VENDOR MANAGED INVENTORY ADOPTION IN MALAYSIA CONSTRUCTION INDUSTRY

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MASTER BY RESEARCH
UNIVERSITI UTARA MALAYSIA
June 2019

VENDOR MANAGED INVENTORY ADOPTION IN MALAYSIA CONSTRUCTION INDUSTRY

By

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Thesis Submitted to
School of Technology Management and Logistics (STML),
Universiti Utara Malaysia,
in Fulfilment of the Requirement for the Degree of Master by Research

Kolej Perniagaan
(College of Business)
Universiti Utara Malaysia

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Program Pengajian *(Programme of Study)*	:	Master of Science (Operation Management)
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ABSTRACT

The growth of the Malaysian construction industry is burdened by conditions in which 'time overruns' in projects still exist. The quest to overcome construction delays motivates the industry to improve its performance by learning from the other industries. Supply chain management is an important aspect of performance in construction projects recognised by literatures in recent years. The distinctive characteristic of supply chain management in construction does compare to other industries to motivate the need to collaborate horizontally and vertically within the construction industry. Vendor- managed inventory (VMI), famous for eliminating additional costs that may result from the excessive supply and stock-in-hand inventory as practised in other industries, may potentially be adopted and implemented in the construction industry. Therefore, conditions in which VMI is suitable to be adopted, barriers to the effort to adopt VMI and the readiness of the contractors to adopt VMI were evaluated in this study. The results of the survey using 97 CIDB grade G7 registered contractors in Malaysia, show that suppliers' market competition, supplier-buyer cooperation, and demand uncertainty positively influence the intention of contractors to adopt VMI. However, notwithstanding that G7 contractors are large contractors in Malaysia, perceived lack of trust and mutual misunderstanding between supply chain partners are considered top among the many barriers to adopt VMI despite evidence that respondents of the study indicate moderate to high readiness to adopt the recommendations of the study. The study contributes to literature on VMI in the area of the construction industry which has not been explored comprehensively.

Keywords: vendor- managed inventory, construction industry, environment determinants, adoption readiness, intention to adopt.

ABSTRAK

Pertumbuhan industri pembinaan Malaysia dibebani dengan keadaan 'kelewatan' sesebuah projek. Sebagai usaha untuk mengatasi kelewatan pembinaan telah mendorong pihak industri untuk meningkatkan prestasi mereka dengan belajar dari industri lain. Pada masa ini, pengurusan rantaian bekalan merupakan aspek penting dalam projek pembinaan yang dikenal pasti dalam kajian-kajian lepas. Ciri khas pengurusan rantaian bekalan dalam pembinaan dibandingkan dengan industri lain bagi memotivasikan keperluan kerjasama secara mendatar dan menegak dalam industri pembinaan. Inventori Terurus Vendor (VMI) yang terkenal dalam industri lain melalui pengurangan kos tambahan yang mungkin disebabkan oleh lebihan bekalan dan inventori saham, mungkin berpotensi untuk diterima pakai dan dilaksanakan dalam industri pembinaan. Oleh itu, kesesuaian penerimaan VMI, halangan penerimaan VMI dan kesediaan para kontraktor untuk menerima pakai VMI dinilai dalam kajian ini. Dapatan kajian yang melibatkan sejumlah 97 kontraktor berdaftar dengan CIDB gred G7 di Malaysia, menunjukkan bahawa persaingan pasaran pembekal, kerjasama pembekal-pembeli, dan ketidakpastian permintaan secara positif mempengaruhi niat kontraktor untuk menerima pakai VMI. Walau bagaimanapun, meskipun kontraktor G7 adalah kontraktor besar di Malaysia, kurangnya kepercayaan dan saling salah faham antara rakan kongsi rantaian bekalan merupakan halangan utama untuk menerima pakai VMI walaupun responden kajian menunjukkan kesediaan sederhana dan tinggi untuk menerima pakai cadangan-cadangan kajian. Kajian ini menyumbang kepada rujukan kesusasteraan mengenai VMI dalam bidang industri pembinaan yang belum diterokai secara komprehensif.

Kata Kunci: Inventori Terurus Vendor, industri pembinaan, penentu persekitaran, kesediaan penerimaan, niat untuk menerima pakai

ACKNOWLEDGEMENT

A special thanks to my supervisor, Mohamad Hanizan bin Zalazilah. Even though with his tight working schedule, he still provide room for sharing his knowledge and experience with me. His competences, constant supervision and professional work in guiding me were very much appreciated in the process of completing my thesis.

A token of appreciation goes to my parents and my sister for their strong moral support and continuous pray that makes an end to this long and memorable journey. Their concepts of hard work and endurance that I imbibed mage every great achievement of my life just like this to be possible.

Finally, to all my friends, thank you for all the trust, commitment and support. And to those who participated in this research and various people who have helped me, thank you very much.

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
CIDB	Construction Industry Development Board
CPT	Culture, Policy and Technology
DOI	Diffusion of Innovation
ECT	Environmentally Conscious Technology
EDI	Electronic Data Interchange
GDP	Gross Domestic Product
IBS	Industrialized Business System
ICT	Information Communication Technology
ISM	Interpretive Structural Modelling
IT	Information Technology
JIT	Just in Time
KMO	Kaiser-Meyer-Olkin
MRA	Multiple Regression Analysis
RMI	Retailed Managed Inventory
SCM	Supply Chain Management
SPSS	Statistical Package for the Social Science
SSIM	Structured Self-Interaction Matrix
TCE	Transaction Cost Economics
TOE	Technology Organization Environment
VMI	Vendor Managed Inventory
VMR	Vendor Managed Replenishment

CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter will discuss the importance of Vendor Managed Inventory (VMI) implementation in Malaysia construction industry and its adoption issues. Elaboration on the identification of the gap which lead to the objectives and research questions of this study is presented in this chapter. Finally, the scope of study and the outline of the study are elaborated.

1.2 Background of Study

As one of the largest contributor of national economy and growth, Construction industry have many challenges to overcome to achieve a successful project with minimum cost and efficient utilization of required materials (Nasir et al., 2016; Seng et al., 2018). Malaysia construction output has contributed about 4.5 percent to the Gross Domestic Product (GDP) in 2015 and expecting steady 5 to 6 percent growth per year (CIDB Construction Economics, 2015). Efficiently utilize required materials of the project could consequently reduce the project cost. Supply Chain Management (SCM) as one of the factor that involved in a construction project has received some attention to the literature (Arbulu, Ballard, & Harper, 2003; Ballard & Howell, 2003; Elfving, Tommelein, & Ballard, 2005; Koskela, 2000; Tanskanen et al., 2008; Ajayi et al., 2017) highlighting the difference of characteristics of supply chain management (SCM) in construction project compared to manufacturing and consumer goods. The distinctions of SCM between these industries, which include supply chain with short-term relationship driven by lack of information sharing,

competitive bidding process and little motivation for new knowledge learning or technology innovation, become a challenge to both researchers and practitioners.

Managing efficient supply chain in construction, especially managing materials essential or required for the construction project, associated with purchasing or ordering materials as one of many supply chain function (Georgy & Basily, 2008; Seng et al., 2018). Consequent to the ordering or purchasing material, Ajayi et al. (2017) consider the effect of excess and insufficient quantity of ordered materials on inventory management and its cost impact. Ajayi et al. (2017) later determined that in both cases, excess or insufficient quantity of ordered material could impact total inventory holding cost.

Moreover, the factor of efficient performance of inventory management in construction project include a good coordination and integration between contractor and its material supplier to optimize their supply decisions (Donato et al., 2015; Fulford & Standing, 2014; Rahman et al., 2014; Gadde & Dubois, 2010). For the past two decades, studies regarding collaboration of supplier and buyer of in the construction industry, referred as material supplier and contractor, had received a lot of attention in order for both parties received the highest advantage out of their relationship (Akintoye et al., 2000; Briscoe & Dainty, 2005; Akintoye & Main, 2007; Gadde & Dubois, 2010; Aloini et al., 2012, 2015; Chow et al., 2012; Hughes et al., 2012; Jiang et al., 2012; Donato et al., 2015)

Traditional inventory policy focus on internal business view with no attention on coordination at the vertical level, which resulted information and logistic flow is not

smooth, overstock inventory, and higher total inventory cost (He & Hu, 2010). With integrated and coordinated relationship network, interaction between network results in fast responsive ability to reduce mentioned inventory problems. However, the success of a good coordination lies to the commitment and consistency hold by each member on the supply chain network (Aloini et al., 2015). As construction supply chain becoming more complex with the pressure to collaborate to cope with the constant change and competitive and cost critical environment in the industry, managers in the construction industry are challenged to consider adopting innovative approaches to solve these complex problems (Behera et al., 2015; Tanskanen et al., 2015). Determined with traditional business approaches in the construction management often fail to perform in these situations.

In short, Vendor Managed Inventory (VMI) is a business practice of an integration between supplier and buyer where the supplier has the responsibility to manage the inventory at buyer's premises and make replenishment decisions (Lee et al., 2015). However, the ownership of the item remains to the supplier or in some cases to the buyer, depending on the contract of integration agreement. VMI practices has been successfully introduced by Wall-mart and Proctor and Gamble in late 1980s (Waller et al., 1999) and has been adopted to current manufacturing firms such as Dell, Barilla and Costco (Haisheng Yu et al., 2009).

Maintain lower inventory cost and higher service level is the basic activity to ensure a successful VMI (Dong et al., 2014). A successful VMI reduce inventory cost while increase customer service level compared to traditional inventory policy (He & Hu, 2010). Buyer benefit VMI with less administrative ordering process, while supplier

have the benefit of obtaining whole inventory distribution and accurate market information.

1.3 Problem Statement

VMI has been observed to have the ability to lead to operational and strategic benefits for both suppliers and buyer. However, it is depending on the surrounding environmental factors (Kauremaa et al., 2009). Management and coordination of supplier and buyer collaboration to be an important management practice which contractor need to improve their performance (Soetanto et al., 2001). In the buyer performance measure, the management and coordination of supply chain collaboration ranked as an important measurement.

Past literature (Achabal et al., 2000; Choi et al., 2004; Kiesmüller & Broekmeulen, 2010; Krichanchai & Maccarthy, 2016) have suggested the importance of supply chain collaboration practices in many industries, such as manufacturing, retailing, and pharmaceutical. However, still lack empirical study on the complex project form in terms of managing production and operation, such as construction (Tanskanen et al., 2008), shipbuilding, oil and gas, sports events and media. Collaboration in construction supply chain is limited due to the characteristic of construction supply chain which contractor as a buyer normally compete on the price (Cicmil & Marshall, 2005) which often lead to opposite relationship. Moreover, in a developing country such as Malaysia, construction industries are not ready to transform from the traditional constructions practices to a collaborative construction practices (Nawi et al., 2011). In the past literature on construction supply chain management, empirical

studies in the industrial fields found to be inadequate (Aloini et al., 2012). There is a gap due to limited discovery of supply chain collaboration on vertical collaboration between supplier and contractor (Rahman et al., 2014), especially on VMI implementation as it is found to be beneficial to both supplier and contractor in the construction industry (Tanskanen, Holmström, Elfving, & Talvitie, 2008). In order to fulfill the gap, Tanskanen et al (2008) suggested to do an empirical investigation on the effectiveness and adoption of supply chain collaboration or integration especially in construction industry.

However, among the common benefit of total inventory cost reduction (Claassen et al., 2008), higher service level (Dong et al., 2014), inventory stock reduction (Yao et al., 2007), reduce demand variability (Yan Dong et al., 2014), and increased market visibility (De Toni & Zamolo, 2005), VMI provides great benefit to the adopting organizations, including to both supplier and buyer. Theoretical studies in the literature have classified several strategic drivers for benefit of VMI includes: coordination of production and delivery (Zhao et al., 2010), economic production (Lee & Cho, 2014), shipment consolidation (Marklund, 2011), information sharing (Disney & Towill, 2003) and competition among supplier (Mishra & Raghunathan, 2004b). However, a limited empirical study has been carried out on the environmental determinants of initial VMI adoption. Behera et al. (2015) & Radosavljevic and Bennett (2012) recommend that future research works in the construction supply chain management to test and validate past conceptual and empirical hypothesis and instruments on not only the roles of stakeholders in the adoption of new knowledge/technology in the project management in construction.

Therefore this study will aim to determine the environmental determinants of VMI adoption following the past empirical literature (Dong et al., 2007; Krichanchai & Maccarthy, 2016) that has been done previously. Dong et al. (2007) refer environment determinant as environment or surrounding situation or condition of an organization in which influence the decision of the organization to the adoption of VMI.

The objectives of adopting VMI in the supply chain collaboration between the buyer or contractor and the supplier greatly focus on achieving operational benefits and performance improvement. However, the adoption process is not free from barriers or obstacles to both contractor and supplier, which influence the adoption process itself (Borade & Bansod, 2010). In most of the case studies by Guimarães et al. (2013), found that most of the healthcare center hindered to adopt VMI successfully due to the great power of the implementation barriers. They suggested that, in an effort to adopt VMI, it is important to carefully observe the barriers in the adoption as Lean practices in VMI is not an easy process to course. An earlier study by Callender & Grasman (2010) found that more benefits are more likely to be realized if adoption barriers were explored and overcome. Ern & Kasim (2012) found that, in Malaysia construction industry, the awareness of contractors on the need to adopt new technology innovation is significant, however the progression of ICT adoption in the industry remained stagnant due to the existence of barriers of the adoption. Thus, barriers to the adoption of VMI in construction projects should be recognized and investigated.

On the other hand, some literature were also discovered the problematic adoption of VMI in achieving or realizing benefits of VMI. The arguments of the suitable time to adopt VMI in the supply chain business transactions has been neglected by most literature (Niranjan et al., 2012). In respects to realized benefits, unless the firms identify VMI initiative value to the company not exceeding the cost related to the adoption, the firms may be reluctant to adopt VMI. Niranjan et al. (2012) added that practitioners need a toolkit to determine when VMI is seemed sensible to be adopted to achieve greater benefits of it, therefore a measurement framework was developed to assess organization readiness of the firms to adopt VMI. Organization readiness was found to be the most significant organization attribute to the influence of adoption of technology innovation such as VMI (Hameed et al., 2012), compared to other organization attributes (top management supports, IT expertise/skill, resources, organization size). However, in the study of organizational readiness of Malaysian contractors to the adoption of ICT innovation, Ern & Kasim (2012) found a very low readiness level among the G7 contractors. They added that, there is a great need to develop a framework to assess the adoption readiness of technology innovation in order to encourage contractor's readiness of ICT adoption.

However, the moderating effect of organization size found to be mixed, whether large or smaller firms to have higher adoption level. Large firms with their availability of financial resources which facilitate them in the adoption of technology innovation (Bordonaba- Juste et al., 2012) were hypothesized in the most literature compared to smaller firms with their flexibility to change and centralized decision making helps them to adopt technology innovation such as VMI (Gong et al. 2013).

Moreover, Niranjan et al. (2012) state that perceived benefits of VMI are different to the firms in every conditions and in every organization setting, therefore organization readiness of G7 contractors in Malaysia construction industry will be tested in the respective conditions in order to analyze whether VMI is a suitable solution for them in respect to their organization setting.

1.4 Research Questions

Based on the problems discussed in the study above, therefore this study will aim to answer these questions:

1. How significant each determinants of VMI adoption in influencing initial adoption decision of VMI strategy in Malaysia Construction Industry?
2. What are the adoption barriers highly perceived by Malaysian G7 contractors in adopting VMI?
3. How ready Malaysian G7 contractors in adopting VMI?

1.5 Research Objective

This study tested the environment determinants of VMI adoption following the result of study by past empirical literature (Dong et al., 2007). The study tested whether the broaden model had the same result on the different industry which is Construction Industry. The extent of significant influence on each proposed environment determinant to the decision of VMI adoption will also investigated to determine which determinant influence the most in the Construction Industry. This study also tested adoption barriers of VMI in the industry following the observation by Borade

& Bansod (2010). This study observed which adoption barrier highly and lowly perceived by G7 contractors in Malaysia. This study also examined the organization readiness of G7 contractors in adopting VMI into their supply chain network with their suppliers.

Therefore, the objectives of this study are:

1. To identify the extent of significant influence of each environment determinants to VMI adoption in Malaysia Construction Industry.
2. To examine the most common adoption barrier perceived by Malaysian G7 contractors in adopting VMI.
3. To examine the readiness of Malaysian G7 contractors in adopting VMI.

1.6 Significance of Study

The study contributes to the literature on the empirical study on VMI adoption issues related to determinants of initial VMI adoption. This study also contribute to the literature on the implementation of supplier-buyer collaboration in Construction industry. Moreover, the study can benefit to academician and practitioners such as procurement manager & supply chain manager, to provide feasible insights on initial issues of VMI adoption.

1.7 Scope of the Study

Despite the empirical literature on the adoption of VMI, this study focus on the environmental determinants or factors that influence the intention to adopt VMI. This empirical study also different from most empirical studies in which evaluate the

adoption of VMI based on technological aspects, this study use environmental determinant or surrounding conditions that is most likely VMI will be adopted. As the study investigate with a variety of influencing factors of VMI adoption, the environmental determinants of VMI adoption in this study were identified from literature, which include supplier's market competition, demand uncertainty and buyer-supplier cooperation.

Although the benefits of VMI are significantly improving the performance of supply chain process, there are barriers or obstacles perceived by firms in attempt to adopt VMI. As the study investigate on the adoption of VMI in the construction industry, in which collaboration in the supply chain management limited due to the characteristic of the industry, therefore barriers in the adoption process of VMI were identified from the literature, which include lack of the suitable information technology infrastructure, lack of trust and mutual understanding between supply chain partners, ineffective organizational structure, improper decision support tools and internal/external integration.

Moreover, in the essence of argumentative findings in the literature in which noted that barriers to the adoption of VMI is different between smaller and larger firms in respect to their access to resources and flexibility to change. Due to the selection of G7 contractor as the respondent of the study, this study empirically test the barriers identified from the literature to confirm the findings on perceived adoption barrier by large firms in the literature.

In addition to the barriers of VMI in which perceived as resistances to the adoption of VMI, literature found that benefits of VMI differ from every adoption of VMI subjective by the organizational readiness of the firms in adopting VMI. As the study investigate the adoption of VMI, organizational readiness of G7 contractors in the Malaysia construction industry were measured using developed framework of VMI readiness identified from the literature to analyze the readiness of contractors in Malaysia in the adoption of VMI.

1.8 Operational Definitions

- Operation Management: The administration of business day-to-day practices to generate the highest level of efficiency within an organization. It is focus to utilizing materials and labor into goods and services as efficiently as possible to maximize the profit of an organization.

- Supply Chain Management: The arrangement of actual when and how procurement process of necessary services, products and materials in concern to achieve the great success, quality, functionality and profitability of any construction project. It provides an inter-connecting structure which connects construction contractors, material suppliers, service crews and other involved parties to collaborate in a mutually beneficial project.

- Inventory Management: The process to provide right material at right place at right time in right quantity in attempt to minimize the cost of the project. It aims at optimization of inventory investment to ensure continuity in availability of materials.

- Vendor Managed Inventory: An approach that Contractors transfer substantial works generated by managing inventories to Material suppliers. It aims to minimize logistics activities and optimize performance of logistic activities.

- Construction project management: The process of planning, organizing and managing the various tasks involved in a construction project. It is to ensure a project is built according to plan.

- Market competition: The rivalry/competition between Material Suppliers in selling similar or comparable products or materials in the Contractor's market.

- Demand uncertainty: The uncertainty or variability in the demand of the contractor for a particular material. The uncertainty of given Bill of Quantity from contractor to material suppliers. The frequency of change in BOQ during the project development.

- Supplier-buyer collaboration: The collaboration of Contractors and Material supplier in supply chain to share their responsibilities, resources, and performance information to acquire mutual advantages.

1.9 Organization of Thesis

The study consists of 5 chapters with following details; Chapter 1 will discuss the background of the study and identify the gap of the study. Chapter 2 will review previous literatures and past studies on the following subject proposed by this study. Chapter 3 will present the method of research from data collection, research

framework, and methodology adopted in the study. Chapter 4 will then present the result of the study and discuss the result. Chapter 5 will finally draw the summary and conclusions of the study with recommendation to the future studies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The literature review is structured in order as follow: the first section will discuss the definition and introduction of supply chain management in general, and followed by the emergence of Supplier-Buyer integration in supply chain management. The next section will discuss the emergence of Vendor Managed Inventory as one of supply chain management (SCM) integration. The fourth and fifth section of literature review will discuss the adoption of VMI and its determinants of adoption. The next section will solely discuss on the barriers of VMI adoption based on past literature followed by a literature review on the readiness to the adoption of VMI. For the eighth section, distinction of construction supply chain management and common supply chain management is discussed thoroughly, followed by the adoption of VMI in the construction industry in the last section.

2.2 Supply Chain Management

The concept of supply chain was inspired to be applied in various areas: quality revolution (Dale et al., 1994), industrial market and network (Ford, 1990; Jarillo, 1993); material control and logistic integration (Carter and Price, 1993; Forrester, 1961); the concept of increased focus (Porter, 1987; Snow et al., 1992) and industry-specific studies (Womack et al., 1990; Lamming, 1993). The term of Supply chain management first appeared in the literature in 1982 (Oliver & Weber, 1982) which

viewed as a solution to manage resources and asset (Houlihan, 1985, 1988; Stevens, 1989).

The term of Supply Chain Management (SCM) is commonly defined as "a process-oriented approach to managing product, information, and funds flows across the overall supply network, from the initial suppliers to the final end consumers" (Metz, 1998). However there is a high variability in the definition of SCM in the mind of most people regarding the definition (New, 1997; Kauffman, 2002; Kathawala & Abdou, 2003; Burgess et al., 2006; Lemay et al., 2016; Stock & Boyer, 2009). Therefore Mentzer et al. (2001) tried to propose a broad definition of SCM that is not limited to a specific discipline area (logistics, purchasing, operations management, etc.) and tried to cover wide range of subjects covered under this term. Mentzer et al. (2001) define Supply Chain Management as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole. Illustration of a typical supply chain of a company is illustrated in Figure 2.1 showing the network of materials, information, and services processing links with the characteristics of (1) supply, (2) transformation, and (3) demand.

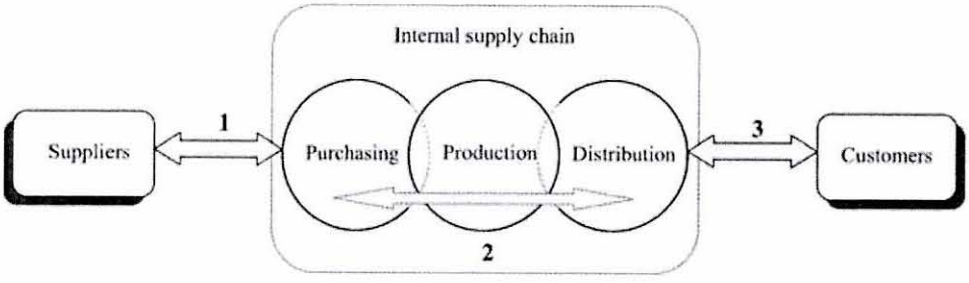


Figure 2.1
An Illustration of A Company's Supply Chain (Adopted From Chen & Paulraj, 2004)

Recent study of Lemay et al. (2016), discuss on the current definitions of SCM that are developed in the literature. They propose a definition of SCM which use the concept of supply chain (Carter, Rogers, & Choi, 2015) as a base to broaden the proposed definition of SCM. LeMay defined supply chain management (SCM) as "the design and coordination of a network through which organizations and individuals get, use, deliver, and dispose of material goods; acquire and distribute services; and make their offerings available to markets, customers, and clients". This definition cover inbound and outbound distribution nature of supply chain that covered in most of the definition in each discipline area.

Discipline areas of supply chain management (SCM) that divide perception of people regarding the definition of SCM is defined as "a body of practice that supported by occupational groupings that identify with a defined territory of activity" (Burgess et al., 2006). However the term of "discipline" is derived from a latin word "disciplina" which means instruction of disciples. According to Shepherd (1993), it is related to doctrine and is argumentative. Discipline areas that are relevant to SCM are ranging from least popular in the literature (Marketing,

Psyhology/sociology, Finance/economics) to most popular discipline areas (Operation management, Purchasing, Strategy, Logistic, Information/Communication) (Burgess, 2006). Discipline areas referred as functional area in the study of Ellram & Cooper (2014). Functional area as one of the perspective of SCM (process, discipline, philosophy, governance structure & functional) that proposed by Ellram and Cooper (2014) defined as a set of people in an organization that do certain tasks or has a specific role.

Moreover, framework or construct of supply chain management (SCM) in order to provide better understanding of the term (Nunnally, 1978) has increase in numbers to the extent that it is difficult to synchronize a pattern of framework of SCM (Ho et al., 2002). The main problem of multiple sets of constructs/framework in the literature is due to inadequate specification of "construct" used in the literature that lead to multiple labels under the same construct (Soni & Kodali, 2013). By focusing on using similarities of proposed constructs in the literature (Chen & Paulraj, 2004; Min & Mentzer, 2004; Tracey, Fite, & Sutton, 2004). Burgess (2006) reduced the constructs of SCM into a set of seven constructs (Leadership, Inter & Intra-organizational relationship, logistics, process improvement orientation, information system, and business result and outcomes). Burgess also classify these constructs into two broad group similar to other areas in management. The two group classified as soft people focused construct which associate with social relationship (Leadership, Inter & Intra-organizational relationship) and hard system dominated constructs which associate with technological and infrastructural issues (logistics, process improvement orientation, information system, and business result and

outcomes) (Keller, Savitskie, Stank, Lynch, & Ellinger, 2002; Power, Sohal, & Rahman, 2001).

Furthermore, Burgess et al. (2006) suggest due to its new introduction of supply chain management (SCM), development of SCM is critical to analyze whether newer literature will propose different or new framework of SCM. Therefore Soni & Kodali (2013) analyze the inclination of novel framework in the newer literature and proposed a set of SCM construct narrowed from the newer literature available. A set of nine constructs of SCM resulted from the analysis (Strategic Management, Manufacturing Management, Marketing Management, Integration, Information Technology, Logistic Management, Supplier Management, Demand Management, and Collaboration Management). On the other hand, Chen & Paulraj (2004) proposed a framework of SCM focusing on the concept of collaboration management between supplier and buyer which follows strategic management theory that emphasize on the development of collaborative advantage (Contractor and Lorange, 1988; Kanter, 1994; Dyer, 2000) instead of competitive advantage (Porter, 1985).

2.2.1 SCM Activities

Mentzer et al. (2001) defined supply chain management as a set of activities in implementing management philosophy in which perceived supply chain management as a single system approach to manage total flow of goods from supplier to end customers (Ellram and Cooper 1990; Tyndall et al. 1998) with effort to synchronize and unify the operational activities and strategic capabilities (Ross, 1998) in order to

focus on the customer satisfaction with unique and personalized customer value (Ellram & Cooper, 1990; Tyndall et al. 1998). Through a thorough analysis on the earlier literature on the management practices and activities necessary to implement supply chain management, Mentzer et al. (2001) listed seven key activities in the supply chain management, namely: integrated behavior, mutually sharing information, mutually sharing risks and rewards, cooperation, same goal and same focus on serving customers, process integration and partnering to build and maintain long term relationship.

In the following years, Stock & Boyer (2009) explored in the same direction and classify two key activities of supply chain management in which stated in the definitions in the literatures, namely: material/physical, finances, services, and information flows and networks of relationship. However, these two studies (Mentzer et al., 2001; Stock & Boyer, 2009) found to be similar in their findings. Stock & Boyer (2009) explained that material/physical, finances, services, and information flows includes three supply chain activities stated by Mentzer et al. (2001), while another four activities listed by Mentzer' considered as activities included in the networks of relationship by Stock & Boyer.

