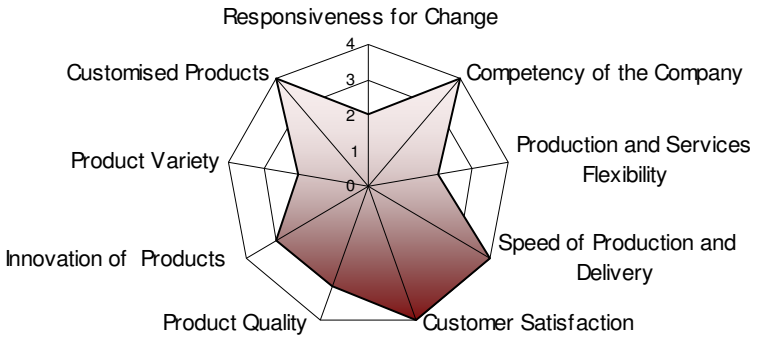

Figure 28 London Electronic Strategic Capabilities Level

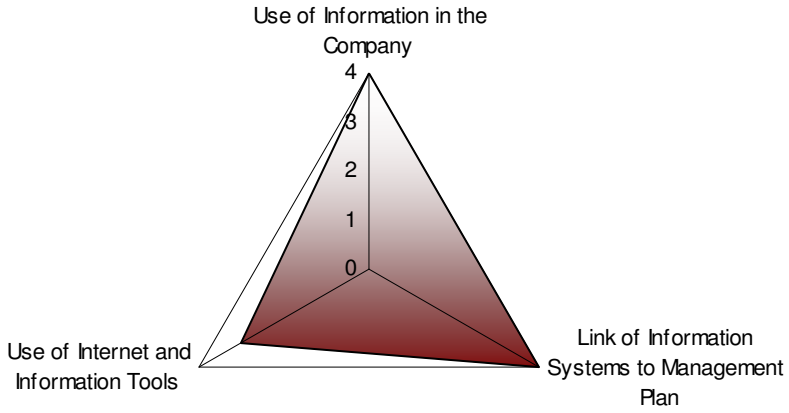

Figure 29 London Electronic Information Systems Level

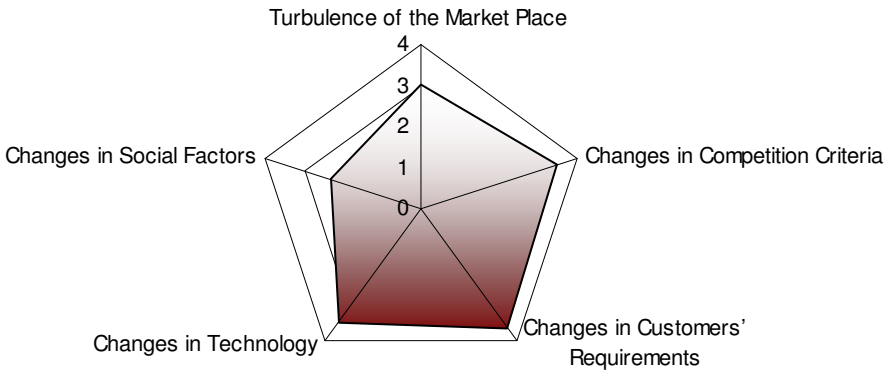

Figure 30 London Electronic Agility Business Environment Drivers Level

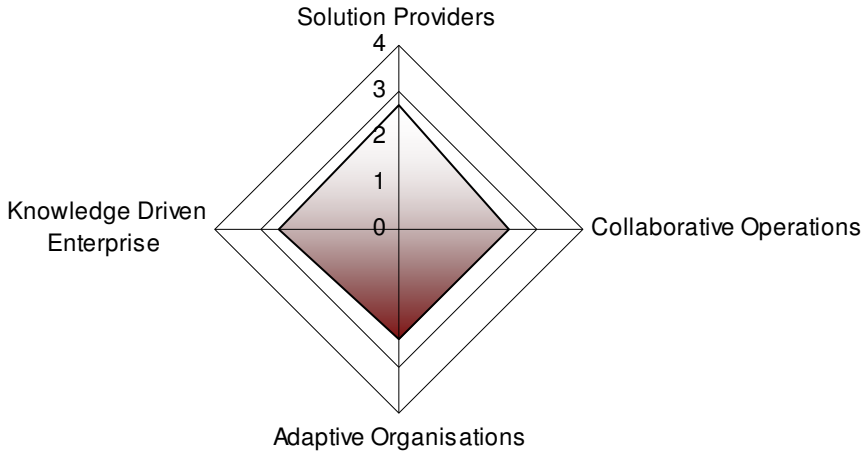

Figure 31 London Electronic Agility Practices levels

Suggested Areas for Improvement Actions

- Use the E – commerce in selling and buying the products.
- Improve the structure of the company website.
- Develop new products to increase the variety of the products.
- Introduction of more new products as solutions for new applications.
- Increase engineering capabilities (tools, people).
- Offer specialised services to retain existing customers.
- Improve after sale services for customers.
- Attend selected exhibitions related to company business.

Identification of the Tactical Response

The actions implemented can be summarised as:

- Introduction of new products:
  - Temperature and Humidity transmitters.
  - New series of panel displays.
  - Factory Traffic Lights.
  - Compact high performance PID controllers.
- Improvements to current products:
  - New Triple Loop splitter released.

    - Loadcell meters - new low cost range.
- Introduced new products for new applications :
    - Mirror Image LED displays.
- Offering new direct link to local distributors for all customers through the company website.
- Offering free software update for existing customers.
- Increase the amount of information shared with suppliers.
- Attend new exhibition (Retailer Solution 2007 NEC Birmingham).

Tactical Output

The actions listed above gave the following measurable outcomes:

- Improvement in Percentage of Total Turnover from New Products by 9 %.
- Suppliers on-time delivery performance increased to 98%.
- Increased product variety.

7.4.3 Horobin Ltd.

Horobin Limited (Horobin Ltd.) was established in 1825. The original Horobin brothers made ram rods for canons, but as they started after the Napoleonic war, there was no call for their products, so they changed tack and used their rods to clear blocked drains, and they have been used down drains ever since.

The company is an OEM belonging to the engineering sector based in Wolverhampton, engaged in the design and manufacture of pipeline solutions and equipments for a wide variety of markets, including Oil and Gas, Industrial Fasteners, Construction and Civil Engineering. The main market of the Horobin products is in the UK and about 25% of its business is exported mainly to Europe, with some to Asia and Africa.

The number of employees in the company is 22 and the annual turnover is £2.3 m. The company is totally UK owned. The production process used by this company was determined to be batch and mass production. The number of total product types the company produces is more than 50 types of products.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 6 and displayed graphically on the accompanying radar plot in figures 32, 33, 34 and 35.

		level	Areas of Focus
Strategic Capabilities		**3.4**	• Product variety • Innovation of products
Information Systems		**3.7**	• No improvement requirement
Agility Business Environment Drivers		**3.0**	• Changes in technology • Changing customer requirements • Changes in competition criteria
Agility levels	**Solution Provider**	**2.8**	• Frequent model changes • Rapid concept to cash • High information products
	Collaborative Operations	**2.3**	• Cooperation strategy • Product integration & process development • Organisation virtual partnership • Information sharing strategy
	Adaptive Organisation	**2.8**	• No improvement requirement
	Knowledge Driven Enterprises	**1.7**	• Dynamic competency testing • Innovative and high-skilled workforce • Knowledge & training-based organisation • Active in societal activities

Table 6 Calculated questionnaire assessment tool results for Horobin Ltd

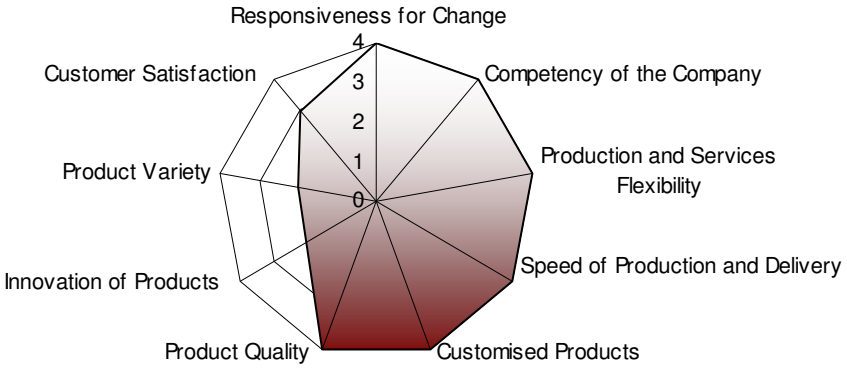

Figure 32 Horobin Strategic Capabilities Level

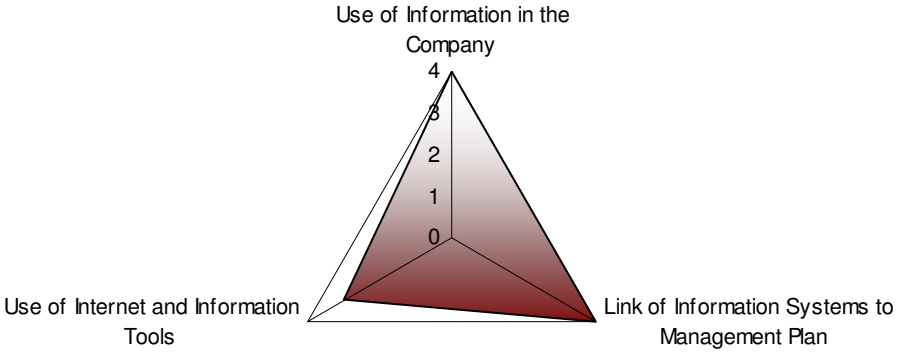

Figure 33 Horobin Information Systems Levels

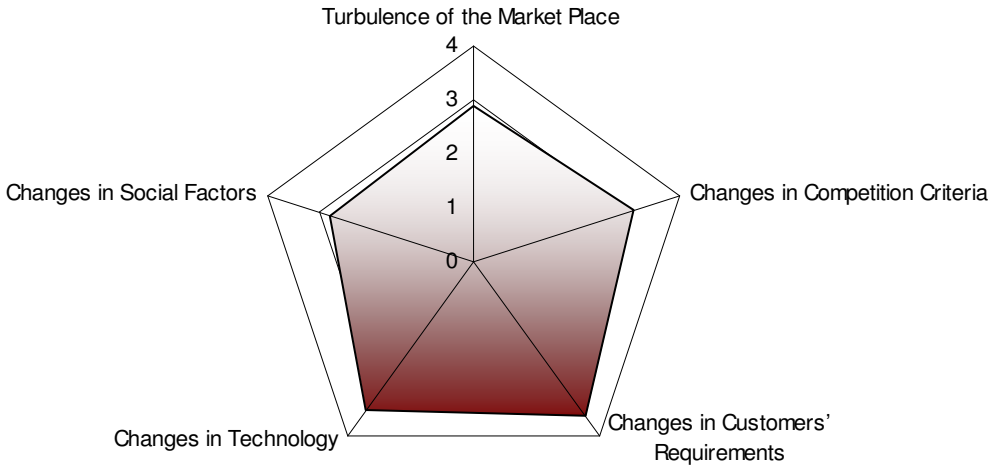

Figure 34 Horobin Agility Business Environment Drivers

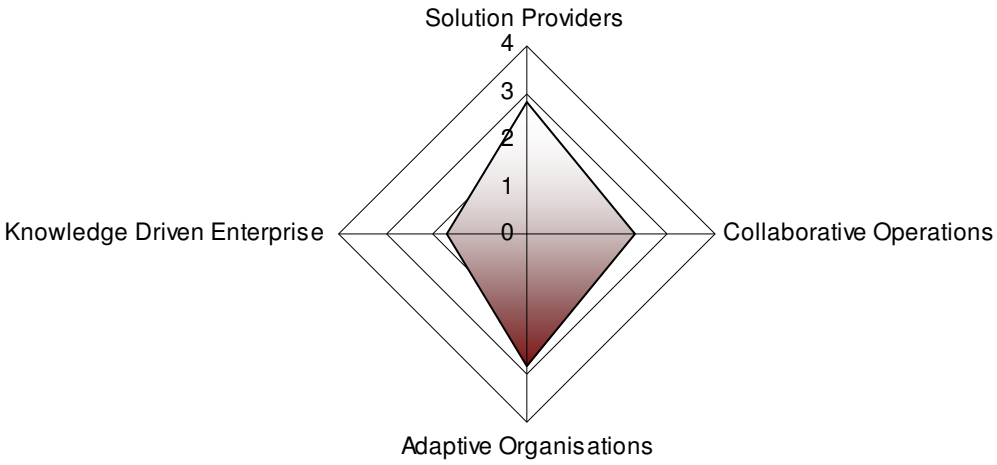

Figure 35 Horobin Agility Practices Levels

Suggested Areas for Improvement Actions

- Allow employees to get access to the information that related to their jobs.
- Involve Higher education institutions in the industrial research contributing to industrial success.
- Update the company website.
- Improve the design for the current products.
- Introduce a new range of products to the market to increase the variety of company products.
- Provide opportunities for people to make decisions about their job and work environment
- Investment in new tools to improve quality.
- Involve employees in making suggestions for improving business and reduce costs.
- Offer a budget for training programs and reward employees.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Increase the products variety of the company by introducing new products to the market :
    - Water jetting unit (Horojet P50).
    - Flounder 70.050.
    - Turbo Gun Nozzle – 400 bar.

- Setting regular meetings with suppliers and employees to discuss any new ideas for improvement.
- Rewarding the best employees annually.
- Collaborating with academic institutions in applied research

Tactical Output

The actions listed above give the following measurable outcomes:

- People productivity improved by 2%.
- Increase in Percentage of Total Turnover from New Products 6%.
- Increase in product variety.

7.4.4 Micromech Ltd.

Micromech Limited (Micromech Ltd.) was established in 1982 and is a privately owned company as a key specialist supplier of motion control products, automation and integrated systems to bring professional distribution techniques to the motion control market, it has become a significant force in the field of sophisticated multi-axis control and is a recognised specialist in servo and stepping motor applications.

The company is an OEM based in Braintree, Essex, belonging to the engineering sector. The number of employees in the company is 15 and the annual turnover is £2.0 m. The company is totally UK owned. The production processes used by this company was determined to be jobbing and customised production. The number of total product types the company produces is more than 10 types of products.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 7 and displayed graphically on the accompanying radar plot in figures 36, 37, 38 and 39.

		level	Areas of Focus
Strategic Capabilities		**2.6**	• Production and services flexibility • Speed of production and delivery • Product variety • Customer satisfaction
Information Systems		**4.0**	• No improvement requirement
Agility Business Environment Drivers		**3.2**	• Changes in technology • Changes in competition criteria • Changing customer requirements
Agility levels	**Solution Provider**	**1.7**	• High product variety • High product introduction rate • Frequent model changes • Rapid concept to cash • Cost-effective low volume producer • Tailor made solutions (products/services) • Product and customer support • High information products • Consumer demand changes
	Collaborative Operations	**2.5**	• Electronically commerce organisation • Short operation cycle
	Adaptive Organisation	**2.8**	• No improvement requirement
	Knowledge Driven Enterprises	**2.2**	• Dynamic competency testing • Knowledge & training-based organisation • Active in societal activities

Table 7 Calculated questionnaire assessment tool results for Micromech Ltd

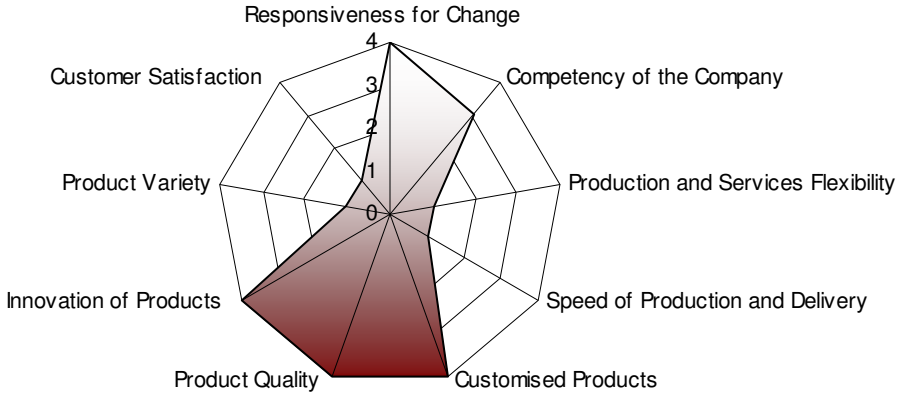

Figure 36 Micromech Strategic Capabilities Level

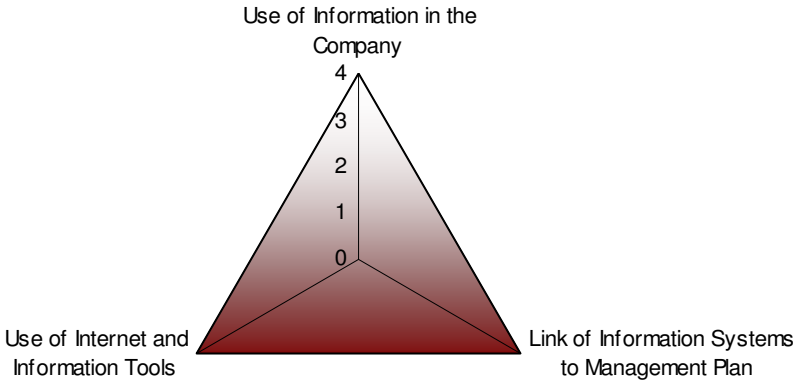

Figure 37 Micromech Information Systems Levels

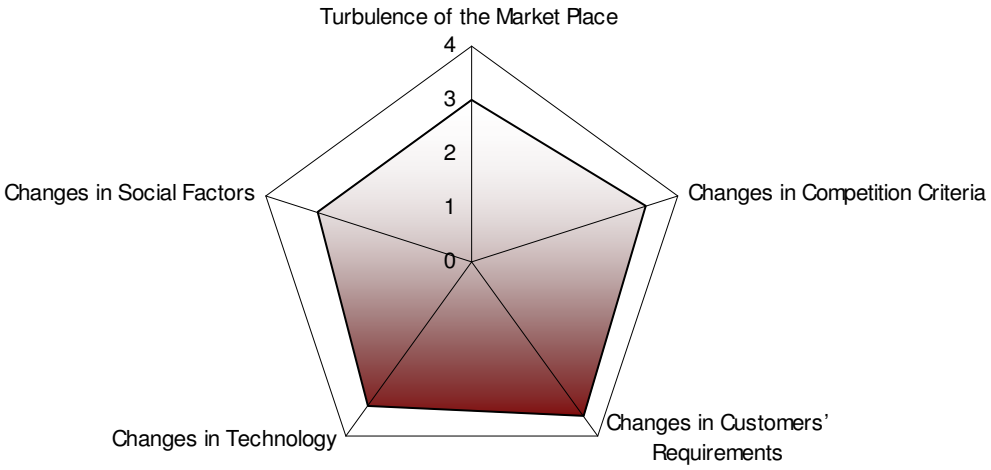

Figure 38 Micromech Agility Business Environment Drivers

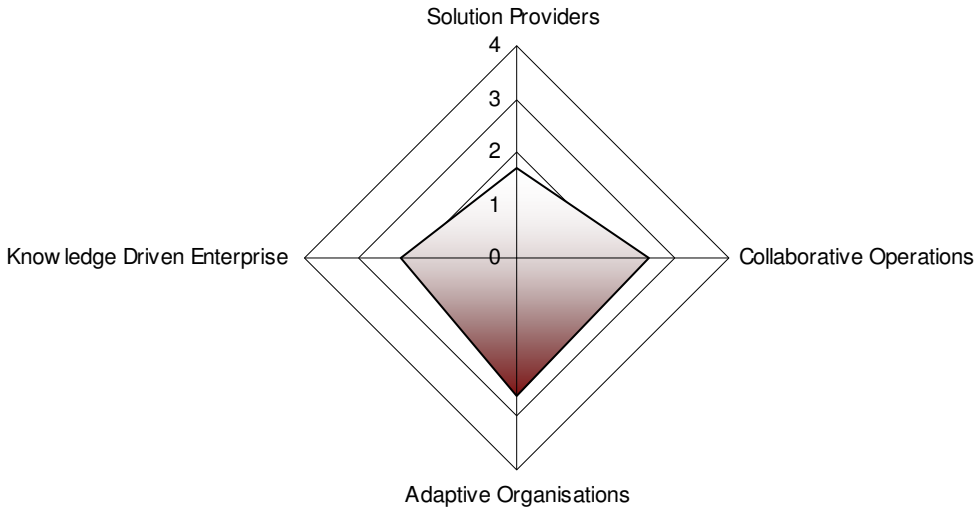

Figure 39 Micromech Agility Practices Levels

Suggested Areas for Improvement Actions

- Introduce new products for new application to the market.
- Show company products in the exhibitions that related to business.
- Survey customers if they have any problems may you can help to solve it.
- Use partnership with other to improve quality and price.
- Update the website more regularly to ensure that website contains all the information that customers need.
- Increase the flexibility of the design processes.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Increasing product variety by introducing new products to the market:
    - New Linear motorised slides for cleanrooms.
    - Introducing new PLC system.
- Introduce new models of current products:
    - New motors with low energy consumption.
    - Introducing new HMI (Human Machine Interface) colour touch screens.
- Introducing a new online catalogue.
- Attending the Machine Building and Automation Exhibition 2007 Birmingham NEC as

an exhibitor.

- Co-operation with another company to improve the (design, quality, cost) of new rotary tables for fibre draw towers.
- Purchase of new software development tools for machine automation.

Tactical Output

The actions listed above give the following measurable outcomes:

- Right First Time of rotary tables increased up to 99%.
- Increase in Percentage of total turnover from new products by10%.

7.4.5 Macair FMI Ltd.

Macair FMI Limited (Macair FMI Ltd.) was established in 1992 is a privately owned company expert in designing manufacturing and installing high quality air conditioning units and systems of different sizes. Macair FMI delivers air conditioning solutions that suit each application, including cooling, heating or ventilation for a single room or a complete building and full function close air conditioning solutions. The company is an OEM producer, based in Hoddesdon, Hertfordshire, belonging to the engineering sector.

The number of employees in the company is 16 and the annual turnover is £3.8 m. The company is totally UK owned. The production process used by this company was determined to be jobbing production. The number of total product types the company produces is more than 14 types of products.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 8 and displayed graphically on the accompanying radar plot in figures 40,41, 42 and 43.

		level	Areas of Focus
Strategic Capabilities		**3.6**	• Responsiveness for change • Customised products
Information Systems		**4.0**	• No improvement requirement
Agility Business Environment Drivers		**3.0**	• Turbulence of the market • Changes in competition criteria • Changing customer requirements • Changes in technology
Agility levels	**Solution Provider**	**2.3**	• High product variety • High product introduction rate • Rapid concept to cash • Cost-effective low volume producer • High information products
	Collaborative Operations	**2.2**	• Product integration & process development • Organisation virtual partnership • Electronically commerce organisation • Short operation cycle • Information sharing strategy
	Adaptive Organisation	**3.1**	• No improvement requirement
	Knowledge Driven Enterprises	**2.5**	• Dynamic competency testing • Knowledge & training-based organisation

Table 8 Calculated questionnaire assessment tool results for Macair Ltd

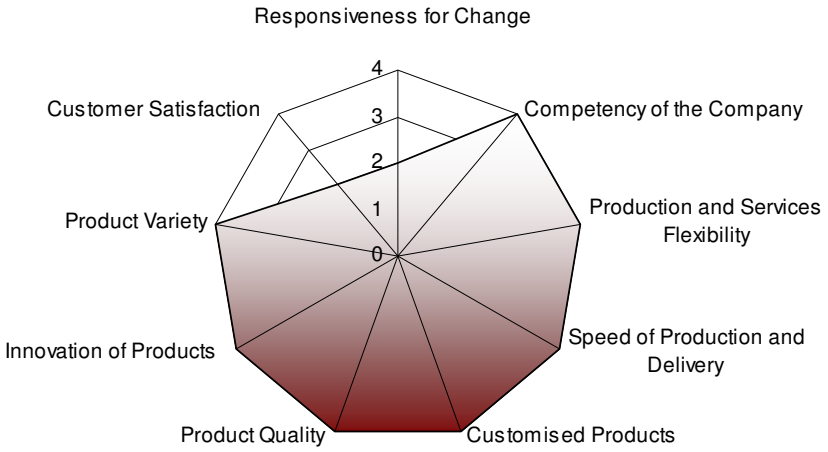

Figure 40 Macair Strategic Capabilities Level

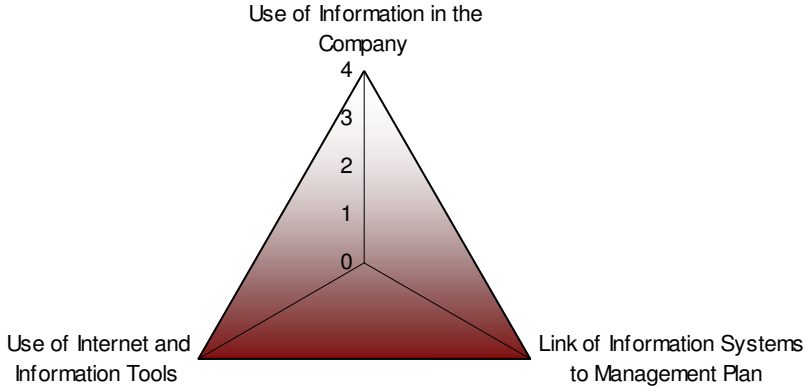

Figure 41 Macair Information Systems Lvels

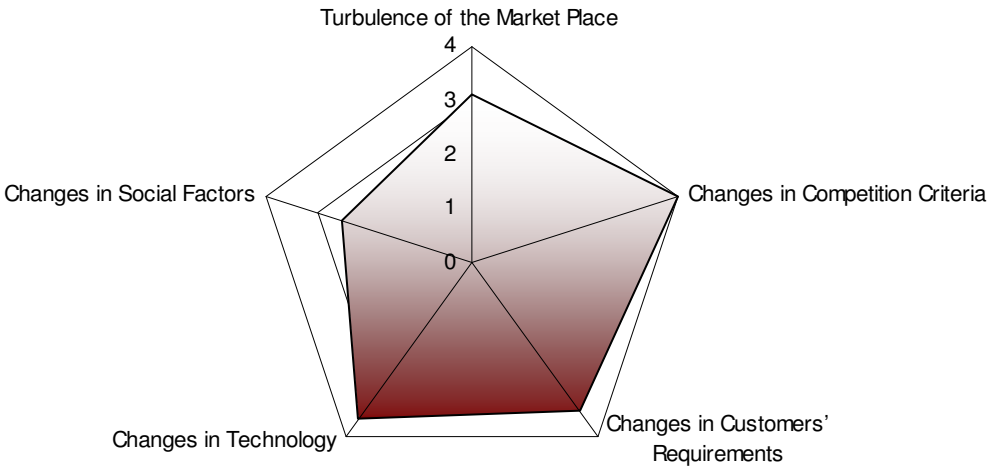

Figure 42 Macair Agility Business Environment Drivers

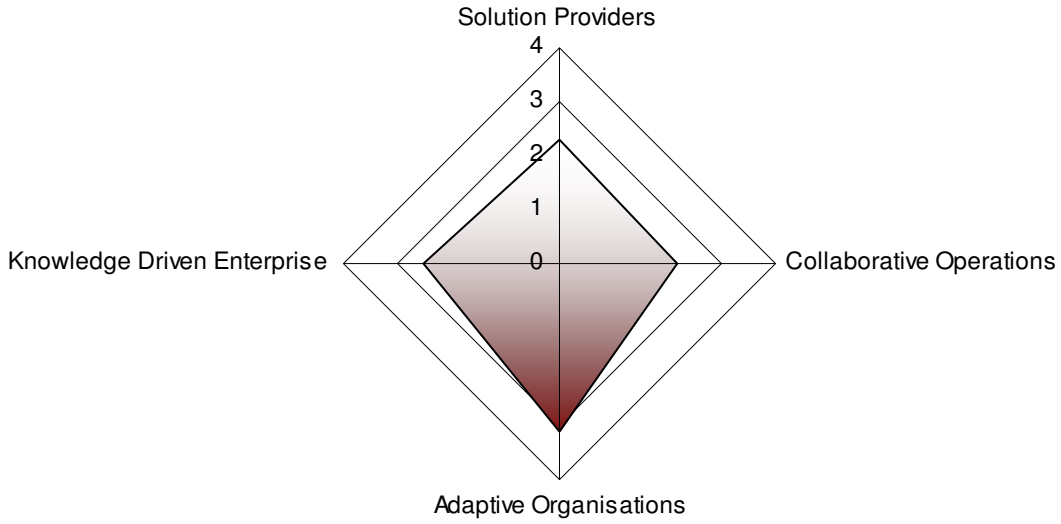

Figure 43 Macair Agility Practices Levels

Suggested Areas for Improvement Actions

- Develop a report that shows all unplaced purchase orders.
- Analyse complaints and take action to prevent repetition.
- Improve maintenance manuals.
- Introduce planning, monitoring and reporting management systems to improve delivery and productivity.
- Train warehouse workers to follow documented procedures when exceptions occur in the warehouse.
- Increase maintenance and services department resources to improve the after sale services.
- Working closely with sales to have visibility of sales demand, checking delivery and providing realistic delivery dates as orders are received.
- Improving monitoring and reporting performance.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Investment in up to date test equipment for measuring bearing conditions.
- Produce software backed maintenance system.
- Using new procedures to analyse equipment faults.

- Monitoring and reporting on delivery performance.
- Develop a customer satisfaction monitoring system.
- Producing new maintenance documents.

Tactical Output

The actions listed above give the following measurable outcomes:

- Percentage of supplies delivered on time improved up to 97%.
- Complaints per order decreased by 14 %.
- Company inventory volume decreased by 11%.

7.4.6 Red Horse Controls Ltd.

Red Horse Controls Limited (Red Horse Controls Ltd.) was established in 2005 and is a privately owned company expert in designing and building equipment control cabinets using Programmable Logic Controllers (PLCs) mainly related to optical fibre equipment design and control. The company is an OEM based Milton Keynes, belonging to the engineering sector.

The number of employees in the company is 17 and the annual turnover is £3.1m. The company is totally UK owned. The production process used by this company was determined to be jobbing and customised production. The number of total product types the company produces is 5 main types of products.

Assessment Tool Results

		level	Areas of Focus
Strategic Capabilities		**2.4**	• Responsiveness for change • Competency of the company • Production and services flexibility • Speed of production and delivery • Product variety
Information Systems		**2.7**	• Use of internet and information tools
Agility Business Environment Drivers		**3.0**	• Changes in competition criteria • Changing customer requirements • Changes in technology
Agility levels	**Solution Provider**	**2.2**	• High product variety • High product introduction rate • Frequent model changes • Rapid concept to cash • Cost-effective low volume producer • High information products • Customer demand changes • Satisfaction customers
	Collaborative Operations	**1.4**	• Cooperation strategy • Product integration & process development • Integrated enterprise processes • Organisation virtual partnership • Electronically commerce organisation • Short operation cycle • Information sharing strategy
	Adaptive Organisation	**1.5**	• Capable and ready for change • Competitors monitoring • Management leadership • High response for change
	Knowledge Driven Enterprises	**1.0**	• Dynamic competency testing • Innovative and high skilled workforce • Knowledge & training-based organisation • Active in societal activities

Table 9 Calculated questionnaire assessment tool results for Red Horse Controls Ltd

The calculated results from the completed questionnaire assessment tool are shown in Table 9 and displayed graphically on the accompanying radar plot in figures 44, 45, 46 and 47.

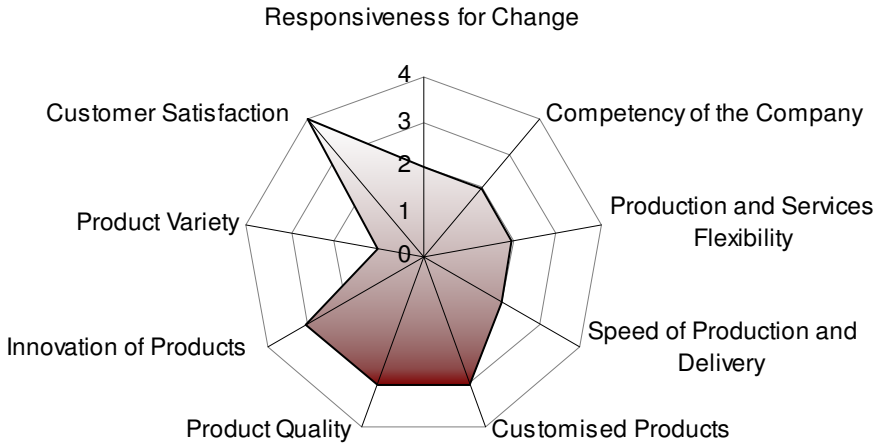

Figure 44 Red Horse Strategic Capabilities Level

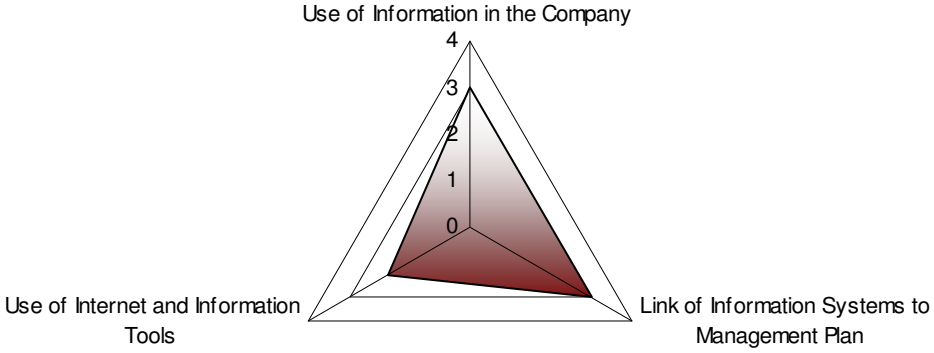

Figure 45 Red Horse Information Systems Levels

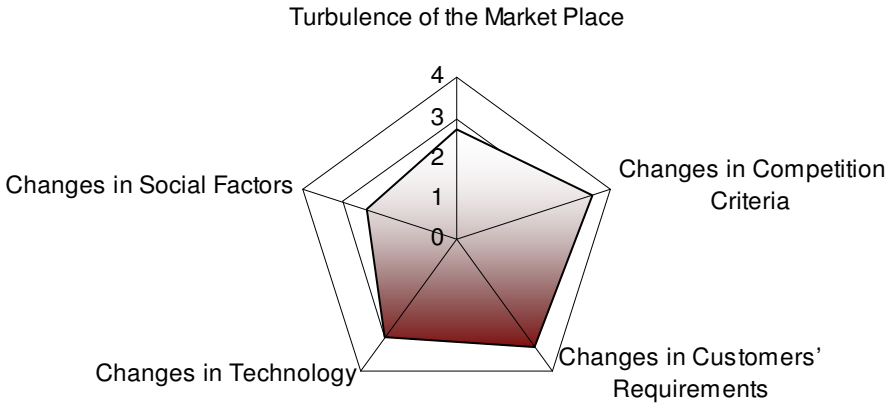

Figure 46 Red Horse Agility Business Environment Drivers

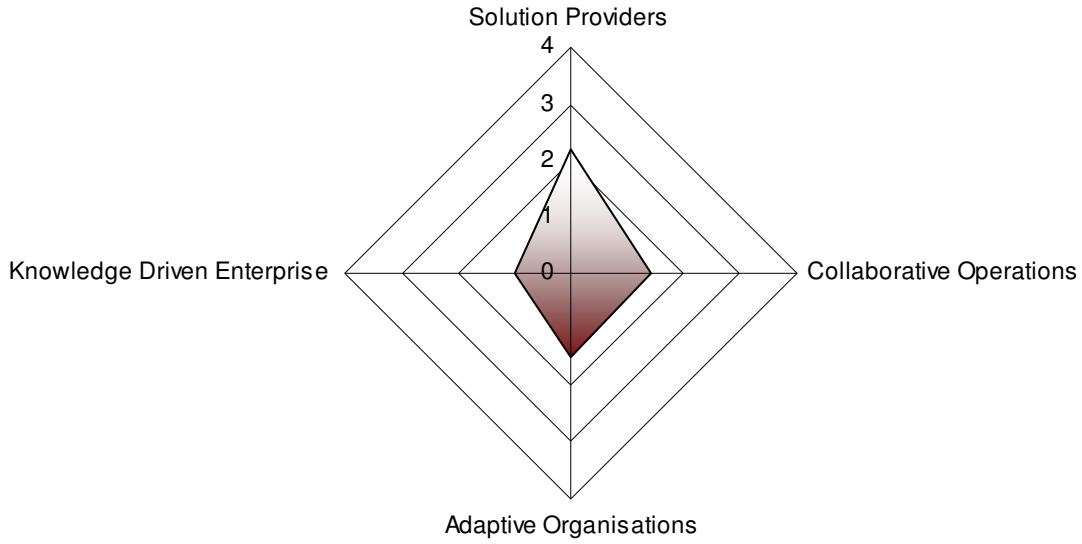

Figure 47 Red Horse Agility Practices Levels

Suggested Areas for Improvement Actions

- Investment in information system technology.
- Establish web presence.
- Employ new design technology.
- Increase the warranty period for products.
- Increase the design and manufacturing flexibility.
- Seek suggestions from customers on ways to improve satisfaction.
- Increase the amount of information shared with suppliers that helps to improve the quality and decrease the cost and improve delivery.
- Investment in new manufacturing technology.
- Conducted employee skills assessment and developed training plans to increase competency levels.
- Survey the customers to obtain the weakness of the services and products of the company.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Increasing the amount of information shared with suppliers.
- Products warranty increased from six months to one year.

- Investing in up to date test/programming equipment.

Tactical Output

The actions listed above give the following measurable outcomes:

- Customer base increased by 17%.
- Percentage of Supplies Delivered on Time increased up to 98 %.
- Improved supplier relationships.

7.4.7 Micromech Systems MSL

Micromech Systems Limited (MSL) was established in 1991 and is a privately owned company, expert in designing and building automation systems. Micromech Systems can produce a complete control system; including initial concept, design, build, test, software programming, installation and commissioning. The company is an OEM based in Chilford Court, Braintree, Essex, belongs to the engineering sector

The number of employees in the company is 11 and the annual turnover is £1.2m. The company is totally UK owned. The production process used by this company was determined to be jobbing and customised production. The number of total product types the company produces was 15 types of products.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 10 and displayed graphically on the accompanying radar plot in figures 48, 49, 50 and 51.

		level	Areas of Focus
Strategic Capabilities		**2.3**	• Competentecy of the company • Production and services flexibility • Speed of production and delivery • Product variety • Customer satisfaction
Information Systems		**4.0**	• No improvement requirement
Agility Business Environment Drivers		**3.2**	• Changes in competition criteria • Changing customer requirements • Changes in technology
Agility levels	**Solution Provider**	**1.6**	• High product variety • High product introduction rate • Frequent model changes • Rapid concept to cash • Cost-effective low volume producer • Production to order • Tailor made solutions (products/ services) • Product and customer support • High information products • Customer demand changes • High quality standards
	Collaborative Operations	**2.1**	• Product integration & process development • Electronically commerce organisation • Short operation cycle • Information sharing strategy
	Adaptive Organisation	**2.2**	• Competitors monitoring • High response for change
	Knowledge Driven Enterprises	**2.1**	• Dynamic competency testing • Innovative and high skilled workforce • Knowledge & training-based organisation • Active in societal activities

Table 10 Calculated questionnaire assessment tool results for Micromech Systems Ltd

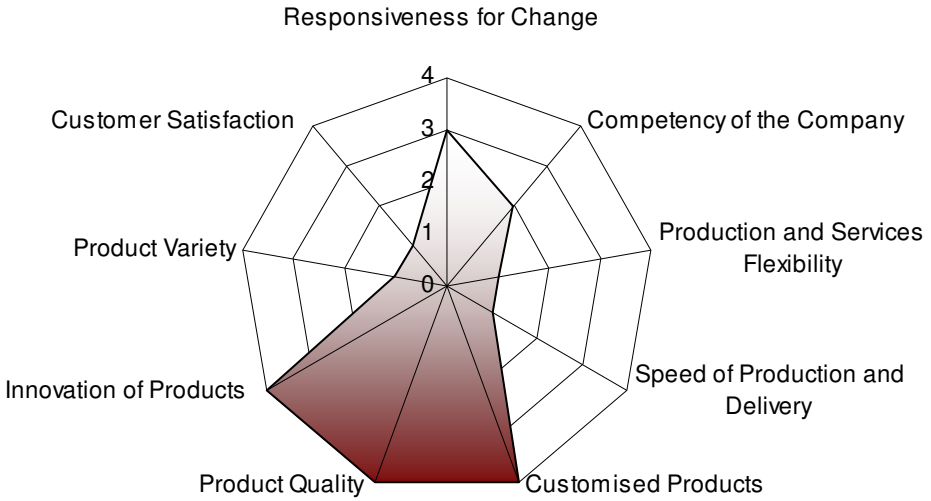

Figure 48 Micromech Systems Strategic Capabilities Level

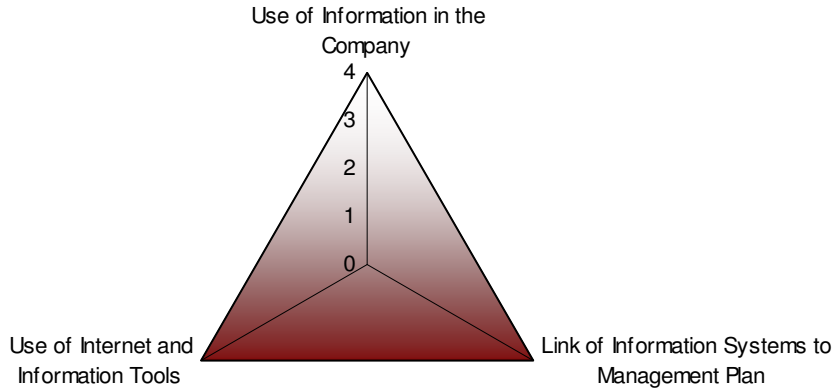

Figure 49 Micromech Systems Information Systems Levels

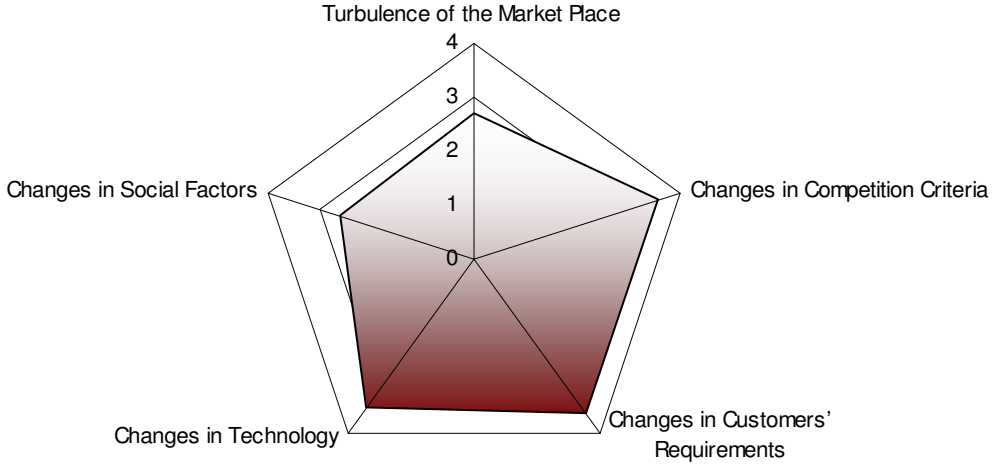

Figure 50 Micromech Systems Agility Business Environment Drivers

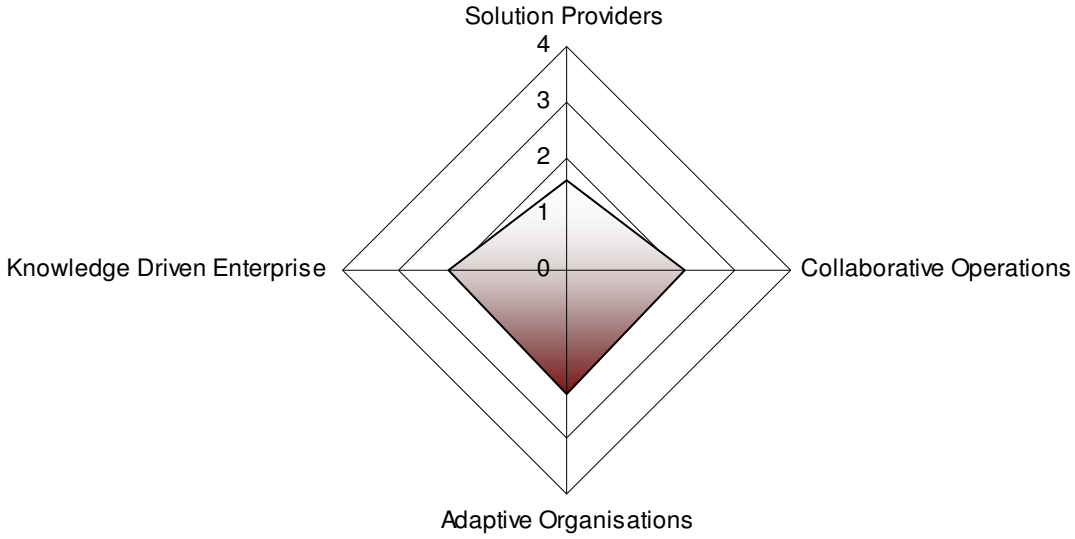

Figure 51 Micromech Systems Agility Practices Levels

Suggested Areas for Improvement Actions

- Increase products variety.
- Decrease finished goods and work in process inventory through better ability to control and handle internal and customer order change.
- Cut direct material costs due to better scheduling of production and therefore better scheduling of raw material purchases.
- Retain existing customer by offering complimentary services for them.
- Improve customer services.
- Reduce stores to hold only essential stocks in priority order.
- Use routine demand forecasting to reduce overstocking.
- Motivating the designers to eliminate or reduce the errors in the design.
- Attending exhibitions related to the company business.
- Provide customer services tailored to individual needs.
- Increase the budget for training programmes.
- Review the supplier list every year for supplier selection and development.
- Share information with suppliers and partners that help to make improvement in all aspects of business operations.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Increasing product variety by introducing a new range of products to the market (Spray-coat, handling-Silicone, Wafer Doping Machine).
- Adopting stock management so that minimum stocks are held at company and instead held at suppliers warehouses.
- Offering free updated software for current customers.
- Attending Machine Building and Automation Exhibition 2007 Birmingham NEC as exhibitor.