Therefore, management activities in which include in the material/physical, finances, services, and information flows by Mentzer et al. (2001) are mutually share information, mutually share risks and rewards, and the same goals & the same focus on serving customers. Mutually share information defined as two directions flows of information exchange from both customer and supplier (Cannella et al., 2015). A frequent information updates such as inventory levels, demand forecast, and

marketing & sales strategies (Uddin et al, 2017) from both supplier and customer are necessary (Dong et al., 2014) for planning and monitoring processes in order to attain effective supply chain management (Zhou et al., 2016). In the meantime, earlier literature suggest that exchange of risks and rewards are expected in a long term relationship between supply chain partners (Cooper et al. 1997; Cooper, Lambert, and Pagh 1997). However it is important in the long term focus and cooperation between supply chain partners (Cooper, Lambert, & Pagh, 1997; Tyndall et al., 1998) and important to generate competitive advantage to the supply chain partners (M. C. Cooper & Ellram, 1993). Aloini et al. (2015) found that sharing of risks and benefits between supply chain partners are important to successfully implement supply chain management. Lastly, Mentzer et al. (2001) distinct a harmonized goals and focus on serving customers as a form of policy integration. He and Hu (2010) suggested that integrated inventory policy is important to reduce inventory cost and increase service level while early literature (Lassar & Zinn, 1995) suggested that it is to avoid redundancy and overlap while trying to develop a cooperation level that allows supply chain partners to be more effective.

On the other hand, relationship network activities includes integrated behavior, cooperation, integration of processes and partnering to build and maintain long-term relationship (Mentzer et al., 2001). Bowersox & Closs (1996) defined integrated behavior in supply chain management as an activity of supply chain members to put effort to coordinate with each other in integration to dynamically react to the end customer's needs (Greene 1991). Cooperation however, defined as a coordinated activities carried out by supply chain partners to produce mutual benefit or outcome

that are mutually anticipated over time (Anderson & Narus, 1990), in which involved cross-functional coordination among supply chain partners and is not limited to the needs of current transaction (Cooper et al. 1997). Moreover, in the study of Deakins et al. (2008) mentioned how understanding each other business processes is important in the relationship between supply chain partners. Integration of processes can be completed through in-plant supplier personnel, cross-functional teams, and third party service providers (Cooper et al., 1997; Tyndall et al., 1998).

2.2.2 SCM Antecedents

In the study of Mentzer et al. (2001), they discuss on the antecedent of supply chain management in which referred to the factors that encourage the implementation of supply chain management. Through literature screening and analysis, eight antecedents for supply chain management discussed how each factor enhance or hinder the implementation of supply chain management. Recent literature (Aloini et al., 2015) also explore on the antecedents for supply chain management in which they referred as prerequisite or precondition factors including financial, managerial, technological, relational, cultural aspects and capabilities which are essential in the implementation of supply chain management in a project. By using ISM method to build a framework on the linkages of antecedents or precondition factors for supply chain management which are taken from past literatures, Aloini et al. (2015) classified sixteen antecedents into three clusters (Interdependence, autonomous & dependence) appeared from the power dependence matrix.

However, the ISM result of Aloini's study (2015) supports most of the antecedents discussed by Mentzer et al. (2001). As underlined by Mentzer that strong commitment of supply chain partners in pursuing common objectives in supply chain management is important to the success of supply chain management adoption, Aloini's case study result showed that commitment from all supply chain partners motivated all the parties involved in the supply chain process. Additionally, Aloini et al. (2015) also suggested that high motivation should emerge from the main contractor as they represent the actor in the supply chain with the management capabilities and highest bargaining power, in which accordance to Mentzer et al. (2001) in their study that discussed the importance of a leader figure within the supply chain partners.

Furthermore, Mentzer et al. (2001) also discussed in their study on how shared vision as an important antecedent for supply chain management even before adopting it. They suggest that visioning provides supply chain partners their goals and strategies to identify and realize opportunities and benefits from adopting supply chain management. Nevertheless, Aloini et al. (2015) refer vision as congruence of objectives in which refers to common values and beliefs of supply chain partners toward supply chain management and their unified vision. The supply chain partner's vision represent as their integrated instrument creating common identity among them and encourage a mutual acceptance in the concept of supply chain management (Hsu et al., 2011). In addition, Mentzer's interdependence antecedent/factor in accordance to Aloini's long term focus antecedent in which mentioned that the dependency of supply chain partner to another member in the

same supply chain network positively associated to the long term relationship orientation of the firm (Ganesan, 1994).

Moreover, Aloini's study also in accordance to the Mentzer et al. (2001) on the trust factor as dependent antecedent for supply chain management success along with working capability (Biedenbach & Müller, 2012), information sharing (Xue et al., 2011), sharing of risks & benefits (Aloini, Dulmin, Mininno, & Ponticelli, 2012), long term focus (W. T. Chen & Chen, 2007) and relational behavior (Leufkens & Noorderhaven, 2011) which are also discussed by Mentzer et al. (2001). However, the ISM model showed that these factors/antecedents are in a cluster which interpreted as the last layer of factors influencing the adoption path of supply chain management although their importance to supply chain management implementation. Especially for share of risks and benefits, the ISM model showed that it is the ultimate factor in the implementation, and it is important to assess risks before adopting supply chain management in order to respond to the risks. It is also noted that benefits arise in the supply chain management should be shared among all supply chain partners (Tommelein et al., 2003), which suggests that relevant and crucial information to be shared consistently and continuously over time among supply chain partners.

Furthermore, ISM model showed that under autonomous antecedent, which includes all the factors interpreted as set of rules & procedures and accessibility which are necessary to ensure no opportunistic behavior and minimize information disruption (Fawcett et al., 2008). Under this cluster, IT integration, selection based on multi criteria, and performance measurements found to have less driving power than

independence antecedents, however they are critical to ensure the satisfactory and completeness in the implementation of supply chain management (Aloini et al., 2015). While IT integration administer the cooperation behavior with its function as support in data management and support collaboration activities, supply chain partners selection based on multi criteria and supply chain performance measurement administer the assessment of a dependable and collaborative supply chain network.

However, there is a distinction between the studies of Mentzer et al. (2001) with Aloini et al. (2015). In the study of Mentzer, they failed to mention on the working skills and capabilities as precondition factor for supply chain management. Additionally, Aloini et al. (2015) explore on the precondition factors for supply chain management in project based, therefore contractual protection was included as necessary factor/antecedent. Due to its frequent usage in project based supply chain management, contractual protection perceived to improve risk management process, minimize relational controversies and would result to significant savings (Palaneeswaran, et al., 2003; Zaghloul & Hartman, 2003).

2.3 SCM in Construction Industry

Construction supply chain management refers to the management of information, material flow and funds in the progress of a construction project (David Simchi-Levi, Kaminsky, & Simchi-Levi, 2000). It refers to a system where contractors, suppliers, clients and other related party work together to use information in order to produce, deliver material, plant and do temporary/permanent works utilizing equipment, labor and other resources for construction projects (Hatmoko & Scott,

2010). Different definition given by Aloini et al. (2012) with consideration of momentary nature of production in construction industry,

"*..it is the coordination and the integration of key construction business both processes and members involved in Construction Supply Chain, extending traditional intra-enterprise activities in a management philosophy by bringing together partners who have the common goals of optimization and efficiency so establishing long-term, win/win, and cooperative relationships between stakeholders in a systemic perspective.*"

Behera et al. (2015) perceived construction supply chain management as not only a management innovation which provides possible improvement in stakeholder value and reductions in overall cost, but also a complex supply chain with short-term relationship driven by lack of information sharing, competitive bidding process and little motivation for new knowledge learning or technology innovation. They added that "low bid wins" is the pricing model applied in each link of the supply chain. The application of construction supply chain management has found difficulties in the consequences of momentary nature of construction industry (Cheng et al., 2010) and difficulties in managing large number of supply chain network which are supplying material, labor & services, components and other multiple services (Aloini et al., 2012; Dainty et al., 2007).

Most firms in manufacturing or any other industry have standard templates for project management, however only few firms have standard templates in project-based industry due to its uncertainty in timing and project specifications compared to

standard procurement based on quantity in process-based supply chains with repetitive demands (Behera et al., 2015). Project-based industry such as construction industry characterized with low productivity, high fragmentation, cost and time overruns and conflicts (Aloini et al., 2012). Yeo & Ning (2006) added that often projects budget and schedule overruns and quality is compromised.

Furthermore, construction involves multiple-organization process which includes contractors, clients, suppliers, consultants, designers and others (Xue et al., 2007), and also involves multi-stage process including conceptual activities, design, construction, maintenance, replacement, and decommission (Aloini et al., 2012). Therefore supply chain in construction involved flow of information, materials and funds between these stakeholders. Figure 2.2 illustrated the flow of construction supply network structure proposed by Crowley & Karim (1995) and improved by Xue et al. (2005) in effort to substitute traditional vertical supply chain and encourage collaboration between supply chain partners.

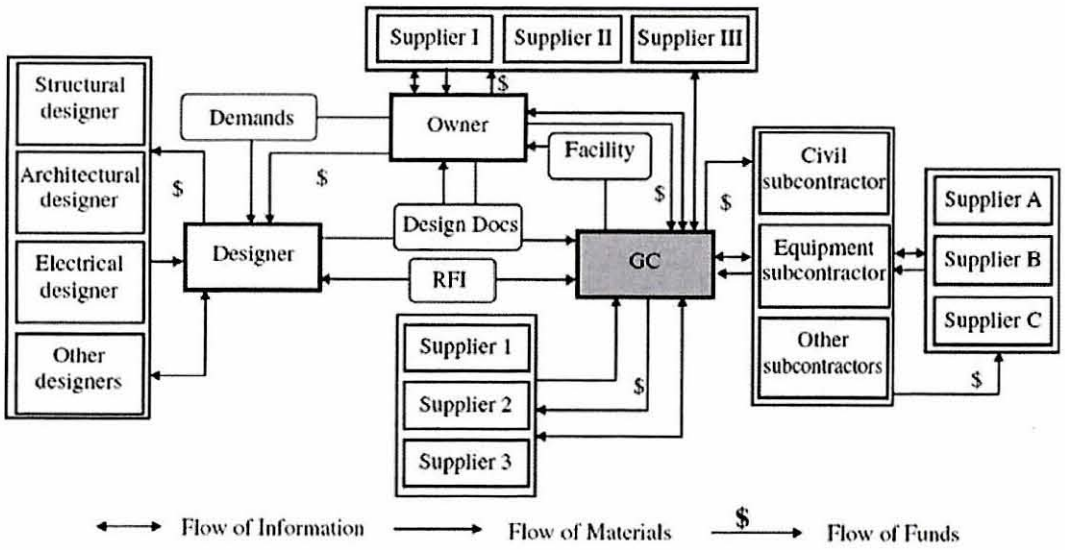


Figure 2.2
Construction Supply Network

Moreover, Behera et al. (2015) illustrated the phases of construction project from the initial concept phase to the winding up phase. The initial phase starts with the initiative of the client to demand a constructed asset as shown in the Figure 2.5. With the demand of a constructed asset, the client finalize the competence and expertise necessary to construct their demand follows with tendering process to select main contractor to be in charge on the construction project. Then the selected main contractor will be responsible for the procurement of materials specified in the material specification requested by the clients. However, in a large-scale construction project, often the client take over the responsibility on decision making for materials procurement and equipment. Physical execution of the construction will start soon after the contract formalized with sufficient amount of information available. The physical execution includes engineering, procurement, fabrication and assembly/installation of components and/or elements to the final completion of the

construction. Soon after the completion of the construction process, the asset is handed over to the clients who responsible for the maintenance afterwards, or in some cases maintenance are guaranteed by the main contractor for a short period of time after completion.

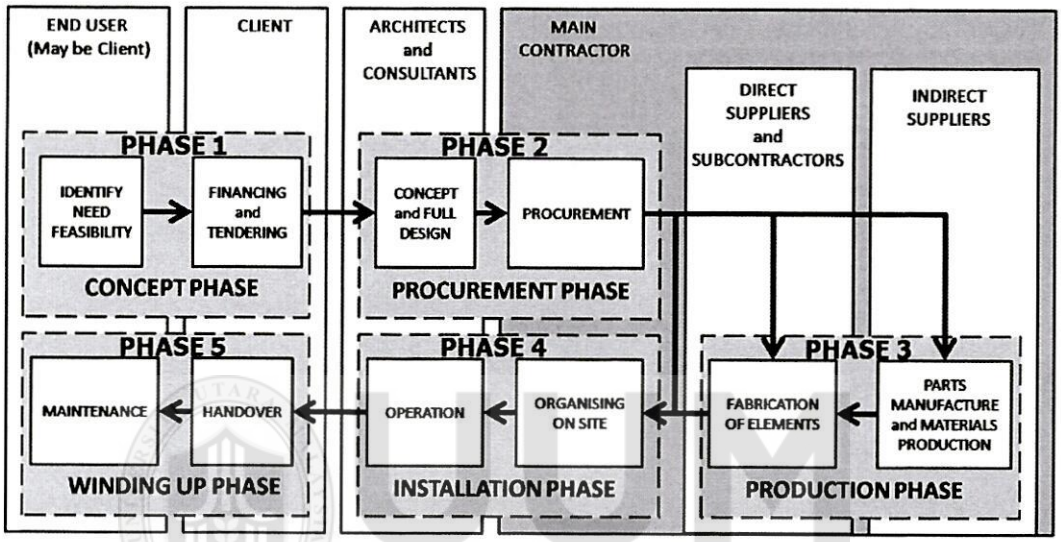


Figure 2.3
Phases in Typical Construction Project

Furthermore, construction supply chain management is characterized by its own distinct features (Aloini et al., 2012; Behera et al., 2015) as follow: Production systems (Fearne & Fowler, 2006), customer influence (Kornelius & Wamelink, 1998; Pesämaa et al., 2009), fragmentation (Baiden et al., 2006), number & type of stakeholders (Xue et al., 2007), buyer-supplier relationship (Hartmann & Caerteling, 2010; Khalfan, Maqsood, & Noor, 2014), temporary configuration (Cox & Thompson, 1997; Kamann et al., 2006) and change inertia (Kumaraswamy et al., 2005; Love et al., 2002). Production system in the construction project associated with the operation under an uncertain and complex environment, while customer

influence and have great involvement in the final product in regards to its physical aspects. Unique features of construction supply chain also emerge from the involvement of multiple organizations and the flow of information, materials and funds among the multiple organizations compared to process-based industry. The transactional nature between supplier and buyer has been the distinct feature of construction project due to its transaction parameter based on the pricing which makes the relationship between supplier and buyer stained by conflict and mistrust (Lu & Yan, 2007; Miller et al., 2002). Construction project also involved with temporary production by temporary organizations at a temporary site, which consequence to possible opportunistic environment where involved organization attempt to leverage every possible profit earning from the existing contract. Another distinct feature of construction supply chain management is that organizations in the supply networks resistance to changes in the project as they are more conservative to change due to the risks associated with the procurement of the project (Cheng et al., 2001).

2.4 Supplier-Buyer Integration

Collaboration between supplier and buyer in business to business transaction that involves greater amount of commitment and trust between both parties in terms of supply chain management overview has been explored by many literatures such as; Waller et al. (1999), Ballard & Howell (2003), Danese & Romano (2011, 2013), (Kull & Ellis, 2016). In the literature found that Supplier-Buyer collaboration have positive relationship to supply chain performance (Danese & Romano, 2013); Uddin, 2017; Wen Ho et al., 2017).

Past literature also found that supplier-buyer collaboration developed from the level of trust and commitment between both parties (Zhou et al., 2016; Uddin, 2017; Wen Ho et al., 2017). Bag (2016) demonstrate the benefits of implementing supplier-buyer collaboration for both supplier and buyer. While the buyer could have better supplier performance, and supplier gain cost advantage with lower transportation cost and buyer dependency. On the other hand, Kull and Ellis (2017) study on the negative effect of buyer dependency to a supplier wherein the buyer loses its power over supplier and suffering lower supplier performance than expected. They also illustrate how supplier cost analysis as an important tool to reduce the negative effect of buyer dependency.

However, while negative effect on buyer dependency treated as a burden, Verwaal et al. (2009) state that most likely supplier will accept supplier-buyer collaboration as it is highlighted as a viable logistics strategy. Supplier-buyer collaboration, however, give significant power to the buyer over supplier to provide better service by adopting e-supply chain integration in which will give both buyer and supplier better supply chain performance (Zhou et al., 2016). Better performance on supply chain also found in the empirical study of Uddin (2017), where they explore on the success factor of supplier-buyer collaboration or state as inter-organizational relation in their study, which includes adoption of lean supply, transparent integrated business activities, and information sharing.

Wen Ho et al. (2017) explore further the supplier-buyer collaboration on the international market to compare whether the same theory applied to the national practices. With the barrier of norms and institutional distance in which complicate

the information sharing between supplier and buyer across culture and country, further effort of trust is required in order to obtained useful information from both parties. In contrast, Salema & Buvik (2016) explore the effect of internal collaboration within the buying firm in the relationship between supplier-buyer collaboration with supplier logistic performance. The study found that internal collaboration has no effect at all to the supplier logistic performance, however it could enhance the relationship as administrative infrastructure.

2.5 Vendor Managed Inventory

Past literature suggested several supply chain strategies in supplier-buyer, including Vendor Managed Inventory (VMI) (Hvolby et al., 2007; Vlist et al., 2007; Yao et al., 2007). Emigh (1999) present evidence that VMI improves supply chain performance in reducing inventory level while increasing warehouse efficiency as a lean supply strategy. For example, a recent case study estimates that VMI reduced inventory by 7% and stockouts by 31% (Dong et al., 2014). Furthermore, Kiesmüller & Broekmeulen (2010) proves that by adopting VMI, lower inventory level causing lower inventory holding cost and transportation cost in which total supply chain cost will consequently reduce.

Moreover, VMI practices also received significant attention from academic researchers due to its successful implementation of industrial practices. Marques et al. (2010) and Govindan (2013) has both providing literature review on VMI, where Marques et al. (2010) focus on describing the concept of VMI process model and

Govindan (2013) more focus on classifying theoretical literature unto six dimensions.

In fact, most researchers use mathematics to explore and determine whether VMI can benefit adopting company (Achabal et al., 2000; Chen et al., 2010; Disney et al., 2003; Nagarajan & Rajagopalan, 2008; Lee & Ren, 2011; Hariga et al., 2013). Under VMI contract agreement between supplier and buyer, there are three types of contract commonly suggested on literature; (z-Z) type VMI contract (Fry et al., 2001), VMI contract with consignment stock and revenue sharing (Wang et al., 2004) and Average-based performance contract (Choudhary & Shankar, 2015).

The (z-Z)-type VMI contract is a mutual agreement supplier and buyer in which the maximum and minimum level of quantity stock at buyer's premises determined in the contract with the penalty of under and over stock per unit of product per period of time (Fry et al., 2001). However, Shah & Goh (2006) stated that this contract might result in higher problem to the supplier as they will be charged on penalty if the level of stock not maintained especially under a stochastic demand.

However, several optimization solutions have been proposed by past literature to prevent such penalties charged to the supplier when buyer experience stock out and backorder (Chaouch, 2001; Al-Ameri, Shah, & Papageorgiou, 2008; Lee & Ren, 2011; Lee & Cho, 2014). While most models consider buyer to charge supplier for the shortage cost (Chaouch, 2001), when demand requirement at buyer not fulfilled, Corbett (2001) consider a solution given to the buyer with multiple options of

contract that will benefit the buyer as every option has been calculated and considered beneficial to the supplier also.

Furthermore, the second type of VMI contract suggested in the literature is the average-performance based contract. This type of contract commonly adopted by supplier-buyer collaboration in which the buyer is a manufacturer which supplier by a supplier for its production components (Choi et al., 2004; Yao et al., 2007). This contract allows the buyer to maintain high service level to its customer independently on how the supplier manages the inventory of components supplied to the buyer under VMI implementation. In addition, supplier service level and target fill rate also considered in this VMI contract type as simulated by Yao et al. (2007) & Van Nyen et al. (2009). Similarly, Savasaneril & Erkip (2010) explore on the VMI system under this type of contract, however, the buyer requires both service level and inventory level as good as traditional system.

Lastly, the third type of VMI contract is VMI contract with consignment stock and revenue sharing. VMI under consignment contract empowers supplier to make replenishment schedule and quantity to buyer's premises and decide the price (L. T. Chen, 2014; Wang et al., 2004). With the uncertain demand condition and price elasticity, supplier and buyer make arrangement on sharing the revenue on retail price based on sales volume (Almehdawe & Mantin, 2010; Chen et al., 2010) and thru discount and rebate on price setting (Guan & Zhao, 2010; Wong et al., 2009).

However, both average-performance-based contract and consignment stock and revenue sharing are more suitable for retailing market industry (Chen et al., 2010;

Wong et al., 2009). Therefore, this study explores on the VMI performance on the construction project, moreover, VMI with (z-Z)-type of contract is more preferable. With supplier maintaining sufficient materials at contractor's premises, contractor will much likely to reduce time for ordering process and administrative work (Tanskanen et al., 2008).

2.5.1 VMI Benefit

According to the study of Claassen et al. (2008), there is a significant positive effect of VMI success on VMI benefits; namely, cost reduction, higher customer service level and supply chain control. However, cost reduction shows the least benefit on VMI performance. This study supports the study of Claassen et al. (2008) that discuss the stage of VMI implementation, where cost-benefit of VMI achieved at later stage of VMI implementation, which both supplier and buyer has fully committed to each other (Holweg et al., 2005) that determined as true VMI.

The performance of VMI mostly measured and evaluated by its result on total inventory reductions (Yao et al., 2012: Dong et al., 2014; Hameri et al, 2014). Reduction of total inventory cost come from several inventory process; namely, inventory holding cost, delivery or transportation cost, production cost (Holmström, 1998; Tyan & Wee, 2003; Kaipia et al., 2002; Dong et al., 2014).

Additionally, as uncertainty is reduced by the shared information within the integrated network, level of safety stock at both supplier and buyer reduced resulting from lower inventory holding cost (Dong & Xu, 2002; Kumar and Kumar, 2003; Tyan & Wee, 2003). The similar result has been reported by Holmström (1998), that

a full-scale VMI introduction leads to saving on inventory holding cost through lower stock level at buyer's premises by 30%. Dong et al. (2014) illustrate similar result in their simulation study with 7% reduction of inventory, however, mentioned that VMI reduce the stockout occurrences by 31%. Reduction of inventory holding cost also found in Hameri et al. (2014) study on VMI implementation at Pulp producer in Brazil.

On the other hand, VMI also benefit to transportation cost reduction with the flexibility of replenishment delivery schedule by the supplier to the buyer, therefore supplier can optimize full-load truck on each delivery (Lee, 2004; Waller et al., 1999). Flexible delivery schedule by supplier not only enable the supplier to optimize the full capacity of each delivery but also the delivery routes (Kleywegt et al., 2002; Rusdiansyah & Tsao, 2005; Archetti et al., 2007; Arora et al., 2010). Optimizing delivery routes can be more beneficial to VMI implemented supply chain network with 2 or more buyer, with either 1 or more supplier.

Additionally, VMI also benefit to production cost reduction (De Toni & Zamolo, 2005; Dong et al., 2014). Lower production cost achieved over improved planning and lower plan adjustment (De Toni & Zamolo, 2005), accurate information on forecast demand (Dong, et al., 2014) and detailed production plan (Hameri et al., 2014). Such improvement on production planning can lead to cost-saving benefit on VMI as the supplier or manufacturer has the information and decision making control to decide how much to produce.

When VMI is implemented and total inventory cost is not reduced, then VMI performance is not optimal (Yu et al., 2015). However, according to Yao et al. (2007) the performance of VMI based on cost improvement cannot be solely depended on, as the level of integration between supplier and buyer developed overtime (Claassen et al., 2008). At the first level of VMI implementation, both supplier and buyer may not benefit from total inventory cost reductions, yet may benefit higher service level.

VMI implementation has a significant positive effect on service level (Claassen et al., 2008; De Toni & Zamolo, 2005; Tyan & Wee, 2003). Tyan & Wee (2003) found that VMI improves the service level compare to traditional inventory strategy. Claassen et al. (2008) stated that VMI most likely will benefit on higher service level than on total cost reduction. As clarified in the Holweg et al. (2005) study, most of the VMI implementation were not properly implemented. Instead of VMI, most of the collaboration are actually Vendor Managed Replenishment (VMR).

However, Kumar et al. (2003) asserted that higher service level on VMI implementation due to higher collaboration level and better understanding on each other between buyer and supplier (Disney et al., 2003). Information availability and visibility in the supply chain network lead to lower emergency orders and incorrect orders as VMI also famous on reducing bull-whip effect (Lee & Whang, 2000; Disney et al., 2003; Reiner & Trcka, 2004).

2.5.2 VMI Driver

Benefits of adopting VMI such as reduced in inventory (Yao et al., 2012; Dong et al., 2014), higher service level (Claassen et al., 2008; Dong et al., 2014), reduced lead time (Kaipia et al., 2002; Tyan & Wee, 2003b) and total cost reductions (Claassen et al., 2008; Yao et al., 2012; Dong et al., 2014) are driven by many factors. Theoretical literature have explored deeper on VMI benefit drivers (Sari, 2007; Kim, 2008; Zhao et al., 2010; Marklund, 2011; Jemai et al., 2013; Lee & Cho, 2014).

Specifically, Zhao et al. (2010) mentioned in their study on VMI implementation on coal delivery activity from upstream level to downstream level, it is best for both upstream and downstream to coordinate and establish a central warehouse and central delivery decision making process which similar to VMI implementation under consignment stock, in order to reduce total cost of ordering and delivery decision process coordination. Similarly, Fry et al. (2001) prove that coordinating production and delivery via VMI implementation can successfully create benefits to the company.

Another driver of VMI benefit is shipment consolidation (Cetinkaya & Lee, 2000). With the consolidated shipment, it would reduce transportation cost and increase delivery effectiveness (Disney et al., 2003). On the other hand, Marklund (2011) illustrate that economic production and delivery frequency can drive benefit of VMI. Comparison of effect of economic production and delivery frequency between VMI and traditional market transaction been done previously (Gümüş et al., 2008;

Bookbinder et al., 2010) and show that in determining benefit of VMI, economic production is examined.

In addition, information sharing is also an important driver for VMI benefit as explored by past literature such as Aviv (2002), Kulp (2002) & Sari (2007). In his study, Kulp (2002) found that benefit of VMI is greater when the information shared between supplier and buyer is reliable and fast. Sari (2007) in her illustration study examine the benefit of VMI related to information sharing and support the result of Disney & Towill (2003) which show that information sharing reduce the bullwhip effect on VMI implementation.

2.5.3 VMI Dimension

Among dimensions of VMI system design proposed by Elvander et al. (2007), includes Inventory-related dimension, Information-related dimension, and Decision making-related dimension. One element of each dimension will be further explored on the effect to VMI performance in Construction Industry.

2.5.3.1 Inventory Location

Inventory location refers to the physical location in which inventory will be managed by the supplier (Elvander et al., 2007). The physical location of inventory under VMI depends on the agreement between Supplier and Buyer according on their optimization policy. Alternatives for physical location of inventory commonly recognize (Elvander et al., 2007; Radzuan et al., 2015) are inventory store at buyer's

warehouse or directly from the production line, inventory store at central distribution warehouse and inventory store at supplier and buyer's premises.

Inventory store at buyer's premises possible in the case where the products are needed and or used directly at buyer's premises (Al-Ameri et al., 2008; Turhan & Vayvay, 2010). Such as healthcare industry, where the inventory is located at the hospital to ensure the products are available when needed (Krichanchai & Maccarthy, 2016). The same implication also applied to the case where the supplier supply component parts to manufacturing buyers, which need to maintain level of inventory at production line to ensure production smoothness (Choi et al., 2004).

On the other hand, inventory store at central distribution warehouse or third-party supply hub may applicable in the case of the buyer with no physical presence in the market and or have outsourced its part or all its logistic process (Elvander et al., 2007), such as e-commerce industry. Mulyono & Ishida (2014) apply the same principle of using central distribution center on disaster relief operations. The objective of using central distribution center is to get as close as possible to the target operations which are separated in multiple locations with access difficulties to distribute logistic supply. Therefore with this alternatives, cost and lead time to make replenishment delivery are reduced.