Tactical Output

The actions listed above give the following measurable outcomes

- Delivery performance increased to 95%.
- Reduced inventory level by 12%.

7.4.8 BGB Innovation

BGB Innovation Limited (BGB Ltd) was established in 1976 and is a privately owned company expert in the manufacture of carbon brush holders. The business progressed into the production of electrical slip rings during the 1980's. BGB is a leading supplier in the development of electrical slip ring systems for rotary applications, underwater lighting, camera solutions and wireless Ethernet Bridge systems.

BGB has built a good reputation for its products worldwide. Predominant European markets include Scandinavia, Spain and Germany in which BGB lays claim as leader in the field. The company is divided into three industry brands, BGB Engineering, BGB Marine and BGB Digilinc. The company is an OEM based Grantham, Lincolnshire and belonging to the engineering sector.

The number of employees in the company is 62 and the annual turnover is £ 8m. The company is totally UK owned. The production processes used by this company was determined to be jobbing and customised production. The number of total product types the company produces was 43 types of products.

Assessment Tool Results

The calculated results from the completed questionnaire assessment tool are shown below in Table 11 and displayed graphically on the accompanying radar plot in figures 52,53, 54 and 55.

		level	Areas of Focus
Strategic Capabilities		**3.8**	• No improvement requirement
Information Systems		**4.0**	• No improvement requirement
Agility Business Environment Drivers		**3.5**	• Turbulence of the market • Changes in competition criteria • Changing customer requirements • Changes in technology
Agility levels	**Solution Provider**	**3.4**	• Frequent model change • Rapid concept to cash
	Collaborative Operations	**3.6**	• No improvement requirement
	Adaptive Organisation	**3.8**	• No improvement requirement
	Knowledge Driven Enterprises	**3.7**	• No improvement requirement

Table 11 Calculated questionnaire assessment tool results for BGB Ltd

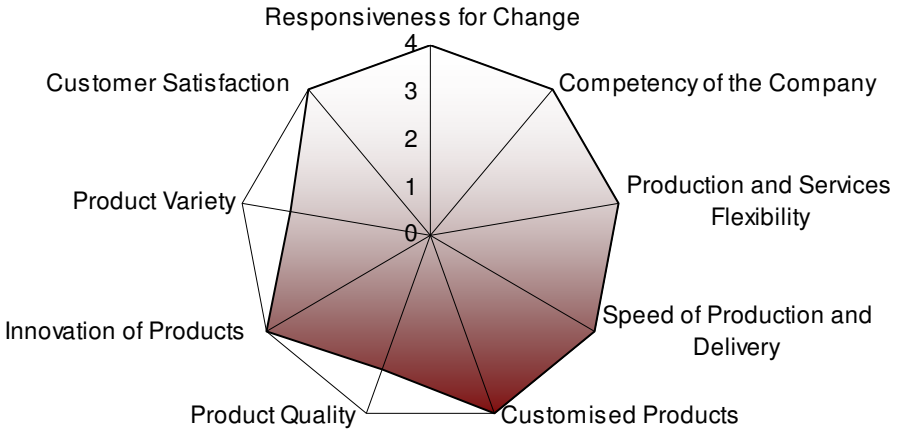

Figure 52 BGB Strategic Capabilities Level

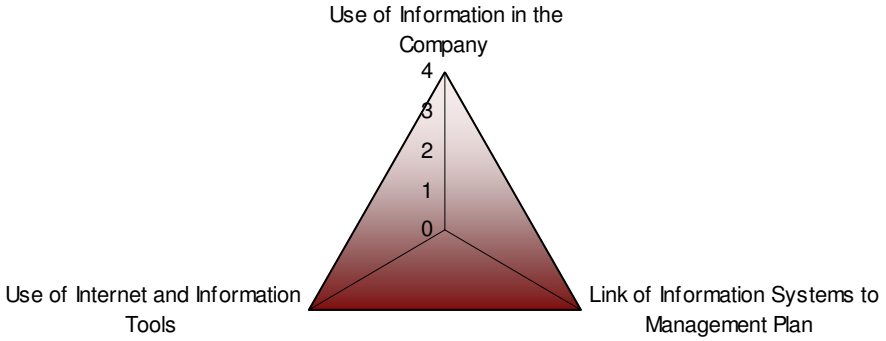

Figure 53 BGB Information Systems Levels

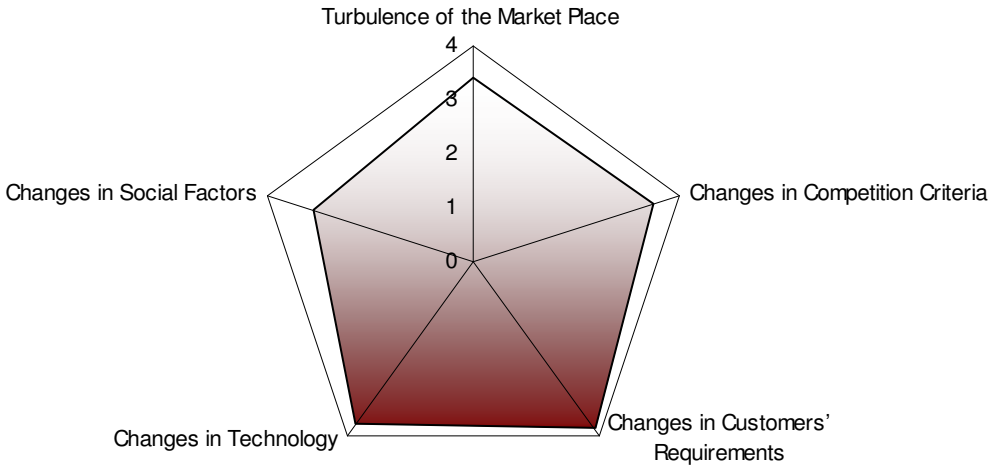

Figure 54 BGB Agility Business Environment Drivers

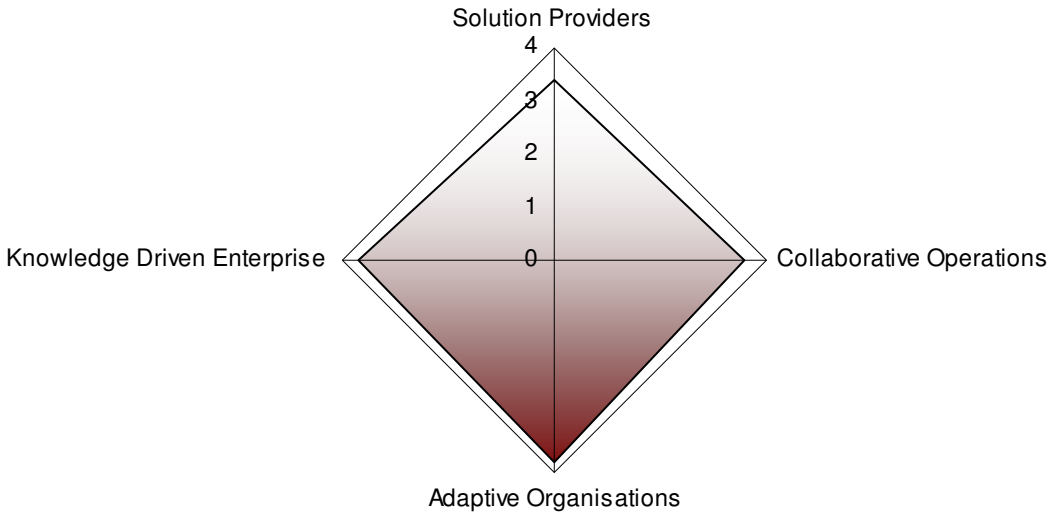

Figure 55 BGB Agility Practices Levels

Suggested Areas for Improvement Actions

- Investment in new technology.
- Increase shop floor area to enhance work space for the manufacturing and remove the congestion points.
- Set regular meeting with employees to discuss any improvement actions.
- Increase the R&D department capabilities.

Identification of the Tactical Responses Taken by the Company

The actions implemented can be summarised as:

- Investing in new technology (Buying new 300 ton press).
- Increasing the shop floor capacity by 500 square metres.
- Expanding the R&D department.

Tactical Output

The actions listed above give the following measurable outcomes:

- Improved overall productivity by 11%.
- Manufacturing output increased by 9%.
- Improved environment conditions for employees.

7.5 Summary

Chapter seven provided the results from conducting and analysing eight case studies of manufacturing companies. This chapter reported the results of the introduction of the developed methodology for achieving agility in the manufacturing industry as the last objective of the research, i.e. to demonstrating the utility of the methodology, in order to assist manufacturing SMEs to adopt agility as a characteristic.

The next chapter will discusses the application of the agility improvement methodology; the results from each of the eight companies involved in this stage of the research and will comment on the finding from each case study, and their relationships to each other.

Chapter 8

Discussion

8.1 Introduction

In the previous chapter, the application of the questionnaire assessment tool in eight case-study companies and the subsequent analysis of the results, confirmed the wider applicability of the methodology. In this chapter discussion will be made on the whole process and achievements of the research. The discussion will focus on the comparison of the results of the application of the methodology in the case studies, and how the application has led to benefits for the companies. How the objectives were approached and achieved considering the inherent limitations of the research, the contribution of the research to the existing literature on agility in manufacturing and finally, the wider finding of the research.

8.2 Conclusion of Applying the Research Methodology

This section will discuss in brief the steps followed in the research methodology. The aim of this research was to study and understand the concept of agility and to provide a methodology for its implementation in small and medium size manufacturing SME's.

After completing the review, the available literature and considering to the nature of the research, it was decided to use a questionnaire survey method as the data collection method. The challenge in this step was; how to avoid the low response rate of this method. The author spent considerable time preparing and collecting the information to produce the questionnaire survey.

Previous studies in literature indicated that a research methodology that included a questionnaire to gather the data was a valid approach to the topic being investigated. The same literature however, acknowledges that inadequate preparation and consideration for recipient could lead to an unrepresentative sample return to be useful. Despite care and attention being devoted to the aspect of the research the response rate was less than 9%, which is less than that which was expected according to the available literature on this subject. The author expected to get a high response rate from some sectors rather than others for example, electrical and electronics, engineering, aerospace and the automotive sector which, according to literature are subject to more frequent manufacturing changes than other sectors. However, in practice the response rate was high in the electrical and

electronics and engineering sectors while it was less than expected in the automotive and aerospace sectors.

The expectation of the author was that responses would be received from all sectors in different percentages however, the response pattern of the survey showed not all the sectors responded to the survey. This pattern of response prevented an inter-sector comparison being made between all selected sectors for the study. Inter-sector comparison in the was made within the study but results were limited to just three sectors; electrical and electronics, engineering and plastic. The response rate of the plastic sector was relatively high compared to the other sectors.

A number of suppositions can be proposed regarding the sectors that provided a very low response. It could be that these companies are not in a rapidly changing market and their products are not constantly requiring development or improvement to meet customer needs. If this is the case then it can be argued that these sectors are less interested in responding because they do not see agility as a key feature and are as a consequence less likely to respond to a questionnaire on Agility.

Other reasons for not responding can also be espoused, for example:

- Companies are not interested in this particular research.
- Companies are no longer in manufacturing.
- The postal address of the company was not correct.
- Companies no longer fit into SME's category.

Some of these are based on the validity of information contained within the database used. Limitations on resources available to this researcher led to a commercially available database being used, (Applegate 2006) which may not have been up to date and therefore not accurate. No further analysis to determine actual reasons for non-completion or non-return of questionnaires was undertaken as the response that was received was regarded as sufficient to provide an acceptable sample for analysis.

The aim of the analysis process was to find a link between the finding from the literature and the results of the analysis as a validating step of the survey.

The first step of the analysis related to the finding from the sample surveyed companies and the general finding from the literature. The second step of the analysis was to compare the sectors results and identify significant differences, where they existed between these sectors

according to agility. The finding of these two steps was aligned with the finding from the literature, providing confidence that the questionnaire is valid.

Having confirmed the validity of the questionnaire the next phase of the research was applying the methodology to (eight) selected case study organisations. This phase of the research involved visiting the case-study companies and in practice, it proved to be significantly more time consuming than anticipated originally where the need to schedule and reschedule the visits to the companies became a feature. In a number of cases, the companies postponed the appointments at short notice because of other important or urgent demands within the organisation.

This happened in a number of cases such as with; ESM, Horobin and Macair., and caused a delay in this phase of the research. If this area of the study was repeated the author would mitigate this particular delay by scheduling in more time for this phase of the study.

In each case study the findings from the questionnaire were accepted with regard to the need for and level of current agility and the areas pinpointed for further consideration for improvement and a number of actions selected by each company according to their ability and resources to implement within a time scale. However some actions were not implemented due to various reasons such as lack of time taken to implement such action and the resources available to complete within an acceptable timeframe..

8.3 Finding and Comparison of Results

The use of the Agility improvement methodology within the case study companies has through a demonstration of consistent improvements been validated. However in order to assess the extent to which the methodology can be considered to be generic it was felt necessary to examine the individual cases in greater depth in an attempt to identify specific cause and effect. And also to undertake an inter-company comparison to determine the extent to which consistency in this area across organisations exists in order that confidence in the outcomes of applying the methodology more widely can be of an acceptable level.

In this section, inter-company comparison between the results of eight case studies will be made according to the important elements of the assessment tool which are:

- Defining low and high score agility practices areas.
- The tactical response.
- The tactical outputs.

Agility Attributes / Company	Agility Areas																														
	Solution Provider														Collaborative Operations								Adaptive Organisation				Knowledge Driven Enterprises				
	High Product Variety	High Product Introduction Rate	Frequent Model Changes	Rapid Concept to Cash	Cost-Effective Low Volume Producer	Production to Order	Tailor Made Solutions (Products/Services)	Product and Customer Support	High Information Products	Long Lasting Customer Relationship	Consumer Demand Changes	High Quality Standards	Customers Satisfaction	Cooperation strategy	Product Integration and Process Development	Integrated Enterprise Processes	Customer-Supplier Interactive Relationships	Organisation Virtual Partnership	Electronically Commerce organisation	Short Operation Cycle	Information Sharing Strategy	Capable and Ready for Change	Monitoring of Competitors	Management Leadership	High Response for Change	Dynamic Competency Testing	High Communication Level	Innovative and High-skilled Workforce	Knowledge and Training-based Organisation	Active in Societal Activities
ESM				X	X												X		X	X	X	X			X				X	X
London Electronics		X	X	X										X						X	X			X				X	X		
Horobin			X	X					X					X	X			X			X					X		X	X	X
Micromech	X	X	X	X	X		X	X	X		X								X	X						X			X	X
Macair	X	X		X	X				X						X			X	X	X	X					X			X	
Red Hours	X	X	X	X	X				X		X		X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
Micromech systems	X	X	X	X	X	X	X	X	X		X	X			X				X	X	X		X		X	X		X	X	X
BGB			X	X																											

Table 12 the comparison of the results of agility attributes in case study companies

Table 12 shows the weak attributes in each area of each company, the first comparison is made according to the low attributes of each area.

According to the results of the case study companies, the most common weak attributes as shown in table 12 are:

- Rapid concept to cash in solution provider area
- Knowledge and Training-based Organisation in knowledge driven enterprise area.

8.3.1 Companies Having Low Score in "Rapid Concept to Cash" Attribute in Solution Provider Area

As was discussed before, the main aim of applying the methodology is to help manufacturing SMEs identifying areas of weakness and pinpoint actions for improvement that if applied would lead to an increase in competitiveness.

The application of the methodology in the case studies shows that all the companies have one common weak attribute in the solution provider area which is "Rapid Concept to Cash" as shown in Table 12.

This attribute consists of one question in the questionnaire assessment tool. By looking at the case study companies' answers, we can see two companies have zero score and the remaining companies having a score of 2 as shown in Table 13.

Rapid Concept to Cash	
Question / Company	How fast the company move product from concept to put the product in customer hand? (0-4)
London Electronics	2
ESM	2
Horobin	2
Micromech	0
Macair	2
Red Horse	2
Micromech systems	0
BGB Innovation	2

Table 13 the rate of Rapid Concept to Cash attribute

The analysis shows that all the case study companies have some difficulties in moving the product from the concept to sales stage. According to the management perspective within the case study companies, these difficulties can be concluded in the following way:

- Design capabilities software and hardware (London Electronics, BGB and ESM)

- Manufacturing technologies (Micromech, Micromech systems and Horobin)
- Testing process (Horobin, Macair, ESM and BGB)
- Employees skills (ESM, Horobin, Macair, Micromech, Micromech systems and Red Horse)

This finding is supported by the review of literature. SME's do suffer from lack of resourses which prevent them from introducing the latest technology, reinvesting in manufacturing tools and equipment, and in training their employees to improve their capabilities.

8.3.1.1 Link the Assessment Tool Results to Improvement Actions Taken by Case Study Companies

As shown in Table 14 the improvement actions taken by the companies were different from one company to another. Some companies took more than one action which led to improvement in this attribute, e.g. ESM Ltd., and BGB Innovation. Other companies took a single action which can be linked directly to the improvement in this attribute. Yet other companies did not take any action regarding this attribute e.g. London Electronic, Horobin and Micromech Systems Ltd. Hence for them there was no visible improvement in this attribute.

Engineering Services Management Ltd. (ESM)

The response of ESM to improve this attribute was the most extensive of all the case study companies, with respect to management concerned about the time taken by the company to design and manufacture new products. The nature of the products (optical fibre machines and tools) of this company is very complicated and is in the forefront of technology in this field. This leads to a lengthy design phase. Hence the company management were very willing to take actions that may help in improving this attribute. The actions taken were:

- Replacement of the company's old PCs with modern and high speed ones to be compatible with the software used for the design process.
- Investment in new tools purchasing new welding machine for electric orbital welding of ultra high pure stainless steel pipe work to decrease the time taken in the welding process and improve the quality of the end product.

Micromech Ltd.

The action taken by Micromech for improvement was to purchase a new software package for the development and automation of pick and place equipment design. The purpose of this software was to improve the design quality and control of motion systems.

Company	Improvement Actions	Tactical Output
ESM	• Replacement of the company's old PCs with new ones. • Investment in new tools • Improving shop floor management layout. • Set regular meetings with suppliers and employees • Set training programs	• Right first time increased up to 99% • Work-in-progress was reduced by 67% • Percentage of suppliers delivered on time improved by 30% • Overall productivity increased by 5% • Improved in employees skills
London Electronics	• Introducing new products for new applications • Improve current products features • Offering direct link to distributors for all customers • Offering free software update for existing customers • Attend new exhibitions • Increase the amount of information shared with suppliers	• Improve in percentage of total turnover from new products 9% • On-time delivery performance increased to 98% • Increase in products variety
Horobin	• Introducing new products to the market • Setting regular meetings with suppliers and employees • Rewarding employees. • Offering cooperation chance for academic researchers	• People productivity improved by 2% • Increase in percentage of total turnover from new products 6% • Increase product variety
Micromech	• Increase product variety • Introducing new online catalogue • Attending new exhibition • Co-operate with other companies • Purchase new software development tools	• Increase in percentage of total turnover from new products 10% • Right first time of rotary tables increased up to 99%
Macair	• Investment in up to date test equipment • Produce software backed maintenance system. • Using new procedures for analyse equipment faults. • Monitoring and reporting delivery performance. • Develop customer satisfaction monitoring system • Producing new maintenance documents	• Percentage of supplies delivered on time improved up to 97% • Complaints per order decreased up to 14 % • Company inventory volume decreased by 11%.
Red Hours	• Cooperating with suppliers • Product warranty increased from six months to one year. • Investing in up to date test/programming equipment	• Customer base increased by 17% • Percentage of supplies delivered on time increased up to 98 % • Improve in supplier relationships
Micromech systems	• Increasing product variety • Adopting stock management system • Offering free update software for current customers. • Attending machine building and automation exhibition.	• Delivery performance increased to 95% • Reduce the inventory level by 12%
BGB Innovation	• Investing in new technology. • Increasing the shop floor capacity • Expanding the R&D department	• Improve in overall productivity by 11% • Manufacturing output increased by 9%. • Improve in environment conditions for employees

Table 14 Comparison of agility actions and tactical outcomes in the case studies

Macair FMI Ltd.

The nature of business of Macair is the design and installation of air conditioning systems. The response taken by this company as an improvement action was to investment in up-to-date test equipment for measuring bearing conditions. The management point of view expressed is that this equipment is very important in the design phase of the air conditioning system; it detects any vibration within the bearing housing and gives an indication on how long it will last. This will help the designer to choose bearings with a higher operating life. Air conditioning systems are normally located in places far away from offices and by designing in reliability they would require less frequent servicing.

Red Horse Controls Ltd.

The action taken by Red Horse Controls Ltd. was to invest in up to date test/programming/drawing equipment as an improvement action. These equipments – according to the company management – were very helpful in increasing the speed of design and commissioning of the control cabinets.

BGB Innovations

With respect weaknesses identified in design capabilities BGB innovation decided to strengthen their capability in this important area by expanding the research and development department in order to assist in decreasing the time of design and help in producing and introducing new products in a timely manner.

8.3.2 Companies Having a Low Score in the "Knowledge and Training-Based Organisation" Attribute in the Knowledge Driven Enterprises Area

Another common weak attribute was found in the knowledge-driven organisation area. This is "Knowledge and Training-based Organisation" as shown in Table 12.

This attribute consisted of three questions in the questionnaire assessment tool. By looking at the case study companies' answers as shown in Table 15, the overall score in this attribute resulted from average score of answering three equally weighted questions. The analysis shows that question number three which related to the cooperation between the SME's and local academic institutions in delivering training, was very low compared to the other questions related more specifically to the training of employees for multi-skilling.

Knowledge and Training-based Organisation			
Question / Company	Q1 Does your company train its personal for multi-skill tasks? (0-4)	Q2 Does your company see training as an investment rather than a cost? (0-4)	Q3 Is your company involved with your local academic institutions in delivering training? (0-4)
ESM	1	2	2
London Electronics	2	2	2
Horobin	2	2	0
Micromech	2	3	0
Macair	3	3	0
Red Horse	0	1	0
Micromech systems	2	2	0

Table 15 the rate of Knowledge and Training-based Organisation attribute

The perception of the case study companies linked the weakness of this attribute to the following points:

- The shortage of staff expertise (Micromech, Micromech systems Macair, ESM and Horobin).
- The time and cost of training (Micromech, Red Horse, Micromech systems, Macair, ESM and Horobin).
- The shortage of staff time for co-operation with academic institutions (Micromech, Red Horse, Micromech systems, Macair, ESM and Horobin).

Views that are also supported through the literature where it is identified that SMEs do not have an adequate budget for staff training, which can help in skills improvement. And in terms of human resources, SMEs are very often faced with the shortage of skilled labour.

8.3.2.1 Linking the Assessment Tool Results to Improvement Actions Taken by the Case Study Companies

The response to taking improvement action regarding this attribute was in general very low. The case study companies considered this attribute a low priority and according to that most of the companies took no action regarding this attribute. The main reason according to the companies was that there are other issues of greater importance that need improvement.

Engineering Services Management Ltd.

The action taken by ESM was a commitment to two training programs; the first one providing a training course for two design engineers on AutoCAD software. This training was needed

to support the design of the optical fibre draw tower components as well as making the equipment start up much easier than at present.

The other program was designing a two-week job rotation program for some jobs to create multi skilled workers.

Horobin Ltd.

The action taken by Horobin was to engage in a programme of co-operation with academic researchers with similar interests in this same field of research.

On the other hand, and according to the results of the case study companies, there are some common, high attributes in all of the case study companies. The most common high attributes as shown in table 12:

- Long Lasting Customer Relationship in solution provider area
- High Communication Level in knowledge driven enterprises area

8.3.3 Companies Having High Score in "Long Lasting Customer Relationship" Attribute in Solution Provider Area

The application of the methodology in the case studies shows all the companies to have one common strong attribute in the solution provider area which is "Long Lasting Customer Relationship" as shown in Table 12.

Customers are the whole reason for continuously improving processes. It is they who decide whether the product or service offers the best value for money when they make their purchasing decisions. And their purchasing decisions determine whether the business will be a success or not.

This attribute consists of three questions in the questionnaire assessment tool. By looking at the case study companies answers, we can see the high score of this attribute comes from the first and third questions as shown in Table 16, which linked directly to the relationship between the company and their customers. All case study companies see the relationship between the company and the customers as one of importance for success and competitiveness which make all the companies try to understand and satisfy their customers as much as they can to keep the customer base growing.

Long lasting customer relationship			
Question / Company	Q1 To what extent the company offer customer after sales services? (0-4)	Q2 To what extent E-business Important for the company business? (0-4)	Q3 To what extent "Know Your Customer" is Important principle for the company? (0-4)
London Electronic	3	3	3
ESM	3	2	3
Horobin	1	4	3
Micromech	3	2	3
Macair	4	1	4
Red Horse	3	1	3
Micromech systems	3	2	2
BGB Innovation	4	2	4

Table 16 the rate of long lasting customer relationship attribute

The second question related to the importance of E-business as a customer satisfaction factor. Some companies do not perceive using E-business is very important for their companies (for example Macair and red Horse Ltd). This is perhaps because of the nature of their products and markets as well as the management views to their business. This is supported by the literature.

8.3.4 Companies Having a High Score in the "High Communication Level" Attribute in the Knowledge Driven Enterprises Area

As mentioned in chapter 2, the importance of speed of the information flow inside and outside the company is regarded as one of the factors of success in manufacturing companies. This attribute shows the companies are concerned about the importance of the communication both inside and outside their organisation.

All the case study companies supported the principle of the importance of speed of information flow partially, if not totally, inside and outside the company as shown in Table 17.

High Communication level						
Question / Company	Q1: To what extent the communication level among departments fast and effective	Q2: To what extent the communication level fast and effective with Customers	Q2: To what extent the communication level fast and effective with Suppliers	Q2: To what extent the communication level fast and effective with Partners	Q2: To what extent the communication level fast and effective Internally	Q2: To what extent the communication level fast and effective with Stakeholders
London Electronic	3	3	3	3	3	3
ESM	1	3	1	2	2	4
Horobin	2	3	3	2	3	3
Micromech	2	3	3	3	3	3
Macair	3	4	4	3	4	1
Red Horse	3	3	2	2	3	2
Micromech sys	3	3	3	3	3	3
BGB Innovation	3	4	4	3	3	4

Table 17 The rate of High Communication level attribute

8.3.5 Link of Improvement Actions Taken by Case Study Companies to Tactical Outputs

As can be seen in the above section the actions of the companies differ from one company to another, according to the view of management to the importance of improving the attribute and the improvement action chosen. These are reflected in the outputs of these actions. In all cases the outputs were a result of a combination of actions (operational and management) taken by the company during the study period.

Although in each case study companies were asked to describe tactical measurable outputs that resulted from the analysis of the questionnaire and acquired improvement actions, it would be naive to suggested that this and only this was the driver for improvement or indeed the only contributor to these measurable results. It is more likely that other factors also contributed. Nevertheless in each case the companies involved were prepared to attest to the fact that the application of the improved methodology was a significant factor to the improvements documented.

8.4 The Utility of the Methodology

The application of the assessment tool in eight case studies shows the ability of the tool to identify the weakness areas of the companies, where improvement is needed. However, the assessment tool alone will not produce measurable improvement without the support of the management of the company and their commitment to implement the improvement actions

that will result in improvement in outcomes for each of the companies. The methodology proposed and demonstrated includes the identification of this needed aspect. In this sense, the methodology includes a 'test' of the readiness of an organisation to commit to change and improvement thus confirming the wider utility of the methodology. It has also been shown that where similarities of strategic objectives occur there exists also a commonality of elements of the assessment tool and of the areas identified for improvement. Similarity of tactical response also existed and though outside the scope of this research it would be possible through repeated application with a variety of different organisations to create a knowledge base for SME's to inform improvement actions.

The usefulness of the methodology has been demonstrated in eight case studies, the application of the methodology in each application resulted in measurable outcomes in all of the companies. The use of the methodology assists the companies to:

- Identify the level of agility business drivers according to the environment conditions where the company compete.
- Identify the current level of strategic capabilities.
- Identify the current level of information systems.
- Identify the current level of agility practices in four dimensions of agility.
- Identify and agree areas of weakness those require tactical actions to improve.
- Evaluate priorities and the selection of appropriate improvement actions.
- Under take actions consistent with the strategic goals of the company that result in business performance improvement.

8.5 The Questionnaire Assessment Tool as an Analysis Framework

It has been demonstrated in chapter 7 that the questionnaire assessment tool is a useful tool for organisations in order to gain a greater understanding of their businesses and in every case that successful implementation work has followed from the process. It has further been demonstrated that the process was practical; from a qualitative point of view the methodology was willingly embraced by all the case study companies and the interest which the managers demonstrated in undertaking the work was high.

In terms of the time undertaken for the process the stages of the methodology can be broken down as follows:

1. To undertake the questionnaire assessment tool took a maximum of ½ day.

2. To identify key improvement activities took on average one week.
3. To undertake the improvement actions took an average of 60 days over a 12-month period.

It can be seen therefore that major improvements in Agility can be achieved in a realistic and practical time scale whilst ensuring that learning points and the continuous improvement ethos become embedded in the day-to-day activities of the company.

8.6 The Degree to which this Process is Generic

In all the case-study companies there have been successful outcomes driven by the use of the improvement methodology. It has been demonstrated that there is a degree of similarity between elements of the questionnaire assessment tool and tactical responses generating real bottom line benefits as an outcome. The analytical loop has been completed by analysing the consistency of these outcomes, which has shown a positive fit. It is therefore considered that the methodology may be used as a generic tool in the manufacturing sector for SME's.

8.7 Limitations of the Research Achievements

During the course of the study, a number of minor limitations that have the potential to undermine the quality of the research were observed.

A limitation of postal surveys is the potential for respondent bias. It is generally people who have the strongest opinions on the issue who normally respond. The number of postal surveys was limited to about two thousand, due to the high cost involved.

The developed methodology in this research is partially based on the results of studying and investigating a limited number of manufacturing companies (103 companies). Although the responses were statistically sufficient to obtain information from them, the newness of the subject to the SME community, the extent of the issues involved and the importance of the agenda necessitates the involvement of a larger sample of manufacturing companies in order to obtain more concrete data and information.

In general, there were limitations inherent within the survey population and the chosen research methodology. In particular, the newness of the subject to manufacturing SMEs, which it can be suggested caused them to avoid involvement. This is one factor perhaps that can account for the low response rate to the questionnaire survey. The number of returned responses however was considered sufficient and provided the necessary information required.

8.8 Main Contributions of the Research

The research question was a cohesive understanding as to how individual manufacturing SME's should go about implementing agility. Contributing to existing literature and body of knowledge in this topic area and informing this is an achievement of this research. The research resulted in the proposal of a methodology for assisting manufacturing SME's in the achievement of agility. The major achievements of the research can be highlighted as follows:

1. A questionnaire assessment tool of agility was developed to present the concept in terms of real world business and to comply with the basic definition of agility. The questionnaire assessment tool takes agility as the response to the changes in the business environment and capabilities and abilities in order to respond to the changes. The tool relates the changes in the business environment directly to strategy, and hence strategic capabilities, of an organisation as the areas where the responses to the changes should be raised.
2. A methodology has been developed as an effective approach for individual SME manufacturing organisations seeking to improve their agility. Although this methodology follows the basic rules and principles of other methodologies in the area of manufacturing, this methodology is novel in that it is specifically designed for manufacturing SME's and includes all of the required steps by which an organisation can assess the level of existing agility and requirement for it, identify and undertake improvement actions and measurably improve the level of Agility..
3. The questionnaire assessment tool sits within the improvement process in that it provides a means by which the organisation can identify strengths and weakness of the current situation of the organisation and identifying the areas of improvement.
4. The development methodology for agility has confirmed its applicability to pinpoint areas of weakness within the organisation by defining the weakness areas of the tested companies, and assists in the development of actions for improvement in the manufacturing SME's.
5. The testing of the methodology in eight different manufacturing companies has shown its capability to focus on improvement actions that result in tactical business performance improvements in a reasonable time scale.

8.9 Wider Findings of the Research

During the research, various findings were made, which in aggregate composed the major

findings of the research. The itemised findings include the basic understandings from the literature survey, the elements considered in developing the questionnaire assessment tool and its validation, and various steps taken in developing and validating the methodology within the work of this thesis.

For achieving agility, an organisation may not necessarily need to make entire changes in its systems and structure, or have to attempt unbearable investment. The basic issue is getting a proper and realistic understanding of the business environment the organisation operates in and determining the areas which need to be improved in order to gain the required capabilities, taking into consideration the specific circumstances the company faces.

8.10 Summary

This chapter was dedicated to providing a discussion and comparison of results and finding from case studies, the utility of the methodology, the degree to which this process is generic, limitations of the research achievements, the main contributions of the research and finally the wider finding of the research. Chapter nine will draw the conclusions of the research.

Chapter 9

Conclusion

9.1 Introduction

The overall purpose of this study has been to provide a methodology to assists the manufacturing SMEs in implementing agility.

Four objectives were established in order to fulfil this aim. In this chapter, the overall conclusion of the thesis will be presented. A summary of the main findings of the research, together with the conclusions drawn, will be provided.

For the purpose of clarity, the four objectives stated in the first chapter are restated below:

1. To provide a comprehensive idea about agility in manufacturing through a survey of relevant literature
2. To identify the main elements of the questionnaire assessment tool needed for agility in manufacturing SMEs
3. To establish a framework to determine the different between actual and required level of agility
4. Demonstrate the utility of the methodology, in order to assist manufacturing SMEs to adopt agility as a characteristic.

9.2 The Achievement of the Research

The research had four objectives and four hypotheses. Regardless of the limits the research experienced, all the objectives were satisfactorily achieved and the hypotheses were convincingly, though partially, validated. The research provided a simple, clear and realistic understanding of the subject. Details of the achievements of the research are provided below:

- The research hypotheses were examined and partially validated. Most of the tested companies proved the first hypothesis of the research, which stated that the manufacturing SME community in the UK is still not familiar with the concept of agility and thus its applicability to competitiveness.

- The full study of the literature review confirmed that no model or framework exist exists currently to specifically bring about an improvement in agility within a manufacturing SME which satisfied the second hypotheses of the research.

- The third and fourth hypotheses of the research were satisfied through the results of applying the methodology in eight manufacturing case studies. i.e. The level of competitiveness within manufacturing SMEs is influenced by the extent to which the organisation is agile, and framework capable of identifying the degree to which a manufacturing SME is considered to be agile and which can pinpoint actions for improvement would if applied lead to an increase in competitiveness.

- The full study of the relevant literature of agility in manufacturing to provided the author with a full understanding about agility in manufacturing SMEs, and to define the main elements needed to build a questionnaire assessment tool. This step satisfied the achievement of the first objective of the research. i.e. to provide a comprehensive understanding about agility in manufacturing SMEs.

- The full analysis of questionnaire results of 103 manufacturing SMEs was made to study the current situation of manufacturing SMEs community and to find out the relation between the questionnaire assessment tool factors. This step satisfied the second objective of the research, i.e. to identify the main factors of the questionnaire assessment tool and the relationship between these factors.

- A methodology for assisting manufacturing organisations in achieving agility was developed based on the literature review and questionnaire survey analysis. This step satisfied the third objective of the research, i.e. To establish a framework to determine the different between actual and required level of agility.

- The methodology was satisfactorily introduced to eight manufacturing companies. This step satisfied the last objective of the research i.e. to demonstrate the utility of the methodology, in order to assist manufacturing SMEs to adopt agility as a characteristic.

Chapter 10

Future Work

10.1 Future Work

This chapter includes to areas of further research which have been highlighted through the work carried out in this thesis.

To this end, this project has described the principles and features of agility and how these can be implement within manufacturing SMEs. The limitation of the research in terms of achievements, as explained in chapter eight and the extent of the potential research area, have produced many opportunities for further research. Many areas have been identified for continuation in this research programme. The research issues are mostly related to the open-ended side of the research, or to the incomplete aspects of the developed methodology and its associated tools. Areas for future work include:

10.1.1 Implementation of the Developed Model in Practice

To ensure that the model can be used by several companies within the manufacturing sector across the UK as a benchmarking tool for agility, this model can be published by producing a web-enabled version that could allow a company to do the assessment process electronically, this would facilitate the use of the model to a larger scale and would provide sectorial benchmarking data that could be used to further refine the model for use by organisations operating in particular sectors and would provide data for analysis to identify if particular sectorial differences do exists with respect to the drivers of and need for agility.

10.1.2 Study the Agility Methodology in a Larger Sample

The achieved findings of this research could be easily extended using the same research methodology in a larger scale to cover more manufacturing organisations in all main industrial sectors. This would provide a more comprehensive empirical basis for the findings and confirm that the methodology is generic for every company, regardless of what sector it belongs. Thus further confirming the wider utility of the methodology.

10.1.3 Study the Agility Methodology in Different Industrial Sectors

Further research could be undertaken in other case study companies from individual industrial sectors. This would demonstrate the common conditions of that sector and how it can be evaluated, and allow other researchers to make comparison of the results of the companies in one sector.

10.1.4 Study the Agility Methodology in Related to Specific Company Size

Studying the methodology in related to specific size such as (micro, small or medium) will help to define the common characteristics of that size and refine the methodology to be more applicable for each size.

10.1.5 Study the Agility Methodology in the Service Sector

Agility is an issue that is not only limited to manufacturing organisations. Every business organisation, which is involved in competition for success, can benefit from this concept and use it to build up its structure to be responsive to changes in the business environment, so this study can be extended and redefined to be valid for other sectors such services sector.

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Appendixes

Appendix 1

Sample of Gunasekaran (2002) Questionnaire

Appendix 2

Survey Cover Letter

Coventry University
Priory Street
Coventry CV1 5FB
Telephone 024 7688 7688

Professor Ian M Marshall
Associate Pro-Vice Chancellor (Research)
Dean of Faculty

Dear / Managing Director

I am Adel Hejaaji, member of the research department of Coventry University. I am writing to you concerning a research on "Agile Manufacturing in small to medium size companies (SMEs)", which will assist UK manufacturers to become more competitive in today's global business environment.

The objective of this research is to develop a tool model to assist in the identification of the appropriate factors for the most Agile Manufacturing practices within an SME organisation.

I would be very grateful if you and/or an appropriate colleague (managing director, manufacturing director, production manager, plant manger or business development manger) could assist to complete and to return the attached questionnaire about the current situation in your company, which will help me to identify the extent of the employment of agile manufacturing practices within the SME community. The questionnaire list should take about 20 minutes to complete, and all returned questionnaires from all participants will be treated in full confidential and kept in the University.

The success of this project relies on the open co-operation of companies like yours, and on the precise completion of the questionnaire. Therefore, if you decided to participate in my research program, please fill the attached questionnaire precisely and return it in the enclosed Pre-paid return envelop. Furthermore, if you have participated, you will receive at the end of the research a copy of the outcome summary results. Otherwise, please send a letter or an email with your declines.

If you have any questions, please feel free to contact me at the contact details shown in the last page of the questionnaire.

Finally, I would like to thank you in advance for your kind sincere effort and all time that you have spend to assist me to provide you with the prospective of the findings of this research, which hopefully will help with your competitive efficiency in the very near future.

Yours Sincerely
Adel Hejaaji
(Researcher, Coventry University)

Faculty of Engineering & Computing
Direct Line
Fax

www.coventry.ac.uk

Appendix 3

Research Survey Questionnaire

Agile Manufacturing Questionnaire Assessment Tool

The need for agility in manufacturing organisations

The main driving force behind agility is change, if the manufacturing companies wish to stay competitive in the future; they must accept new values such as flexibility and agility. In order to do this the company must undergo a cultural shift towards a culture of continuous change.

Agile manufacturing is often confused with lean production or flexible manufacturing, but this is not however the case. Agile manufacturing is a business concept and its aim is to place the company ahead of its competitors. The goal of agile manufacturing is to combine the organization, people and technology into and integrated and coordinated whole. A company can benefit from agile manufacturing only if it has a strategy of agility which will allow it to formulate a change plan to implement agility and be competitive.

In order to implement agile manufacturing we need to have a flexible organization. Implementation of lean manufacturing is also crucial to agile manufacturing, but this paradigm alone is not enough to achieve agile manufacturing. We also need to integrate flexible technologies with highly skilled, knowledgeable, motivated and empowered workforce with the help of organizational and management structures.

To successfully implement agile manufacturing we need a lot more than just technology. Most importantly we need changes in attitudes, work practices, organization and employee skills.