Another alternative for the physical location of inventory is when supplier store inventory at both supplier and buyer's premises. It is when supplier have their own inventory as a buffer to replenish inventory at buyer's premises while expecting delivery from the manufacturer (Elvander et al., 2007). Such alternative commonly

practiced in the electronics industry, which don't have deteriorate properties (Kuk, 2004).

Furthermore, the decision on which alternatives and optimum location for the inventory have received a lot of attention in the literature. Most literature using mathematical approaches to determine optimum inventory location (Nagel, 2000; Bai et al., 2011; Sharifzadeh et al., 2015; Woo et al., 2016). However, the decision on optimum inventory location have impact on the total operation cost: such as, transportation cost (cost related to transporting inputs and outputs) and location cost (cost related to renting or managing respected warehouse) (Radzuan et al., 2015).

2.5.3.2 Demand Visibility

Demand visibility refers to the types of demand data shared between supplier and buyer in order for the supplier to control the buyer's inventory (Elvander et al., 2007). The types of data might be historical data, future needs reflected by demand forecast and current buyer's allocation data. Among historical data valuable and important to the supplier such as sales data, stock withdrawal, inventory level, in-transit goods, incoming order, backorder, and returned order (Vigtil, 2007; Radzuan et al., 2015). In addition to historical data, future demand thru demand forecast also important to be visible by supplier to prepare for future demand for successful VMI.

In fact, by knowing the demand of the market, consequently, the supplier have increased market visibility and better risk management in the future (De Toni and Zamolo, 2005; Hameri et al., 2013). In addition, increasing market and demand visibility, lead to a lower effect on bullwhip effect (Disney and Towill, 2003; Hameri

et al., 2013). Reduction of Bullwhip effect due to demand visibility has been illustrated with simulations (Gronalt & Rauch, 2008; Lin et al., 2010). Hameri et al. (2013) add that demand visibility reduce amplification of order variability at upstream level of the supply chain.

Moreover, another advantage of demand visibility to both supplier and buyer are larger window for replenishment planning (De Toni and Zamolo, 2005), stable production plan (Kaipia et al., 2013), higher customer level (Claassen et al., 2008; Dong et al., 2014), monitored flow of goods and materials (Hameri et al., 2014). Hameri et al. (2013) mention that discrepancy of current and target inventory level at every stage or echelon at the supply chain is reduced with the full visibility of demand from downstream to upstream level.

2.5.3.3 Replenishment Decision

Replenishment decision refers to supplier's decision to make replenishment decision regarding the quantity and delivery time to the buyer (Radzuan et al., 2015). The full authorization of supplier in VMI implementation to make the decision on quantity and time of delivery (Yao et al., 2007; Vigtil, 2007) gives flexibilities and more freedom to the supplier to control the inventory (Elvander et al., 2007). In contrast, in some cases the supplier entitled to either decide on quantity or time of delivery instead of both decision.

Additionally, Kuk (2004) added that supplier shall have the authority to also decide on the location of the buyer on every each delivery. Location replenishing decision applied when there are multiple locations of the buyer's premises stated in the

agreement (Al-Ameri et al., 2008). On the other hand, (David Simchi-Levi, Kaminsky, & Simchi-Levi, 2000) discuss the VMI implementation where the buyer has to confirm the replenishment decision proposed by the supplier. This practice then argued to be considered as not a practice of VMI, however, it might be accepted as the earlier stage of implementing VMI in the buyer-supplier collaboration (Claassen et al., 2008).

Moreover, another alternative of replenishment decision under VMI implementation includes the case where buyer propose or submit a proposed order to the supplier who has the decision right to decide the quantity and delivery time (Elvander et al., 2007). However, the extent of change allowed may be restricted in the proposed order.

Nevertheless, the accuracy and performance of replenishment decision made by the supplier are subjected to the information shared by the buyer (Kuk, 2004). Darwish & Odah (2010) discuss the implication of replenishment decision by the supplier in the case of (z-Z) type of VMI contract with limited storage penalties. Under such penalties, the supplier may experience less flexibility on replenishment decision due to tight lower and upper stock limit (Claassen et al., 2008). Consequently, optimum replenishment cost will not be achieved by the supplier which is the benefit of implcmcnting VMI.

2.6 VMI Adoption

Potential benefits of VMI have been discussed and explored in the literature, however, few literature considered the question on how and when VMI will be

suitable (Niranjan et al., 2012). Implementation of VMI found to be failed to succeed in several works of literature (Holmstrom 1998, Kaipia et al. 2002). Kaipia et al. (2002) mention that VMI may not be the only solution to all replenishment processes. By using Analytic Hierarchy Process (AHP) framework, Borade et al. (2013) determine whether buyer have the factors to adopt VMI. When VMI may create a great benefit to the integration, in some cases VMI offers no benefits (Kaipia et al., 2002; Claassen et al., 2008). In conclusion, companies with no proper prerequisites for VMI experience VMI as a disadvantage as the implementation failed (Niranjan et al., 2012). Empirical works of literature investigate on the value of VMI adoption and its impact on the success of VMI implementation includes Kaipia et al. (2002), Dong et al. (2007), Classen et al. (2008) and Kauremaa et al. (2009). Dong et al. (2007) explore the environmental determinant of VMI adoption. However, their paper in contrast with the past literature that follow technology adoption (Walton, 1994; Germain & Dröge, 1995; Williams et al., 1998), and instead examine the environmental determinant of VMI adoption. They found that supplier's and buyer's market competition and the degree of supplier-buyer integration have positive impact on the adoption of VMI. In addition, their study suggest the timing clue for VMI adoption.

In contrast, Niranjan et al. (2012) propose a framework for buyer and supplier to guide their decision on adopting VMI. The proposed framework can provide awareness and support on the decision-making process whether to adopt VMI or not. By using case study, their proposed framework help the case company to vision their decision in adopting VMI. However this study useful to help the early stage of VMI

adoption, yet the success of VMI implementation is not guaranteed as the success factor of VMI excluded in the framework.

Moreover, in the study of Kauremaa et al. (2009), they propose five inhibitors of VMI implementation. These inhibitors include brand offering, buyer professionalism, supplier's small share of the total business, supplier's long product lifecycle length and supplier's large delivery batch size relative to demand. It suggests that these inhibitors directly impact supplier dependence and buyers perceived value of VMI.

Another in-depth study on VMI adoption issues, Deakins et al. (2008) propose three stages of VMI adoption with management framework. Their study conducted with the case study of oligopoly industry in New Zealand (NZ). The first stage of VMI adoption suggested being the initial stage of VMI consideration, where the top management will decide whether to commit to the relationship with its vertical supply chain. To be the foundation of VMI adoption, stage two refer to the stage when the members of the relationship start to understand each other process and collaborate further to fill in the gaps between each other's business process. Reaching the mature stage of VMI adoption, stage three involve members of the relationship to monitor each other processes and advance its daily performing task through automation to minimize crrors.

Potential benefits of VMI have been discussed and explored in the literature, however, a few literature considers the question on how and when VMI will be

suitable (Niranjan et al., 2012). Therefore this study will explore on the initial determinants of VMI adoption in the construction industry.

2.7 VMI Adoption Determinant

Based on the empirical study of Dong et al. (2007), they propose five environmental determinants of VMI adoption; namely, buyer's market competitiveness, supplier's market competitiveness, product demand uncertainty, buyer operational uncertainty, and supplier-buyer integration. However, the result found that only three out of five proposed determinants positively influence the VMI initial adoption. Positive influence of supplier's and buyer's market competition and supplier-buyer cooperation level associated with higher degree of adoption of VMI, while no influence of demand uncertainty causing the degree of VMI adoption. However, insignificant role of product demand uncertainty to the degree of VMI adoption support the simulation result of Waller et al. (1999) in which stated that volatility in demand does not influence the perceived benefits of VMI.

In accordance to positive influence of supplier's market competition to the degree of VMI adoption, Gadde et al. (2017) illustrated that managing high number of supplier is advantageous to the buyer due to higher opportunity to have low-transaction cost with various price range and lower dependency to particular suppliers. However, handling high number of supplier is consequently associate with higher total cost compared to having collaboration with supplier, in which the cost of maintaining individual relationship is low (Gulati & Singh, 1998). Buyer is also benefit from high competition in supplier's market through promotion wars and marketing

competitive movements by the suppliers in the market (Jaworski & Kohli, 1993), which they can chase for the lowest price available in the market.

On the other hand, buyer's market competition has slighter significant to the adoption of VMI compared to competition of supplier's market (Dong et al., 2007). Additionally, Waller et al. (1999) indicated that compared to buyer, supplier is more likely to benefit from VMI when there is high competition in the buyer's market. Supplier can employ VMI as a tool to lock-in its customers and gain more knowledge about its buyers. Although literatures in the adoption of VMI tend to perceive VMI as an innovation to the buyers in respond to market pressure and competition to achieve efficiency (Grover & Goslar, 1993; Waarts, Van Everdingen, & Van Hillegersberg, 2002), insecurity of the buyer on the important information shared to the supplier leaked or passed to the competitive market discourage the adoption of collaboration initiative with supplier such as VMI, in which involves continuous exchange of information between the buyer and the supplier (Li, 2002).

Additionally, in the collaboration literatures of construction industry, trust issues are among the most popular issue associated with information sharing and collaboration between contractor and supplier (Manu et al., 2015; Challender, 2017; Shen et al., 2017). Manu et al. (2015) stated that contractors are very concern carefully regarding the information shared to the other stakeholders (client, supplier, third-party, and consultant) fearful that the information will be leaked. Thus, insecurity of leaking shared information to the other contractors is much stronger reluctant to collaboration rather than motivation to collaborate with efficiency goal. Therefore in this study which evaluate the adoption of VMI from the perspective of the

contractor, buyer's market competition is not included in the hypotheses as positive environment determinant that influence the degree of VMI adoption. The perspective of contractor selected because of the importance role of contractors in the sustainability of construction industry, in which considered as construction project initiators due to their dominant impact on the entire direction of the project (Abidin et al., 2013; Adewale et al., 2016).

Then again, demand uncertainty and variability perceived as a motivation for firms to improve and advanced their material planning in order to balance their supply and demand in regards to time and quantity to be ordered to the supplier (Jonsson & Mattsson, 2006; Vollman et al., 2005). This findings supported by Jonsson & Mattsson (2016) which noted that demand uncertainty as the most difficult issue in material planning, however it motivates further research on how material should be planned in relation to inventory performance improvement (Christopher & Holweg, 2011). Motivation from demand uncertainty towards improved supply chain management was also explored by Simangunsong et al. (2012) who suggested that through collaboration between business partners, supplier and buyer, causing improvement in demand uncertainty through information sharing.

Despite the finding of insignificant role of demand uncertainty towards the degree of VMI adoption, nevertheless, demand uncertainty has a significant role towards the motivation to collaborate between supplier and buyer in a purchasing management (Gadde & Wynstra, 2018; Handfield, 1993). Handfield (1993) more than two decades ago stated that in order to reduce demand uncertainty, buying firms most likely to have close relationship with their suppliers through inventory management

innovation such as just-in-time (JIT) deliveries. Therefore in this study, VMI in which similar to JIT is proposed as an environment determinant of VMI adoption with significant and positive impact.

Moreover, operational uncertainties of the buyer unsurprisingly found to be negatively influence the adoption of VMI. Dong et al. (2007) indicated that firms with high uncertainty on the inbound logistics processes, such as order cycle times, unpredictable lead times and long inspection process, which are mostly due to poor performance of the supplier, are more reluctant to have close relationship with the supplier and adopt VMI. Unpredictable operations will complicate the cooperation between supplier and buyer later on (Cetinkaya & Lee, 2000) and resulting conflicts. Therefore, greater uncertainty in the buyer operation causing a lower degree of VMI adoption and excluded in this study as an environment determinants of VMI adoption.

With the objective of this study is to examine what are the environment determinants of VMI adoption in construction industry, therefore three proposed environmental determinants of VMI adoption will be included in this study are: supplier's market competition, demand uncertainty, and supplier-buyer integration level. Further discussion on the literatures regarding these three determinants are presented in the next sub-sections.

2.7.1 Supplier's Market Competition

Supplier competition as one of the factor to initiate collaboration with supply chain management (SCM) have been explored since 2 decades ago (Bowersox, 1990; Lee

et al., 1997). Dealing with current intense global competition in the market, collaboration on SC coordination for more effective and efficient operation has received significant attention from literature (Derrouiche et al., 2008; Chen et al., 2009; Haardt et al., 2010; Xiao and Bao, 2011). Collaboration on SCM has its own role as strategic planning in improving the overall performance of SCM which beneficial to all members that create competitive advantage (Derrouiche, Neubert, & Bouras, 2008; Horvath, 2001).

In a competitive market, the buyer expects continuous improvement from the supplier on its product. With the mentioned high expectation from the buyer, the product should not only be cheap and in a good quality, but buyer expects the availability and delivery time to be better (Xiao & Bao, 2011). Therefore, the supplier will not only have to compete by lowering prices and improving quality but also have to develop effective supply chain management to respond market competition (Lehoux et al., 2010).

In response to market competition, SCM collaboration with VMI strategy benefit the members on total cost reduction and higher customer service level (Chen et al., 2009; Shi & Bian, 2009; Haardt et al., 2010). Moreover, exploration literature on the effect of supplier competition to the initiative of SC collaboration has been done in several industrial case study (De Toni & Zamolo, 2005; Haardt et al., 2010). For example, in 1984 due to great competition in a textile industry, market leaders in the US apparel industry collaborate with each other (De Toni & Zamolo, 2005). The same initiative also was taken by the Soft-drink market, which suppliers have been

pushed to improve their production efficiency to outrival the competition (Haardt et al., 2010)

Another evidence of supplier competition effect on VMI adoption also coming from the brand competition (Mishra & Raghunathan, 2004a). It is the competition between suppliers that related to brand substitution in the market. It is when one brand can substitute another brand which has problem with its availability or price difference. Mishra and Raghunathan (2004) suggest that due to the market character with substitute brand competition, collaboration through VMI strategy can benefit buyer compared to traditional Retailed Managed Inventory (RMI). The benefit of VMI under this character arise when buyer's holding cost reduced and stockout occurrence reduced as the Supplier tend to stock more inventory to coping the substitute characteristic from other brands.

With above evidence of positive relationship on supplier competition effect on supply chain collaboration and VMI adoption, therefore this study propose that supplier competition will have a significant effect on the VMI adoption in the construction industry as well, with the consideration that evidence of positive relationship has been found in multiple industries by literature.

2.7.2 Demand Uncertainty

Demand uncertainty is found to have no impact VMI initiative adoption (Dong et al., 2007). Dröge & Germain (1998) characterize demand uncertainty as environment uncertainty including price volatility, product obsolescence, and unpredictable competitor actions. Although demand uncertainty found to have no relationship

towards VMI adoption, the literature suggests that the relationship found to be complex. Using Transaction Cost Economics (TCE) framework (Coase, 1937), early literature found both positive relationship (John & Weitz, 1988; Walker & Weber, 1987) and negative relationship (MacMillan et al., 1986) of demand uncertainty and the necessity of vertical integration.

In the study of Walker & Weber (1987), they suggest that as uncertainty increase, supplier and buyer are most likely to integrate to reduce the uncertainty. This result also supported by in the empirical study of John & Weitz (1988), that manufacturer prefers to rely on direct distribution when environmental uncertainty increases. In contrast, MacMillan et al. (1986) found no relationship on such relationship, which illustrates how supplier and buyer refuse to integrate on an uncertain industry. However, this negative relationship applicable on the consumer goods and consider exception on capital goods and components parts with opposite relationship.

Moreover, literature suggest the same counteracting effect. While (Clark & Hammond, 1997) and Yang et al. (2003) suggest that VMI adoption will perform better on predictable and stable demand patterns, Lee et al. (1997) and Dong et al. (2007) state that the higher the demand uncertainty in the market, the need for VMI adoption will be higher also, in order to reduce the uncertainty. However, Yang et al. (2003) propose that if VMI adopted in a volatile demand industry, supplier have to provide extra effort to reduce stockout cost at buyer's premises.

As mentioned in the evidence above, it is proposed that demand uncertainty most likely has no impact on the VMI adoption in the construction industry. With the

characteristic of components part, the demand for construction consumable materials are unpredictable because they are at the upstream level in the material flow of supply chain (Brown et al., 2001). Therefore this study neglect the literature (Dong et al., 2007) with proposing positive relationship of demand uncertainty towards VMI adoption in Malaysia construction industry, in consideration of given most evident in the literature (Disney & Towill, 2003; Dong et al., 2014) suggest that variability of demand motivate adoption of VMI initiative.

2.7.3 Supplier-Buyer Collaboration

Dong et al. (2007) found that supplier and buyer that have higher collaboration relationship in general business area, tend to adopt VMI strategy. Supplier and buyer also prefer to participate in an SC collaboration, such as VMI, with the motivation of cooperative goals (Wong, 1999). In addition, Bagchi & Skjoett- Larsen (2003) support that supply chain collaboration would most likely fail to perform when the degree of integration is low.

Integration between supplier and buyer in the business process such as Research and Development (R&D), problem-solving operation, and financial management collaboration, found to have a higher degree of trust and lead to the beneficial condition to adopt VMI (Hart & Saunders, 1997). Hausman & Stock (2003) also suggest that adoption of technology integration between supplier and buyer require a higher degree of relationship and long-term coordination.

Moreover, Claassen et al. (2008) also discover that quality of supplier-buyer integration has the significant impact on the success of VMI adoption. The same

result also found earlier by Petersen, Ragatz, & Monczka (2005) in their empirical study that relationship quality has positive influence on the planning process. However, a negative relationship between organization size and perceived value of VMI is found in the empirical study of Kuk (2004). In his study, negative relationship occurs due to a higher degree of challenges and barriers of larger organization compared to the perceived value of VMI benefit. His study looking at the implementation after the initiative of adopting VMI, however, this study emphasize on the initial determinant to adopt VMI.

With above evidence on supplier-buyer integration level, this study supports the literature. In consideration of the suggestion made by Fulford & Standing (2014), towards the need for collaboration in the SC practices in the construction industry for project efficiency improvement and organization performance, this study proposes positive relationship on Supplier-Buyer integration towards the VMI adoption in the construction industry.

2.8 VMI Adoption Barrier

Benefit of adopting technology innovation such as Vendor Managed Inventory (VMI) has been proven to bring benefits in managing their supply chains to the adopting firms compared to those firms who do not (Dong et al., 2014). However it is people who adopt innovation, not firms (Downing, 2006). In order to evaluate the adoption decision of technology innovation such as VMI, it is important to understand the perception of benefit and barriers of the technology itself. Fergusen, Hill, and Hansen (1990) identify a few perceived benefits and barriers in their

investigation on the Technology adoption, which was the use of electronic data interchange (EDI) in the United States firms. Among the barriers to technology adoption found in their study were the high cost of technology setup, compatibility of hardware and software, lack of technology benefit awareness and inexperienced technology users.

In the investigation of E-commerce adoption with the perspective of people perceptions between Chinese MBA and US MBA, Downing (2006) compares 11 obstacles obtained from Rogers' (1995) framework of diffusion. Innovation diffusion framework by Roger's considered to cover the perception of the people who will use and benefit from the technology innovation compared to the framework of Technology Organization and Environmental (TOE) by Tornatsky and Fleischer (1990) and the CPT (Culture, Policy, and Technology) introduced by Bajaj and Leonard (2004). Among the earlier 11 barriers, after the result from 87 and 96 participants from China and US respectively, 5 main barriers were presented as major barriers in the adoption of e-commerce among others. Major barriers presented were lack of security transaction, lack of uniform transaction standards, unreliable delivery of information, hardware and software problems, and user inability to use internet. The result also indicates that compared to US participants who perceived their internal firm were not ready to adopt E-commerce, Chinese participant perceived to be more ready to adopt and implement E-commerce while their customers were not.

In line with method used by Downing (2006), samples of IT managers of SMEs in Italy chosen by Corrocher & Fontana (2008) to examine the perspective of user,

which in this study were IT managers, to the perception of benefits and barriers on the adoption of ICT (Information Communication Technology). Out of 128 samples of SMEs in Italy, the result presented that 3 major barriers in adopting ICT were insufficient information from vendors, lack of compatibility from currently deployed network, and absence of proven performance benefits. However these results were examined further on the factors that influence these barriers perception. They argued that cost structure, firm size, past experience and path-dependence from the previous adopted technology and equipment were the factors that influenced the perceptions of users. However, the result shows that firm characteristics such as firm size and cost structure somehow have less impact on the influence to the perceptions of barriers of ICT compared to past experience from previously adopted technologies and equipment. Furthermore, barriers to the adoption of ICT reduced with more capability of the new technology to integrate with the deployment of present technology due to its positive association with the switching cost.

Moreover, initiated by the emerging problem of environmental issues of technology in developing countries such as India, Mittal & Sangwan (2011) developed ISM model on the obstacles to ECT (Environmentally Conscious Technology). Eleven obstacles were drawn from previous literatures on the subject of technology adoption and analyze with Structural self-interaction Matrix (SSIM) to develop the ISM model which structure the obstacles with their driving power and dependence of each obstacles. Figure 2.4 show the ISM model of obstacles to ECT adoption. The model suggest that the obstacles to ECT adoption were mainly driven by lack of information among government, public and manufacturer. Additionally, each of the

obstacles have different influence on the adoption of ECT while each of the obstacles have connections among themselves.

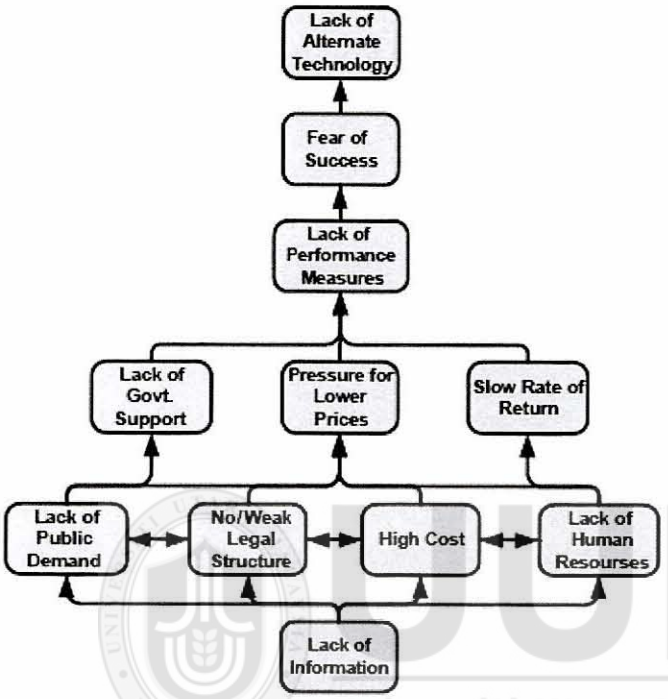


Figure 2.4
ISM-Based Model of Obstacles to ECT Adoption

Following the same objective of efficiency with Downing (2006), the adoption of cloud computing in the healthcare service industries examined by Bernsmed et al. (2014) in order to determine the barriers and solutions to the adoption process of cloud computing in the industry. Technology as a role in the adoption of cloud computing underlies the emphasize on the barriers with the challenge of security, privacy and compliance which were already mentioned by previous literature (AbuKhousa et al., 2012; Rodrigues et al., 2013). Unlike other literature previously (Downing, 2006; Mittal & Sangwan, 2011), Bernsmed et al. (2014) practiced

focused group session to examine the challenges and barriers to the adoption of could computing perceived by Stakeholders in Norwegian healthcare services. The result of the sessions suggesting several barriers to adoption perceived by the Stakeholders. However, the result showed that uncertainties in regards to ownership, privacy and availability of medical data, lack of proven performance evidence, lack of operational ease and possible problems with compliance, to be the major barriers to the adoption of cloud computing in healthcare services in Norway which confirms the result of previous literatures (Ahuja et al., 2012; Lian et al., 2014; Sultan, 2014).

On the other hand, empirical study done by Borade & Bansod (2010) on the adoption of VMI in India includes the objective, strategic driver, obstacles, and affected operation in regards to the adoption of VMI between SMEs and larger firms. Designed from the previous literatures and interviews with academicians, experts and consultants, five obstacles/barriers on the adoption of VMI is tested to 98 and 126 SMEs and larger firms respectively.

Five obstacles proposed by Borade & Bansod (2010) are lack of the suitable information technology infrastructure, lack of trust and mutual understanding between supply chain partners, ineffective organizational structure, improper decision support tools and internal/external integration. These obstacles designed with the perspective of the SMEs and firms who expect to adopt VMI in their supply chain network with their suppliers. These obstacles perceived to be the organizational barriers of the firms in regards to their decision to adopt VMI. However, there are no common obstacles for VMI adoption and on each VMI relationship, the obstacles would be different (Borade & Bansod, 2010). Barriers on

the lack of the suitable IT infrastructure similar to barrier found in the study of Downing (2006) which concern regarding the security of the transaction and possible problems with hardware and software. This barrier also mentioned in the study of Corrocher & Fontana (2008) which perceive compatibility of the previous technology to align with the new technology as the barrier to adopt ICT.

Lack of trust and mutual understanding between supply chain partners has been popular as the major barrier to a collaboration between buyers and their supplier in the literatures (Zhou et al., 2016; Uddin, 2017; Wen Ho et al., 2017). In regards to the adoption technology, trust and mutual understanding also discussed in the study of Barratt (2004). The advancement of technology make the trust and understanding between supply chains partner worse due to its hype recognition that technology as the key to enable broad inter-organizational collaboration (Fawcett, Wallin, Allred, Fawcett, & Magnan, 2011). Barratt (2004) also suggest that mutual understanding could be achieved with clear and extensive line of communication. Corrocher & Fontana (2008) found similar barrier in their study that insufficient information from vendor/supplier perceived as barrier for the adoption of ICT. Chin, Tummala, Leung, & Tang (2004) also added that resistance to information sharing with supplier is the common problem of firms in attempt to adopt new technology initiative. Borade and Bansod (2010) suggest that sufficient information sharing helps managers to adopt VMI smoothly.

Moreover, improper decision tool barrier includes lacks of skills and knowledge of technology possessed by the firm (Chin et al., 2004). Lack of skill to use the technology and make decision on the new technology retain the firm to adopt such

new technology. Bernsmed et al. (2014) suggest that lack of knowledge on the new technology started with the lack of evidence of the benefit of the new technology from the previous practice. Corrocher & Fontana (2008) mentioned earlier that past experience of the technology influenced the perception of the user. Decision support tools such as knowledge, skills and training on the new technology are important to consider to reduce the barrier for adopting VMI (Chin et al., 2004; De Toni & Zamolo, 2005; Sharma & Bhagwat, 2006).

On the other hand, barrier of internal/external integration in the supply chain network has limited study on the literature. However, Sharma & Bhagwat (2006) stated that disparity in capabilities between supply chains partner is a vital barrier for implementation and adoption of new technology initiative. Integration with lack of similarity in goals and objectives influence the decision to adopt new technology collaboration. They also added that similar to resistance to information sharing with supply chain partners initiated from the threats of information security between supply chain partners. Insecurity of the firm to information security barrier the firm in decision to adopt new technology initiative (Sharma & Bhagwat, 2006). Toni & Zamolo (2005) also added that long distance of physical location between supply chain partners in the collaboration influence the resistance to adopt VMI.

Lastly, lack of vision and resistance to change are the characteristic of an organization structure that is ineffective and prevent firms to adopt VMI (Sharma & Bhagwat, 2006). Ineffective organization structure also mentioned in the study of (Singh, Narain, & Yadav, 2006), who classified barriers related to budget and organizational culture as organization structure in which influence the decision to

adopt new technology. Additionally, lack of commitment of the top management in the collaboration and the adaption of the new technology perceived as another barrier under ineffective organization structure (Chin et al., 2004).