The Tool

This document, the Agile Manufacturing Questionnaire Assessment Tool, is a set of questions based on Agility Attributes of manufacturing companies according to the following four main areas of Agility identified:

Solution provider

For the enterprise which is capable of rapidly designing for niche markets, manufactures to individualized customer order, and arranges a high quality-diverse product mix that is: information rich, designed with life cycle design philosophy, and based upon a strategy of enduring, proactive customer perceived value relationships.

Collaborative Operation

For the enterprise that has the technology, information sharing culture, and motivation to globally locate, evaluate and engage assets of any customer, partner or supplier, for the purpose of designing and manufacturing products of shared benefit, in a highly concurrent, nearly co-located environment.

Adaptive Organization

For the enterprise that creates and maintains a culture that holds change as an opportunity. It empowers its organization by facilitating and encouraging rapid reconfigure of its human and physical resources as a strategy for successful in an ever-changing market environment.

Knowledge Driven Enterprise

For the innovative organization that has a documented, open communication policy with its employees, recognizing and continually demonstrating that they and the expertise, knowledge, information, they have

and can obtain are its most important asset. It encourages and rewards innovation, multi-discipline and cross-functional education and training on an aggressive and continuing basis and internalizes ethical and societal values.

In order to obtain the required information for this study the tool has been classified according to:

1. Company Profile and Product Information
2. Company Strategy
3. Information Systems
4. Lean Manufacturing Practices
5. Agility Needed Drivers
6. Agilty Areas Practices
7. General

Purpose of the Agile Manufacturing Questionnaire Assessment Tool (AMQAT)

As a result of a study into agility within manufacturing organisations the AMQAT has been designed to show the area and extent of an organisation's agility. Analysis of the completed AMQAT will result in a quantitative score for agility attributes. Subsequently these can be used by the participating organisation to inform those areas in which change is necessary, if the company is to continue to meet the ever changing needs of it's customers and remain competitive in the marketplace.

The completed questionnaire and its subsequent analysis will be used to further refine the tool and to develop a methodology to improve agility within the manufacturing SMEs Community in the UK.

General Instructions

The questionnaire, which should take no more than 20 minutes to complete, should be undertaken by someone within the company who has knowledge of the customers and suppliers of the organization and the marketplace in which the business operates.

Although subjective, an accurate response will provide a more meaningful analysis result. If time allows, getting a number of senior managers within the company to complete the questionnaire and reaching a consensus view would improve the output from the exercise.

Answering the Questions

This set of questions has been designed to be simple and easy to answer. It offers discrete options to guide the respondents to answer the question by circling or checking the answer that most closely corresponds with his/her opinion

I would like to thank you in advance for your help

Agile Manufacturing Questionnaire Assessment Tool

Section 1 Company Profile and Product Information

Company Name

Respondent Name **Job Title**

Company Address

Post Code

Tel. No. **Fax. No.** **E mail**

2. What is the number of employees in the company?

☐**1-50** ☐**51-100** ☐**1-150** ☐**150-200** ☐**201-250** ☐**more than 250**

3. What is the annual turnover of the company?

☐ **up to £ 4 m** ☐ **£4.1-8m** ☐ **£8.1-12 m** ☐ **£12.1-16m** ☐ **£16.1-20m**

☐ **£20.1-23m** ☐ **£23.1-27m** ☐ **£27.1-30m** ☐ **£30.1-33m** ☐ **more than £33m**

4. What is the ownership type of the company?

☐ **UK owned** ☐ **Non UK owned** ☐ **Joint venture**

5. To what industry sector does your company belong?

☐ **Food/drink** ☐**Electrical/electronics** ☐ **Plastic** ☐ **Engineering** ☐ **Chemical**

☐ **Metal** ☐ **Pharmaceutical** ☐ **Wood** ☐ **Medical Equipment** ☐ **Textile**

☐**Automotive** ☐ **Aerospace** ☐ **Leather** ☐ **Construction** ☐ **Others** .....

6. You produce mainly:

☐ **Raw material** ☐ **Parts** ☐ **Finished marked product**

7. Who are your main customers?

☐ **End user** ☐ **Distributors** ☐ **Other companies**

8. Which of the following best describes your company production type?

☐ **Jobbing** ☐ **Process** ☐ **Batch production**

☐ **Mass production** ☐ **Others** .....

9. How many product types do you produce?

☐**1-5** ☐ **6-10** ☐ **11-15** ☐ **16-20** ☐ **More than 20**

10. How many new products typically do you introduce per year?

☐**1-5** ☐ **6-10** ☐ **11-15** ☐ **16-20** ☐ **More than 20**

11. To what extent you are familiar with the concept of AGILITY? **0** **1** **2** **3** **4**
(0= not familiar at all, 4=very familiar) ☐ ☐ ☐ ☐ ☐

12. To what extent do you consider your company to be a World Class Manufacturing organization?
(0=low extent, 4 =large extent) **0** **1** **2** **3** **4**
☐ ☐ ☐ ☐ ☐

Section 2 Company Strategy **(0= not important, 4= very important)**

1. In response to change situation which of the following capabilities are more important for your company as strategic action for success :

	0	1	2	3	4
a. Increasing responsiveness for change	☐	☐	☐	☐	☐
b. Increasing competency of the company	☐	☐	☐	☐	☐
c. Increasing flexibility in production and services	☐	☐	☐	☐	☐
d. Increasing speed of production and delivery	☐	☐	☐	☐	☐
e. Focusing on customer satisfaction	☐	☐	☐	☐	☐
f. Focusing on product quality	☐	☐	☐	☐	☐
g. Focusing on producing Innovative Products	☐	☐	☐	☐	☐
h. Increasing product's variety	☐	☐	☐	☐	☐
i. Producing customized products	☐	☐	☐	☐	☐

Section 3 Information Systems **(0=not at all, 4= very well)**

1. Is information valued and well used in your company?

0	1	2	3	4
☐	☐	☐	☐	☐

2. Does your company's information management plan identify the strategic use of information systems to improve its competitive advantage in the market place?

0	1	2	3	4
☐	☐	☐	☐	☐

3. Does your company use the internet and related information tools as a means of communication with outside the company and capturing market and company's environment information?

0	1	2	3	4
☐	☐	☐	☐	☐

Section 4 Lean Manufacturing Practices **(0=not at all, 4=completely implemented)**

1. To what level has your company implemented the following lean manufacturing practices:

	0	1	2	3	4
a. Just in time (JIT)	☐	☐	☐	☐	☐
b. Work Cells	☐	☐	☐	☐	☐
c. Standardization of Operations (STOPS)	☐	☐	☐	☐	☐
d. Kanban systems	☐	☐	☐	☐	☐
e. Kaizen	☐	☐	☐	☐	☐
f. Value Stream Mapping (VSM)	☐	☐	☐	☐	☐
g. Total Productive Maintenance (TPM)	☐	☐	☐	☐	☐

Section 5 Agility Needed Drivers

a- Turbulence of the market place environment

1. How often does the company have to review the market's demands in order to monitor its stability? *(0=yearly, 4=weekly)*

0	1	2	3	4
☐	☐	☐	☐	☐

2. What kind of products does the company sell? *(0=basic, 4=luxuries)*

0	1	2	3	4
☐	☐	☐	☐	☐

3. How fashion oriented is the market for the company's products? *(0=not at all, 4=high oriented)*

0	1	2	3	4
☐	☐	☐	☐	☐

4. What is the average rate of change in product models in the marketplace in the sector where the company competes? **0** **1** **2** **3** **4**
   (0=low decreasing, 4=high increasing) ☐ ☐ ☐ ☐ ☐
5. What is percentage of the company's products for which markets are saturated?
   (0=low percentage, 4=high percentage) **0** **1** **2** **3** **4**
   ☐ ☐ ☐ ☐ ☐
6. How long is the average life cycle of the company's products? **0** **1** **2** **3** **4**
   (0=less than a year, 4=more than 10 years) ☐ ☐ ☐ ☐ ☐

b- Various changes in competition bases and criteria

1. Number of direct competitors in local markets? **0** **1** **2** **3** **4**
   (0=few decreasing, 4=many increasing) ☐ ☐ ☐ ☐ ☐
2. Number of competitors in global markets? **0** **1** **2** **3** **4**
   (0=few decreasing, 4=many increasing) ☐ ☐ ☐ ☐ ☐
3. How strong is the competition for market share in local markets? **0** **1** **2** **3** **4**
   (0=very easy, 4=very strong) ☐ ☐ ☐ ☐ ☐
4. How strong is the competition for market share in global markets? **0** **1** **2** **3** **4**
   (0=very easy, 4=very strong) ☐ ☐ ☐ ☐ ☐
5. Trend of new entrances to market where the company competes? **0** **1** **2** **3** **4**
   (0= very low, 4=very high) ☐ ☐ ☐ ☐ ☐
6. Number of substitutes for the company's products? **0** **1** **2** **3** **4**
   (0=none, 4=many) ☐ ☐ ☐ ☐ ☐

c- Ever changing customers' requirements

1. What is the orders type of the company's customers? **0** **1** **2** **3** **4**
   (0=identical, 4= varied) ☐ ☐ ☐ ☐ ☐
2. How high is the rate of change in customer requirements? **0** **1** **2** **3** **4**
   (0=very high, 4= very low) ☐ ☐ ☐ ☐ ☐
3. How often does the company have to retool its manufacturing system because of changes in customer requirements? **0** **1** **2** **3** **4**
   (1=none of any order/product, 4=every order/product) ☐ ☐ ☐ ☐ ☐
4. How critical is the quality of products for your customers? **0** **1** **2** **3** **4**
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☐
5. To what extent has the company had to modify and adjust its systems due to changes in customers' expectations for quality during the past few years? **0** **1** **2** **3** **4**
   (0=no change, 4=high extent change) ☐ ☐ ☐ ☐ ☐
6. How critical is fast/on-schedule delivery time for your customers? **0** **1** **2** **3** **4**
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☐
7. To what extent has the company had to modify and adjust its systems due to changes in the customer's expectations for delivery time during the past few years?
   (0=no change, 4=high extent change) **0** **1** **2** **3** **4**
   ☐ ☐ ☐ ☐ ☐

d- Fast changes and improvement in technology

1. Number of newly introduced product technologies and process technologies (hard facilities, material, software, methods) in the area of the company's business in the past few years?
   (0=not at all, 4=many) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
2. Rate of change in introduction of new product technology and process technology related to the company's business area? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=very low, 4=very high)
3. To what extent has the company had to change and adjust its systems with changes in product and process technology in the past few years? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=no change, 4=high extent change)
4. Complexity of product design process? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=very low,4=very high)
5. Complexity of technology used in products? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=very low, 4=very high)

e- Changes in social factors

1. To what extent has the company had to modify and adjust its systems and products to comply with the requirements for a healthy environment in the few past years?
   (0=no change, 4=high extent change) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
2. Number and change rate of regulations and laws affecting the normal trend of the company's business? *(0=very low, 4=very high)* **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
3. Rate of changes in international political/economic issues related to the company's business?
   (0=very low, 4=very high) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐

Section 6 Agility Areas Practices

1. To what extent is your company considered as a multi product producer?
   (0=not at all, 4=very large extent) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
2. To what extent are your products successful in the market? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=not at all, 4=very large extent)
3. Does your company innovate any of its products every year? **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
   (0=not at all, 4=yes it is)
4. Is your company considered as a leader in introducing new products to the market?
   (0=not at all, 4=yes it is) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
5. To what extent is your company rapid in introducing new models to the market?
   (0=not at all, 4=very fast) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐
6. Is your company rapid in changing production to introduce new models?
   (0=very slow, 4=very fast) **0** ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐

7. How fast does your company move a product from a concept to putting the product in customer hands? **0** **1** **2** **3** **4**
   (0=very slow, 4=very fast) ☐ ☐ ☐ ☐ ☐
8. Is your company driving toward producing a very low cost product? **0** **1** **2** **3** **4**
   (0=not at all, 4=yes it is) ☐ ☐ ☐ ☐ ☐
9. Do your fixed costs influence your production decisions? **0** **1** **2** **3** **4**
   (0=not at all, 4=yes it is) ☐ ☐ ☐ ☐ ☐
10. Are your suppliers working with you to support cost-effective low volume production?
    (0=not at all, 4=yes they are) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
11. To what level does your company meet customers' needs? **0** **1** **2** **3** **4**
    (0= low, 4=high) ☐ ☐ ☐ ☐ ☐
12. How rapid is your company in response to changing demands? **0** **1** **2** **3** **4**
    (0=very slow, 4=very fast) ☐ ☐ ☐ ☐ ☐
13. Is your company quick in manufacturing a unique, customised product?
    (0=very slow, 4=very quick) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
14. Is your company flexible with its products towards customers' needs?
    (0=not at all, 4= very flexible) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
15. Is your company striving to make each customer a lifetime customer?
    (0=not at all, 4=yes it is) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
16. Does your products designed to change with changing customer demands?
    (0=not at all, 4=large extent) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
17. Does your company sell skills, knowledge, and information in a relationship over time?
    (0=not at all, 4=large extent) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
18. To what level does your company need to be effective in the E- commerce marketplace?
    (0=not at all, 4=high level) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
19. Does your company offer after sales services for your customers? **0** **1** **2** **3** **4**
    (0=not at all, 4=high level services) ☐ ☐ ☐ ☐ ☐
20. To what extent does E-business play a role in the company business?
    (0=not at all, 4=large extent) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐
21. How important is it to your company to "Know Your Customer"? **0** **1** **2** **3** **4**
    (0=not important, 4=very important) ☐ ☐ ☐ ☐ ☐
22. Is your marketing strategy linked directly to product design concepts?
    (0=not at all, 4=large extent) **0** **1** **2** **3** **4**
    ☐ ☐ ☐ ☐ ☐

23. Is your company effective in bringing innovations to market?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=very effective)	☐	☐	☐	☐	☐
24. Does your company help customers to identify and solve their problems?					
(0=not at all, 4=very helpful)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
25. Is your company fast in penetrating new markets for your products?					
(0=very slow, 4=very fast)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
26. Does your company consider itself a market leader in your business sector?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
27. Does your product meet quality standards?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
28. To what extent are your customers satisfied with the following parameters:					
(0= very dissatisfied, 4=very satisfied)	**0**	**1**	**2**	**3**	**4**
a. Quality	☐	☐	☐	☐	☐
b. Delivery	☐	☐	☐	☐	☐
c. Price	☐	☐	☐	☐	☐
29. Does your company know and understand how and why your customers use your products?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
30. To what extent does your company seek new ways to attract and keep customers?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
31. Does your company observe, analyse and understand your customers' behaviour?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
32. Does your company view your customers' complaints as opportunities to learn and to improve?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
33. Does your company continuously search out new ways for customers to communicate with you?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
34. Does your company employ both physical and electronic channels to connect with, and to serve your customers?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
35. Does your company use external partnerships to reduce the overall cost of your products?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
36. Do decisions to collaborate with other companies reflect near-term tactical, rather than long-term strategic, objectives?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

37. Would your company go in partnership with your competitors when it makes business sense to do so? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

38. Are your customers proactively engaged in your product development teams? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

39. Do your company mission, goals, and objectives support all the company business functions? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

40. Is your supply chain management dynamic with the market? *(0=not at all, 4=very dynamic)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

41. Does your company believe in people empowerment and team working principles within the whole organisation? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

42. Does your company recognise and reward human capital with its added value partnership contribution to the organization is total value? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

43. Does individual staff work closely with both suppliers and customers? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

44. Can your company respond quickly to a customer's cost, schedule or performance change request? *(0=not at all, 4=very quick)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

45. Does your company strategy include cooperative efforts through partnerships when pursuing new market opportunities? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

46. Which of the following represent reasons why your company would consider entering a virtual partnership or collaboration: *(0=not important, 4=very important)*

	0	**1**	**2**	**3**	**4**
a. Sharing infrastructure, R&D costs.	☐	☐	☐	☐	☐
b. Complementary company product identified.	☐	☐	☐	☐	☐
c. Reducing concept-to-cash through sharing.	☐	☐	☐	☐	☐
d. Increasing facilities and apparent size.	☐	☐	☐	☐	☐
e. Gaining access to markets and sharing information.	☐	☐	☐	☐	☐
f. Developing selling solution skills from selling products.	☐	☐	☐	☐	☐

47. Does your company consider that a partnership with your business network creates synergy for market opportunities and/or maintaining market competitive position? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

48. Does your company use E-commerce to sell your products? *(0=not at all, 4=large extent)*

0	**1**	**2**	**3**	**4**
☐	☐	☐	☐	☐

49. Are your electronic information systems integrated with customers' and suppliers' systems?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
50. Is your company sensitive to accelerating time pressures and demands and strive does it to short the management operational cycle?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
51. Do your suppliers have access to your strategic information?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
52. Are the following types of information shared with your partners/suppliers?					
(0=not at all, 4=large extent shared)	**0**	**1**	**2**	**3**	**4**
a. Cost	☐	☐	☐	☐	☐
b. Technical	☐	☐	☐	☐	☐
c. Marketing	☐	☐	☐	☐	☐
d. Strategic	☐	☐	☐	☐	☐
e. Training	☐	☐	☐	☐	☐
f. Cultural	☐	☐	☐	☐	☐
53. Does your company have the ability to change?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large ability)	☐	☐	☐	☐	☐
54. Does your company recognize change as an "opportunity"?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
55. How fast is the speed of change of your company?	**0**	**1**	**2**	**3**	**4**
(0=very slow, 4=very fast)	☐	☐	☐	☐	☐
56. Is your company active and effective at meeting changing goals and objectives?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
57. Is your company able to identify, capture and analyse your competitors' strengths, weaknesses, and opportunities as well as threats they represent?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
58. Does your company monitor your industry and your competitors' activities?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
59. Does your company monitor other industries and areas of potential competitive threat or opportunity?	**0**	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐
60. Are your management leaders proactive, supportive, and motivational?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐
61. Are your employees motivated to embrace change as an opportunity rather than a threat?					
(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

62. Does your company understand the benefits that result from making decisions more rapidly and effectively than your competitors, and aggressively pursue this strategy?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

63. Does your company focus its energies in improving speed and effectiveness in everything you do?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

64. Does your company quickly and effectively restructure to the changing needs of the marketplace and exploit all potentially profitable marketplace opportunities?

	0	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

65. To what extent is your company able to respond to Market change by modifying:

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
a. Product design	☐	☐	☐	☐	☐
b. Manufacturing processes	☐	☐	☐	☐	☐
c. Administrative procedures	☐	☐	☐	☐	☐
d. Marketing techniques/strategies	☐	☐	☐	☐	☐
e. Sales procedures	☐	☐	☐	☐	☐
f. Supplier relations	☐	☐	☐	☐	☐

66. To what extent is your strategic plan supported by technical plans & operational execution?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

67. Does your company benchmark your competencies?

	0	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

68. Is your company communication among departments highly encouraged and well facilitated?

(0=not at all, 4=very well)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

69. To what extent do you communicate with : (0=v. low, 4=v. high)

	0	**1**	**2**	**3**	**4**
a. Customers	☐	☐	☐	☐	☐
b. Suppliers	☐	☐	☐	☐	☐
c. Partners	☐	☐	☐	☐	☐
d. Internally	☐	☐	☐	☐	☐
e. Stakeholders	☐	☐	☐	☐	☐

70. Does your company employ cross-functional teams to increase the effectiveness of the solutions you deliver to your customers?

	0	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

71. Does every employee in your company have access to all the information he requires to perform the job most effectively and efficiently?

	0	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

72. Does your company train its personnel for multi-skill tasks?

	0	**1**	**2**	**3**	**4**
(0=not at all, 4=large extent)	☐	☐	☐	☐	☐

73. Does your company see training as an investment rather than a cost?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

74. Is your company involved with your local academic institution in delivering training?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

75. Is your company effectively involved in environmental programs?

(0=not at all, 4=very effective)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

76. To what extent are societal values considered in the company's strategic plan?

(0=not at all, 4=large extent)	**0**	**1**	**2**	**3**	**4**
	☐	☐	☐	☐	☐

Section 7 General

1. The next stage of the research will involve structured interviews or the documenting of case studies. Would your company be willing to take part in the second phase?

   ☐ Interview ☐ Case study

2. Would you like to receive a copy of the results of this survey?

   ☐ Yes ☐ No

3. Please fell free to add any comments.

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Thank you for your time, information and assistance

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Appendix 4

Follow-Up Company E- Mails Reminder

Dear Manufacturing Director

I would like to reminder you that we are still awaiting your valuable response to our Questionnaire that was sent to you on 1st Oct 2006. If you have completed the questionnaire please could you send it back to us as soon as you can, to make our analysis of your company and to complete our project.

Thank you for your help and co-operation

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Appendix 5

Likert Scale

Likert Scale

The Likert scale was used to determine the extent to which the areas of; strategic capability, information systems, agility business environments drivers and current level of agility .

Respondent were asked to express agreement or disagreement on a five-point scale. Each degree of agreement is given a numerical value from zero to four. Thus a total numerical value can be calculated from all of the responses.

Before the analysis of the questionnaire assessment tool results was undertaken a scale for the answers according to the Likert scale was produced to locate all the responses within boundaries to provide a means of comparison, as shown below.

0	1	2	3	4
☐	☐	☐	☐	☐

Likert Scale of the Questions

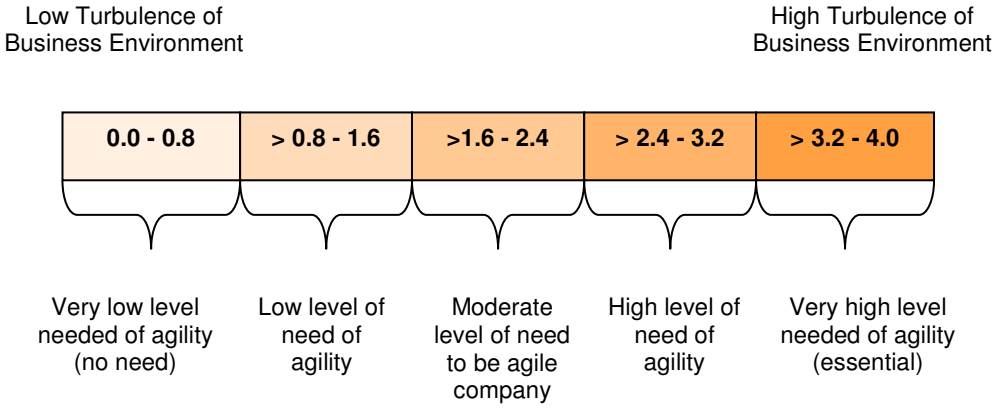
Appendix 6

Measuring Scale

Measuring scale

Measuring scale produced to assess the questionnaire assessment tool ability to define the level of business environment drivers and need of agility level; five separate multilevel analyses were carried out on the following domains:

1. Very low level needed of agility (no need) Low Turbulence of Business Environment
2. Low level need of agility
3. Moderate level need to be agile company
4. High level need of agility
5. Very high level needed of agility (essential) High Turbulence of Business Environment



Classification of the Measuring Scale According Level of Turbulence of Business Environment

Appendix 7

Sample of the Returned Questionnaire

Section 2 Company Strategy (0= not important, 4= very important)

1. In response to change situation which of the following capabilities are more important for your company as strategic action for success :

	0	1	2	3	4
a. Increasing responsiveness for change	☐	☐	☑	☐	☐
b. Increasing competency of the company	☐	☐	☐	☑	☐
c. Increasing flexibility in production and services	☐	☐	☐	☑	☐
d. Increasing speed of production and delivery	☐	☐	☑	☐	☐
e. Focusing on customer satisfaction	☐	☐	☐	☐	☑
f. Focusing on product quality	☐	☐	☐	☐	☑
g. Focusing on producing Innovative Products	☐	☐	☑	☐	☐
h. Increasing product's variety	☐	☐	☑	☐	☐
i. Producing customized products	☐	☐	☐	☐	☑

Section 3 Information Systems (0=not at all, 4= very well)

1. Is information valued and well used in your company?

0	1	2	3	4
☐	☐	☐	☐	☑

2. Does your company's information management plan identify the strategic use of information systems to improve its competitive advantage in the market place?

0	1	2	3	4
☐	☐	☐	☐	☑

3. Does your company use the internet and related information tools as a means of communication with outside the company and capturing market and company's environment information?

0	1	2	3	4
☐	☐	☑	☐	☐

Section 4 Lean Manufacturing Practices (0=not at all, 4=completely implemented)

1. To what level has your company implemented the following lean manufacturing practices:

	0	1	2	3	4
a. Just in time (JIT)	☐	☐	☑	☐	☐
b. Work Cells	☑	☐	☐	☐	☐
c. Standardization of Operations (STOPS)	☐	☐	☑	☐	☐
d. Kanban systems	☑	☐	☐	☐	☐
e. Kaizen	☑	☐	☐	☐	☐
f. Value Stream Mapping (VSM)	☑	☐	☐	☐	☐
g. Total Productive Maintenance (TPM)	☐	☐	☐	☑	☐

Section 5 Agility Needed Drivers

a- Turbulence of the market place environment

1. How often does the company have to review the market's demands in order to monitor its stability? *(0=yearly, 4=weekly)*

0	1	2	3	4
☐	☐	☐	☐	☑

2. What kind of products does the company sell? *(0=basic, 4=luxuries)*

0	1	2	3	4
☐	☐	☐	☐	☑

3. How fashion oriented is the market for the company's products? *(0=not at all, 4=high oriented)*

0	1	2	3	4
☑	☐	☐	☐	☐

4. What is the average rate of change in product models in the marketplace in the sector where the company competes? 0 1 2 3 4
   (0=low decreasing, 4=high increasing) ☐ ☐ ☐ ☑ ☐
5. What is percentage of the company's products for which markets are saturated?
   (0=low percentage, 4=high percentage) 0 1 2 3 4
   ☐ ☐ ☐ ☐ ☑
6. How long is the average life cycle of the company's products? 0 1 2 3 4
   (0=less than a year, 4=more than 10 years) ☐ ☐ ☐ ☐ ☑

b- Various changes in competition bases and criteria

1. Number of direct competitors in local markets? 0 1 2 3 4
   (0=few decreasing, 4=many increasing) ☐ ☐ ☐ ☐ ☑
2. Number of competitors in global markets? 0 1 2 3 4
   (0=few decreasing, 4=many increasing) ☐ ☐ ☐ ☐ ☑
3. How strong is the competition for market share in local markets? 0 1 2 3 4
   (0=very easy, 4=very strong) ☐ ☐ ☐ ☐ ☑
4. How strong is the competition for market share in global markets? 0 1 2 3 4
   (0=very easy, 4=very strong) ☐ ☐ ☐ ☐ ☑
5. Trend of new entrances to market where the company competes? 0 1 2 3 4
   (0= very low, 4=very high) ☐ ☐ ☐ ☑ ☐
6. Number of substitutes for the company's products? 0 1 2 3 4
   (0=none, 4=many) ☐ ☐ ☑ ☐ ☐

c- Ever changing customers' requirements

1. What is the orders type of the company's customers? 0 1 2 3 4
   (0=identical, 4= varied) ☐ ☐ ☐ ☐ ☑
2. How high is the rate of change in customer requirements? 0 1 2 3 4
   (0=very high, 4= very low) ☐ ☐ ☐ ☐ ☑
3. How often does the company have to retool its manufacturing system because of changes in customer requirements? 0 1 2 3 4
   (1=none of any order/product, 4=every order/product) ☐ ☐ ☐ ☑ ☐
4. How critical is the quality of products for your customers? 0 1 2 3 4
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☑
5. To what extent has the company had to modify and adjust its systems due to changes in customers' expectations for quality during the past few years? 0 1 2 3 4
   (0=no change, 4=high extent change) ☐ ☐ ☐ ☐ ☑
6. How critical is fast/on-schedule delivery time for your customers? 0 1 2 3 4
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☑
7. To what extent has the company had to modify and adjust its systems due to changes in the customer's expectations for delivery time during the past few years?
   (0=no change, 4=high extent change) 0 1 2 3 4
   ☐ ☐ ☐ ☑ ☐

d- Fast changes and improvement in technology

1. Number of newly introduced product technologies and process technologies (hard facilities, material, software, methods) in the area of the company's business in the past few years?
   (0=not at all, 4=many) 0 1 2 3 4 — ☐ ☐ ☐ ☐ ☑
2. Rate of change in introduction of new product technology and process technology related to the company's business area? 0 1 2 3 4
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☑
3. To what extent has the company had to change and adjust its systems with changes in product and process technology in the past few years? 0 1 2 3 4
   (0=no change, 4=high extent change) ☐ ☐ ☐ ☑ ☐
4. Complexity of product design process? 0 1 2 3 4
   (0=very low,4=very high) ☐ ☐ ☐ ☐ ☑
5. Complexity of technology used in products? 0 1 2 3 4
   (0=very low, 4=very high) ☐ ☐ ☐ ☐ ☑

e- Changes in social factors

1. To what extent has the company had to modify and adjust its systems and products to comply with the requirements for a healthy environment in the few past years?
   (0=no change, 4=high extent change) 0 1 2 3 4 — ☐ ☐ ☑ ☐ ☐
2. Number and change rate of regulations and laws affecting the normal trend of the company's business? *(0=very low, 4=very high)* 0 1 2 3 4 — ☐ ☐ ☐ ☑ ☐
3. Rate of changes in international political/economic issues related to the company's business?
   (0=very low, 4=very high) 0 1 2 3 4 — ☐ ☐ ☑ ☐ ☐

Section 6 Agility Areas Practices

1. To what extent is your company considered as a multi product producer?
   (0=not at all, 4=very large extent) 0 1 2 3 4 — ☐ ☐ ☐ ☑ ☐
2. To what extent are your products successful in the market? 0 1 2 3 4
   (0=not at all, 4=very large extent) ☐ ☐ ☐ ☐ ☑
3. Does your company innovate any of its products every year? 0 1 2 3 4
   (0=not at all, 4=yes it is) ☐ ☐ ☑ ☐ ☐
4. Is your company considered as a leader in introducing new products to the market?
   (0=not at all, 4=yes it is) 0 1 2 3 4 — ☐ ☐ ☐ ☑ ☐
5. To what extent is your company rapid in introducing new models to the market?
   (0=not at all, 4=very fast) 0 1 2 3 4 — ☐ ☐ ☐ ☑ ☐
6. Is your company rapid in changing production to introduce new models?
   (0=very slow, 4=very fast) 0 1 2 3 4 — ☐ ☐ ☐ ☑ ☐

7. How fast does your company move a product from a concept to putting the product in customer hands?
(0=very slow, 4=very fast)

0	1	2	3	4
☐	☐	☑	☐	☐

8. Is your company driving toward producing a very low cost product?
(0=not at all, 4=yes it is)

0	1	2	3	4
☐	☑	☐	☐	☐

9. Do your fixed costs influence your production decisions?
(0=not at all, 4=yes it is)

0	1	2	3	4
☐	☐	☑	☐	☐

10. Are your suppliers working with you to support cost-effective low volume production?
(0=not at all, 4=yes they are)

0	1	2	3	4
☐	☑	☐	☐	☐

11. To what level does your company meet customers' needs?
(0= low, 4=high)

0	1	2	3	4
☐	☐	☐	☐	☑

12. How rapid is your company in response to changing demands?
(0=very slow, 4=very fast)

0	1	2	3	4
☐	☐	☐	☑	☐

13. Is your company quick in manufacturing a unique, customised product?
(0=very slow, 4=very quick)

0	1	2	3	4
☐	☐	☐	☑	☐

14. Is your company flexible with its products towards customers' needs?
(0=not at all, 4= very flexible)

0	1	2	3	4
☐	☐	☐	☑	☐

15. Is your company striving to make each customer a lifetime customer?
(0=not at all, 4=yes it is)

0	1	2	3	4
☐	☐	☐	☑	☐

16. Does your products designed to change with changing customer demands?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☑	☐	☐

17. Does your company sell skills, knowledge, and information in a relationship over time?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

18. To what level does your company need to be effective in the E- commerce marketplace?
(0=not at all, 4=high level)

0	1	2	3	4
☐	☐	☐	☑	☐

19. Does your company offer after sales services for your customers?
(0=not at all, 4=high level services)

0	1	2	3	4
☐	☐	☐	☑	☐

20. To what extent does E-business play a role in the company business?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

21. How important is it to your company to "Know Your Customer"?
(0=not important, 4=very important)

0	1	2	3	4
☐	☐	☐	☑	☐

22. Is your marketing strategy linked directly to product design concepts?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

23. Is your company effective in bringing innovations to market? 0 1 2 3 4
(0=not at all, 4=very effective) ☐ ☐ ☐ ☑ ☐

24. Does your company help customers to identify and solve their problems?
(0=not at all, 4=very helpful) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

25. Is your company fast in penetrating new markets for your products?
(0=very slow, 4=very fast) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

26. Does your company consider itself a market leader in your business sector?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

27. Does your product meet quality standards? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☐ ☑ ☐

28. To what extent are your customers satisfied with the following parameters:
(0= very dissatisfied, 4=very satisfied) 0 1 2 3 4
a. Quality ☐ ☐ ☐ ☑ ☐
b. Delivery ☐ ☐ ☐ ☑ ☐
c. Price ☐ ☐ ☐ ☐ ☑

29. Does your company know and understand how and why your customers use your products?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

30. To what extent does your company seek new ways to attract and keep customers?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

31. Does your company observe, analyse and understand your customers' behaviour?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

32. Does your company view your customers' complaints as opportunities to learn and to improve?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☐ ☑

33. Does your company continuously search out new ways for customers to communicate with you?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

34. Does your company employ both physical and electronic channels to connect with, and to serve your customers? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☐ ☑ ☐

35. Does your company use external partnerships to reduce the overall cost of your products?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☐ ☑

36. Do decisions to collaborate with other companies reflect near-term tactical, rather than long-term strategic, objectives? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☐ ☐ ☑

37. Would your company go in partnership with your competitors when it makes business sense to do so? *(0=not at all, 4=large extent)*

0	1	2	3	4
☐	☐	☐	☑	☐

38. Are your customers proactively engaged in your product development teams?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

39. Do your company mission, goals, and objectives support all the company business functions?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

40. Is your supply chain management dynamic with the market?
(0=not at all, 4=very dynamic)

0	1	2	3	4
☐	☐	☐	☑	☐

41. Does your company believe in people empowerment and team working principles within the whole organisation?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

42. Does your company recognise and reward human capital with its added value partnership contribution to the organization is total value?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

43. Does individual staff work closely with both suppliers and customers?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

44. Can your company respond quickly to a customer's cost, schedule or performance change request?
(0=not at all, 4=very quick)

0	1	2	3	4
☐	☐	☐	☐	☑

45. Does your company strategy include cooperative efforts through partnerships when pursuing new market opportunities?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☐	☑

46. Which of the following represent reasons why your company would consider entering a virtual partnership or collaboration: *(0=not important, 4=very important)*

	0	1	2	3	4
a. Sharing infrastructure, R&D costs.	☐	☐	☐	☐	☑
b. Complementary company product identified.	☐	☐	☐	☑	☐
c. Reducing concept-to-cash through sharing.	☐	☐	☐	☑	☐
d. Increasing facilities and apparent size.	☐	☐	☐	☑	☐
e. Gaining access to markets and sharing information.	☐	☐	☐	☑	☐
f. Developing selling solution skills from selling products.	☐	☐	☐	☑	☐

47. Does your company consider that a partnership with your business network creates synergy for market opportunities and/or maintaining market competitive position?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☐	☐	☑	☐

48. Does your company use E-commerce to sell your products?
(0=not at all, 4=large extent)

0	1	2	3	4
☐	☑	☐	☐	☐

49. Are your electronic information systems integrated with customers' and suppliers' systems?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

50. Is your company sensitive to accelerating time pressures and demands and strive does it to short the management operational cycle? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☑ ☐ ☐ ☐

51. Do your suppliers have access to your strategic information? 0 1 2 3 4
(0=not at all, 4=large extent) ☑ ☐ ☐ ☐ ☐

52. Are the following types of information shared with your partners/suppliers?
(0=not at all, 4=large extent shared) 0 1 2 3 4
a. Cost ☐ ☐ ☑ ☐ ☐
b. Technical ☐ ☐ ☑ ☐ ☐
c. Marketing ☐ ☐ ☑ ☐ ☐
d. Strategic ☐ ☑ ☐ ☐ ☐
e. Training ☑ ☐ ☐ ☐ ☐
f. Cultural ☐ ☐ ☑ ☐ ☐

53. Does your company have the ability to change? 0 1 2 3 4
(0=not at all, 4=large ability) ☐ ☑ ☐ ☐ ☐

54. Does your company recognize change as an "opportunity"? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☑ ☐ ☐

55. How fast is the speed of change of your company? 0 1 2 3 4
(0=very slow, 4=very fast) ☐ ☑ ☐ ☐ ☐

56. Is your company active and effective at meeting changing goals and objectives?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☑ ☐ ☐

57. Is your company able to identify, capture and analyse your competitors' strengths, weaknesses, and opportunities as well as threats they represent? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☑ ☐ ☐

58. Does your company monitor your industry and your competitors' activities?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☑ ☐

59. Does your company monitor other industries and areas of potential competitive threat or opportunity? 0 1 2 3 4
(0=not at all, 4=large extent) ☐ ☐ ☐ ☐ ☑

60. Are your management leaders proactive, supportive, and motivational?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☐ ☐ ☐ ☑

61. Are your employees motivated to embrace change as an opportunity rather than a threat?
(0=not at all, 4=large extent) 0 1 2 3 4
☐ ☑ ☐ ☐ ☐

62. Does your company understand the benefits that result from making decisions more rapidly and effectively than your competitors, and aggressively pursue this strategy?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☑	☐	☐

63. Does your company focus its energies in improving speed and effectiveness in everything you do?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☑	☐	☐

64. Does your company quickly and effectively restructure to the changing needs of the marketplace and exploit all potentially profitable marketplace opportunities?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☑	☐	☐	☐

65. To what extent is your company able to respond to Market change by modifying:

(0=not at all, 4=large extent)	0	1	2	3	4
a. Product design	☐	☑	☐	☐	☐
b. Manufacturing processes	☐	☐	☑	☐	☐
c. Administrative procedures	☐	☑	☐	☐	☐
d. Marketing techniques/strategies	☐	☑	☐	☐	☐
e. Sales procedures	☐	☑	☐	☐	☐
f. Supplier relations	☐	☐	☑	☐	☐

66. To what extent is your strategic plan supported by technical plans & operational execution?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☐	☑	☐

67. Does your company benchmark your competencies?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☑	☐	☐

68. Is your company communication among departments highly encouraged and well facilitated?

(0=not at all, 4=very well)	0	1	2	3	4
	☐	☑	☐	☐	☐

69. To what extent do you communicate with : (0=v. low, 4=v. high)

	0	1	2	3	4
a. Customers	☐	☐	☐	☑	☐
b. Suppliers	☐	☑	☐	☐	☐
c. Partners	☐	☐	☑	☐	☐
d. Internally	☐	☐	☑	☐	☐
e. Stakeholders	☐	☐	☐	☐	☑

70. Does your company employ cross-functional teams to increase the effectiveness of the solutions you deliver to your customers?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☐	☑	☐

71. Does every employee in your company have access to all the information he requires to perform the job most effectively and efficiently?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☐	☑	☐

72. Does your company train its personnel for multi-skill tasks?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☑	☐	☐	☐

73. Does your company see training as an investment rather than a cost?

(0=not at all, 4=large extent)	0	1	2	3	4
	☐	☐	☑	☐	☐

74. Is your company involved with your local academic institution in delivering training?

	0	1	2	3	4
(0=not at all, 4=large extent)	☐	☐	☑	☐	☐

75. Is your company effectively involved in environmental programs?

	0	1	2	3	4
(0=not at all, 4=very effective)	☐	☐	☑	☐	☐

76. To what extent are societal values considered in the company's strategic plan?

	0	1	2	3	4
(0=not at all, 4=large extent)	☐	☐	☑	☐	☐

Section 7 General

1. The next stage of the research will involve structured interviews or the documenting of case studies. Would your company be willing to take part in the second phase?

   ☑ Interview ☑ Case study

2. Would you like to receive a copy of the results of this survey?

   ☑ Yes ☐ No

3. Please fell free to add any comments.

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Thank you for your time, information and assistance

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Appendix 8

Scoring System of Agility Business Environment Drivers

Could you please rate the following items:

For all questions (0= not at all 1 2 3 4= very high)

items	Agility Business Environment Drivers	Score 0- 4
Item a	**Turbulence of the market place environment**	**Average a**
1	Rate of review the market's demands in order to monitor company stability	
2	Level of complexity of products the company sell	
3	Fashion effect on the market for the company's products	
4	Rate of change in product models	
5	Percentage of the company's products for which markets are saturated	
6	Average of life cycle of the company's products	
Item b	**Various changes in competition bases and criteria**	**Average b**
1	Number of direct competitors in local markets	
2	Number of competitors in global markets	
3	Strength of the competition for market share in local markets	
4	Strength of the competition for market share in global markets	
5	Trend of new entrances to market where the company competes	
6	Number of substitutes for the company's products	
Item c	**Ever changing customers' requirements**	**Average c**
1	Rate of differences in customers orders of the company products	
2	Rate of change in customer requirements	
3	Level of need to retooling of manufacturing system according to changes in customer requirements	
4	How critical is the quality of products for your customers	
5	Level of need to modifying and adjust its systems due to changes in customers' expectations for quality	
6	How critical is delivery time for your customers	
7	Level of need to modifying and adjust its systems due to changes in the customer's expectations for delivery time	
Item d	**Fast changes and improvement in technology**	**Average d**
1	Number of newly introduced product technologies and process technologies	
2	Rate of change in introduction of new product technology and process technology related to the company's business area	
3	Rate of changing systems, process and technology in the last 3 years	
4	Complexity level of product design process	
5	Complexity level of technology used in products	
Item e	**Changes in Social Factors**	**Average e**
1	Changes level of systems, technology and products to comply with the requirements for a healthy environment	
2	Change rate of regulations and laws affecting the normal trend of the company's business	
3	Rate of changes in international political/economic issues related to the company's business	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Agility Business Environment Drivers can be calculated as follows:

Step 1: fill the right score of the sub items of a, b, c, d and e according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of each item a, b and c according to the following equation:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of Y sub items*

X = *Score of each sub item of Y*

Y = *a, b, c, d, e*

Step 3: calculate the total average of Agility Business Environment Drivers according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$

Where

n = *Number of items = 5*

Y = *Item average*

Method 2: Electronic Method

Fill all the scores of the items through the Excel work sheet and the total average of the Agility Business Environment Drivers will appear total average cell.

Appendix 9

Scoring System of Strategic Capabilities

Could you please rate the following capabilities according to importance for your company as strategic action for success :

For all items (0 = not important 1 2 3 4 = very important)

Items	Agility Strategic Capabilities	Score 0- 4
1	Increasing responsiveness for change	
2	Increasing competency of the company	
3	Increasing flexibility in production and services	
4	Increasing speed of production and delivery	
5	Focusing on customer satisfaction	
6	Focusing on product quality	
7	Focusing on producing Innovative Products	
8	Increasing product's variety	
9	Producing customised products	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Agility Strategic Capabilities can be calculated as follows:

Step 1: fill the right score of nine Agility Strategic Capabilities according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the total average of Agility Strategic Capabilities according to the following equation:

Total average = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of items = 9*

X = *Score of each item*

Method 2: Electronic Method

Fill all the scores of the items through the Excel work sheet and the total average of the Agility Strategic Capabilities will appear total average cell.

Appendix 10

Scoring System of Information Systems

Could you please score the following Information Systems items:

For all questions (0= not at all 1 2 3 4= large extent)

Items	Information Systems	Score 0- 4
1	Use of Information inside the company	
2	Management plan identify the strategic use of information systems	
3	Use of internet and information tools in the company	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Information Systems can be calculated as follows:

Step 1: fill the right score of the items of 1, 2 and 3 according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of all items according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of items*

X = *Score of each item*

Method 2: Electronic Method

Fill all the scores of the items through the Excel work sheet and the total average of the Information Systems will appear total average cell.