The study of Borade & Bansod (2010) support the suggestions in the study of Kuk (2004) that larger firms have the advantage on the resources allowing them to meet the expense of experiments with new technology, failures and bear the price of implementing the innovative technology. Larger firms perceive lack of trust and mutual understanding with supply chain partners as the highest barriers on the adoption of VMI, whereas SMEs perceive lack of suitable IT infrastructure as their biggest barriers and improper decision support tools as the next important barriers to their decision on the adoption of VMI.

Moreover, the result of Borade & Bansod (2010) suggest that ineffective organization structure perceived as the least felt barrier by SMEs and second least felt barrier to the larger firms. However in the study of Borade & Bansod (2012) where they connects and structured the five barriers in their previous study (Borade & Bansod, 2010) using ISM methodology and presented that ineffective organization structure served as the highest driving power to the decision to adopt new innovative technology such as VMI. The linkages of barriers to the adoption of VMI on ISM based model shown in Figure 2.5. Nevertheless, ineffective organizational structure have lowest dependable power to the other barriers. Lack of the suitable information technology infrastructure, lack of trust and mutual understanding between supply chain partners, improper decision support tools and internal/external integration have

strong driving power and strong dependence power making them very important because their influence on the adoption process.

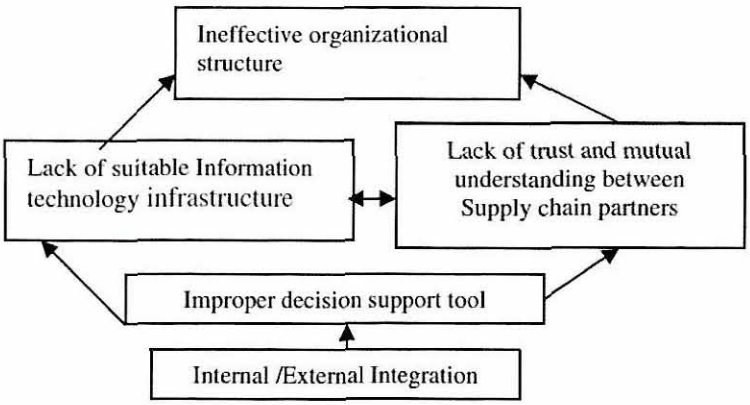


Figure 2.5
ISM-Based Model for VMI Adoption Barriers

2.9 VMI Readiness

Successful implementation of VMI has been realized in many cases in the literatures (Yan Dong, Dresner, & Yao, 2014; Tyan & Wee, 2003). Real benefits of VMI also mentioned in the literatures (Kulp et al., 2004; Kauremaa et al., 2009; Krichanchai & Maccarthy, 2016). However unsuccessful adoption of VMI also realized in the literature (Vigtil, 2007; Ellegaard & Freytag, 2010; Niranjan et al., 2012). Several literatures suggest that unsuccessful adoption of VMI is for the reason that most of the firms are not realize the indication of when VMI could benefit them (Dong et al., 2007; Bookbinder et al., 2010; Niranjan et al., 2012; Ryu, 2016). For example in the work of Dong et al. 2007, VMI is suggested to be adopted when there are great competition in the market of the supplier, less uncertainty in the operations and higher level of collaboration between supplier and buyer. These suggestions provides

valuable practical clues to the managers and practitioners on when VMI will be beneficial and make sense.

However, there are several barriers to the successful adoption of VMI (Borade & Bansod, 2010; Kaipia, et al., 2002). There are barriers in the administration aspect where the administration costs are high and the process of filling and replacing orders are ineffective (De Toni & Zamolo, 2005). Barriers and difficulties in the lack of information technology used by the supplier and buyer were also found in the case in the literature in which hold their decision to adopt VMI (Borade & Bansod, 2010). Additionally, problems in the planning made by supplier nor buyer were also suggested in the literature (Claassen et al., 2008; Hameri et al., 2014). In some cases, the burden of shortages when buyer realize fully to the supplier and demands were just not full filled (Yan Dong et al., 2014; Hameri et al., 2014). In conclusion, there are proven cases that failure in VMI implementation is possible (Kuk, 2004).

Therefore, several literature had proposed several determinants and steps in order to reduce the possibility of failure in adoption and implementation of VMI (Dorling et al., 2006; Dong et al., 2007; Deakins et al., 2008). Niranjan et al. (2012) broaden the work of Dong et al. (2007) and explore features that are recognized to be advantageous to VMI. The study involved with extensive literature assessment and interviews with researchers to indicate key features of requirement for a successful VMI implementation. The assessment and interviews generated 15 key features of pre-requisite to a successful VMI implementation. These features then finalized with practitioners and experts review to weight each features on the importance of a successful VMI adoption. Niranjan et al. (2012) perceived these pre-requisite

features as organization readiness to VMI adoption instead of technology readiness in which constitutes with physical resources & infrastructure and intangible knowledge of IT expertise and skills (Oliveira & Martins, 2010).

Organization readiness refer to the degree of commitment, awareness, resources and control possessed by an organization to adopt new technology innovation (Tsao et al., 2004). Hameed et al. (2014) with their meta-analysis study found that organization readiness is the most significant organization attribute to the adoption of information technology (IT) innovation compared to the other attributes (resources, top management support, expertise, infrastructure and organization size). Readiness to adopt new technology innovation positively influenced by the perceived usefulness and perceived ease of use of the innovation itself to the organization (Gangwar et al., 2015). Organizations with higher level or readiness are most likely to adopt new technology innovation.

Moreover, it was found that organizational size significantly related to the adoption of a new technology innovation (Hameed et al., 2012; Lee & Xia, 2006). Organizational readiness associated with the resources and control over the new technology innovation possessed by the organization (Tsao et al. 2004) and organizational size measured by its owned-resources and structural complexity (Hitt et al., 1990). However, arguments regarding the significant influence of organizational size to the adoption of new technology innovation. Some empirical literature found the significant (Baker & Yousof, 2017; Bordonaba- Juste et al., 2012; Lee & Xia, 2006) and several literatures empirically found no significant on the relation of size to the adoption of a new technology innovation (Oliveira &

Martins, 2010; Perrigot et al., 2012; Oliveira et al., 2014). Additionally, arguments also emerged from whether smaller or larger organization has the higher readiness to adopt new technology innovation such as VMI. Among the literatures indicated that larger organization possess higher readiness includes: Lee & Xia (2006); Cudanov et al. (2010); Bordonaba- Juste et al. (2012); Saldanha & Krishnan (2012). Most of the literatures noted that larger organization perceived to have higher readiness to the adoption of new technology innovation due to its access and possession of infrastructure, technology and resources to adopt and implement the new technology innovation (Cudanov et al., 2010; Bordonaba-Juste et al., 2012). However, it was found that for non-profit organization, having the access and possession of such resources and financial capabilities not significantly impact the readiness and the adoption of new technology innovation (Jaskyte, 2013).

On the hand, some literature suggest that smaller organization perceived more benefits to adopt new technology in terms of their organization readiness towards new technology innovation (Alshamaila et al., 2013; Gong et al., 2013; Son & Benbasat, 2007; Zhu & Kraemer, 2005). Most of the literature discussed the importance of structural complexity of an organization in which influence the ability of the organization to change and adopt the new technology innovation. For small businesses in which just starting the business up, its flexibility to change and adopt new technology innovation is greater than older and larger business (Alshamaila, et al., 2013). Similarly, Zhu & Kraemer (2005) mentioned that larger organizations are burdened by the structure inertia due to its broad organization structure, in which influence the decision making process more complex and takes much longer time

(Hitt,et al., 1990). Hitt et al. (1990) added that small organization has the advantage of better close relationship and coordination between its partners compared to larger organization, in which allowing them to adopt new technology innovation collaboratively easier. Gong et al. (2013) supported the findings of flexibility advantage of smaller organization in order to adopt new technology innovation and added that organization with its wide and large organization structure creates differentiation and consequently creates conflicts of interest when decision is going to be make.

On the other hand, the 15 features of pre-requisites of a successful VMI, Niranjan et al. (2012) classified the features into 3; namely product related, company related and supplier related features. On product related features, they emphasize on the characteristics or features of products that are most likely be feasible in the implementation of VMI. Niranjan et al. (2012) described the product related features in regards to their level of demand, standard product, volume of the product, and identification of the product and the value of the product. According to Raghunathan & Yeh (2001), products feasible in the implementation of VMI are better be mature products with high and stable demand. Kauremaa et al (2009) also suggested that VMI implementation with customized products has limited value. However, information sharing will be beneficial to the introduction of new products with elastic demand (Mateen & Chatterjee, 2015). Standard product identification with integrated information system is also suggested as product related features. Kuk (2004) stated that high levels in integration in the logistic identification ensure VMI success. Moreover, product demand as Disney & Towill (2003) mentioned in their

study, in order to reduce bullwhip effect in the supply chain transactions, VMI could be beneficial under both low and high volume product. Aligned with the result, Franke (2010) also found a successful case of VMI under low volume production environments. In addition to that, Franke (2010) also discuss on the misconceptions of products related features of VMI in which suggest only low value products to be included in the VMI transaction because high value products need more attention to handle internally. However, the study showed that even for high value products, VMI is still possible to be implemented.

On the other hand, under company related features, VMI is feasible to be successful when purchasing is not a core competency of the firm. They suggested that such firm with purchasing competencies, will be reluctant to adopt VMI and maintain traditional purchase transactions. Kauremaa et al. (2009) also suggest that buying firms with high purchasing skills are less likely to adopt VMI because they are most likely to be independent with their suppliers. Yao et al. (2007) mention some other requirement to the success of VMI implementation, such as shared information and coordination in business process between supplier and buyer. They also added that adoption of VMI is feasible when the total cost to maintain traditional transaction practices is high.

Lastly, Niranjan et al. (2012) highlight the supplier related features by the level of relationship quality of supplier and buyer including their trust and mutual advantages perceived with VMI implementation. It has been widely suggested that quality of the relationship recognized as an enablers of a successful VMI implementation (Claassen et al., 2008). In a comparison study of VMI adoption between SMEs and

larger firms in India, Borade & Bansod (2010, 2013) found that larger firms have high barriers for the adoption of VMI due to its trust issue with their suppliers. Blackhurst et al. (2006) earlier mentioned that lack of trust between supply chain partners causing unwillingness to share information in which is important to a successful VMI adoption (Kaipia et al., 2017). Hausman & Stock (2003) suggested that along with the degree of trust, long-term relationship between supply chain partners is also required in the relationship. Franke (2010) added that long term relationship in VMI implementation is favorable because there will be less conflicts over inventory, trust issues and payments. Additionally, Kaipia et al. (2002) suggested that VMI implementation will most likely to be successful when it could demonstrate to supply chain partners the benefits of shifting to VMI.

In conclusion, these features are an easy-to-use methodology to assess firms' readiness to adopt VMI. Decision to whether adopt VMI or not can be asses with this methodology (Niranjan et al., 2012). A possible range of 0-400 score from overall score with score below 200 indicates that firms' VMI readiness is low and suggested to maintain traditional supply chain transactions instead of to adopt VMI. However, with score between 200 & 300, the methodology suggests that firms should consider to adopt VMI. Lastly, it is suggested that firms should adopt VMI when total score reach above 300. These features are also considered to measure the readiness of firms to adopt VMI in their business transactions, however the readiness is measured with the perspective of organizational readiness instead of technological readiness. The framework assess the readiness to adopt VMI through the company organization structure, product characteristics and level of integration with the supplier.

2.10 VMI in Construction Industry

Study on inventory management in the construction project has been popular in the literature (Elzarka & Bell, 1995; Caron et al., 1998; Al-Khalil et al., 2004; Horman & Thomas, 2005; Tserng et al., 2006; Tanskanen et al., 2008). Most of the literature focus on reviewing and modeling the performance measurement and optimization for the material inventory management in the construction project. However, unsuccessful material inventory management practices found in some literature (Koushki & Kartam, 2004; Thomas et al., 2005; Lædre et al., 2006).

To measure the performance of supply chain management (SCM) in a construction project, AL-Khalil et al. (2004) have proposed performance measurement indicator based on the work of Plemmons & Bell (1995). Meanwhile, Horman & Thomas (2005) explore in the same performance measurement indicator but instead propose safety stock buffer to be the fundamental parameter for supply chain management in the construction project. In order to achieve the highest performance of inventory management, Thomas et al. (2005) propose fundamental practices to overcome poor performance associated with cost, schedule, and labor productivity in a project.

Nevertheless, an improvement on construction supply chain management potentially occurs on supply chain elements such as demand, design, material requirement planning, delivery of the product, and supplier or subcontractor management (Zou, 2009). Potential improvement in production of construction industry also feasible through supply chain collaboration. However, relationship with contractor and supplier with only informal communication and without formal practices are most likely to be problematic (Fulford & Standing, 2014). Formal practices such as the

use of proper software system, contract standardization, and collaboration most likely to produce greater result such as waste reduction and production improvement.

A successful relationship between contractor and supplier indicated as a part of an overall strategy of the contractor (Stiles, 1995; Rahman et al., 2014). However clear goals and objective identification and full attention in partner selection are needed in order for both participants get the greatest benefit by reducing potential difficulties. Crouse (1991) conclude that the benefit of collaboration relationship will benefit both organizations, namely: ability to control internal investments, concentrate on core competencies, control other partner's core competencies, capital needs reduction, improve productivity and quality, gain access to alternate technology, and higher customer satisfaction.

Similarly, in an SCM collaboration such as VMI, the number of the supplier will consequently reduce, this is due to the selection of supplier which has the capability to maintain long-term stability, service quality, delivery and price competitive advantage (Fulford & Standing, 2014). With VMI collaboration, a significant reduction in cost and improved SCM performance has been found in many industries such as Manufacturing, Retailing, and Pharmaceutical. But yet limited discovery in the construction industry (Love, 2000). Collaboration in construction supply chain management is limited due to the characteristic of construction supply chain management which contractor normally compete on the price (Benjaoran, 2009) which often lead to opposite relationship.

Moreover, Segerstedt & Olofsson (2010) describe the distinction of Construction industry characteristic compared to manufacturing industry; namely, short-term relationship, one-of-a-kind products, and onsite production. Different from manufacturing industry which has on-going processes and relationship with most of its supplier, construction industry are project based with shorter processes and relationship to its local suppliers. Additionally, most products purchased in the construction industry are customized products, which also different from manufacturing products components. Therefore, Tanskanen et al. (2008) propose VMI implementation for small item components which have the characteristic of cheap, standardized and continuous in the construction industry, such as bolt and nuts. The implementation of VMI for this type of product is found to be successful and beneficial to the contractor, therefore this study will focus only on small item components of the construction industry.

However, due to challenges of initiating and managing such vertical collaboration, VMI adoption as a solution for the construction industry has not widely introduced on the corporate level, however in some cases found to be implemented project to project basic (Tanskanen et al., 2008). Thus limited study has concerned on the SCM collaboration on vertical collaboration (Crespin-Mazet & Ghauri, 2007). In conclusion, there is a gap due to limited in the discovery of SCM collaboration on vertical collaboration between supplier and contractor, especially on VMI implementation as it is found to be beneficial to both supplier and contractor in the construction industry.

2.11 VMI in Malaysia Construction Industry

Although the authorities governing the construction industry in Malaysia, such as CIDB, has recommended the stakeholders in the construction industry to involved in partnering as a method to overcome the issues in the construction industry, in which included in the 10-year Malaysian Construction Industry Master Plan, Nifa et al. (2016) found that most of the contractors were not aware of the partnering practices. However, some of the contractors mentioned that they have been already practicing collaborative practices informally with other organization. In addition, the contractors were aware of the many benefits of the partnering practices. The contractors were optimistic about the practices, yet they were not well educated about the partnering practices.

Nifa et al (2016) added that the governing authorities in the construction industry play an important role in educating and promoting the partnering practices as the solutions for the issues in the construction industry. Their study found that the authorities need to actively involved in providing the encouragement and guidelines in the implementation of partnering practices. The contractors will not aware of such solution practices unless it is informed and required by the authorities (Nifa et al., 2016). Din et al. (2016) added that the adoption of such practices which involve technology adoption, require pull and push effort from Malaysian government or authorities in order to motivate the contractors to change from traditional to new innovated business transactions.

Reluctant from contractors in Malaysia to transform from traditional practice towards innovative and collaborative practices is observed due to their willingness to

change. Nawi et al. (2012) mentioned that the adoption and usage of new innovated technology in the business transactions of contractors in Malaysia construction industry is still low and below the targeted number by the government. Several literature were also found similar result, thus claimed that the phenomenon is due to the fragmentation of traditional business practices maintained by most contractors, in which cost them in quality issues, poor performances and inefficiency of the project delivery (Kamar et al., 2012; Kamar et al., 2009; Nawi et al., 2011). Several studies in the literature revealed some common barriers in the adoption of new innovative and collaborative practices in the Malaysian construction industry, including readiness issues, awareness issues, cost & equipment, poor planning & regulations, negative perceptions, and poor knowledge (Kassim & Walid, 2013; Kamar et al., 2009; Nawi et al., 2011). In addition, negative perceptions are most likely incur due to the contractor's lack of knowledge (Tamrin, Nawi, & Nifa, 2016).

2.12 Summary

The main objective of a supply chain management is to cut off any excessive cost and activity throughout the distribution and value adding process from the raw material up to consumer goods delivery. Especially on the discussion regarding the inventory management, in which said to be an excessive cost to be bear by any company if not managed properly. Many strategies has been proposed and applied in order to effectively and efficiently manage inventories of a company.

However, towards a globalize business orientation to cope with globalization demand of the market, it is important to strengthen the relationship with business

partner along the supply chain. Collaboration between supplier and buyer, consumer and supplier, and manufacturer and its supplier has become an essential factor to achieve a better performance of supply chain management. Especially collaborating with supplier to manage an inventory is an idea and a strategy that a buyer could resist.

Vendor Managed Inventory (VMI) not only offer the benefit of having a good relationship between supplier and buyer, and also a better inventory management performance for both supplier and buyer if managed properly. However, the result will not be achieved in a short time. Few modifications and adjustments need to be made along the process of adoption, depending on conditions and requirements of each company in each industry. For such constructions industry, in which has trust issues among the stakeholders and shorter period of business in the business location, to have the same benefit of VMI with other industry such as manufacturing is not promising.

However, recent studies showed that collaboration between contractors and their suppliers has become an essential factor to achieve a successful and efficient construction project. Therefore this study cultivate this issue to examine whether VMI could help construction industry to achieve a better performance in inventory management in their construction projects.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter discuss the research area of this study, in which narrowed down from the literature review of the previous chapter. Research Framework, development of hypotheses, research design and detail methodology of the research will be discussed.

3.2 Research Framework

The first objective of this study was to investigate on the environmental determinants of VMI initiative adoption suggested by Dong et al. (2007). Based on the result of their work, three positive determinants of VMI adoption include supplier's market competition, buyer's market competition, and supplier-buyer cooperation level. Each determinant has been tested and described to have an impact on the decision of buyer to adopt VMI initiative by past literature (Haardt et al., 2010; Dong et al., 2014; Claassen et al., 2008).The result from a structural empirical analysis of 137 buying organizations, Dong et al. (2007) found that adoption of VMI initiative is influenced by the great degree of supplier and buyer cooperation, the high degree of competition in the supplier's and buyer's market and low degree of buyer's operational uncertainty. High degree of cooperation between supplier and buyer at other business areas can facilitate the adoption of VMI in the supply chain integration. As VMI is the form of cooperation between supplier and buyer which require high degree of

trust to implement, having high degree of cooperation with supplier at other business areas can be beneficial in the adoption process.

Meanwhile, a high degree of competition in the supplier market found to be a significant determinants of VMI adoption in the Dong et al. (2007) result. However, with this result, the supplier may have more benefit more compared to the buyer (Waller et al., 1999). When competition among suppliers in the industry is high, with information shared in the supply chain through VMI, supplier have the critical knowledge on the requirements of the buyer than its competitors (other suppliers).

Surprisingly, the result shows no significant in the hypothesis of product demand uncertainty impact on the adoption of VMI initiative. The result suggests that low degree of buyer's operational uncertainty influence the decision. Under high degree of buyer's demand uncertainty, the supplier may have significant resistance to the adoption and implementation of the VMI adoption. Demand uncertainty give larger inventory burden to the supplier if they have to manage the inbound logistics for the buyer. However, Jonsson & Mattsson (2016) noted that demand uncertainty as the most difficult issue in material planning, however it motivates further research on how material should be planned in relation to inventory performance improvement (Christopher & Holweg, 2011). Simangunsong et al. (2012) suggested that through collaboration between business partners, supplier and buyer, causing improvement in demand uncertainty through information sharing. Therefore, in the perspective of a buyer, VMI initiative is perceived to be beneficial to them. Thus demand uncertainty level proposed as an environment determinant of VMI adoption with significant and positive impact.

On the other hand, the level of relationship between supplier and buyer found to lead to supply chain efficiency (Cachon, 2001). Collaboration between supplier and buyer in multiple areas such as R&D, operation problem solving and sharing of joint-cost savings, indicates a great degree of trust and engagement between supplier and buyer (Hart & Saunders, 1997). Hausman & Stock (2003) describe that in order to adopt such supply chain technology innovations, a great degree of trust and long-term coordination between supplier and buyer is required in the relationship. High degree of cooperation between supplier and buyer at other business areas can facilitate the adoption of VMI in the supply chain integration. As VMI is the form of cooperation between supplier and buyer which require high degree of trust to implement, having high degree of cooperation with supplier at other business areas can be beneficial in the adoption process. However, this study will test these determinants (supplier's market competition, demand uncertainty and buyer-supplier cooperation) whether they have the same result as the findings in the literature on influencing the intention to adopt VMI in Malaysia construction industry.

The second objective of this study is to explore the barriers perceived by the contractors in order to adopt VMI. Through literature review, it was found several most significant and common barriers to the adoption of technology innovation such as VMI, including lack of compatibility (Corrocher & Fontana, 2008; Downing, 2006), lack of performance evidence (Corrocher & Fontana, 2008; Bernsmed et al., 2014), lack of technology infrastructure (Borade & Bansod, 2010; Bernsmed et al. 2014), and lack of trust between partners (Downing, 2006; Borade & Bansod, 2010; Bernsmed et al., 2014). Based on literature review and interviews with academicians,

experts and consultants, Borade & Bansod (2010) developed barrier framework of VMI adoption which cover all ever mentioned barriers and obstacles to the adoption of VMI in the literature. Most of the literature (Simchi-Levi et al., 2003; De Toni & Zamolo, 2005; Downing, 2006; Singh et al., 2006; Mittal & Sangwan, 2011) argued that perceived barrier differ among SMEs and larger firms in the adoption of VMI. With the characteristic of G7 contractors that is described as the largest contractors among all contractors registered in CIDB (Adewale, Mohammed, & Nasrun, 2016), therefore this study aimed to compare the findings of this study with the findings of perceived barriers of large firms identified from the literature.

For the third objective of the study, this study aim to investigate the readiness of the contractors to adopt VMI. Niranjan et al. (2012) propose a framework consist of 15 features in which used as factors to measure the readiness of firms to adopt VMI. Although literature has provided significant findings on the benefits of VMI to the adopting firms, adoption of VMI comes with a significant cost and pre-requisite factors which are not adequate to everyone. Therefore, an assessment of readiness to adopt VMI is important to analyze whether VMI is the suitable solution for the firm and the timing to finally adopt the VMI.

Moreover, readiness to adoption of technology innovation such as VMI broadly differentiate into two category; technology and organizational readiness (Gangwar, Date, & Ramaswamy, 2015). Where technology readiness defined as technology infrastructure and human resources IT skill in which possessed by a firm, and organizational readiness refer to the degree of perception and evaluation of the firm in terms of their awareness, resources, commitment and governance to adopt VMI.

However, most of the literature suggest that there is a difference on the readiness to adopt technology innovation such as VMI between smaller and larger firms. Larger firms indicated to have higher readiness due to their financial power and ease of access to the technology (Lee et al 2006, Saldanha 2012), while smaller firms indicated to have higher readiness to change due to their flexible organization structure (Alshamaila, 2013; Gong 2013). Therefore, comparison on the degree of organization readiness to adopt VMI between the findings from G7 contractors in Malaysia and the findings identified from literature on the readiness of larger firms.

Thus the research framework of this study illustrated in Figure 3.1.

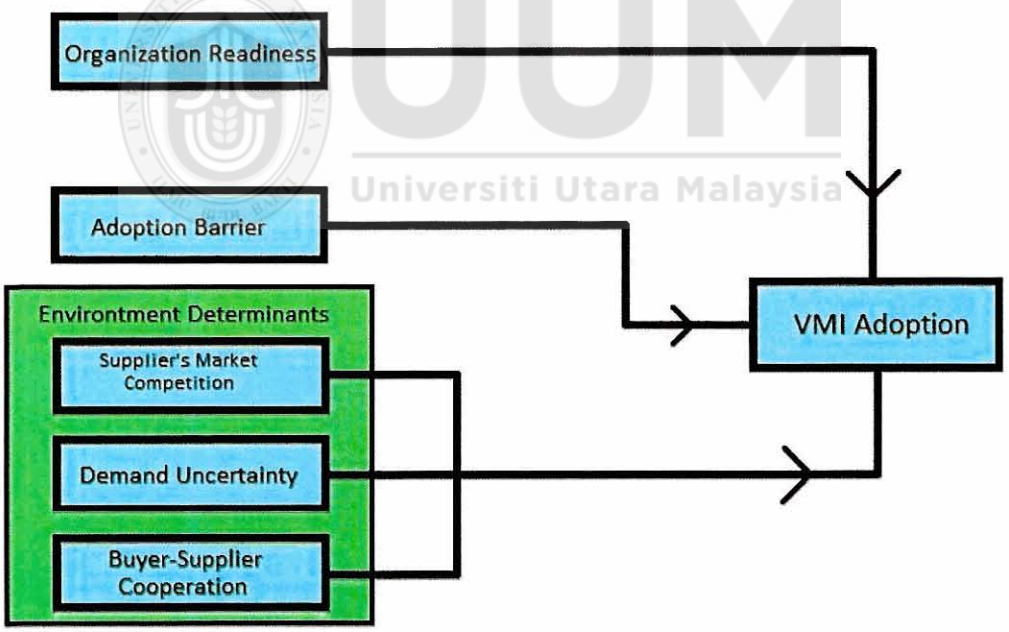


Figure 3.1
Research Framework

3.3 Research Hypothesis Development

Hypothesis of the study is developed following the discussion on the literature review and presented below:

3.3.1 Supplier's Market Competition Level

Supporting the result of past literature (Mishra & Raghunathan, 2004; Derrouiche et al., 2008; Haardt et al., 2010; Lehoux et al., 2010; Xiao & Bao, 2011) that competition of supplier market has significant impact on buyer's collaboration decision with its supplier. Therefore, the first hypothesis (H1) of this study is as follow:

$H1_0$: Higher supplier's market competition positively influence the degree of intention to adopt VMI.

$H1_1$: Higher supplier's market competition negatively influence the degree of intention to adopt VMI.

3.3.2 Demand Uncertainty Level

Past literature suggest that VMI implementation would be successful for predictable and less volatile demand products (Clark & Hammond, 1997; Yang et al., 2003). However, Patterson et al. (2003) suggest that environment uncertainty such as demand uncertainty would motivate company's decision to adopt new technology innovation such as VMI. Therefore, Hypothesis 2 (H2) of this study is as follow:

$H2_0$: Higher demand uncertainty positively influence the degree of intention to adopt VMI.

$H2_1$: Higher demand uncertainty negatively influence the degree of intention to adopt VMI.

3.3.3 Buyer-Supplier Collaboration Level

Study of Dong et al. (2007) suggest that high degree of collaboration between supplier and buyer in other business area aside of supply chain management, has the highest possibility to adopt VMI initiative. A strong relationship between supplier and buyer influence the success result of the collaboration (Claassen et al., 2008). Bagchi & Skjoett-Larsen (2003) also mention that a lower degree of integration between buyer and supplier, would result poor performance on the collaboration between buyer and supplier. Therefore, Hypothesis 3 (H3) of this study is as follow:

H30: Higher degree of buyer-supplier collaboration positively influence the degree of intention to adopt VMI.

H31: Higher degree of buyer-supplier collaboration negatively influence the degree of intention to adopt VMI.

3.3.4 Barriers to VMI Adoption

Based on the literature discussion in the section 2.6, it confirms that there is a difference in the perceived barriers to the adoption of VMI by smaller and larger firms. Larger firms found to perceived lack of trust and mutual understanding

between supply chain partners as the biggest barrier, while improper decision support tool perceived as the least barrier to the adoption of VMI. Therefore, to validate the findings of by Borade & Bansod, hypothesis 4 (H4) of this study is as follow:

$H4_0$: Obstacles for adopting the VMI practice are similar to the findings in the literature (Borade & Bansod, 2010).

$H4_1$: Obstacles for adopting the VMI practice are different to the findings in the literature (Borade & Bansod, 2010).

3.3.5 Readiness of VMI Adoption

Based on the literature discussion in the section 2.7, there is an argumentative findings which need to be tested to explore which of the finding applied in the construction industry in Malaysia. Most of the literatures mentioned how smaller firms have the advantage of flexibility to change which consequently enabling them to have higher readiness to adopt technology innovation such as VMI in their business transactions (Zhu & Kraemer 2005; Son, 2007; Alshamaila, 2013; Gong 2013). On the other hand, larger firms are more capable to adopt such technology innovation due to their better access and physical resources to the technology to adopt new innovation (*Lee et al 2006, Saldanha 2012, Bordonaba 2012, and* Cudanov 2010). Therefore, by using the framework of Niranjan et al. (2012) to assess the organizational readiness of G7 contractors in Malaysia to adopt VMI, hypothesis 5 of this study as follow:

$H5_0$: G7 as Malaysian large contractors have high degree of readiness to the adoption of VMI.

$H5_1$: G7 as Malaysian large contractors have low degree of readiness to the adoption of VMI.

3.4 Data Collection Technique

This study use primary data to address the research problem. Primary data will be collected through survey using structured questionnaire. A formal questionnaire is prepared and will be distributed to the target sample respondents to gain needed information. The success of this research depends on the survey questionnaire distributed to the target sample respondent. The questionnaires being disseminated among the Malaysia CIDB registered contractors.

3.5 Research Design

Research plan of this study is developed to answer and test the hypothesis of the study. Initial stages of the research plan which are identify the problem of the study and determine the goals and objectives of the study. After identifying and determine the goals and objectives of the study, there are five stages of research methodology plan of this study. First stage of the research methodology plan involve developing the survey instruments with its cover letter, and supporting letters for data collection. The second stage involve the execution of the survey. This stage includes the distribution of the survey questionnaires to the target sample respondents. The fourth stage involve the analysis of the collected data from the sample respondents. The

data analysis using specific data analysis technique to test the hypothesis. The last stage of this research methodology plan involve the interpretation of the result in the data analysis. It also involves relating the findings of the study with the implication of the study.

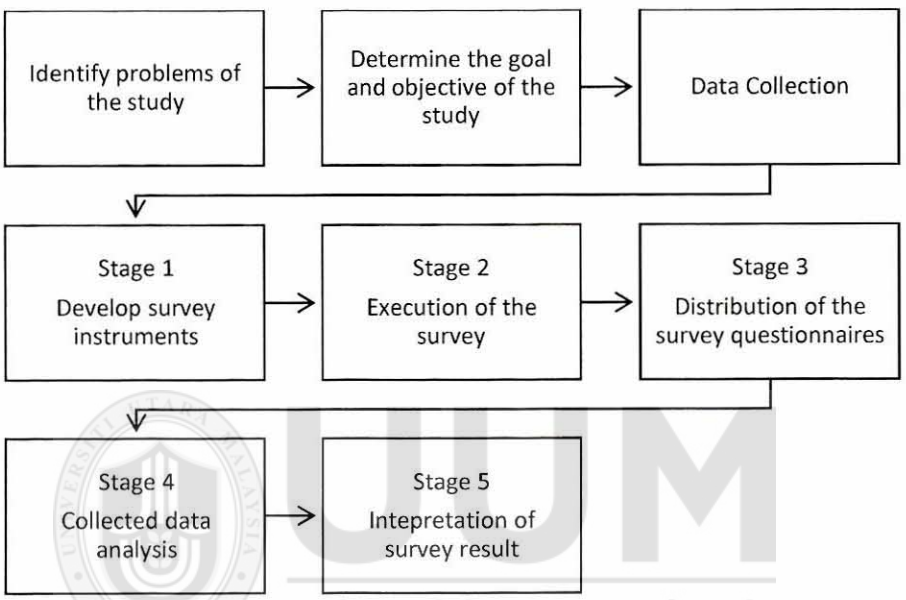


Figure 3.2
Research Design Flow Chart

3.6 Unit of Analysis

Unit of analysis refer to type of unit in measuring variable (Neuman, 2014). The study focus to determine the determinants of VMI initiative adoption by Malaysian construction companies for their inventory and material management at their projects. Dong, Xu, & Dresner (2007) use an organizational perspective to determine the adoption level of VMI initiative, as well as recent studies by Lal (2008) and Krichanchai & Maccarthy (2016) which use organization perspective as the unit of analysis to determine the level of innovative technology such as VMI. Organization

perspective chosen because VMI is adopted by the organization, not personally adopted by the practitioners. It is a systemized process involving the entire organization in order to successfully adopt and implement VMI. Therefore the unit of analysis of this study follow the past literature to use organization perspective. In addition, the study conducted with the perspective of contractor towards the adoption of VMI instead of using the perspective of the supplier. The perspective of contractor selected because of the importance role of contractors in the sustainability of construction industry, in which considered as construction project initiators due to their dominant impact on the entire direction of the project (Abidin et al., 2013; Adewale et al., 2016).

3.7 Survey Methodology

The survey questionnaires will be distributed through mail survey to the target sample respondent. Being an efficient and cost effective way of gathering data from large geographically spread (Dillman, 1979), electronic mail surveys chosen in this study. Mail surveys are also allowing target respondent to take more care on the survey with more time to complete the survey, while avoid bias from the use of personal interviewers (Mangione, 1995; Malhotra, 1999).

3.7.1 Population and Targeted Respondent

A research population refer to the collection of individuals or objects that is the main focus of the research problem (Sekaran, 2003). It has the characteristic of having the same or similar binding trait. This study involve a comparison of VMI initiative adoption determinants of smaller and larger organization size. Therefore, the targeted

respondent of this study will be the Malaysian contractor registered in Construction Industry Development Board (CIDB) Malaysia with G7 grade. Each contractor will be represented by the key manager level such as general manager, purchasing manager, logistic manager, construction manager, or any other higher level manager (eg. senior executive & supervisors). This approach follow the same approach by previous study on VMI program (Kuk, 2004; Dong, Xu, & Dresner, 2007; Krichanchai & Maccarthy, 2016).

Grade G7 contractor classified as contractor with limitless tender capacity value (in RM). Based on published bulletin by CIDB for 2nd quarter of 2017 statistics shown at Appendix 4, total Malaysian contractor registered to CIDB with grade G7 are 7,013 contractors. Table 3.1 show the breakdown of total number in each grade. Due to the limitation of time and funds of the study, the targeted respondents are focused only to the contractors in the northern states of Malaysia including Penang, Perlis and Kedah state. Breakdown of population number of G7 contractor in each state is shown in the Table 3.2.

Table 3.1
Total Registered Contractor in CIDB 2017

Grade	Total Registered Contractor
G1	35,468
G2	16,817
G3	11,198
G4	3,936
G5	5,173
G6	1,696
G7	7,013
Total	81,301

Table 3.2
Registered Contractor in Northern State of Malaysia

State	Registered Contractor
Penang	464
Kedah	210
Perlis	31
Total	705

3.7.2 Sampling Method

Sampling method are classified as probability and non-probability. Probability sampling methods includes random sampling, systematic sampling, and stratified sampling. With the segmented population of CIDB registered contractors with G7 grade, to consistently capture the variance of all the grade segments, target sample respondents are selected utilizing a stratified random sampling methodology. The sample is randomly drawn from the segment or strata. Total samples of each segment or strata or in this study used state, have an equal portion of samples between each

segments. The portion of each segment derived from the portion of numbers of contractors in each state towards total numbers of contractors in Northern region of Malaysia.

3.7.3 Sample Selection and Sample Size

The population is assumed to be normally distributed and contains 7,013 contractors within Malaysia obtained from CIDB registered contractor statistics as per second quarter 2017. Sample size is influenced by few conditions such as required accuracy of the study, heterogeneity or diverseness of the sample, the number of variables in the study and statistical tools will be used in the study (Neuman, 2014). This study follow the recommended sample size by Sekaran (2003), which refer to the population of 7,013 contractors, the sample size should be 365 (for the population size of about 7,000). This sample size supported by the recommended sample size by Krejcie & Morgan (1970).

In an empirical study of VMI implementation in Malaysia by Radzuan et al. (2015), 31% respond rate from the required sample size achieved by the authors. However, in the similar subject of VMI adoption by Dong et al. (2007), as low as 7.0% respond rate achieved in the study. In the study of VMI practices in India, Borade & Bansod (2010) got 17.6% respond rate from large firms and 12.6% respond rate from SMEs. In addition, the assumption for response rate for construction industry was 25-35% (Fellows & Liu, 2003, 2008). However, in the survey of Industrialized Business System (IBS) in Malaysia construction among G7 contractors, 18.5% respond rate achieved.

On the other hand, Salkind (1997) recommend that in account to cover the unresponsive subjects and undelivered mail, the sample size should be increased by 40-50 percent. Therefore the sample size of this study is increase by 50 percent from the total sample size of 365 contractors to 548 contractors (365 sample size x 1.5) based on Salkind (1997) recommendation. Total of 548 survey questionnaires will needed to be mailed to the target sample respondents.

Northern region of Malaysia in which closest to international connection through road connection to Thailand and other Southeast Asian & Asian countries, needed great infrastructure to support the international trading. Therefore the emergence and development of contractors in Northern region of Malaysia is highly appreciated and encouraged. More research on the efficient and better performance of contractor's performance in managing their construction projects were recently stimulated, therefore this study chose the northern region of Malaysia as the population representing the Malaysia contractor's population.

Moreover, as explained in the section 3.6.1, due to a limited time and funds to conduct the survey, target respondents of the study focused only to the northern region of Malaysia including Penang, Perlis & Kedah state. With stratified random sampling from these states, Table 3.3 present the distribution number of respondents from each state.

Table 3.3
Target Respondent in Each Northern State of Malaysia

State	Target Respondent
Penang	360
Kedah	164
Perlis	24
Total	548

3.8 Variables and Measurement

Section A of the survey questionnaire is intended to gather the information on the contractor demographic. Nominal scale is used to measure the demographic variable. Demographic information on section A includes the position of representative of the contractor, department of representative of the contractor, business category of contractor registration, state of origin, annual revenue of the contractor, total number of staff in the company, and awareness on the VMI integration.

Section B, C, D, and E are designed to gather the data on dependent and independent variable measures. Section F is design to gather survey data on the obstacles to adopt VMI. Dependent and independent variable measure is measured with interval scale using 6 points Likert scales. The six point Likert scales is adopted in the study as it is more accurate than 5 point scale (Vagias, 2006), and it has the ability to provide more accurate measurement (Hair, Black, Babin, & Anderson, 2006). The six-point Likert scale also preferred when measuring familiarity with VMI because the absence of neutral rating (Paul, 2010). Moreover, social desirability bias is reduced by the elimination of the mid-point that exists in the odd point scale (Garland, 1991).

The respondents will scale their answer with the question of "to what extent do you agree with each of the following statements". The scales item using 6 point as described in Table 3.4. Section G is designed to gather the data on VMI-readiness adopted from Niranjan et al. (2012). The scales to on this section follows the original scale suggested by the authors which uses 5 point rating scale ranging from 0 "not important at all" to 4 "highly important".

Table 3.4
Scale of Measurement

Strongly disagree	1
Disagree	2
Somewhat Disagree	3
Somewhat Agree	4
Agree	5
Strongly Agree	6

The measurement items on section B, C, D, E & F are adapted from various authors. The adaptation of a formerly tested instrument and measurement can enhance the reliability and validity of the study (Cavana et al., 2001). Competition in supplier market measured by its competition intensity perceived by the buyer using five-item scale adopted from Jaworski & Kohli (1993), Dong et al. (2007) & Yang et al. (2016). The five-item scale assess the competition in general, price competition, promotion and new competitive moves (Jaworski & Kohli, 1993) with additional scale to assess existence of dominant competitors in the supplier market suggested by Dong et al. (2007). Demand uncertainty measured by four-item scale measure the unpredictable nature of the buyer's demand, demand forecast reliability, demand

trends volatility and demand fluctuations. These items are adapted from previous literature on the measurement of demand uncertainty (Celly and Frazier, 1996; Chen & Paulraj, 2004; Dong et al., 2007). Supplier buyer cooperation measured by using a total of four-item scale adapted from Dong et al. (2007) and Walter et al. (2003) measuring supplier involvement and relationship quality between the buyer and supplier. Three-item scale for relationship scale chosen because the explicit focus on business to business relationship and thorough approach on the development of the scale on relationship quality (Claassen et al., 2008).

To measure adoption level of VMI, direct question regarding current integration with a frequent supplier and intention to use adapted from previous literature on technology adoption (Dong et al., 2007 & Al-Ajam & Nor, 2015). Current integration measurement includes shared information and goals common with VMI implementation between the buyer and supplier, measured with four-item scale. On the other hand, intention to use measured using five-item scale adapted from Al-Ajam & Nor (2008). Moreover, changes on the term "use" on "intention to use" applied considering the appropriate word for VMI is "implementation" instead of "use". Barriers of the adoption of VMI is adopted from the study of Borade & Bansod (2010), in which developed by the issues on the adoption of VMI using past literatures and interviews discussion with academician, consultants and experts. Obstacles perceived to hinder the process of adopting VMI in to the organization.

In measuring VMI readiness in Section G, fifteen (15) items or features adopted from the original framework of Niranjan et al. (2012). These features includes product-related features, company-related features and supplier-related features

which are determining the readiness of each company on adopting VMI. Each features will have its own weight on the total survey questionnaire. A maximum score of 400 to a minimum of 0 score will be the range of the measurement (Niranjan et al., 2012). The organization of structured measurement of each variables are presented on Table 3.5 below:

Table 3.5
Organization of Adopted Questionnaire Measurements of Each Variable

Section	Variable	Original Author
B	Supplier's market competition	Jaworski & Kohli (1993), Dong et al. (2007) & Yang et al. (2016)
C	Demand uncertainty	Celly and Frazier (1996), Chen & Paulraj (2004) & Dong et al. (2007)
D	Supplier-buyer cooperation	Dong et al. (2007), Claassen et al. (2008)
E	Adoption level	Dong et al. (2007) & Al-Ajam & Nor (2015)
F	Obstacles	Borade & Bansod (2010)
G	VMI-Readiness	Niranjan et al. (2012)

3.9 Data Analysis Technique

Any research would require data to be analyzed, in order to obtain the data, data collection method is fundamental. The accuracy of the data plays a main role in determining the feasibility of the research on the subject matter. This research focuses on primary data which comes from first-hand experience collected through surveys on the purpose of collecting information on specific area in Malaysia. It also refers to data that has not been used in any previous researches and acquired from the researcher field visits.

This research will convert the collected data to become useable information or understanding in achieving the objectives of this research. In order to convert the collected data to become useable information, Easterby-Smith, Thrope, & Jackson (2012) suggest that a clear explanation on data analysis process and raw data transformation to analysis result is required. Additionally, collected data will also go through data screening process before data analysis process. Data screening primary purpose is to identify any potential miscoded, missing or messy data on collected data.

Data collected from the survey will be coded and analyzed using Statistical Package for the Social Science (SPSS) version 19.0. Preliminary test of response rate, descriptive statistic, validity and reliability will be conducted. Response rate will be determined by calculating the frequency and percentage of response from the survey. Descriptive statistic to determine the highlighted characteristic of sample will be analyzed using frequency and percentage analysis. Moreover, statistical methods of Pearson Correlation analysis and Multiple Regression Analysis (MRA) will be used to answer the research questions.

Pearson Correlation analysis will be used to investigate the relationship and its impact of each VMI determinants with adoption level of VMI initiative. Correlation coefficient will reveal the extent or degree of the relationship and the direction of the relationship. The degree of the relationship shows the strength of the relationship (Sekaran, 2003). The strength of the relationship will be determined as no relationship when correlation value of 0 resulted, whereas correlation value of ±1.0 will be determined as a perfect positive or negative relationship (Pallant, 2005).

Therefore Pearson correlation analysis will be used to examine the hypothesis 1, 2 and 3.

In order to verify the hypothesis 4 and 5, independent sample t-test was used and conducted. The test result of the t-test from the respondents indicate the t-value, means of larger firms, and the two-tailed significance. By the difference between means values of G7 and larger firms in the literature, the hypothesis will be verified.

3.10 Pilot Test

Pilot test is a small scale test of methods and procedures to be used on a large scale (Porta, 2008). In order to test whether all of the questionnaire's items can be able to be understood by the respondents prior to adoption, a pilot study was conducted on 30 contractor firms. A suitable range of 25-100 of respondent for pilot test was achieved (Cooper & Schindler, 2003), however the ideal sample size for pilot study is suggested to be relatively smaller (Malhotra, 2008). Hence, 30 samples of contractor firms has been chosen for pilot test in this study. The pilot test was conducted during International Construction Week (ICW) 2018 hosted by CIDB Malaysia. By conducting pilot test, it will improve the quality of the questionnaire (Neuman, 1997) and enhance the success probability of larger hypothesis testing later (Leon et al., 2011). Moreover, pilot test able to detect weaknesses of the design and instrumentation and provide proxy data for probability sample selection (Cooper & Schindler, 2003).

3.11 Reliability and Validity Test

In order to measure consistency of the questionnaire items in measuring whatever it measures, reliability test of the pilot study was conducted. Coefficient alpha or known as Cronbach's Alpha was used to measure the reliability test of the conducted pilot study for each scale. As shown in the Table 3.6, all of the dimensions have Cronbach's Alpha score above 0.70, in which ranged from 0.731 to 0.828 and indicated that all the dimensions have acceptable internal consistency. The overall Cronbach's Alpha for 13 items of environment determinants of VMI adoption that measure on the supplier's market competition, demand uncertainty and buyer-supplier cooperation, scored 0.731 coefficient alpha. All the dimensions of environment determinants Cronbach's Alpha scored were ranged from 0.762 to 0.828. Meanwhile, Alpha coefficient for 4 items of intention to adopt VMI was 0.740. Next, for the 5 item barriers of VMI adoption, Cronbach's alpha scored 0.731. Therefore, the reliability test of pilot study indicated that all the dimensions have internal consistency higher than the threshold value of 0.7 suggested by Nunnally (1978). Data collected from the pilot study are reliable.

Table 3.6
Cronback's Alpha Reliability Test Result of Pilot Study

Dimensions	Cronbach's Alpha
Environmental determinants:	0.731
Supplier's market competition	0.762
Demand uncertainty	0.769
Buyer-Supplier cooperation	0.828
Intention to adopt	0.740
Adoption Barriers	0.731

The construct validity of the study measured with the validity from the pilot study. The construct validity of the pilot study tested through factor analysis. To measure the factor analysis, results from KMO and Bartlett's test employed to determine the adequacy of sample size, normality and linearity. Factor loadings from Principle Component Analysis with Varimax rotation was also employed to identify the factorable of the dimensions. As shown in Table 3.7, all dimensions scored KMO & Barlett's test above acceptable score of 0.60 and Factor loadings above acceptable score of 0.40. Environment determinants measured by supplier's market competition with KMO & Bartlett's test and Factor loadings of 0.744 and 0.987 respectively, demand uncertainty with KMO & Bartlett's test and Factor loadings of 0.658 and 0.927 respectively, and buyer-supplier cooperation with KMO & Bartlett's test and Factor loadings of 0.751 and 0.944 respectively. All items in the dimensions scored Factor loadings above 0.50, which ranged from 0.611 to 0.918 (supplier's market competition), 0.785 to 0.942 (demand uncertainty), 0.716 to 0.917 (supplier-buyer cooperation), 0.622 to 0.957 (intention to adopt), and 0.562 to 0.880 (adoption barriers).

Table 3.7
KMO & Bartlett's Test and Factor Loadings of Pilot Study

Dimensions	**KMO Test**	**Factor Loadings**
Environment determinants:		
Supplier's market competition	0.744	0.987
Item 1		0.791
Item 2		0.868
Item 3		0.918
Item 4		0.611
Item 5		0.676

Dimensions	KMO Test	Factor Loadings
Demand Uncertainty	0.658	0.927
Item 1		0.785
Item 2		0.908
Item 3		0.785
Item 4		0.942
Buyer-supplier cooperation	0.751	0.944
Item 1		0.716
Item 2		0.917
Item 3		0.840
Item 4		0.907
Intention to adopt	0.618	
Item 1		0.957
Item 2		0.815
Item 3		0.901
Item 4		0.622
Adoption Barriers	0.652	
Ineffective Organizational Structure		0.826
Lack of Suitable IT Infrastructure		0.562
Improper Decision Support Tool		0.714
Lack of Trust & Mutual Understanding Between Supply Chain Partners		0.856
Internal/External Integration		0.880

3.12 Data Cleaning and Test of Non-Response Bias

All the data were exposed from error-free in coding before continue for further analysis. In order to identify errors, frequency test was used in the data entry. Errors within the data will be detected when the mean was outside the specific range. Additionally, errors value should be within the minimum and maximum value. Meyers et al. (2006) suggested that if the data error reaches 15 percent, the data should be deleted. Scatter plot was employed to examine the linearity between two

variables, which indicated with an oval shape of the scatter plot. In addition, test of non-response bias assessed through the difference of early and late respondents by using T-test. If the result of T-test is significant, means that data is considered bias in response.

3.13 Factor Analysis

One way to test the construct of questionnaire is through factor analysis. The goal of factor analysis is to test the pattern or relationship of several variables and to determine whether the information can be summarized in a smaller set of factors or components (Hair et al., 2006). Generally, it means that a result of a group of items can represent and explain every item in the construct. It also assist researchers to ensure the existence of construct validity of the questionnaire items. All of the dimension's construct will be entered to Principal Component Analysis (PCA) with Varimax rotation in order to determine the dimension is factorable. KMO measured value used as guidelines to identify the factor loadings based on the sample size (Hair et al., 2006).

3.14 Summary

In this chapter, methodology of the research has been discussed and elaborated. The framework of the research generated from the objectives of the study discussed on chapter one. The research framework were designed following past literature regarding the relationship between each variables. Literature suggested that there are five environmental determinants that influence the adoption of Vendor Managed Inventory (VMI) in construction industry, however with the objectives of the study

to examine environmental determinants that are influence the adoption of VMI in construction industry positively, in which to motivate contractors to adopt VMI in their business operation in order to gain advantage from it, in this study three environmental determinants selected to be examined whether these determinants support the findings in the literatures. Barriers to the adoption decision of VMI in construction industry was also included in the research framework based on its effect in determining the contractor's willingness to adopt VMI in their supply chain strategy. And an addition of VMI readiness score measurement of the contractors in the construction industry in determination to adopt VMI in the supply chain operations. This study used primary data with a questionnaire questions method in order to collect the data from contractors with G7 grading in Malaysia. Contractors from northern part of Malaysia was selected as the sample of this study due to their fast development in the past 5 years. Pilot test has been conducted and adjustment on the questionnaire measurement and item were made.

CHAPTER FOUR
DATA ANALYSIS AND FINDINGS

4.1 Introduction

Profile of the respondents including respondent's position & department, category of the contractor, state of origin and contractor's awareness of VMI are reviewed in this chapter. The factor analysis of each variables are also elaborated along with the data evaluation, including non-response bias test and normality test. The hypothesis in chapter 3 are tested in this chapter. The result of the analysis and findings of the study are presented. The hypothesis testing were calculated by using Pearson correlation test, multiple regression analysis, descriptive analysis & score analysis of the VMI readiness. The result are showed and discussed.

4.2 Sample Study

The list of samples were collected from the directory of registered contractors in CIDB. The required sample size number was 354 respondents out of 7,000 population of G7 contractors in Malaysia. A total of 548 contractors selected as respondents to anticipate a very low respond rate of construction industry in Malaysia and the undeliverable questionnaires. However, due to the limitation of time and fund to conduct this research, samples of the population were selected only from the northern states of Malaysia peninsular, including Kedah, Perlis and Penang. The questionnaire surveys were sent through electronic-mails to the respective official e-mail address provided in the CIDB directory. In the end, a total of 103 responded questionnaires received after data collection period of 2 months.

However, out of 103 responded questionnaires, 6 of the responded questionnaires were excluded due to incomplete questionnaires. Thus this study achieved 17.70 percent respond rate from the total distributed questionnaire surveys and 26.50 percent respond rate from the total required sample size. Although the response rate and feedback of this study was not favorable, the response rate was expected to be not as high as 30 percent as indicated in the literature from the previous empirical studies in the similar topic and industry. Table 4.1 summarize several the response rate of empirical studies in the literature in the similar topic and industry.

Table 4.1
Response Rate of Empirical Studies in the Similar Topic and Industry

Author(s)	Topic of study	Response rate
Dong et al. (2007)	Environmental determinants of VMI adoption	Respond rate of 7% (137 out of 629)
Borade & Bansod (2010)	VMI practices in India	17.6% respond rate from large firms and 12.6% respond rate from SMEs
Radzuan et al. (2015)	VMI implementation in manufacturing industry in Malaysia	31% respond rate (101 out of 330)
Claasen et al. (2008)	Performance outcomes and success factors of vendor managed inventory (VMI)	10.2% respond rate (54 out of 629)
Kamar et al. (2014)	IBS survery 2010 in Malaysia construction industry	18.5% respond rate (37 out of 200)

4.3 Profile of the Respondents

This section present descriptive information of respondent's profile including respondent's position, department, contractor's type of construction, state of origin, and awareness of VMI.

4.3.1 Respondent's Posistion

Respondents in this study consist of 14 directors (14.4 %), 41 assistant manager (42.3%) and 42 senior executives (43.3%). However, the questionnaire expected to get respondent of senior manager position, unfortunately, it was not found in the respondents. Table 4.2 summarize the respondent's position.

Table 4.2
Frequency Table of Respondent's Position

Position	Frequency	Percentage
Director	14	14.4%
Assistant Manager	41	42.3%
Senior Executive	42	43.4%
Total	97	100%

4.3.2 Respondent's Department

In terms of respondent's department in the firm, most of the respondents were from Procurement department with 42.3% or 41 respondents. As for Design/Engineering and Logistic department, an equal number of respondents found in the study, which cover 28.9% of the total on each of the department. Table 4.3 summarize the respondent's department.

Table 4.3
Frequency Table of Respondent's Department

Department	Frequency	Percentage
Design/Engineering	28	28.9%
Procurement	41	42.2%
Logistic	28	28.9%
Total	97	100%

4.3.3 Category of Contractor

CIDB categorized the contractors to the category of building, civil engineering, and mechanical & electrical construction or combinations of categories. Among the respondents, combination of all the category were found dominate the respond percentage with 56.7%, while respondents from contractors with category of combination building and civil engineering construction as the least percentage of total with 14.4%. It was followed with a percentage of 28.9 % or 28 respondents are contractors with combination of civil engineering & mechanical & electrical construction category. Table 4.4 summarize the respondent's departments.

Table 4.4
Frequency Table of Respondent's Contractor Category

Category	Frequency	Percentage
Combination of i & ii	14	14.4%
Combination of ii & iii	28	28.9%
Combination of all	55	56.7%
Total	97	100%

4.3.4 State of Origin

Respondents of the study were dominated by the respondents from Penang state with over half of the respondent, which specifically 67% of total. Followed by respondents from Kedah with 28 respondents or 28.9%. Additionally, respondents from Perlis state were only 4 respondents, or 4.1% of total respondents. Table 4.5 summarize the respondent's state of origin.