Appendix 11

Agility Dimensions Practices Scouring System

A- Solutions Provider Area

Could you please rate the following items:

For all questions (0= not at all 1 2 3 4= large extent)

Items	Solutions Provider Area	Score 0- 4
Item a	**High Product variety**	**Average a**
1	To what extent the company considered as multi product producer	
2	To what extent company products successful in the market	
Item b	**High Product Introduction Rate**	**Average b**
1	To what extent the company innovative its products	
2	To what extent the company considered leader in introducing new products to the market	
Item c	**Frequent Model Changes**	**Average c**
1	Rapid in introducing new models to the market	
2	Rapid in changing production to introduce new models	
d	**Rapid Concept to Cash**	**Average d**
1	Fast move product from a concept to putting product in customer hands	
Item e	**Cost-Effective Low Volume Producer**	**Average e**
1	To what extent the company considered low cost products	
2	To what extent the company apply reduce costs strategy	
3	To what extent your suppliers support cost-effective low volume production	
Item f	**Production to Order**	**Average f**
1	To what extent the company meets customers' needs	
2	To what extent the company rapid in response to change demands	
Item g	**Tailor made Solutions (Products/Services)**	**Average g**
1	To what extent the company quick in manufacturing a unique customised product	
2	To what extent the company flexible of products towards customers' needs	
Item h	**Product and Customer Support**	**Average h**
1	To what extent the company strive to keep customers as lifetime customers	
2	To what extent company products designed to evolve with changing customer demands	
Item i	**High Information Products**	**Average i**
1	To what extent the company considered selling skills, knowledge, and information	
2	To what extent the company effective in the digital commerce marketplace	
Item j	**Long lasting customer relationship**	**Average j**
1	To what extent the company offer customer after sales services	
2	To what extent E-business Important for the company business	

3	To what extent “Know Your Customer” is Important principle for the company	
Item k	**Consumer Demand Changes**	**Average k**
1	To what extent the company link marketing strategy to product design concepts	
2	To what extent the effective in bringing innovations to market	
3	To what extent the company help customers to identify and solve their problems	
4	To what extent the company fast in penetrating new markets for products	
5	To what extent the company considered market leader in a business sector	
Item l	**High Quality Standards**	**Average l**
1	To what extent the company produce high quality standards products	
2	To what extent the company customers satisfaction with Quality	
3	To what extent the company customers satisfaction with Delivery	
4	To what extent the company customers satisfaction with Price	
Item m	**Satisfaction customers**	**Average m**
1	To what extent the company understanding how and why customers use company products	
2	To what extent the company seeking new ways to attract and keep customers	
3	To what extent the company understanding customers' behaviour	
4	To what extent the company considers customers' complaints as opportunities to learn and improve	
5	To what extent the company searching of new ways to communicate with customers	
6	To what extent the company employing physical and electronic channels to serve customers	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Solutions Provider Area can be calculated as follows:

Step 1: fill the right score of the sub items of a, b, c, d. e, f, g, h, i, j, k, l and m according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of each item a, b, c, d. e, f, g, h, i, j, k, l and m according to the following equation:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of Y sub items*

X = *Score of each sub item of Y*

Y = *a, b, c, d. e, f, g, h, i, j, k, l, m*

Step 3: calculate the total average of Solutions Provider Area according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$

Where

n = *Number of items = 13*

Y = *Item average*

Method 2: Electronic Method

Fill all the scores of the sub items through the Excel work sheet and the total average of the Solutions Provider Area will appear total average cell.

B- Collaborative Operations Area

Could you please rate the following items:

For all questions (0= not at all 1 2 3 4= large extent)

Items	Collaborative Operations Area	Score 0- 4
Item a	**Cooperation strategy**	Average a
1	To what extent the company using external partnerships to reduce products cost	
2	To what extent the company support collaboration strategy with other companies	
3	To what extent the company partnering with competitors when it necessary	
Item b	**Product Integration & Process Development**	Average b
1	To what extent the company engaging customers in product development	
2	To what extent the company meet goals, and objectives with all business functions	
3	To what extent the company suppliers support delivery schedule	
c	**Integrated Enterprise Processes**	Average c
1	To what extent the company support people empowerment and team working principle	
2	To what extent the company supporting partnership strategy	
Item d	**Customer-Supplier Interactive Relationships**	Average d
1	To what extent the staff, suppliers and customers cooperate with each other	
2	To what extent the company fast in responding to customer's change requests	
Item e	**Organisation Virtual Partnership**	Average e
1	To what extent the company work to Increase overall effectiveness through collaboration	
	To what extent the company work to:	
2	Decrease infrastructure and R&D costs	
3	Complementary company product identified	
4	Reducing concept-to-cash	
5	Increasing facilities and apparent size	
5	Gaining access to new markets	
7	Developing selling solution skills from selling products	
8	To what extent the company consider partnership with business network creates synergy for competitive position	
Item f	**Electronically Commerce organisation**	Average f
1	To what extent the company adoption of electronic commerce to sell products	
2	To what extent the company information systems Integrated with customers' and suppliers' systems	
g	**Short operation cycle**	Average g

1	To what extent the company sensitive to accelerating time pressures to short the management operational cycles	
Item h	**Information sharing strategy**	**Average h**
1	To what extent the company give authority for suppliers to access company strategic information	
	To what extent the company shared Information with suppliers:	
2	Cost	
3	Technical	
4	Marketing	
5	Strategic	
6	Training	
7	Cultural	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Collaborative Operations Area can be calculated as follows:

Step 1: fill the right score of the sub items of a, b, c, d. e, f, g and h according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of each item a, b, c, d. e, f, g and h according to the following equation:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = number of Y sub items X = Score of each sub item of Y Y = a, b, c, d. e, f, g, h

Step 3: calculate the total average of Collaborative Operations Area according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$

Where n = Number of items = 8 Y = Item average

= No score cell

Method 2: Electronic Method

Fill all the scores of the sub items through the Excel work sheet and the total average of the Collaborative Operations Area will appear total average cell.

C- Adaptive Organisation Area

Could you please rate the following items:

For all questions (0= not at all 1 2 3 4= large extent)

items	Adaptive Organisation Area	Score 0- 4
Item a	**Capable and ready for change**	**Average a**
1	To what extent the company has ability to change	
2	To what extent the manufacturing facilities of the company has ability to change	
3	To what extent the company speedy of change	
4	To what extent the company active and effectiveness in meeting changing goals and objectives	
Item b	**Competitors Monitoring**	**Average b**
1	To what extent the company has ability to identify, and analyse competitors' strengths, weaknesses	
2	To what extent the company monitoring industry and competitors' activities	
3	To what extent the company monitor other industries for competitive threat or opportunity	
Item c	**Management Leadership**	**Average c**
1	To what extent the company practicing and supporting of management leaders	
2	To what extent the company motivation of employees	
Item d	**High Response for change**	**Average d**
1	To what extent the company decisions are fast and rapid of making more than competitors	
2	To what extent the company focusing in improving speed and effectiveness	
3	To what extent the company quickness of restructure to the changing needs of the marketplace	
	To what extent the company has ability to respond to market change by modifying:	
4	Product design	
5	Manufacturing processes	
6	Administrative procedures	
7	Marketing techniques/strategies	
8	Sales procedures	
9	Supplier relations	
Total Average		

Scoring

Method 1: Calculation Method

The total average of Adaptive Organisation Area can be calculated as follows:

Step 1: fill the right score of the sub items of a, b, c and d according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of each item a, b, c and d according to the following equation:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of Y sub items*

X = *Score of each sub item of Y*

Y = *a, b, c, d*

Step 3: calculate the total average of Adaptive Organisation Area according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$

Where

n = *Number of items = 4*

Y = *Item average*

 = No score cell

Method 2: Electronic Method

Fill all the scores of the sub items through the Excel work sheet and the total average of the Adaptive Organisation Area will appear total average cell.

D- Knowledge Driven Enterprise Area

Could you please rate the following items:

For all questions (0= not at all 1 2 3 4= large extent)

Items	Knowledge Driven Enterprise area	Score 0- 4
Item a	**Dynamic Competency Testing**	**Average a**
1	To what extent the company strategic plan supported by technical plans and operational execution	
2	To what extent the company apply benchmarking with competencies	
Item b	**High communication level**	**Average b**
1	To what extent the communication level among departments fast and effective	
	To what extent the communication level fast and effective with:	
2	Customers	
3	Suppliers	
4	Partners	
5	Internally	
6	Stakeholders	
Item c	**Innovative and high skilled Workforce**	**Average c**
1	To what extent the company employing cross-functional teams	
2	To what extent the employees have access to all the information requires performing their jobs	
Item d	**Knowledge & Training based Organisation**	**Average d**
1	To what extent the company train employees for multi-skill tasks	
2	To what extent the company consider training in its strategy	
3	To what extent the company involving in local academic institution training	
Item e	**Active in Societal activities**	**Average e**
1	To what extent the company effective in environmental programs	
2	To what extent the company links societal values to company's strategic plan	
	Total Average	

Scoring

Method 1: Calculation Method

The total average of Knowledge Driven Enterprise Area can be calculated as follows:

Step 1: fill the right score of the sub items of a, b, d and e according to Likert scale from 0 to 4 as shown above.

Step 2: calculate the average of each item a, b, d and e according to the following equation:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of Y sub items*

X = *Score of each sub item of Y*

Y = *a, b, c, d, e*

Step 3: calculate the total average of Knowledge Driven Enterprise Area according to the following equation:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$

Where

n = *Number of items = 5*

Y = *Item average*

 = No score cell

Method 2: Electronic Method

Fill all the scores of the sub items through the Excel work sheet and the total average of the Knowledge Driven Enterprise Area will appear total average cell.

Appendix 12

Agility Attributes Definitions

Solution Provider

1. High Product Variety : An organisation or individual that focuses on selling its products or services to a select group of consumers and the specialised, sometimes customised products or services that they purchase, its the level of product variety of the company comparing to competitive.
2. High Product Introduction Rate: the level of introduction new products to the market.
3. Frequent Model Changes: how rapidly the company able to change the products models regularly, the variation of product types as determined by metrics, such as the number of product types and the number of distinct markets for the products.
4. Rapid Concept to Cash: how rapidly the company can move idea of new product from concept to put it in the customer hand, the relatively small time interval between when an idea for a product or service is first conceived and when the customer is billed.
5. Cost-Effective Low Volume Producer: the ability to produce arbitrarily small lot sizes with out detrimental effects on quality or profitability.
6. Production to Order: the manufacture of the exact number of items specified by a customer. In an agile environment, the capability to produce a product to order is usually accompanied by rapid response to customer demands.
7. Tailor Made Solutions (Products/Services): the ability of the company to produce products and services which can easily configure and customised for individual customers.
8. Product and Customer Support: the ability of the company to design and produce products to evolve with changing with the customer and market demands. A value based strategy built upon customer satisfaction with the ongoing support of products or services.
9. High Information Products: the quality of information offered by the company for the customers related to the products and services whose value is contained in the skills and information that they represent.
10. Long Lasting Customer Relationship: A collaborative, amicable, long-lasting relationship between a customer and supplier. Actions taken by a supplier that contribute to an Enduring Customer Relationship include regular tracking and use of customer data such as repeat business and referral customers, anticipation of customer demands, and the use of customers' inputs.
11. Consumer Demand Changes: how the company able to produce new products for new application for their customers, the premise of building a marketing strategy around value added services and or products which solve customer problems.
12. High Quality Standards: the level of quality of company's products and services, the degree of product or service excellence; characterised by exceeding customer requirements of reliability, durability, and freedom from defects

13. Customers Satisfaction: the level of company's customer satisfaction, the pursuit of marketing strategies and tactics that anticipate changing market conditions. The process of taking the initiative in developing marketing strategies, products, and solutions that anticipate the current and future needs of a customer.

Collaborative Operations

1. Cooperation strategy: the ability of the company to adopt cooperation strategy when it's useful to do so, the strategy of first choice for creating products and solutions, cooperation within the company and externally with customers, suppliers and others.
2. Product Integration and Process Development: the level of integration between the company and customers, partners and suppliers in product development. The simultaneous consideration of product design, manufacturing process, customer needs, and business practices by the extended enterprise.
3. Integrated Enterprise Processes: the integration level inside the company. A relationship between all elements of the supply chain, including partners, in which the processes, procedures, and communications between the elements are so integrated that the differences between the elements are not apparent.
4. Customer-Supplier Interactive Relationships: the relation between the staff and customers and suppliers. A relationship between all elements of the supply chain, including partners, characterised by frequent, meaningful communications between all levels and elements of the supply chain
5. Organisation Virtual Partnership: how the company able to make effective partnership. The ability of an organisation to form and dissolve partnerships rapidly.
6. Electronically Commerce organisation; the level of using and benefit form e-commerce in all aspects of the business. The ability to conduct business transactions electronically, including Electronic Data Interchange and E-mail.
7. Short Operation Cycle: how short the time needed by the management to take decisions.
8. Information Sharing Strategy: the level of information shared with others (customers, suppliers, and partners) to increase the business effectiveness. The exchange of information between all elements of the supply chain for the purpose of gaining competitive advantage.

Adaptive Organisation

1. Capable and Ready for Change: the capability of the company to change according to the customer and market demands. In the context of human resources, an environment in which employees are empowered to interchange and re-orient their roles as required to meet customers' changing needs. In the context of physical resources, an environment where machines and equipment can be rapidly rearranged and redeployed to meet customers' changing needs

2. Monitoring of Competitors; how company can monitor competitors activities and market and business changes.
3. Management Leadership: how management leaders supportive and proactive and motivational. Management style in which managers take the initiative in helping an empowered workforce solve problems encountered in meeting requirements and inspire the workforce to exceed customer demands.
4. High Response for Change: company speed of change process. The speed, effectiveness, and efficiency of an organisation or company in responding to changing market conditions and customer demands and requirements

Knowledge Driven Enterprises

1. Dynamic Competency Testing: strategic plan that optimises the benefits derived from the knowledge, skills, and core competencies of the workforce, and of the organisation as a whole
2. High Communication Level: quality and speed of communication inside and outside the company. An environment characterised by the regular sharing of critical and sensitive information and made it available across all levels of, and functions within, the enterprise.
3. Innovative and High-skilled Workforce: A workforce capable of both proposing improvements (work flow, products, and services) and creating imaginative marketing opportunities.
4. Knowledge and Training-based Organisation: The ongoing process of training and developing personnel in the organisation to perform tasks that require multiple skills. Continuous education and training is facilitated by job rotation and education at local academic institutions, the training of a worker to proficiently perform more than one task.
5. Active in Societal Activities: The process in which an enterprise takes in and incorporates values of society into its values, the relation between the company and environment. The process anticipates trends in the public concern for ethical and social values, workforce diversity, environmental and safety concerns, and recognises and understands different legal, social, and moral norms of global competitors.

Appendix 13

Full Report of the Analysis of the Questionnaire Survey for One Case Study

Implementation of Agility Assessment Tool in Manufacturing SME

Research Findings

(Phase One)

Individual Analysis Report

Case study No. 1

Engineering Services Management ESM Ltd.

Head office, design centre and factory
Unit 20 New Horizons Business
Centre Barrows Road
Harlow
Essex CM19 5AT
ENGLAND

Prepared by

Adel Hejaaji

Future Manufacturing Applied Research Centre (FMARC)
Faculty of Engineering and Computing
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UK

Summary

The aim of this report is to illustrate the results of applying the questionnaire assessment tool of agility in ESM, the report will show the calculated results of the current levels of important elements of agility in ESM; strategic capabilities, information systems , agility business environment drivers and the agility practices .

The analyse of the results will assist the ESM to find out the weakness areas that need improvement, and help in defined the improvement actions needed to improve the level of agility in ESM.

Acknowledgement

The author would like to express gratefulness to ESM Ltd. management for providing me with this opportunity, and their agreement to participate in the second phase of my project.

ESM Profile and History

Introduction

All businesses today operate in a marketplace characterised by change. For manufacturers, the challenge is to become agile in order to ensure a flexible response to changing market conditions. Today's manufacturing world leaders are characterised by their ability to deliver the products that customers want with minimum time-to market and maximum capability to produce products to meet market expectations and customer needs.

The agility of manufacturing companies can be measured by the speed and ability of the company to respond to the changes in the environment in which the company operates, and how to deal with these changes.

ESM Profile

Engineering Services Management Limited (ESM Ltd), is based in Harlow, Essex. It was established in July 1997 and is a privately owned company dedicated to the turnkey design and construction of optical fibre manufacturing facilities, together with all the associated environmental control plants. ESM offers specialised product and service to support the manufacturing industry.

ESM is focusing on providing equipment and services to: fibre optic product manufacturers, network equipment manufacturers, test equipment manufacturers, field installation contractors and custom assembly manufacturers.

The company operates in a competitive market and supports a wide range of customers globally. The number of employees in the company is 15 and the annual turnover is £1.8m. The company is totally UK owned and belongs to engineering sector.

Agility Questionnaire Assessment Tool

The purpose of the questionnaire assessment tool is to assess the extent to which a company pays attention to the importance of the application of Agility and its practices and actions across the organisation. Using the questionnaire assessment tool will pinpoint areas of weakness within the organisation and assist in the development of actions for improvement.

The agility questionnaire assessment tool is a set of questions ranked on a Likert scale based on the Agility Attributes of manufacturing companies according to the following four main areas of the tool:

- Agility Strategic Capabilities
- Information Systems
- Agility Business Environment Drivers
- Agility Practices

These main elements of the questionnaire assessment tool are sub-divided into a number of elements for consideration. Within each element, there are further sub-divisions into detailed questions for the complete questionnaire assessment tool.

The questionnaire assessment tool has been developed to provide an assessment of individual organisations to define the current level of strategic capabilities, information system level, the level of agility business environment drivers and the current level of agility practices in the company. The questionnaire assessment tool output is therefore a reflection of the current level of these factors within the organisation.

The main aim of applying the tool is to help ESM to improve the current level of agility of the company to increase its ability to response to the changes in the market and take these changes as opportunities to improve the current situation of the company and to increase the customer satisfaction and market needs.

Agility Strategic Capabilities

Strategic capabilities are defined as required abilities to respond to changes necessary to becoming an agile company. To find out how these strategies are important to the company, the company was asked to rate nine capabilities (as shown in Figure 1). The results of the questionnaire assessment tool identified four particular capabilities of concern, as shown in Figure 1:

1. Speed of production and delivery.
2. Product variety.
3. Innovation of products.
4. Responsiveness for change.

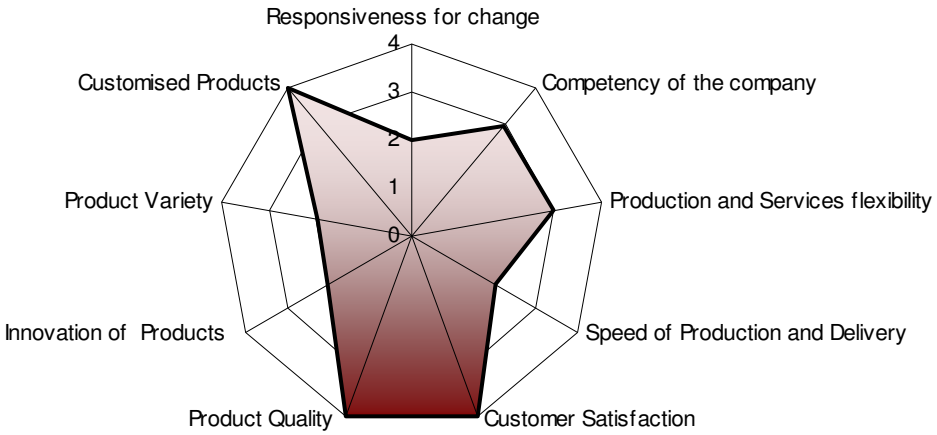


Figure 56 Company Strategic Capabilities Level

Whereas the overall current level of strategic capabilities of the company is relatively high (2.9 out of 4 as shown appendix 2), some capabilities got low scores as mentioned above. The recommendation to the company is to consider the lower scoring strategic capabilities as important issues for agility when they next review the strategy of the company in order to make the company more agile than the competitors.

3.3 Information Systems

Information systems and tools are considered as a communication link inside and outside the environment of the company and it plays a very important role to facilitate the information flow from and to the company.. The information system level was 3.3 out of 4, as shown in appendix 3, which is located as a high level according to the tool scale (see appendix 1). Thus suggesting that in this area the company is already agile.

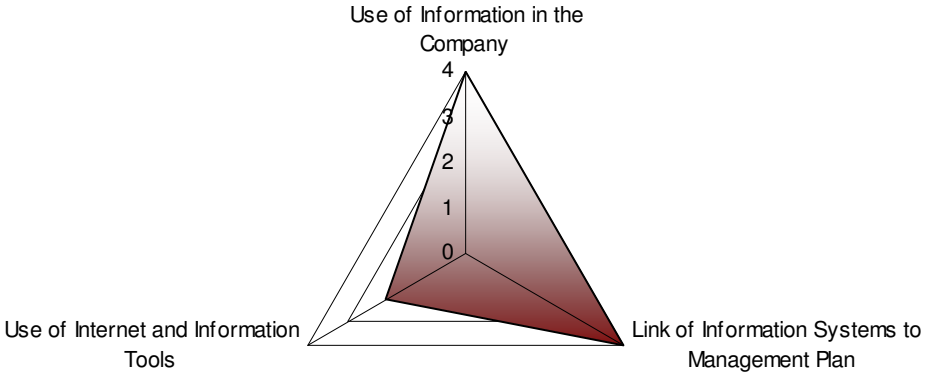


Figure 57 Information System

The analysis of the calculated results shows that the company in the current circumstance achieved one low level score in information systems as shown in Figure 2, which is:

- The use of internet and information tools.

Agility Business Environment Drivers

This part of the tool was designed to examine the level of agility business environment drivers to the company, these drivers or pressures from the business environment, were categorised under five main titles. These were examined to find out to what extent the company needs to be agile.

The main five agility drivers' factors were evaluated by asking the company 27 questions to determine the weight of each factor (appendix 4).

Analysis

According to the questionnaire assessment tool results, the average of agility business environment drivers of ESM was 3.3 out of 4, as shown in appendix 4. According to this, the company is under a very high pressure to change. Therefore the needed level of agility is very high according to the definition of agility levels (appendix 1).

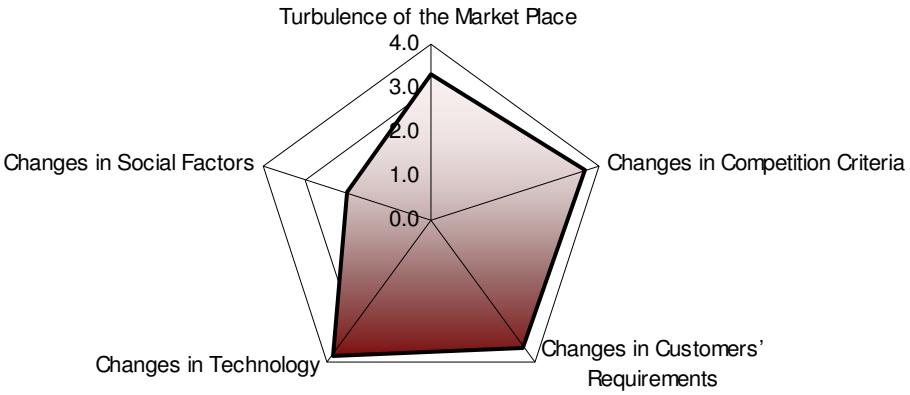


Figure 58 Agility Business Environment Drivers

The analysis of tool results shows the most important drivers for change were as shown in Figure 3:

- Changes in technology
- Changes in customer requirements

- Turbulence of the market place
- Changes in competition criteria

Factors Determining the Turbulence of the Business Environment

The analysis of the questionnaire assessment tool, indicated some sub-factors pertaining to the company's business environment which can be very turbulent and can cause threats or, on the other hand, opportunities for the company. The analysis of the above factors, through the company results, shows some factors have a degree of turbulence of 4.

The analysis of the company situation shows that these items need to receive more attention when the company's strategy is studied and defined. These factors can cause serious threats to the company and at the same time can be regarded as new opportunities:

- Rate of review the market's demands in order to monitor company stability
- Level of complexity of products the company sell
- Percentage of the company's products for which markets are saturated
- Average life cycle of the company's products
- Number of direct competitors in local markets
- Number of competitors in global markets
- Strength of the competition for market share in local markets
- Strength of the competition for market share in global markets
- Rate of differences in customers orders of the company products
- Rate of change in customer requirements
- How critical is the quality of products for your customers
- Level of need to modifying and adjust its systems due to changes in customers' expectations for quality
- How critical is delivery time for your customers
- Number of newly introduced product technologies and process technologies
- Rate of change in introduction of new product technology and process technology related to the company's business area
- Complexity level of product design process
- Complexity level of technology used in products

Other sub-factors are given a turbulence level of 3, which can be considered to be less important, but still need to be looked after.

There have been some factors indicated as being not related to the company's business or not applicable to the company's circumstances. These factors are recognised as not important or turbulent by the company.

The above analysis shows to the management how turbulent the environment is to the company. The recommendation to the company is to consider the high scoring factors when reviewing the strategy of the company.

3.5 Agility Practices

The results of the questionnaire assessment tool indicated that the current agility level in four areas, as shown in appendix 5:

- The Solution Provider area scored an average score of 2.8.
- The Collaborative Operation area scored an average score of 2.6.
- The Adaptive Organisation area scored an average score of 2.1.
- The Knowledge Driven Enterprise area scored an average score of 2.3.

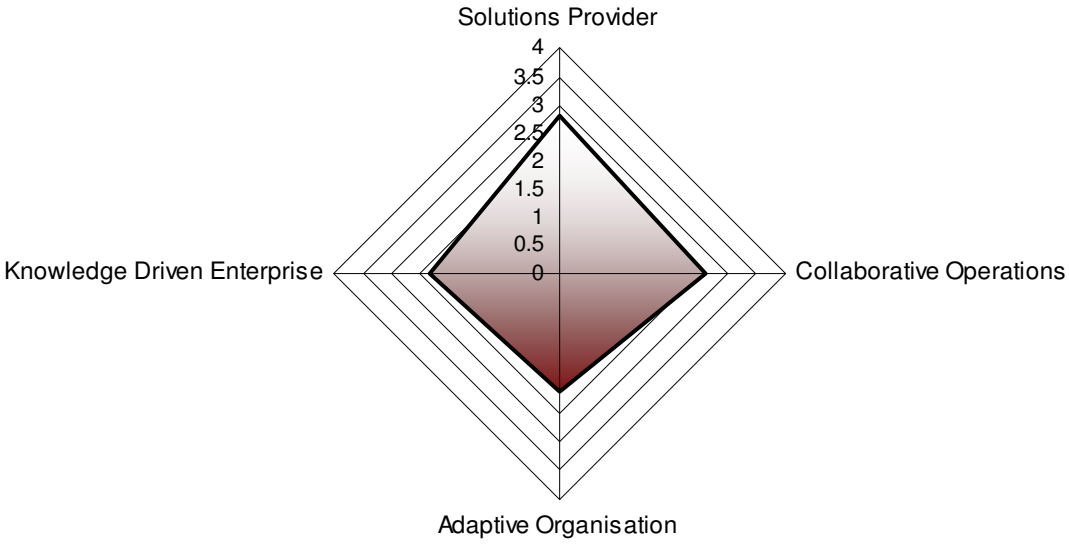


Figure 59 Agility Practices Levels

These scores are the current level of agility practices the company has. These can be considered the average degree of ability of the company in dealing with a turbulent business environment and managing changes. However, this level has a considerable association with the competitive environment of the company, and can

indicate relative to this the level to which the company can respond appropriately to the change drivers.

The analysis of the calculated results of the questionnaire assessment tool shows that the scores of some attributes are relatively low and pinpoints the need for the company to give more attention and take some actions to the low scoring areas as shown in Figure 4:

Solution Providers area

- Rapid concept to cash.
- Cost-Effective Low Volume Producer.

Collaborative Operation Area

- Electronic commerce organisation.
- Short Operation Cycle.
- Information Sharing Strategy.

Adaptive Organisation Area

- Capable and Ready for Change.
- High Response for Change.

Knowledge Driven Enterprise Area

- Knowledge and training based organisation.
- Active in societal activities.

Case Study Appendixes

Appendix 1	Measuring scale
Appendix 2	Manufacturing Strategies scouring system
Appendix 3	Information Systems scouring system
Appendix 4	Agility Business Environment Drivers scouring system
Appendix 5	Agility Practices scouring system
	a - Solutions Provider Area Scouring system
	b - Collaborative Operations area Scouring system
	c - Adaptive Organisation area Scouring system
	d - Knowledge Driven Enterprise area Scouring system

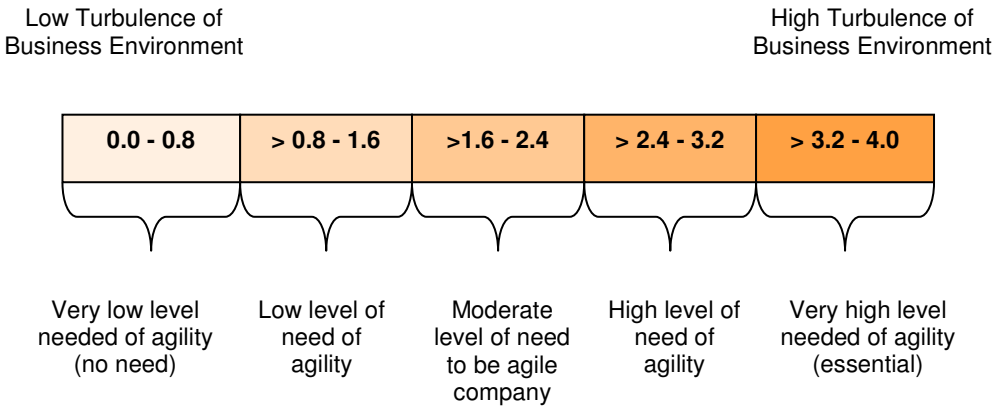
Appendix 1

Measuring Scale

Measuring scale

Measuring scale produced to assess the questionnaire assessment tool ability to define the level of business environment drivers and need of agility level; five separate multilevel analyses were carried out on the following domains:

6. Very low level needed of agility (no need) Low Turbulence of Business Environment
7. Low level need of agility
8. Moderate level need to be agile company
9. High level need of agility
10. Very high level needed of agility (essential) High Turbulence of Business Environment



Classification of the Measuring Scale According Level of Turbulence of Business Environment

Appendix 2

Agility strategic capabilities scouring system

Items	Agility Strategic Capabilities	Score 0- 4
1	Increasing responsiveness for change	2
2	Increasing competency of the company	3
3	Increasing flexibility in production and services	3
4	Increasing speed of production and delivery	2
5	Focusing on customer satisfaction	4
6	Focusing on product quality	4
7	Focusing on producing Innovative Products	2
8	Increasing product's variety	2
9	Producing customised products	4
Total Average		**2.9**

Scoring

Calculation

The total average of Agility Strategic Capabilities can be calculated as follows:

Total average = $\frac{1}{n}\sum_{i=1}^{n} Xi$ = 2.9

Where n = number of items = 9

X =Score of each item

Appendix 3

Information Systems scouring system

Items	Information Systems	Score 0- 4
1	Use of Information inside the company	**4**
2	Management plan identify the strategic use of information systems	**4**
3	Use of internet and information tools in the company	**2**
Total Average		**3.3**

Scoring

Calculation

The total average of Information Systems can be calculated as follows:

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Xi$ = 3.3

Where

n = *number of items* = 3

X = *Score of each item*

Appendix 4

Agility Business Environment Drivers scouring system

items	Agility Business Environment Drivers	Score 0- 4
Item a	**Turbulence of the market place environment**	**Average 3.2**
1	Rate of review the market's demands in order to monitor company stability	4
2	Level of complexity of products the company sell	4
3	Fashion effect on the market for the company's products	0
4	Rate of change in product models	3
5	Percentage of the company's products for which markets are saturated	4
6	Average of life cycle of the company's products	4
Item b	**Various changes in competition bases and criteria**	**Average 3.5**
1	Number of direct competitors in local markets	4
2	Number of competitors in global markets	4
3	Strength of the competition for market share in local markets	4
4	Strength of the competition for market share in global markets	4
5	Trend of new entrances to market where the company competes	3
6	Number of substitutes for the company's products	2
Item c	**Ever changing customers' requirements**	**Average 3.7**
1	Rate of differences in customers orders of the company products	4
2	Rate of change in customer requirements	4
3	Level of need to retooling of manufacturing system according to changes in customer requirements	3
4	How critical is the quality of products for your customers	4
5	Level of need to modifying and adjust its systems due to changes in customers' expectations for quality	4
6	How critical is delivery time for your customers	4
7	Level of need to modifying and adjust its systems due to changes in the customer's expectations for delivery time	3
Item d	**Fast changes and improvement in technology**	**Average = 3.8**
1	Number of newly introduced product technologies and process technologies	4
2	Rate of change in introduction of new product technology and process technology related to the company's business area	4
3	Rate of changing systems, process and technology in the last 3 years	3
4	Complexity level of product design process	4
5	Complexity level of technology used in products	4
Item e	**Changes in Social Factors**	**Average = 2.3**
1	Changes level of systems, technology and products to comply with the requirements for a healthy environment	2
2	Change rate of regulations and laws affecting the normal trend of the company's business	3
3	Rate of changes in international political/economic issues related to the company's business	2
Total Average		**3.3**

Scoring

Calculation

The total average of Agility Business Environment Drivers can be calculated as follows:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where n = number of Y sub items, X = Score of each sub item of Y, Y = a, b, c, d, e

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$ = 3.3

Where n = Number of items = 5 Y = Item average

Appendix 5

Agility Practices scouring system
a- Solutions Provider Area

Items	Solutions Provider Area	Score 0- 4
Item a	**High Product variety**	**Average = 3.5**
1	To what extent the company considered as multi product producer	3
2	To what extent company products successful in the market	4
Item b	**High Product Introduction Rate**	**Average = 2.5**
1	To what extent the company innovative its products	2
2	To what extent the company considered leader in introducing new products to the market	3
Item c	**Frequent Model Changes**	**Average = 3.0**
1	Rapid in introducing new models to the market	3
2	Rapid in changing production to introduce new models	3
d	**Rapid Concept to Cash**	**Average = 2.0**
1	Fast move product from a concept to putting product in customer hands	2
Item e	**Cost-Effective Low Volume Producer**	**Average = 1.3**
1	To what extent the company considered low cost products	1
2	To what extent the company apply reduce costs strategy	2
3	To what extent your suppliers support cost-effective low volume production	1
Item f	**Production to Order**	**Average = 3.5**
1	To what extent the company meets customers' needs	4
2	To what extent the company rapid in response to change demands	3
Item g	**Tailor made Solutions (Products/Services)**	**Average = 3.0**
1	To what extent the company quick in manufacturing a unique customised product	3
2	To what extent the company flexible of products towards customers' needs	3
Item h	**Product and Customer Support**	**Average = 2.5**
1	To what extent the company strive to keep customers as lifetime customers	3
2	To what extent company products designed to evolve with changing customer demands	2
Item i	**High Information Products**	**Average = 3.0**
1	To what extent the company considered selling skills, knowledge, and information	3
2	To what extent the company effective in the digital commerce marketplace	3
Item j	**Long lasting customer relationship**	**Average = 3.0**
1	To what extent the company offer customer after sales services	3

2	To what extent E-business Important for the company business	3
3	To what extent “Know Your Customer” is Important principle for the company	3
Item k	**Consumer Demand Changes**	**Average = 3.0**
1	To what extent the company link marketing strategy to product design concepts	3
2	To what extent the effective in bringing innovations to market	3
3	To what extent the company help customers to identify and solve their problems	3
4	To what extent the company fast in penetrating new markets for products	3
5	To what extent the company considered market leader in a business sector	3
Item l	**High Quality Standards**	**Average = 3.3**
1	To what extent the company produce high quality standards products	3
2	To what extent the company customers satisfaction with Quality	3
3	To what extent the company customers satisfaction with Delivery	3
4	To what extent the company customers satisfaction with Price	4
Item m	**Satisfaction customers**	**Average = 3.2**
1	To what extent the company understanding how and why customers use company products	3
2	To what extent the company seeking new ways to attract and keep customers	3
3	To what extent the company understanding customers' behaviour	3
4	To what extent the company considers customers' complaints as opportunities to learn and improve	4
5	To what extent the company searching of new ways to communicate with customers	3
6	To what extent the company employing physical and electronic channels to serve customers	3
Total Average		**2.8**

Scoring

Method 1: Calculation Method

The total average of Solutions Provider Area can be calculated as follows:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where

n = *number of Y sub items*

X = *Score of each sub item of Y*

Y = *a, b, c, d. e, f, g, h, i, j, k, l, m*

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$ = 2.8

Where

n = *Number of items = 13*

Y = *Item average*

b- Collaborative Operations area

Items	Collaborative Operations Area	Score 0- 4
Item a	**Cooperation strategy**	**Average = 3.7**
1	To what extent the company using external partnerships to reduce products cost	4
2	To what extent the company support collaboration strategy with other companies	4
3	To what extent the company partnering with competitors when it necessary	3
Item b	**Product Integration & Process Development**	**Average = 3.0**
1	To what extent the company engaging customers in product development	3
2	To what extent the company meet goals, and objectives with all business functions	3
3	To what extent the company suppliers support delivery schedule	3
c	**Integrated Enterprise Processes**	**Average = 3.0**
1	To what extent the company support people empowerment and team working principle	3
2	To what extent the company supporting partnership strategy	3
Item d	**Customer-Supplier Interactive Relationships**	**Average = 3.5**
1	To what extent the staff, suppliers and customers cooperate with each other	3
2	To what extent the company fast in responding to customer's change requests	4
Item e	**Organisation Virtual Partnership**	**Average 3.3**
1	To what extent the company work to Increase overall effectiveness through collaboration	4
	To what extent the company work to:	
2	Decrease infrastructure and R&D costs	4
3	Complementary company product identified	3
4	Reducing concept-to-cash	3
5	Increasing facilities and apparent size	3
5	Gaining access to new markets	3
7	Developing selling solution skills from selling products	3
8	To what extent the company consider partnership with business network creates synergy for competitive position	3
Item f	**Electronically Commerce organisation**	**Average = 2.0**
1	To what extent the company adoption of electronic commerce to sell products	1
2	To what extent the company information systems Integrated with customers' and suppliers' systems	3
g	**Short operation cycle**	**Average = 1.0**
1	To what extent the company sensitive to accelerating time pressures to short the management operational cycles	1
Item h	**Information sharing strategy**	**Average = 1.3**

1	To what extent the company give authority for suppliers to access company strategic information	0
	To what extent the company shared Information with suppliers:	
2	Cost	2
3	Technical	2
4	Marketing	2
5	Strategic	1
6	Training	0
7	Cultural	2
Total Average		**2.6**

Scoring

Calculation

The total average of Collaborative Operations Area can be calculated as follows:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where n = number of Y sub items, X = Score of each sub item of Y, Y = a, b, c, d. e, f, g, h

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$ =2.6

Where n = Number of items = 8, Y = Item average, = No score cell

c- Adaptive Organisation Area

items	Adaptive Organisation Area	Score 0- 4
Item a	**Capable and ready for change**	**Average = 1.5**
1	To what extent the company has ability to change	1
2	To what extent the manufacturing facilities of the company has ability to change	2
3	To what extent the company speedy of change	1
4	To what extent the company active and effectiveness in meeting changing goals and objectives	2
Item b	**Competitors Monitoring**	**Average = 3.0**
1	To what extent the company has ability to identify, and analyze competitors' strengths, weaknesses	2
2	To what extent the company monitoring industry and competitors' activities	3
3	To what extent the company monitor other industries for competitive threat or opportunity	4
Item c	**Management Leadership**	**Average = 2.5**
1	To what extent the company practicing and supporting of management leaders	4
2	To what extent the company motivation of employees	1
Item d	**High Response for change**	**Average 1.4**
1	To what extent the company decisions are fast and rapid of making more than competitors	2
2	To what extent the company focusing in improving speed and effectiveness	2
3	To what extent the company quickness of restructure to the changing needs of the marketplace	1
	To what extent the company has ability to respond to market change by modifying:	
4	Product design	1
5	Manufacturing processes	2
6	Administrative procedures	1
7	Marketing techniques/strategies	1
8	Sales procedures	1
9	Supplier relations	2
Total Average		**2.1**

Scoring

Calculation

The total average of Adaptive Organisation Area can be calculated as follows:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where n = number of Y sub items,

X = Score of each sub item of Y,

Y = a, b, c, d

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$ = 2.1

Where n = Number of items = 4,

Y = Item average,

 = No score cell

d- Knowledge Driven Enterprise Area

Items	Knowledge Driven Enterprise area	Score 0- 4
Item a	**Dynamic Competency Testing**	**Average = 2.5**
1	To what extent the company strategic plan supported by technical plans and operational execution	3
2	To what extent the company apply benchmarking with competencies	2
Item b	**High communication level**	**Average = 2.2**
1	To what extent the communication level among departments fast and effective	1
	To what extent the communication level fast and effective with:	
2	Customers	3
3	Suppliers	1
4	Partners	2
5	Internally	2
6	Stakeholders	4
Item c	**Innovative and high skilled Workforce**	**Average = 3.0**
1	To what extent the company employing cross-functional teams	3
2	To what extent the employees have access to all the information requires performing their jobs	3
Item d	**Knowledge & Training based Organization**	**Average = 1.7**
1	To what extent the company train employees for multi-skill tasks	1
2	To what extent the company consider training in its strategy	2
3	To what extent the company involving in local academic institution training	2
Item e	**Active in Societal activities**	**Average = 2.0**
1	To what extent the company effective in environmental programs	2
2	To what extent the company links societal values to company's strategic plan	2
	Total Average	**2.3**

Scoring

Calculation

The total average of Knowledge Driven Enterprise Area can be calculated as follows:

Item average (Y) = $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where n = number of Y sub items,

X = Score of each sub item of Y,

Y = a, b, c, d, e

Total Average = $\frac{1}{n}\sum_{i=1}^{n} Yi$ = 2.3

Where n = Number of items = 5,

Y = Item average,

 = No score cell

Appendix 14

Published Papers

- Adel Hejaaji (2007) Application of a Methodology of Agile Manufacturing Within Small and Medium Size Enterprises (SMEs). The 3rd International Conference on Business, Management and Economics ICBME 13-17 June Izmir – Turkey

- Adel Hejaaji and Stephen Martin (2007) Application of Agility Assessment Tool for Small and Medium Size (SMEs) Manufacturing Companies. The 14th international annual EurOMA conference Managing operation in an expanding Europe 17-20 June 2007 Ankara - Turkey

- Adel Hejaaji and Stephen Martin (2007) The development of a model of agility for Small and Medium Size (SMEs) manufacturing companies. The 11th International Conference on Human Aspects of Advanced Manufacturing Agility and Hybrid Automation — HAAMAHA Poznan, Poland on 9-12 July, 2007.

- Adel Hejaaji and Stephen Martin (2007) The development of a model of Agile manufacturing for the Small or Medium Size (SME's) manufacturing company. The ICSB 2007 World conference 13-15 June 2007 Turku, Finland.

- Adel Hejaaji Research Students Symposium Competition Poster Coventry University 27 March 2007 Coventry

- Adel Hejaaji Research Students Symposium Competition Poster Coventry University 7 March 2008 Coventry