Table 4.5
Frequency Table of Respondent's State of Origin

State of origin	Frequency	Percentage
Kedah	28	28.9%
Perlis	4	4.1%
Penang	65	67%
Total	97	100%

4.3.5 Awareness of VMI

In terms of respondent's awareness of VMI, more than half of the respondents were not aware of VMI with 57.7 percent of total respondents, and only 41 respondents were aware of the VMI initiative. Moreover, among the 41 respondents with awareness of VMI, 28 of them are senior executive, followed by 13 assistant managers. The statistic in Table 4.7 showed that out of 14 directors involved in the survey, none of them were aware of VMI. In addition, awareness of VMI is higher from respondents from the state of Penang compared to Kedah state with the percentage of 27.8% and 14.4% respectively (see Table 4.8). Unfortunately, all respondents from Perlis state were not aware of VMI. Table 4.6 present the frequency of awareness of VMI.

Table 4.6
Frequency Table of Respondent's VMI Awareness

VMI Awareness	Frequency	Percent (%)
No	56	57.7
Yes	41	42.3
Total	97	100.0

Table 4.7
Crosstab Table of Respondent's VMI Awareness on Position

			Position Label		
			Director	**Assistant Manager**	**Senior Executive**
VMI Awareness	No	Count	14	28	14
		% within VMI Awareness	25.0%	50.0%	25.0%
		% within Position Label	100.0%	68.3%	33.3%
		% of Total	14.4%	28.9%	14.4%
	Yes	Count	0	13	28
		% within VMI Awareness	0.0%	31.7%	68.3%
		% within Position Label	0.0%	31.7%	66.7%
		% of Total	0.0%	13.4%	28.9%

Table 4.8
Crosstab Table of Respondent's VMI Awareness on State of Origin

			State of Origin		
			Kedah	**Penang**	**Perlis**
VMI Awareness	No	Count	14	38	4
		% within VMI Awareness	25.0%	67.9%	7.1%
		% within State of Origin	50.0%	58.5%	100.0%
		% of Total	14.4%	39.2%	4.1%
	Yes	Count	14	27	0
		% within VMI Awareness	34.1%	65.9%	0.0%
		% within State of Origin	50.0%	41.5%	0.0%
		% of Total	14.4%	27.8%	0.0%

4.4 Result of Factor Analysis

One way to test the construct of questionnaire is through factor analysis. The goal of factor analysis is to test the pattern or relationship of several variables and to determine whether the information can be summarized in a smaller set of factors or components (Hair et al., 2006). Generally, it means that a result of a group of items can represent and explain every item in the construct. This section will present the factor analysis result of the dimensions in the study, including environment determinant of VMI adoption, intention to adopt VMI, and barriers to VMI adoption.

4.4.1 Environment Determinants

Sampling adequacy measured with The Kaiser-Meyer-Olkin (KMO) indicated at 0.681 and Barlett's Sphericity test indicated significant (p=0.000). Therefore there is sufficient correlation among the items of environmental determinants (competition, demand uncertainty, cooperation) with acceptable sampling adequacy which above 0.60. The communalities were also high with ranged of 0.738 to 0.987. The Cronbach's alpha is 0.774 (supplier's market competition), 0.777 (demand uncertainty), and 0.831 (buyer-supplier cooperation). Table 4.9 summarize the factor analysis of environmental determinants dimension.

Table 4.9
Factor Analysis of Environmental Determinants

Dimension	Cronbach's Alpha	KMO	Communalities	Factor Loadings
Environmental determinants		0.681		
Supplier's market competition	0.774		0.987	0.958
Demand uncertainty	0.777		0.826	0.893
Buyer-supplier cooperation	0.831		0.738	0.785

4.4.2 Intention to Adopt VMI

Sampling adequacy measured with The Kaiser-Meyer-Olkin (KMO) indicated at 0.651 and Barlett's Sphericity test indicated significant (p=0.000). Therefore there is sufficient correlation among the items of intention to adopt VMI with acceptable sampling adequacy which above 0.60. The communalities were also high with ranged of 0.843 to 0.920. The Cronbach's alpha is 0.810 with a lowest corrected item-Total correlation value of 0.573 which is far from the minimum value of 0.30. Table 4.10 summarize the factor analysis of intention to adopt VMI.

Table 4.10
Factor Analysis of Intention to Adopt VMI

Dimension	Cronbach's Alpha	KMO	Communalities	Factor Loadings
Intention to adopt	0.810	0.651		
Item 1			0.920	0.950
Item 2			0.891	0.869
Item 3			0.858	0.896
Item 4			0.843	0.895

4.4.3 Barriers to VMI Adoption

Sampling adequacy measured with The Kaiser-Meyer-Olkin (KMO) indicated at 0.681 and Barlett's Sphericity test indicated significant (p=0.000). Therefore there is sufficient correlation among the items of intention to adopt VMI with acceptable sampling adequacy which above 0.60. The communalities ranged from 0.427 to 0.769. The Cronbach's alpha is 0.679 with a lowest corrected item-Total correlation value of 0.340 which if deleted, the new Cronbach's alpha will not be higher than 0.681. Table 4.11 summarize the factor analysis of barriers to adopt VMI.

Table 4.11
Factor Analysis of Barriers to VMI Adoption

Dimension	Cronbach's Alpha	KMO	Communalities	Factor Loadings
Barriers to VMI adoption	0.679	0.681		
Ineffective Organizational Structure			0.715	0.845
Lack of Suitable IT Infrastructure			0.547	0.621
Improper Decision Support Tool			0.427	0.638
Lack of Trust & Mutual Understanding Between Supply Chain Partners			0.769	0.807
Internal/External Integration			0.753	0.867

4.5 Data Evaluation

The data evaluated in regards of the non-response bias, normality, and linearity test before testing the hypotheses.

4.5.1 Test of Non-Response Bias

The responded questionnaire then divided into earlier and late respondents, which consist of 22 and 75 responded questionnaire respectively. Test of non-response bias assessed through the difference of early and late respondents by using T-test. If the result of T-test is significant, means that data is considered bias in response. Therefore, all dimensions were tested using T-test. Table 4.12 present the result of T-test on early and late respondents. The table shows that there are no dimensions in the study with significant value below 0.05 (Lavene's Test for Equality Variances). Therefore, this study has no response bias between earlier and late respondents.

Table 4.12
Result of T-Test for Non-Response Bias Analysis

Variable	T-value	Significant
Supplier's market competition	0.755	0.387
Demand uncertainty	1.667	0.200
Buyer-supplier cooperation	0.066	0.798
Intention to adopt VMI	3.189	0.077
Barriers to VMI adoption	1.737	0.191

4.5.2 Normality Test

Skewness and kurtois value of the variables can be used to assess the normality of the variables (Pallant, 2001). If the value of skewness is below 2.0 and kurtois value less than 7, the variable considered normally distributed (Cohen & Cohen, 1983). Table 4.13 present the normality assessment of the variables in the study. Overall, all the variable were distributed normally.

Table 4.13
Result of Normality Assessment

Variable	Skewness	Std. Error	Kurtois	Std. Error
Supplier's market competition	-0.515	0.245	-0.343	0.485
Demand uncertainty	-0.260	0.245	-0.518	0.485
Buyer-supplier cooperation	-0.451	0.245	-0.754	0.485
Intention to adopt VMI	0.166	0.245	-0.862	0.485
Barriers to VMI adoption	-0.314	0.245	-0.899	0.485

4.6 Descriptive Statistical Analysis

In the study, overall respondents are strongly intended to adopt VMI in the future (means of 4.53). Given the chance, most likely they will adopt VMI in the future. For the environmental determinants of VMI adoption, level of competition in the supplier's market found to be high with means at 4.43. The result suggest that there are few bigger firms in the market competing (means at 4.77). Frequent competitive moves (means at 4.51) are also considered by respondents as a strong condition of competition in the supplier's market. However, respondents consider lower competition conditions on the promotion wars made by the suppliers (means at 4.31).

Moreover, uncertainty of demand considered strong by the respondent with means of 4.62, higher than competition in the supplier's market. The descriptive analysis showed that demands for consumables in the construction industry in Malaysia is high with means at 4.66. Strong consideration also found on the difficulties of demand trend to be monitored at 4.65 means. However, demand forecast was considered highly unreliable (means at 4.59) and the variance of weekly material supply requirement is high at 4.60 means. On the other hand, cooperation between

respondents as contractors and their supplier found to be high at 5.03 means. It is showed that suppliers of the respondents are actively involved in the operation of the respondents (means at 5.0). Respondents are also found to have high satisfaction (means at 5.06) and trust (means at 5.06) to their suppliers.

In addition, on the barriers to the adoption of VMI, respondent perceived lack of suitable IT infrastructure as the highest means at 4.16 and internal/external integration barrier as the lowest means at 4.05. Table 4.14 present the descriptive statistics of the variables.

Table 4.14
Result of Descriptive Statistical Analysis

Variable	Mean	Std. Error
Environmental determinants:		
Supplier's market competition	4.43	2.695
Demand uncertainty	4.62	2.678
Buyer-supplier cooperation	5.03	2.890
Intention to adopt VMI	4.53	2.259
Barriers to VMI adoption:		
Ineffective Organizational Structure	4.07	0.767
Lack of Suitable IT Infrastructure	4.10	0.669
Improper Decision Support Tool	4.05	0.566
Lack of Trust & Mutual Understanding Between Supply Chain Partners	4.16	0.825
Internal/External Integration	4.07	0.617

4.7 Hypothesis Testing

This section present the result of the study in regards to the data analysis technique and the objectives of the study.

4.7.1 Pearson Correlation Test Results

Pearson correlation test employed to test the hypothesis 1, 2 and 3 of the study as the first objective of the study. The objective is to investigate the environmental determinants of VMI adoption in Malaysia construction industry. Therefore, if the correlation value from the Pearson correlation test equal to 0, there is no relationship considered between the dependent variable to the independent variable. However, if the value is ±1, positive or negative relationship is found (Pallant, 2005). In addition to the relationship of the dependent and independent variable, Cohen (1988) suggest the strength of each relationship interpreted from the correlation value as small strength (r = ±0.1 to ±0.29); medium strength (r = ±0.30 to ±0.49); large strength (r = ±0.50 to ±1.00).

The correlation value of all environmental determinants used in the study show significant and positive relationships with different strength on every relationships. Supplier's market competition show the least strength of environmental determinant dimensions towards the adoption of VMI with correlation of r =0.312. Followed by the demand uncertainty correlation value of r =0.449 with significant and moderate strength toward the adoption of VMI. Lastly, Supplier-buyer cooperation show a strong correlation value of r =0.630 with significant level at 0.01 towards the adoption of VMI in the construction industry in Malaysia. Therefore, hypothesis 1, 2, and 3 is supported by the findings, which show significant and positive relationship among environmental determinants of VMI adoption towards the intention to adopt VMI.

In addition, although it was not mentioned in the objective of the study, it is important to test whether the proposed list of barriers in the study have a significant relationship to the intention to adopt VMI in Malaysia construction industry. The Pearson correlation test result show no significant relationship between the barriers and the intention to adopt VMI. The correlation value is r =0.46, which show no significance in the relationship, although the correlation value r <0. However, the barriers in the study are to validate whether these perceived barriers from the literature have the same result on the perceived barriers to the contractors in Malaysia.

4.7.2 Multiple Regression Analysis

The multiple regression analysis was conducted in this study to examine whether overall environmental determinants dimension have significant power towards the intention to adopt VMI in the construction industry in Malaysia. This method identifies the contribution of each independent variables to the regression model. Table 4.15 present the result of Multiple Regression of Intention to adopt VMI as the predictor and environmental determinants as the dependent variable, which include supplier's market competition, demand uncertainty and supplier-buyer cooperation. The table shows that the environmental determinants variables contributes 39.40% significantly at p<0.05 to the intention to adopt VMI in the Malaysia construction industry.

In this study, the measurement of contribution is using Adjusted R square as it gives the variance of a dependent variable. According to Pallant (2007), the use of adjusted

R square can better estimate the actual population and avoid excessive estimates. While, the Beta is a standardized coefficient which shows the value of the independent variables contribution to the dependent variable (Hair, Black, Babin, & Anderson, 2010; Pallant, 2010). Beta values are used to make comparisons of each independent variables. The higher the beta value, means the higher the contribution of independent variables to the dependent variables.

Table 4.15
Result of Multiple Regression

	B	Std. Error	Beta	t	Sig.
(Constant)	7.430	1.664		4.465	0.000
Competition	0.236	0.079	0.282	3.011	0.000
Demand	0.131	0.083	0.156	1.590	0.000
Cooperation	0.436	0.078	0.558	5.571	0.000

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.643[a]	0.413	0.394	1.758

4.7.3 Descriptive Analysis of Barriers to VMI Adoption

For the second objective of the study, comparison of descriptive analysis was used in this study. The objective is to test and validate whether the proposed barriers to the adoption of VMI by literature have similar or the same result from the contractors in the Malaysia construction industry. As stated in the section 4.5, according to the statistical result of the study, the respondents did perceived Lack of trust & mutual understanding between supply chain partners as the highest means at 4.16 and improper decision support tool as the lowest means at 4.05. Ineffective organizational structure shown with means of 4.07, followed by internal/external

integration barrier (means at 4.10) and lack of suitable IT infrastructure at 4.10 means. Comparison between the result of perceived barriers to the adoption of VMI in this study and from the previous study (Borade & Bansod, 2010) presented in the Table 4.16.

The table show that, although lack of trust & mutual understanding between supply chain partners was found the highest perceived barrier in this study, the means value of this study is still lower than the means value of perceived barrier from the previous empirical study. Moreover, the same condition found between the comparisons of mean value of lack of suitable IT infrastructure, which in this study is found to be lower than the previous empirical study of Borade & Bansod (2010). However, the hypothesis 4 is supported with the result of the study, which found that lack of trust and mutual understanding as the highest perceived barrier of large firm or in this study by larger contractor (G7) and found improper decision support tools as the least perceived barrier by larger firms, which supported the previous empirical findings.

Table 4.16
Comparison of Means of Barriers to VMI Adoption

Descriptive Statistics	**Current**	**Previous**
Barriers to adoption	Mean	Mean
Ineffective Organizational Structure	4.07	3.56
Lack of Suitable IT Infrastructure	4.10	4.37
Improper Decision Support Tool	4.05	3.04
Lack of Trust & Mutual Understanding Between Supply Chain Partners	4.16	4.57
Internal/External Integration	4.07	3.77

4.7.4 VMI Readiness Score Analysis

For the third objective of the study, it involves with an examination of respondent's readiness toward VMI adoption in three VMI-related features (Product related, Company related & Supplier related). The measurement framework consist of 15 survey items extracted from the literature, with item weights elicited by the experts. Decision to whether adopt VMI or not can be asses with this methodology (Niranjan et al., 2012). A possible range of 0-400 score from overall score with score below 200 indicates that firms' VMI readiness is low and suggested to maintain traditional supply chain transactions instead of to adopt VMI. However, with score between 200 & 300, the methodology suggests that firms should consider to adopt VMI because their readiness is moderate. Lastly, it is suggested that firms should adopt VMI when total score reach above 300, which considered as high readiness. Table 4.17 present the 15 feature items with the respective weight on each item.

From the descriptive analysis of the readiness score, 69 out of the total respondents scored 200-300. While the other 28 respondent indicate high readiness of VMI, which is 29 percent of total respondents. Therefore, the result suggest that the respondents are at moderate to high level of readiness to the adoption of VMI. Thus, this study support the hypothesis 5, in which state that large contractors (G7) in Malaysia construction industry have high level of readiness, although the result indicated that the readiness level of the respondents is strained from moderate to high level of readiness to VMI adoption.

Table 4.17
List of Item of VMI Readiness Framework

Item	Weight
Company related features:	
Our company revenues have been stable over the years, neither growing nor falling rapidly.	3.86
Transaction costs pertaining to purchase are high.	5.14
Information and communication systems are good.*	6.75
The company has no problem sharing inventory/forecast information with the suppliers.*	9.97
Purchasing is a core competence of our organization.	7.07
Product related features:	
Products are standardized, and customization is minimal.	7.07
Products are repetitive with infrequent changes in product specification by Customer.	8.04
Products have standard product identification throughout the supply chain.*	6.75
Demand variance is low.	4.82
Demand is forecasted and stock levels are monitored closely.*	7.40
Supplier related features:	
High levels of trust and long-term relationships with the suppliers exist.*	7.72
VMI benefits are evident to both our company and our suppliers.	7.07
Key suppliers constitute a high percentage of purchase orders.*	5.14
Suppliers are willing to cooperate with a VMI initiative.	8.68
The company's information system is integrated with the suppliers.*	4.50

4.8 Summary

Questionnaire survey has been conducted in order to answer the research questions of the study. Total 0f 97 responded questionnaires from Malaysia G7 contractors were collected out of 548 sent questionnaires, resulting 26.50 percent respond rate from the total required sample size. The responded questionnaires majority were responded by senior executives from procurement department as compared to other departments. Most of the responded unfamiliar/unaware with the strategy of VMI in

the construction industry. All the item measurements were indicated sufficient correlation among the items in the dimension with range of medium to high communalities, indicating the result of a group of items can represent and explain every item in the construct. Non-response bias was also conducted with the indication of no response bias in the collected response with all of the variables were distributed normally. The descriptive statistical analysis showed that most of the contractors intended to adopt VMI in the future with the advantages upcoming from the implementation of VMI in their already good relationship with their suppliers. Good relationship between the contractors and their suppliers reflected from high means value of supplier-buyer relationship measurement and barrier of supplier-buyer integration as the lowest barrier to the adoption of VMI in the survey. However, the intention of contractors to adopt VMI were challenged by the unreliable demand forecast from either the supplier or the contractor. High perceived lack of suitable IT infrastructure was also indicated as highest barrier to the adoption of VMI from the responded survey. The hypothesis testing was conducted and the result showed full support to the hypothesis of the study, which will fatherly discussed on the next chapter.

CHAPTER FIVE
DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter will recap the overview of the research. This final chapter will also provide discussion of the result generated in chapter 4. The contributions and limitations of the study, and recommendation for future research are discussed.

5.2 Recapitulation of the Findings of the Study

The main objective of the study is to examine the adoption of Vendor Managed Inventory (VMI) as a solution to a better and improved supply chain management to the supply chain management in the construction industry in Malaysia. In order to assess the adoption issue of VMI in the supply chain of a construction industry, which has significant distinctions to other industry such as manufacturing and services industry, this study examine the adoption of VMI in the context of environmental determinants of the contractors instead of technological determinants such as DOI or TOE theory.

In addition, through literature reviews and assessment, adoption of VMI into the existing supply chain management found to be burdened by the barriers to the adoption of the VMI. Therefore, several barriers proposed and tested to validate the findings in the literature. Furthermore, adoption of VMI was also influenced by the readiness of the firm itself on the technology innovation. Therefore, by adopting the framework of VMI readiness from the literature, this study aim to examine the readiness of the contractors to the adoption of VMI.

In order to achieve the objectives, 5 hypotheses were developed. Data were collected by administering questionnaires to G7 contractors in the Northern states of Malaysia. A total of 97 usable response were received and the data had gone through some test as explained in the previous chapter. The result showed that all the hypotheses developed were supported. Table 5.1 summarize the hypotheses.

Table 5.1
Hypothesis Summary After Findings

Hypothesis	Statement	Result
H1	Higher supplier's market competition positively influence the degree of intention to adopt VMI	Supported
H2	Higher demand uncertainty positively influence the degree of intention to adopt VMI	Supported
H3	Higher degree of buyer-supplier collaboration positively influence the degree of intention to adopt VMI	Supported
H4	Obstacles for adopting the VMI practice are similar to the findings in the literature	Supported
H5	G7 as Malaysian large contractors have high degree of readiness to the adoption of VMI.	Supported

5.3 Discussion

This section will discuss on each relationship and the result on the hypotheses of the study.

5.3.1 Environment Determinants

This study found positive and significant relationship on each variables under this dimension (supplier's market competition, demand uncertainty, and supplier-buyer cooperation). Thus, hypothesis 1, 2, and 3 were supported as stated in Table 5.1. This result support the findings of Dong et al. (2007) which noted that environmental

determinants as the conditions which VMI most likely to be adopted. However, the findings of Dong et al. (2007) showed that demand uncertainty and buyer's operational uncertainty have no significant influence and negatively influence the adoption of VMI and found supplier's and buyer's market competition along with supplier-buyer cooperation level positively and significantly promotes the adoption of VMI. Therefore, this study partly support the findings of Dong et al. (2007) on the supplier's market competition and cooperation of supplier and buyer, but challenge the findings of Dong et al. (2007) on the no significant relationship of demand uncertainty toward the adoption of VMI, which also was found in the study of MacMillan et al. (1986).

Supplier's market competition positive influence to the adoption of VMI was also found in the findings of Haardt et al. (2010), Lehoux et al. (2010), and Xiao & Bao (2011). However, the influence of market competition were found mostly in the motivation to collaborate in order to achieve a competitive advantage with the collaboration. In addition, in the adoption of VMI initiated by the contractor, who was not in the competitive market, does not have many reasons to adopt VMI because they can utilize the price wars between supplier's competitions. However, the benefits of VMI are not limited to cost reduction only, but several others such as higher availability of materials at contractor's premises and better supplier performance, in which contractors could absorb more benefits than cost-benefit of VMI in regards to the high competition in the supplier's market. As stated by Claassen et al. (2008), that cost-benefit is the least benefit of VMI perceived by the

buyers, and cost-benefit will be exist when the supplier and the contractor has been fully committed to each other.

Positive and strong significant influence of supplier-buyer cooperation found in the findings of this study. The result support most of the literatures on the relationship between these two variables (Kuk, 2004; Claassen et al. 2008; Dong et al. 2007). Claassen et al. (2008) discover that quality of supplier-buyer integration has the significant impact on the success of VMI adoption. The same result also found earlier by Petersen, Ragatz, & Monczka (2005) in their empirical study that relationship quality has positive influence on the planning process. The result also support the findings of Bagchi & Skjoett-Larsen (2003), that a lower degree of integration between buyer and supplier, would result poor performance on the collaboration between buyer and supplier. Therefore, the success of VMI adoption needs good integration and cooperation between the contractor and the supplier in any other business functions such as design and finance, in order to smoothen the adoption process (Aloini et al. 2012).

Moreover, literature suggest the same counteracting effect on the demand uncertainty towards the adoption of collaboration in supply chain management. While (Clark & Hammond, 1997) and Yang et al. (2003) suggest that VMI adoption will perform better on predictable and stable demand patterns, Lee et al. (1997) and Dong et al. (2007) state that the higher the demand uncertainty in the market, the need for VMI adoption will be higher also, in order to reduce the uncertainty. However, Yang et al. (2003) propose that if VMI adopted in a volatile demand

industry, supplier have to provide extra effort to reduce stockout cost at buyer's premises.

Nevertheless, this study focus on the adoption of VMI in the construction industry in Malaysia for the small items or consumables materials as recommended by the Tanskanen et al. (2008), in which saw the opportunity of success implementation of VMI in the construction industry for small items materials. With the characteristic of small items or consumables materials similar to components part to the manufacturing industry, the demand for construction consumable materials are predictable because they are at the upstream level in the material flow of supply chain (Brown et al., 2001). Therefore, this study assumed that the result of a positive relationship of product demand uncertainty and adoption of VMI consequent with the same assumptions of contractors toward the predictable and stable characteristic of consumables materials in which perceived to motivate the adoption of VMI (Yang, Ruben, & Webster, 2003)

In addition, under high degree of buyer's demand uncertainty, the supplier may have significant resistance to the adoption and implementation of the VMI adoption. Demand uncertainty give larger inventory burden to the supplier if they have to manage the inbound logistics for the buyer. However, Jonsson & Mattsson (2016) noted that demand uncertainty as the most difficult issue in material planning, however it motivates further research on how material should be planned in relation to inventory performance improvement (Christopher & Holweg, 2011). Especially for the contractors as the buyer in the transactions, their unpredictable demands and

volatile material requirement eventually motivate them to collaborate with their supplier to get the advantage of the relationship with reduced inventory level.

5.3.2 Barriers to VMI Adoption

On the objective to validate the findings in the literature on the barriers perceived by large firms, this study found that G7 as the largest contractors in Malaysia construction industry perceived lack of trust and mutual understanding between supply chain partners as the highest perceived barriers to the adoption of VMI. This particular findings similar and support the findings in the literature (Borade & Bansod, 2010), however, the mean value of this study is slightly lower than the findings in the literature. Slight difference in the mean value may be subjected the total number of respondents in the study, which in this study was only 97 respondents. While in the study of Borade & Bansod (2010), 126 large firms were involved. The findings of this study also supported the findings of other barriers to adoption of VMI with higher mean value for internal/external integration, improper decision support tools and suitable IT infrastructure with slightly higher mean values. This findings suggest that G7 contractors can afford the experiments of new technologies, fascinate the cost of failures and bear the cost of adoption, however restrained by the trust and mutual understanding with the supply chain partners.

5.3.3 Readiness to Adopt VMI

The findings of the study was cleared, that most of the respondents in the study have moderate to high VMI readiness. Supported by the study of Ern & Kasim (2012) which noted that contractors in Malaysia were actually ready and able to adopt new

technology innovation, but the adoption of the technology is very low because of the adoption barriers which impact the contractors to reluctant to transform the traditional business transaction into better and more efficient technology innovation. The resistance of the contractors to involve and adopt new technological innovations is not because of low organizational readiness of the contractor, but the consequent result of the lack of government support and promotional campaign of the new innovation, which impact the perception of contractors that the expected benefits of new technology are not as profitable and efficient as the traditional transaction process (Mohd Nawi et al., 2017).

On the hypothesis 5 of the study, it was stated that G7 contractors as large contractors in Malaysia construction industry have high readiness to the adoption of VMI. Since the hypothesis is supported, then the study could support the literatures mentioned that larger firms are financially ready and have the access to technology innovation that could help them to adopt VMI. Although several literature strongly argue on the smaller firms who will have better readiness to change, the empirical findings of the study supported by the literature indicated that larger organization possess higher readiness includes: Lee & Xia (2006); Cudanov et al. (2010); Bordonaba- Juste et al. (2012); Saldanha & Krishnan (2012). Most of the literatures noted that larger organization perceived to have higher readiness to the adoption of new technology innovation due to its access and possession of infrastructure, technology and resources to adopt and implement the new technology innovation (Cudanov et al., 2010; Bordonaba-Juste et al., 2012).

5.4 Contributions of the Study

This study contributes to both theoretical contributions and managerial implications, which will be discussed below.

5.4.1 Theoretical Contributions

This study has provided the evidence of variables under environmental determinants including supplier's market competition, demand uncertainty and supplier-buyer cooperation positively and significantly influence the intention to adopt VMI in the construction industry in Malaysia. Previous studies on the adoption of VMI has been examining the factors that influence the intention to adopt VMI including environmental determinants, with empirical and theoretical methodologies, however this study has theoretically contribute by providing the evidence that environmental determinants of the contractor, which refer to the conditions most likely VMI to be adopted, positively and significantly influence the intention to adopt VMI.

5.4.2 Managerial Implications

This study will help practitioners and/or contractors in construction industry to evaluate the solution of VMI for their supply chain management innovation to be adopted for various expected benefits. This study will help to increase the awareness of decision makers in construction industry in Malaysia regarding the environmental conditions in which VMI is most likely suitable for them. This study also will help to increase the awareness of barriers in the attempt to adoption VMI, which will help practitioners and contractors to evaluate for what to expect and what to do when

facing such barriers. This study will also help the practitioners and contractor to evaluate their firm's VMI readiness by using the framework used in this study.

5.5 Limitation of the Study

This study limited only to three variables under environmental determinants which positively influence the contractor's intention to adopt VMI. Additionally, the adoption of VMI is measured solely on the intention to use/adopt variable. Besides, this study only limit the samples from the Northern state of Malaysia due to limited time and funds in conducting the study. Moreover, the VMI readiness only measured with one measurement framework, which cover the organizational readiness only. This study is also limited to only G7 contractors as the sample of the study.

5.6 Recommendations for Future Research

Based on the limitation of the study discussed previously, future research on adoption of VMI in construction industry in Malaysia may be conducted by extending the research to investigate both environmental determinants and technology determinants to the adoption level of VMI. The future research may also be conducted with the perspective of both supplier and buyer to compare the adoption level under same circumstances and perceived barriers on the adoption of VMI. It is also recommended for future research to compare the adoption level of VMI between private and public-owned contractors. Future research is highly recommended to cover all of the CIDB grade contractors in Malaysia to investigate the mediating effect of organizational size on the VMI adoption level in the construction industry.

5.7 Conclusion

To summarize, this study was conducted to examine the environmental determinant which influence the intention to adopt Vendor Managed Inventory (VMI) in the construction industry in Malaysia. This study was also conducted to validate the previous findings in the literature regarding the barriers to VMI adoption and readiness to adopt VMI in Malaysia construction industry. For the purpose of the study, three research objectives and questions have been raised and used to direct the study. To answer the research questions of the study, 5 hypotheses were developed and all of them have been supported in the findings. Data analysis was done on the collected data from G7 contractors from Northern region of Malaysia. This study shall help contractors to raise their awareness of VMI as a solution for their supply chain management which brings benefits to them and their suppliers with a win-win situation.

However, this study had contributed on the empirical evidence of significant influence of environmental determinants to the intention to adopt VMI in the construction industry in Malaysia. Unfortunately, there are few limitations of the study, in which used as future research recommendations on the same field to this study.

REFERENCES

Abidin, N. Z., Yusof, N., & Othman, A. a. E. (2013). Enablers and challenges of a sustainable housing industry in Malsaysia. *Construction Innovation: Information, Process, Management*, *13*(1), 10–25.

AbuKhousa, E., Mohamed, N., & Al-Jaroodi, J. (2012). e-Health Cloud: Opportunities and Challenges. *Future Internet*, *4*(4), 621–645.

Achabal, D. D., McIntyre, S. H., Smith, S. A., & Kalyanam, K. (2000). A decision support system for vendor managed inventory. *Journal of Retailing*, *76*(4), 430–454.

Adewale, B. J., Mohammed, K. A., & Nasrun, M. N. M. (2016). Assessing the sustainable construction of large construction companies in Malaysia. *AIP Conference Proceedings*, *20027*(1761), 20027.

Ahuja, S. P., Mani, S., & Zambrano, J. (2012). A Survey of the State of Cloud Computing in Healthcare. *Network and Communication Technologies*, *1*(2).

Ajayi, S. O., Oyedele, L. O., Akinade, O. O., Bilal, M., Alaka, H. A., & Owolabi, H. A. (2017). Optimising material procurement for construction waste minimization: An exploration of success factors. *Sustainable Materials and Technologies*, *11*, 38–46.

Akintoye, A., & Main, J. (2007). Collaborative relationships in construction: the UK contractors' perception. *Engineering, Construction and Architectural Management*, *14*(6), 597–617.

Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing & Supply Management*, *6*(3–4), 159–168.

Al-Ameri, T. A., Shah, N., & Papageorgiou, L. G. (2008). Optimization of vendor-managed inventory systems in a rolling horizon framework. *Computers and Industrial Engineering*, *54*(4), 1019–1047.

Al-Khalil, M., Assaf, S., Al-Faraj, T., & Al-Darweesh, A. (2004). Measuring effectiveness of materials management for industrial projects. *Journal of Management in Engineering*, *20*(July), 82–87.

Almehdawe, E., & Mantin, B. (2010). Vendor managed inventory with a capacitated manufacturer and multiple retailers: Retailer versus manufacturer leadership. In *International Journal of Production Economics* (Vol. 128, pp. 292–302).

Aloini, D., Dulmin, R., Mininno, V., & Ponticelli, S. (2012). Supply chain management: a review of implementation risks in the construction industry. *Business Process Management Journal*, *18*(5), 735–761.

Aloini, D., Dulmin, R., Mininno, V., & Ponticelli, S. (2015). Key antecedents and practices for supply chain management adoption in project contexts. *International Journal of Project Management*, *33*(6), 1301–1316.

Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England. *Journal of Enterprise Information Management*, *26*(3), 250–275.

Anderson, J. C., & Narus, J. A. (1990). A model of distributor firm and manufacturer firm working partnerships. *Journal of Marketing*, *54*(1), 42.

Arbulu, R., Ballard, G., & Harper, N. (2003). Kanban in construction. *International Group for Lean Construction*, (September), 1–12. Retrieved from http://leanconstruction.dk/media/17574/Kanban in Construction.pdf

Archetti, C., Bertazzi, L., Laporte, G., & Speranza, M. G. (2007). A branch-and-cut algorithm for a vendor-managed inventory-routing problem. *Transportation Science*, *41*(3), 382–391.

Arora, V., Chan, F. T. S., & Tiwari, M. K. (2010). An integrated approach for logistic and vendor managed inventory in supply chain. *Expert Systems with Applications*, *37*(1), 39–44.

Aviv, Y. (2002). Gaining benefits from joint forecasting and replenishment processes : The case of auto-correlated demand. *Manufacturing & Service Operations Management*, *4*(1), 55–74.

Bagchi, P. K., & Skjoett- Larsen, T. (2003). Integration of information technology and organizations in a supply chain. *The International Journal of Logistics Management*, *14*(1), 89–108.

Bai, Y., Hwang, T., Kang, S., & Ouyang, Y. (2011). Biofuel refinery location and supply chain planning under traffic congestion. *Transportation Research Part B: Methodological*, *45*(1), 162–175.

Baiden, B. K., Price, A. D. F., & Dainty, A. R. J. (2006). The extent of team integration within construction projects. *International Journal of Project Management*, *24*(1), 13–23.

Baker, M. B., & Yousof, Z. (2017). Factors influencing knowledge sharing in enterprise resource planning system usage in small and medium enterprises. *Journal of Theoretical and Applied Information Technology*, *95*(8), 1693–1702. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85018453573&partnerID=40&md5=06b27bd82fb1a25dac2e58803361ba59

Ballard, G., & Howell, G. A. (2003). Lean project management. *Building Research and Information*, *31*(2), 119–133.

Barratt, M. (2004). Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: An International Journal*, *9*(1), 30–42.

Behera, P., Mohanty, R. P., & Prakash, A. (2015). Understanding construction supply chain management. *Production Planning & Control*, *26*(16), 1332–1350.

Benjaoran, V. (2009). A cost control system development: A collaborative approach for small and medium-sized contractors. *International Journal of Project*

Management, *27*(3), 270–277.

Bernsmed, K., Cruzes, D. S., Jaatun, M. G., Haugset, B., & Gjaere, E. A. (2014). Healthcare services in the cloud - Obstacles to adoption, and a way forward. In *Proceedings - 9th International Conference on Availability, Reliability and Security, ARES 2014* (pp. 158–165).

Biedenbach, T., & Müller, R. (2012). Absorptive, innovative and adaptive capabilities and their impact on project and project portfolio performance. *International Journal of Project Management*, *30*(5), 621–635.

Bookbinder, J. H., Gumus, M., & Jewkes, E. M. (2010). Calculating the benefits of vendor managed inventory in a manufacturer-retailer system. *International Journal of Production Research*, *48*(19), 5549–5571.

Borade, A. B., & Bansod, S. V. (2010). Study of vendor- managed inventory practices in Indian industries. *Journal of Manufacturing Technology Management*, *21*(8), 1013–1038.

Borade, A. B., & Bansod, S. V. (2012). Interpretive structural modeling-based framework for VMI adoption in Indian industries. *International Journal of Advanced Manufacturing Technology*, *58*(9–12), 1227–1242.

Borade, A. B., Kannan, G., & Bansod, S. V. (2013). Analytical hierarchy process-based framework for VMI adoption. *International Journal of Production Research*, *51*(4), 963–978.

Bordonaba- Juste, V., Lucia- Palacios, L., & Polo- Redondo, Y. (2012). The influence of organizational factors on e- business use: analysis of firm size. *Marketing Intelligence & Planning*, *30*(2), 212–229.

Bowersox, D., & Closs, D. (1996). *Logistical management: The Integrated supply chain process. Hwa-Tai Bookstore Ltd., Taiwan*. Retrieved from http://www.lavoisier.fr/livre/notice.asp?id=OOLWRRAKOLOOWU

Bowersox, D. J. (1990). The strategic benefits of logistics alliances. *Bowersox, D.J.*, *68*(4), 36–45.

Briscoe, G., & Dainty, A. (2005). Construction supply chain integration: an elusive goal? *Supply Chain Management: An International Journal*, *10*(4), 319–326.

Burgess, K., Singh, P. J., & Koroglu, R. (2006). Supply chain management: a structured literature review and implications for future research. *International Journal of Operations & Production Management*, *26*(7), 703–729.

Cachon, G. P. (2001). Stock wars: Inventory competition in a two-echelon supply chain with multiple retailers. *Operations Research*, *49*(5), 658–674.

Callender, C., & Grasman, S. E. (2010). Barriers and Best Practices for Material Management in the Healthcare Sector. *Engineering Management Journal*, *22*(4), 11–19.

Cannella, S., Framinan, J. M., Bruccoleri, M., Barbosa-Póvoa, A. P., & Relvas, S.

(2015). The effect of inventory record inaccuracy in information exchange supply chains. *European Journal of Operational Research*, *243*(1), 120–129.

Caron, F., Marchet, G., & Perego, A. (1998). Project logistics: integrating the procurement and construction processes. *International Journal of Project Management*, *16*(5), 311–319.

Carter, C. R., Rogers, D. S., & Choi, T. Y. (2015). Toward the theory of the supply chain. *Journal of Supply Chain Management*, *51*(2), 89–97.

Cavana, R. Y., Delahaye, B. L., & Sekaran, U. (2001). *Applied business research: qualitative and quantitative methods*. *Recherche En Soins Infirmiers*.

Cetinkaya, S., & Lee, C.-Y. (2000). Stock replenishment and shipment scheduling for vendor-managed inventory systems. *Management Science*, *46*(2), 217–232.

Challender, J. (2017). Trust in collaborative construction procurement strategies. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law*, *170*(3), 115–124.

Chaouch, B. a. (2001). Stock levels and delivery rates in vendor-managed inventory programs. *Production and Operations Management*, *10*(1), 31–44.

Chen, I. J., & Paulraj, A. (2004). Towards a theory of supply chain management: The constructs and measurements. *Journal of Operations Management*, *22*(2), 119–150.

Chen, J. M., Lin, I. C., & Cheng, H. L. (2010). Channel coordination under consignment and vendor-managed inventory in a distribution system. *Transportation Research Part E: Logistics and Transportation Review*, *46*(6), 831–843.

Chen, J., Zhang, Y., & Shi, C. (2009). The application of supply chain management performance model based on VMI. *2009 International Conference on Management and Service Science*, 1–5.

Chen, L. T. (2014). Optimal dynamic policies for integrated production and marketing planning in business-to-business marketplaces. *International Journal of Production Economics*, *153*, 46–53.

Chen, W. T., & Chen, T. T. (2007). Critical success factors for construction partnering in Taiwan. *IJoPM*, *25*(5), 475–484. https://doi.org/10.1016/j.ijproman.2006.12.003

Cheng, J. C. P., Law, K. H., Bjornsson, H., Jones, A., & Sriram, R. (2010). A service oriented framework for construction supply chain integration. *Automation in Construction*, *19*(2), 245–260.

Chin, K.-S., Tummala, V. M. R., Leung, J. P. F., & Tang, X. (2004). A study on supply chain management practices: The Hong Kong manufacturing perspective. *International Journal of Physical Distribution & Logistics Management*, *34*(6), 505–524.

Choi, K.-S., Dai, J. G., & Song, J.-S. (2004). On measuring supplier performance under vendor-managed-inventory programs in capacitated supply chains. *Manufacturing & Service Operations Management*, *6*(1), 53–72.

Choudhary, D., & Shankar, R. (2015). The value of VMI beyond information sharing under time-varying stochastic demand. *International Journal of Production Research*, *53*(5), 1472–1486.

Chow, P. T., Cheung, S. O., & Chan, K. Y. (2012). Trust-building in construction contracting: Mechanism and expectation. *International Journal of Project Management*, *30*(8), 927–937.

Christopher, M., & Holweg, M. (2011). "Supply Chain 2.0": managing supply chains in the era of turbulence. *International Journal of Physical Distribution & Logistics Management*, *41*(1), 63–82.

Cicmil, S., & Marshall, D. (2005). Insights into collaboration at the project level: Complexity, social interaction and procurement mechanisms. *Building Research and Information*.

Claassen, M. J. T., van Weele, A. J., & van Raaij, E. M. (2008). Performance outcomes and success factors of vendor managed inventory (VMI). *Supply Chain Management: An International Journal*, *13*(6), 406–414.

Clark, T. H., & Hammond, J. H. (1997). Reengineering channel reordering processes to improve total supply-chain performance. *Production and Operations Management*, *6*(3), 248–265.

Coase, R. H. (1937). The nature of the firm. *Economica*, *4*(16), 386–405.

Cooper, D. R., & Schindler, P. S. (2003). Business research methods. *Business*. Retrieved from http://130.209.236.149/headocs/31businessresearch.pdf

Cooper, M. C., & Ellram, L. M. (1993). Characteristics of supply chain management and the implications for purchasing and logistics strategy. *The International Journal of Logistics Management*, *4*(2), 13–24.

Cooper, M. C., Ellram, L. M., Gardner, J. T., & Hanks, A. M. (1997). Meshing multiple alliances. *Journal of Business Logistics*, *18*(1), 67–89. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9710284080&site=ehost-live

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply chain management: More than a new name for logistics. *The International Journal of Logistics Management*, *8*(1), 1–14.

Corbett, C. J. (2001). Stochastic inventory systems in a supply chain with asymmetric information: Cycle stocks, safety stocks, and consignment stock. *Operations Research*, *49*(4), 487–500.

Corrocher, N., & Fontana, R. (2008). Objectives, obstacles and drivers of ICT adoption: What do IT managers perceive? *Information Economics and Policy*, *20*(3), 229–242.

Cox, A., & Thompson, I. (1997). "Fit for purpose" contractual relations: determining a theoretical framework for construction projects. *European Journal of Purchasing & Supply Management*, *3*(3), 127–135.

Crespin-Mazet, F., & Ghauri, P. (2007). Co-development as a marketing strategy in the construction industry. *Industrial Marketing Management*, *36*(2), 158–172.

Crouse, H. J. (1991). The power of partnership. *Journal of Business Strategy*, *12*(6), 4–8. Retrieved from

Crowley, L. G., & Karim, M. A. (1995). Conceptual Model of Partnering. *Journal of Management in Engineering*, *11*(5), 33–39.

Cudanov, M., Jasko, O., & Savoiu, G. (2010). Interrelationships of Organization Size and Information and Communication Technology Adoption. *Journal of Applied Quantitative Methods*, *5*(1), 29–40. Retrieved from http://jaqm.ro/issues/volume-5,issue-1/pdfs/cudanov_jasko_savoiu.pdf%5Cnhttp://jaqm.ro/issues/volume-5,issue-1/pdfs/jaqm_vol5_issue1.pdf#page=34

Dainty, A., Grugulis, I., & Langford, D. (2007). Understanding construction employment: the need for a fresh research agenda. *Personnel Review*, *36*(4), 501–508.

Danese, P., & Romano, P. (2011). Supply chain integration and efficiency performance: a study on the interactions between customer and supplier integration. *Supply Chain Management: An International Journal*, *16*(4), 220–230.

Danese, P., & Romano, P. (2013). The moderating role of supply network structure on the customer integration- efficiency relationship. *International Journal of Operations & Production Management*, *33*(4), 372–393.

Darwish, M. A., & Odah, O. M. (2010). Vendor managed inventory model for single-vendor multi-retailer supply chains. *European Journal of Operational Research*, *204*(3), 473–484.

Deakins, E., Dorling, K., & Scott, J. (2008). Determinants of successful vendor managed inventory practice in oligopoly industries. *International Journal of Integrated Supply Management*, *4*(3/4), 355.

De Toni, A. F., & Zamolo, E. (2005). From a traditional replenishment system to vendor-managed inventory: A case study from the household electrical appliances sector. *International Journal of Production Economics*, *96*(1), 63–79.

Derrouiche, R., Neubert, G., & Bouras, A. (2008). Supply chain management: A framework to characterize the collaborative strategies. *International Journal of Computer Integrated Manufacturing*, *21*(4), 426–439.

Dillman, D. A. (1979). Mail and telephone surveys : The total design method. *John Wiley & Son*, *2*(3), 247.

Disney, S. M., Potter, A. T., & Gardner, B. M. (2003). The impact of vendor managed inventory on transport operations. *Transportation Research Part E: Logistics and Transportation Review*, *39*(5), 363–380.

Disney, S. M., & Towill, D. R. (2003). Vendor- managed inventory and bullwhip reduction in a two- level supply chain. *International Journal of Operations & Production Management*, *23*(6), 625–651.

Donato, M., Ahsan, K., & Shee, H. (2015). Resource dependency and collaboration in construction supply chain: literature review and development of a conceptual framework. *International Journal of Procurement Management*, *8*(3), 344.

Dong, Y., Dresner, M., & Yao, Y. (2014). Beyond information sharing: an empirical analysis of vendor-managed inventory. *Production and Operations Management*, *23*(5), 817–828.

Dong, Y., Xu, K., & Dresner, M. (2007). Environmental determinants of VMI adoption: An exploratory analysis. *Transportation Research Part E: Logistics and Transportation Review*, *43*(4), 355–369.

Dong, Y., & Xu, K. F. (2002). A supply chain model of vendor managed inventory. *Transportation Research Part E-Logistics and Transportation Review*, *38*, 75–95.

Dorling, K., Scott, J., & Deakins, E. (2006). Determinants of successful vendor managed inventory relationship in oligopoly industries. *International Journal of Physical Distribution & Logistics Management*, *36*(3), 176–191.

Downing, R. E. (2006). The benefits and obstacles of e-commerce: toward an understanding of adoption. *Journal of Internet Commerce*, *5*(2), 95–122.

Dröge, C., & Germain, R. (1998). The design of logistics organizations. *Transportation Research Part E: Logistics and Transportation Review*, *34*(1), 25–37.

Easterby-Smith, M., Thrope, R., & Jackson, P. (2012). *Management research. SAGE Publication LTD.*

Elfving, J. A., Tommelein, I. D., & Ballard, G. (2005). Consequences of competitive bidding in project-based production. *Journal of Purchasing and Supply Management*, *11*(4), 173–181.

Ellegaard, C., & Freytag, V. P. (2010). The effects of unsuccessful VMI on customer attractiveness. *Conference Paper -The International IPSERA Workshop*, *nil*(nil), 1–18.

Ellram, L. M., & Cooper, M. C. (1990). Supply Chain Management, Partnerships, and the Shipper -Third Party Relationship. *International Journal of Logistics Management*, *1*(2), 1–10.

Elzarka, H. M. ., & Bell, L. C. (1995). Object-oriented methodology for materials-management systems. *Engineering*, *121*(4), 8.

Ern, P. A. S., & Kasim, N. (2012). E-readiness for Industrialised Building System (IBS) components management: Exploratory study in Malaysian construction projects. *ICIMTR 2012 - 2012 International Conference on Innovation, Management and Technology Research*, 454–459.

Fawcett, S. E., Magnan, G. M., & McCarter, M. W. (2008). Supply chain alliances and social dilemmas: bridging the barriers that impede collaboration. *International Journal of Procurement Management*, *1*(3), 318.

Fawcett, S. E., Wallin, C., Allred, C., Fawcett, A. M., & Magnan, G. M. (2011). Information technology as an enabler of supply chain collaboration: A dynamic-capabilities perspective. *Journal of Supply Chain Management*, *47*(1), 38–59.

Fearne, A., & Fowler, N. (2006). Efficiency versus effectiveness in construction supply chains: the dangers of "lean" thinking in isolation. *Supply Chain Management: An International Journal*, *11*(4), 283–287.

Fellows, R., & Liu, A. (2003). *Research Methods for Construction. Quarterly Journal of Economics*.

Fellows, R., & Liu, A. (2008). *Research Methods for Construction. Quarterly Journal of Economics*.

Franke, P. D. (2010). *Vendor-managed Inventory for high value parts: Results from a survey among leading international manufacturing firms*. (F. Straube, Ed.) (3rd ed.). Berlin: Inst. Technologie und Management (ITM).

Fry, M. J., Kapuscinski, R., & Olsen, T. L. (2001). Coordinating production and delivery under a (z, Z)-type vendor-managed inventory contract. *Manufacturing & Service Operations Management*, *3*(2), 151–173.

Fulford, R., & Standing, C. (2014). Construction industry productivity and the potential for collaborative practice. *International Journal of Project Management*, *32*(2), 315–326.

Gadde, L.-E., & Wynstra, F. (2018). Purchasing management and the role of uncertainty. *IMP Journal*, *12*(11), 00–00.

Gadde, L. E., & Dubois, A. (2010). Partnering in the construction industry-Problems and opportunities. *Journal of Purchasing and Supply Management*, *16*(4), 254–263.

Ganesan, S. (1994). Determinants of Long-Term Orientation in Buyer-Seller Relationships. *Journal of Marketing*, *58*(2), 1.

Gangwar, H., Date, H., & Ramaswamy, R. (2015). Understanding determinants of cloud computing adoption using an integrated TAM-TOE model. *Journal of Enterprise Information Management*, *28*(1), 107–130.

Georgy, M., & Basily, S. Y. (2008). Using genetic algorithms in optimizing construction material delivery schedules. *Construction Innovation*, *8*(1), 23–45.

Germain, R., & Dröge, C. (1995). Just-in-time and context: Predictors of electronic

data interchange technology adoption. *International Journal of Physical Distribution & Logistics Management*, *25*, 18–33.

Gong, Y., Zhou, J., & Chang, S. (2013). Core knowledge employee creativity and firm performance: The moderating role of riskiness orientation, firm size, and realized absorptive capacity. *Personnel Psychology*, *66*(2), 443–482.

Govindan, K. (2013). Vendor-managed inventory: a review based on dimensions. *International Journal of Production Research*, *51*(13), 3808–3835.

Gronalt, M., & Rauch, P. (2008). Vendor managed inventory in wood processing industries - A case study. *Silva Fennica*, *42*(1), 101–114.

Grover, V., & Goslar, M. D. (1993). The Initiation, Adoption, and Implementation of Telecommunications Technologies in U.S. Organizations. *Journal of Management Information Systems*, *10*(1), 141–164.

Guan, R., & Zhao, X. (2010). On contracts for VMI program with continuous review (r, Q) policy. *European Journal of Operational Research*, *207*(2), 656–667.

Guimarães, C. M., Carvalho, J. C. de, & Maia, A. (2013). Vendor managed inventory (VMI): evidences from lean deployment in healthcare. *Strategic Outsourcing: An International Journal*, *6*(1), 8–24.

Gümüş, M., Jewkes, E. M., & Bookbinder, J. H. (2008). Impact of consignment inventory and vendor-managed inventory for a two-party supply chain. *International Journal of Production Economics*, *113*(2), 502–517.

Haardt, E. R. W., Ottjes, J. A., Delft, B. J. H. Van, & Lodewijks, G. (2010). Vendor managed inventory in the inbound supply chain in the soft-drink industry. *The European Simulation and Modelling Conference 2010*, *2010*, 396–400.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2006). Multivariate data analysis (6th ed.). *Analysis*, 4–4.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis. *Vectors*.

Hameed, M. A., Counsell, S., & Swift, S. (2012). A meta-analysis of relationships between organizational characteristics and IT innovation adoption in organizations. *Information and Management*, *49*(5), 218–232.

Hameri, A.-P., Borg, A., & Eloranta, E. (2014). Vendor-managed inventory in a global maritime supply chain – The case of a Brazilian pulp producer. *Maritime Economics & Logistics*, *16*(2), 207–227.

Handfield, R. B. (1993). A resource dependence perspective of Just-in-Time purchasing. *Journal of Operations Management*, *11*(3), 289–311.

Hariga, M., Gumus, M., Daghfous, A., & Goyal, S. K. (2013). A vendor managed inventory model under contractual storage agreement. *Computers and Operations Research*, *40*(8), 2138–2144.

Hart, P., & Saunders, C. (1997). Power and trust: Critical factors in the adoption and

use of electronic data interchange. *Organization Science*, *8*(1), 23–42.

Hartmann, A., & Caerteling, J. (2010). Subcontractor procurement in construction: the interplay of price and trust. *Supply Chain Management: An International Journal*, *15*(5), 354–362.

Hatmoko, J. U. D., & Scott, S. (2010). Simulating the impact of supply chain management practice on the performance of medium-sized building projects. *Construction Management and Economics*, *28*(1), 35–49.

Hausman, A., & Stock, J. R. (2003). Adoption and implementation of technological innovations within long-term relationships. *Journal of Business Research*, *56*(8), 681–686.

He, S., & Hu, Y. (2010). Research on coordinated inventory policy in supply chain. *ICLEM 2010: Logistics for Sustained Economic Development - Infrastructure, Information, Integration - Proceedings of the 2010 International Conference of Logistics Engineering and Management*, *387*, 4746–4754.

Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. (1990). Mergers and Acquisitions and Managerial Commitment To Innovation in M-Form Firms. *Strategic Management Journal*, *11*(4), 29–47.

Ho, D. C. K., Au, K. F., & Newton, E. (2002). Empirical research on supply chain management: A critical review and recommendations. *International Journal of Production Research*, *40*(17), 4415–4430.

Holmström, J. (1998). Business process innovation in the supply chain – a case study of implementing vendor managed inventory. *European Journal of Purchasing & Supply Management*, *4*(2–3), 127–131.

Holweg, M., Disney, S., Holmström, J., & Småros, J. (2005). Supply chain collaboration: Making sense of the strategy continuum. *European Management Journal*, *23*(2), 170–181.

Horman, M. J., & Thomas, H. R. (2005). Role of inventory buffers in construction labor performance. *Journal of Construction Engineering and Management*, *131*(7), 834–843.

Horvath, L. (2001). Collaboration: the key to value creation in supply chain management. *Supply Chain Management: An International Journal*, *6*(5), 205–207.

Houlihan, J. B. (1985). International Supply Chain Management. *International Journal of Physical Distribution & Materials Management*, *15*(1), 22–38.

Houlihan, J. B. (1988). International Supply Chains: A New Approach. *Management Decision*, *26*(3), 13–19.

Hsu, J. S., Liang, T. P., Wu, S. P. J., Klein, G., & Jiang, J. J. (2011). Promoting the integration of users and developers to achieve a collective mind through the screening of information system projects. *International Journal of Project Management*, *29*(5), 514–524.

Hughes, D., Williams, T., & Ren, Z. (2012). Differing perspectives on collaboration in construction. *Construction Innovation*, *12*(3), 355–368.

Hvolby, H. H., Trienekens, J., & Steger-Jensen, K. (2007). Buyer-supplier relationships and planning solutions. *Production Planning and Control*, *18*(6), 487–496.

Jaskyte, K. (2013). Does size really matter? Organizational size and innovations in nonprofit organizations. *Nonprofit Management and Leadership*, *24*(2), 229–247.

Jaworski, B. J., & Kohli, A. K. (1993). Market Orientation: Antecedents and Consequences. *Journal of Marketing*, *57*(3), 53.

Jemai, Z., Rekik, Y., & Kalaï, R. (2013). Inventory routing problems in a context of vendor-managed inventory system with consignment stock and transshipment. *Production Planning and Control*, *24*(8–9), 671–683.

Jiang, Z., Henneberg, S. C., & Naudé, P. (2012). Supplier relationship management in the construction industry: the effects of trust and dependence. *Journal of Business & Industrial Marketing*, *27*(1), 3–15.

John, G., & Weitz, B. A. (1988). Forward integration into distribution: An empirical test of transaction cost analysis. *Journal of Law, Economics & Organization*, *4*(2), 337.

Jonsson, P., & Mattsson, S. (2006). A longitudinal study of material planning applications in manufacturing companies. *International Journal of Operations & Production Management*, *26*(9), 971–995.

Jonsson, P., & Mattsson, S.-A. (2016). Advanced material planning performance: a contextual examination and research agenda. *International Journal of Physical Distribution & Logistics Management*, *46*(9), 836–858.

Kaipia, R., Holmström, J., Småros, J., & Rajala, R. (2017). Information sharing for sales and operations planning: Contextualized solutions and mechanisms. *Journal of Operations Management*, *52*, 15–29.

Kaipia, R., Holmström, J., & Tanskanen, K. (2002). VMI: What are you losing if you let your customer place orders? *Production Planning and Control*, *13*(1), 17–25.

Kamann, D. J. F., Snijders, C., Tazelaar, F., & Welling, D. T. (2006). The ties that bind: Buyer-supplier relations in the construction industry. *Journal of Purchasing and Supply Management*, *12*(1), 28–38.

Kamar, K. A. M., Hamid, Z. A., & Din, I. (2012). The adoption of Industrialised Building System (IBS) construction in Malaysia. *Gerontechnology*, *11*(2).

Kassim, U., & Walid, L. (2013). Awareness of the Industrialized Building System (IBS) implementation in Northern Malaysia - A case study in Perlis. In *Procedia Engineering* (Vol. 53, pp. 58–63).

Kathawala, Y., & Abdou, K. (2003). Supply chain evaluation in the service industry: a framework development compared to manufacturing. *Managerial Auditing Journal*, *18*(2), 140–149.

Kauffman, R. G. (2002). Supply management : What ' s in a name ? or , do we know who we are ? *Purchasing and Supply Management*, *1*(November), 46–50.

Kauremaa, J., Småros, J., & Holmström, J. (2009). Patterns of vendor- managed inventory: findings from a multiple- case study. *International Journal of Operations & Production Management*, *29*(11), 1109–1139.

Keller, S. B., Savitskie, K., Stank, T. P., Lynch, D. F., & Ellinger, A. E. (2002). A Summary and Analysis of Multi-Item Scales Used in Logistics Research. *Journal of Business Logistics*, *23*(2), 83–281.

Khalfan, M. M. A., Maqsood, T., & Noor, M. A. (2014). Relationships among supply chain participants: the case of Australia and Malaysia. *International Journal of Procurement Management*, *7*(4), 376.

Kiesmüller, G. P., & Broekmeulen, R. A. C. M. (2010). The benefit of VMI strategies in a stochastic multi-product serial two echelon system. *Computers and Operations Research*, *37*(2), 406–416.

Kim, H.-S. (2008). Research note: Revisiting "retailer- vs. vendor-managed inventory and brand competition." *Management Science*, *54*(3), 623–626.

Kleywegt, A. J., Nori, V. S., & Savelsbergh, M. W. P. (2002). The stochastic inventory routing problem with direct deliveries. *Transportation Science*, *36*(1), 94–118.

Koskela, L. (2000). *An exploration towards a production theory and its application to construction. VTT Building Technology*.

Koushki, P. A., & Kartam, N. (2004). Impact of construction materials on project time and cost in Kuwait. *Engineering, Construction and Architectural Management*, *11*(2), 126–132.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *38*, 607–610.

Krichanchai, S., & Maccarthy, B. L. (2016). The adoption of vendor managed inventory for hospital pharmaceutical. *International Journal of Logistics Management*, *15*(October), 1–13.

Kuk, G. (2004). Effectiveness of vendor-managed inventory in the electronics industry: Determinants and outcomes. *Information and Management*, *41*(5), 645–654.

Kull, T. J., & Ellis, S. C. (2016). Coping with dependence: A logistics strategy based on interorganizational learning for managing buyer–supplier relations. In *Journal of Business Logistics* (Vol. 37, pp. 346–363).

Kulp, S. C. (2002). The effect of information precision and information reliability on

manufacturer-retailer relationships. *Accounting Review*, *77*(3), 653–677.

Kulp, S. C., Lee, H. L., & Ofek, E. (2004). Manufacturer Benefits from Information Integration with Retail Customers. *Management Science*, *50*(4), 431–444.

Kumaraswamy, M. M., Ling, F. Y., Rahman, M. M., & Phng, S. T. (2005). Constructing Relationally Integrated Teams. *Journal of Construction Engineering and Management*, *131*(10), 1076–1086.

Lædre, O., Austeng, K., Haugen, T. I., & Klakegg, O. J. (2006). Procurement routes in public building and construction projects. *Journal of Construction Engineering and Management*, *132*(7), 689–696.

Lal, K. (2008). Asian journal of technology innovation information and communication technology adoption in Malaysian SMEs, (September 2012), 37–41.

Lassar, W., & Zinn, W. (1995). Informal channel relationships in logistics. *Journal of Business Logistics*, *16*(1), 81–106. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9509300851&site=ehost-live%5Cnhttp://content.ebscohost.com/ContentServer.asp?T=P&P=AN&K=9509300851&S=R&D=bth&EbscoContent=dGJyMNXb4kSep7c4yOvsOLCmr0uep7NSsq+4SK+WxWXS&ContentCustomer=dGJyMPGnrkq

Lee, G., & Xia, W. (2006). Organizational size and IT innovation adoption: A meta-analysis. *Information and Management*, *43*(8), 975–985.

Lee, H. L. (2004). The triple-A supply chain. *Harvard Business Review*, *82*(10), 102–112.

Lee, H. L., Padmanabhan, V., & Wang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review*, *38*(3), 93–102.

Lee, H. L., & Whang, S. (2000). Information sharing in a supply chain. *International Journal of Manufacturing Technology*, *1*(1), 79–93.

Lee, J.-Y., Paik, S.-K., & Cho, R. K. (2015). Vendor-managed inventory: a literature review on theoretical and empirical studies and future research directions. *International Journal of Advanced Operations Management*, *7*(3), 199–228.

Lee, J. Y., & Cho, R. K. (2014). Contracting for vendor-managed inventory with consignment stock and stockout-cost sharing. *International Journal of Production Economics*, *151*, 158–173.

Lee, J. Y., & Ren, L. (2011). Vendor-managed inventory in a global environment with exchange rate uncertainty. *International Journal of Production Economics*, *130*(2), 169–174.

Lehoux, N., D'Amours, S., & Langevin, A. (2010). A win-win collaboration approach for a two-echelon supply chain: a case study in the pulp and paper industry. *European J. of Industrial Engineering*, *4*(4), 493.

Lemay, S., Helms, M. M., Kimball, B., & McMahon, D. (2016). Supply chain management: the elusive concept and definition. *International Journal of Logistics Management*.

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of Psychiatric Research*, *45*(5), 626–629.

Leufkens, A. S., & Noorderhaven, N. G. (2011). Learning to collaborate in multi-organizational projects. *International Journal of Project Management*, *29*(4), 432–441.

Li, L. (2002). Information sharing in a supply chain with horizontal competition. *Management Science*, *48*(9), 1196–1212.

Lian, J. W., Yen, D. C., & Wang, Y. T. (2014). An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. *International Journal of Information Management*, *34*(1), 28–36.

Lin, K. P., Chang, P. T., Hung, K. C., & Pai, P. F. (2010). A simulation of vendor managed inventory dynamics using fuzzy arithmetic operations with genetic algorithms. *Expert Systems with Applications*, *37*(3), 2571–2579.

Love, P. E. D., Holt, G. D., Shen, L. Y., Li, H., & Irani, Z. (2002). Using systems dynamics to better understand change and rework in construction project management systems. *International Journal of Project Management*, *20*(6), 425–436.

Lu, S., & Yan, H. (2007). A model for evaluating the applicability of partnering in construction. *International Journal of Project Management*, *25*(2), 164–170.

MacMillan, I. c., Hambrick, D. C., & Pennings, J. M. (1986). Uncertainty reduction and the threat of supplier retaliation: Two views of the backward integration decision. *Organization Studies*, *7*(3), 263–278.

Malhotra, N. K. (1999). *Marketing research: An applied orientation. The Handbook of Marketing Research Uses Misuses and Future Advances* (Vol. 10).

Mangione, T. W. (1995). Mail surveys the basics of avoiding nonresponse errors. In *Mail Surveys* (pp. 60–78).

Manu, E., Ankrah, N., Chinyio, E., & Proverbs, D. (2015). Trust influencing factors in main contractor and subcontractor relationships during projects. *International Journal of Project Management*, *33*(7), 1495–1508.

Marklund, J. (2011). Inventory control in divergent supply chains with time-based dispatching and shipment consolidation. *Naval Research Logistics*, *58*(1), 59–71.

Marques, G., Thierry, C., Lamothe, J., & Gourc, D. (2010). A review of vendor managed inventory (VMI): From concept to processes. In *Production Planning and Control* (Vol. 21, pp. 547–561).

Mateen, A., & Chatterjee, A. K. (2015). Vendor managed inventory for single-vendor multi-retailer supply chains. *Decision Support Systems*, *70*, 31–41.

Mentzer, J. J. T., Dewitt, W., Keebler, J. J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Journal of Business Logistics*, *22*(2), 1–25.

Metz, P. J. (1998). Demystifying supply chain management. *Supply Chain Management Review*, *1*, 46–55.

Miller, J. H., Butts, C. T., & Rode, D. (2002). Communication and cooperation. *Journal of Economic Behavior and Organization*, *47*(2), 179–195.

Min, S., & Mentzer, J. T. (2004). Developing and measuring supply chain management concepts. *Journal of Business Logistics*, *25*(1), 63–99.

Mishra, B. K., & Raghunathan, S. (2004a). Retailer- vs. vendor-managed inventory and brand competition. *Management Science*, *50*(4), 445–457.

Mishra, B. K., & Raghunathan, S. (2004b). Retailer vs vendor-managed inventory and brand competition. *Management Science*, *50*(4), 445–457.

Mittal, V. K., & Sangwan, K. S. (2011). Development of an interpretive structural model of obstacles to environmentally conscious technology adoption in Indian industry. In *Glocalized Solutions for Sustainability in Manufacturing - Proceedings of the 18th CIRP International Conference on Life Cycle Engineering* (pp. 383–388).

Mohamad Kamar, K. A., Alshawi, M., & Abd Hamid, Z. (2009). Barriers To Industrialized Building System (Ibs): the Case of Malaysia. *Built and Human Environment 9th International Postgraduate Research Confrence*, (2009), 1–16.

Mohd Nawi, M. N., Osman, W. N., Mohd Shafiei, M. W., Ibrahim, F. A., & AM, M. A. B. (2017). Construction Firm Readiness towards Implementing Integrated Project Delivery (IPD). *International Journal of Supply Chain Management*, *6*, 360–366.

Mulyono, N. B., & Ishida, Y. (2014). Clustering inventory locations to improve the performance of disaster relief operations. *Procedia Computer Science*, *35*(C), 1388–1397.

Nagarajan, M., & Rajagopalan, S. (2008). Contracting under vendor managed inventory systems using holding cost subsidies. *Production and Operations Management*, *17*(2), 200–210.

Nagel, J. (2000). Determination of an economic energy supply structure based on biomass using a mixed-integer linear optimization model. *Ecological Engineering*, *16*, 91–102.

Nasir, N. M., Nawi, M. N. M., Rahim, M. K. I. A., Bahaudin, A. Y., & Tapa, A. (2016). A review of delay factors in Malaysian industrialized Building System (IBS) construction project. *ARPN Journal of Engineering and Applied Sciences*, *11*(16), 9868–9873.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2012). Critical success factors for improving team integration in Industrialised Building System (IBS) construction projects: The Malaysian case. *Malaysian Construction Research Journal*, *10*(1), 44–62.

Nawi, M. N. M., Lee, A., & Nor, K. M. (2011). Barriers to implementation of the industrialised building system (IBS) in Malaysia. *The Built & Human Environment Review*, *4*(February), 22–35.

Neuman, W. L. (2014). *Social research methods: Qualitative and quantitative approaches. Relevance of social research* (Vol. 8).

New, S. J. (1997). The scope of supply chain management research. *Supply Chain Management: An International Journal*, *2*(1), 15–22.

Nifa, F. A. A., Ahmed, V., & Rahim, S. A. (2016). Partnering awareness in the Malaysian construction industry: A study on consultant engineers. *Social Sciences (Pakistan)*, *11*(12), 2946–2953.

Niranjan, T. T., Wagner, S. M., & Nguyen, S. M. (2012). Prerequisites to vendor-managed inventory. *International Journal of Production Research*, *50*(4), 939–951.

Nunnally, J. C. (1978). *Psychometric Theory. McGraw-Hill Series in Psychology.*

Oliveira, T., & Martins, M. F. (2010). Understanding e- business adoption across industries in European countries. *Industrial Management & Data Systems*, *110*(9), 1337–1354.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information and Management*, *51*(5), 497–510.

Oliver Yao, Y., Dong, Y., & Dresner, M. (2012). Supply chain learning and spillovers in vendor managed inventory. *Decision Sciences*, *43*(6), 979–1001.

Palaneeswaran, E., Kumaraswamy, M., Rahman, M. M., & Ng, T. (2003). Curing congenital construction industry disorders through relationally integrated supply chains. *Building and Environment*, *38*(4), 571–582.

Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS. Step by step guide to data analysis using SPSS.*

Perrigot, R., Kacker, M., Basset, G., & Cliquet, G. (2012). Antecedents of early adoption and use of social media networks for stakeholder communications: evidence from franchising. *Journal of Small Business Management*, *50*(4), 539–565.

Pesämaa, O., Eriksson, P. E., & Hair, J. F. (2009). Validating a model of cooperative procurement in the construction industry. *International Journal of Project Management*, *27*(6), 552–559.

Petersen, K. J., Ragatz, G. L., & Monczka, R. M. (2005). An examination of

collaborative planning effectiveness and supply chain performance. *Journal of Supply Chain Management*.

Plemmons, J. K., & Bell, L. C. (1995). Measuring effectiveness of materials management process. *Journal of Management in Engineering*, *11*(6), 26–32.

Power, D. J., Sohal, A. S., & Rahman, S. (2001). Critical success factors in agile supply chain management - An empirical study. *International Journal of Physical Distribution & Logistics Management*, *31*(4), 247–265.

Radzuan, K., Rahim, M. K. I. A., Anuar, H. S., Nawi, M. N. M., & Osman, W. N. (2015). Inventory management practices and its effects on vendor managed inventory performance. *Advanced Science Letters*, *21*(6), 2114–2117.

Radzuan, K., Udin, Z. M., Othman, S. N., Anuar, H. S., & Osman, W. N. (2015). The moderating effect of product attributes in vendor managed inventory (VMI) performance. *Jurnal Teknologi*, *77*(4), 23–32.

Raghunathan, S., & Yeh, A. B. (2001). Beyond EDI: Impact of Continuous Replenishment Program (CRP) between a Manufacturer and Its Retailers. *Information Systems Research*, *12*(4), 406–419.

Rahman, S. H. A., Endut, I. R., Faisol, N., & Paydar, S. (2014). The importance of collaboration in construction industry from contractors' perspectives. *Procedia - Social and Behavioral Sciences*, *129*, 414–421.

Reiner, G., & Trcka, M. (2004). Customized supply chain design: Problems and alternatives for a production company in the food industry. A simulation based analysis. In *International Journal of Production Economics* (Vol. 89, pp. 217–229).

Rodrigues, J. J. P. C., De La Torre, I., Fernández, G., & López-Coronado, M. (2013). Analysis of the security and privacy requirements of cloud-based electronic health records systems. *Journal of Medical Internet Research*, *15*(8).

Ross, D. F. (1998). Supply chain quality and performance measurement. In *Competing Through Supply Chain Management* (pp. 247–288).

Rusdiansyah, A., & Tsao, D. B. (2005). Coordinating deliveries and inventories for a supply chain under vendor managed inventory system. *Jsme International Journal Series a-Solid Mechanics and Material Engineering*, *48*(2), 85–90.

Ryu, C.-S. (2016). Review of vendor managed inventory: investigation on how it improves supply chain performance. *Journal of Distribution Science*, *14*(9), 47–64.

Saldanha, T. J. V., & Krishnan, M. S. (2012). Organizational Adoption of Web 2.0 Technologies: An Empirical Analysis. *Journal of Organizational Computing and Electronic Commerce*, *22*(4), 301–333.

Salema, G., & Buvik, A. (2016). The impact of buyer-supplier integration on supplier logistics performance in the hospital sector in Tanzania: the moderation effect of buyers' cross functional integration. *International Journal of*

Procurement Management, *9*(2), 166.

Sari, K. (2007). Exploring the benefits of vendor managed inventory. *International Journal of Physical Distribution & Logistics Management*, *37*(7), 529–545.

Savasaneril, S., & Erkip, N. (2010). An analysis of manufacturer benefits under vendor-managed systems. *IIE Transactions (Institute of Industrial Engineers)*, *42*(7), 455–477.

Segerstedt, A., & Olofsson, T. (2010). Supply chains in the construction industry. *Supply Chain Management: An International Journal*, *15*(5), 347–353.

Sekaran, U. (2003). *Research methods for business a skill building approach. John Wiley & Sons, Inc.*

Seng, L. Y., Riazi, S. R. M., Nawi, M. N. M., & Ismail, R. (2018). Review of material supply chain management during pre-construction phases in Malaysia. *International Journal of Supply Chain Management*, *7*(1), 155–162.

Shah, J., & Goh, M. (2006). Setting operating policies for supply hubs. *International Journal of Production Economics*, *100*(2), 239–252.

Sharifzadeh, M., Garcia, M. C., & Shah, N. (2015). Supply chain network design and operation: Systematic decision-making for centralized, distributed, and mobile biofuel production using mixed integer linear programming (MILP) under uncertainty. *Biomass and Bioenergy*, *81*, 401–414.

Sharma, M. K., & Bhagwat, R. (2006). Practice of information systems: Evidence from select Indian SMEs. *Journal of Manufacturing Technology Management*, *17*(2), 199–223.

Shen, W., Tang, W., Wang, S., Duffield, C. F., Hui, F. K. P., & You, R. (2017). Enhancing Trust-Based Interface Management in International Engineering-Procurement-Construction Projects. *Journal of Construction Engineering and Management*, *143*(9), 4017061.

Shi, C., & Bian, D. (2009). Supply chain management model based on VMI. In *2009 International Conference on Information and Multimedia Technology* (pp. 90–93). https://doi.org/10.1109/ICIMT.2009.21

Simangunsong, E. S., Hendry, L., & Stevenson, M. (2012). Supply chain uncertainty: a review and theoretical foundation for future research. *International Journal of Production Research*, *50*(16), 4493–4523.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2000). *Designing and managing the supply chain: concepts, strategies, and case studies. McGraw-Hill, New York, NY* (Vol. 3).

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2003). *Designing and managing the supply chain: concepts, strategies, and case studies. Journal of Business Logistics* (Vol. 1). Retrieved from http://books.google.com/books?id=SYKYU06odPgC

Singh, A., Narain, R., & Yadav, R. C. (2006). Benchmarking and performance measurement of supply chain management practices: A survey of Indian organisations. *International Journal of Services and Operations Management*, *2*(4), 313–334.

Soetanto, R., Proverbs, D. D., & Holt, G. D. (2001). Achieving quality construction projects based on harmonious working relations. *International Journal of Quality & Reliability Management*, *18*(5), 528–548.

Son, J.-Y., & Benbasat, I. (2007). Organizational Buyers' Adoption and Use of B2B Electronic Marketplaces: Efficiency- and Legitimacy-Oriented Perspectives. *Journal of Management Information Systems*, *24*(1), 55–99.

Soni, G., & Kodali, R. (2013). *A critical review of supply chain management frameworks: proposed framework. Benchmarking: An International Journal* (Vol. 20).

Ståhl Elvander, M., Sarpola, S., & Mattsson, S. (2007). Framework for characterizing the design of VMI systems. *International Journal of Physical Distribution & Logistics Management*, *37*(10), 782–798.

Stevens, G. C. (1989). Integrating the Supply Chain. *International Journal of Physical Distribution & Materials Management*, *19*(8), 3–8.

Stiles, J. (1995). Collaboration for competitive advantage: The changing world of alliances and partnerships. In *Long Range Planning* (Vol. 28, pp. 109–112).

Stock, J. R., & Boyer, S. L. (2009). Developing a consensus definition of supply chain management: a qualitative study. *International Journal of Physical Distribution & Logistics Management*, *39*(8), 690–711.

Sultan, N. (2014). Making use of cloud computing for healthcare provision: Opportunities and challenges. *International Journal of Information Management*, *34*(2), 177–184.

Tamrin, N., Nawi, M. N. M., & Nifa, F. A. A. (2016). Readiness in knowledge and ability for implementation of industrialised building system (IBS) in Malaysian construction industry. *Revista Tecnica de La Facultad de Ingenieria Universidad Del Zulia*, *39*(9), 47–53.

Tanskanen, K., Holmström, J., Elfving, J., & Talvitie, U. (2008). Vendor-managed- inventory (VMI) in construction. *International Journal of Productivity and Performance Management*, *58*(1), 29–40.

Tanskanen, K., Holmström, J., & Öhman, M. (2015). Generative mechanisms of the adoption of logistics innovation: The case of on-site shops in construction supply chains. *Journal of Business Logistics*, *36*(2), 139–159.

Thomas, H. R., Riley, D. R., & Messner, J. I. (2005). Fundamental principles of site material management. *Journal of Construction Engineering and Management*, *131*(July), 808–815.

Tommelein, I. D., Akel, N., & Boyers, J. C. (2003). Capital Projects Supply Chain

Management: SC Tactics of a Supplier Organization. In *Construction Research Congress* (pp. 1–8).

Tracey, M., Fite, R. W., & Sutton, M. J. (2004). An explanatory model and measurement instrument: A guide to supply chain management research and applications. *American Journal of Business*, *19*(2), 53–70.

Tsao, H.-Y., Lin, K. H.-C., & Lin, C. (2004). An Investigation of Critical Success Factors in the Adoption of B2BEC by Taiwanese Companies. *Journal of American Academy of Business, Cambridge*, *5*(September), 198–202. Retrieved from http://search.proquest.com/docview/222872063?accountid=14484%5Cnhttp://www.tdnet.com/bgu/resolver/default.asp??genre=article&issn=15401200&volume=5&issue=1/2&title=Journal+of+American+Academy+of+Business,+Cambridge&spage=198&date=2004-09-01&atitle=An+Inve

Tserng, H. P., Yin, S. Y. L., & Li, S. (2006). Developing a resource supply chain planning system for construction projects. *Journal of Construction Engineering and Management*, *132*(4), 393–407.

Turhan, S. N., & Vayvay, Ö. (2010). *Healthcare supply chain information systems via service-oriented architecture. Handbook on Business Information Systems.*

Tyan, J., & Wee, H. M. (2003). Vendor managed inventory: A survey of the Taiwanese grocery industry. *Journal of Purchasing and Supply Management.*

Tyndall, G., Gopal, C., Partsch, W., & Kamauff, J. (1998). Supercharging supply chains: New ways to increase value through global operational excellence. *Transportation Journal*, *38*(1), 47–48. Retrieved from http://search.proquest.com/docview/204589274?accountid=14484%5Cnhttp://www.tdnet.com/bgu/resolver/default.asp??genre=article&issn=00411612&volume=38&issue=1&title=Transportation+Journal&spage=47&date=1998-10-01&atitle=Supercharging+Supply+Chains:+New+Ways

Uddin, N. (2017). Inter-organizational relational mechanism on firm performance. *Industrial Management & Data Systems*, *117*(9), 1934–1953.

Vagias, W. (2006). Likert-type scale response anchors. *Clemson International Institute for Tourism and ...*, 3–4.

Van Nyen, P. L. M., Bertr, J. W. M., Van Ooijen, H. P. G., & Vandaele, N. J. (2009). Supplier managed inventory in the OEM supply chain: The impact of relationship types on total costs and cost distribution. In *Supply Chain Planning: Quantitative Decision Support and Advanced Planning Solutions* (pp. 219–246).

Verwaal, E., Commandeur, H., & Verbeke, W. (2009). Value Creation and Value Claiming in Strategic Outsourcing Decisions: A Resource Contingency Perspective. *Journal of Management*, *35*(2), 420–444.

Vigtil, A. (2007). Information exchange in vendor managed inventory. *International Journal of Physical Distribution & Logistics Management*, *37*(2), 131–147.

Vlist, P. van der, Kuik, R., & Verheijen, B. (2007). Note on supply chain integration in vendor-managed inventory. *Decision Support Systems*, *48*, 360–375.

Vollman, T., Berry, W., Jacobs, F. R., & Whybark, D. C. (2005). Manufacturing Planning and Control. *Manufacturing Planning and Control for Supply Chain Management 5th Edition*, 1–10.

Waarts, E., Van Everdingen, Y. M., & Van Hillegersberg, J. (2002). The dynamics of factors affecting the adoption of innovations. *Journal of Product Innovation Management*, *19*(6), 412–423.

Walker, G., & Weber, D. (1987). Supplier competition, uncertainty, and make-or-buy decisions. *Academy of Management Journal*, *30*(3), 589–596.

Waller, M., Johnson, M. E., & Davis, T. (1999). Vendor-managed inventory in the retail supply chain. *Journal of Business Logistics*, (20), 183–204.

Walton, L. W. (1994). Electronic data interchange (EDI): Study of its usage and adoption within marketing and logistics channels. *Transportation Journal*, *34*(2), 37–45. Retrieved from http://www.jstor.org/stable/20713233

Wang, Y., Jiang, L., & Shen, Z.-J. (2004). Channel performance under consignment contract with revenue sharing. *Management Science*, *50*(1), 34–47.

Williams, L., Magee, G., & Suzuki, Y. (1998). A multidimensional view of EDI: Testing the value of EDI participation to firms. *Journal of Business Logistics*, *19*(2), 73–87.

Wong, A. (1999). Total quality management in the construction industry in Hong Kong: A supply chain management perspective. *Total Quality Management*, *10*(2), 199–208.

Wong, W. K., Qi, J., & Leung, S. Y. S. (2009). Coordinating supply chains with sales rebate contracts and vendor-managed inventory. *International Journal of Production Economics*, *120*(1), 151–161.

Woo, Y., Cho, S., Kim, J., & Kim, B. S. (2016). Optimization-based approach for strategic design and operation of a biomass-to-hydrogen supply chain. *International Journal of Hydrogen Energy*, *41*(12), 5405–5418.

Xiao, D., & Bao, X. (2011). Inventory management in competition environment based on customer service. *Applied Mechanics and Materials*, *58–60*, 2141–2146.

Xue, X., Li, X., Shen, Q., & Wang, Y. (2005). An agent-based framework for supply chain coordination in construction. *Automation in Construction*, *14*(3), 413–430.

Xue, X., Shen, Q., Tan, Y., Zhang, Y., & Fan, H. (2011). Comparing the value of information sharing under different inventory policies in construction supply chain. *International Journal of Project Management*, *29*(7), 867–876.

Xue, X., Wang, Y., Shen, Q., & Yu, X. (2007). Coordination mechanisms for

construction supply chain management in the Internet environment. *International Journal of Project Management*, *25*(2), 150–157.

Yang, K.-K., Ruben, R. A., & Webster, S. (2003). Managing vendor inventory in a dual level distribution system. *Journal of Business Logistics*, *24*(2), 91–108.

Yang, Z., Zhang, H., & Xie, E. (2016). Performance feedback and supplier selection: A perspective from the behavioral theory of the firm. *Industrial Marketing Management*, *63*, 105–115.

Yao, Y., Evers, P. T., & Dresner, M. E. (2007). Supply chain integration in vendor-managed inventory. *Decision Support Systems*, *43*(2), 663–674.

Yeo, K. T., & Ning, J. H. (2006). Managing uncertainty in major equipment procurement in engineering projects. *European Journal of Operational Research*, *171*(1), 123–134.

Yu, H., Tang, L., Xu, Y., & Wang, Y. (2015). How much does VMI better than RMI in a global environment? *International Journal of Production Economics*, *170*, 268–274.

Yu, H., Zeng, A. Z., & Zhao, L. (2009). Analyzing the evolutionary stability of the vendor-managed inventory supply chains. *Computers and Industrial Engineering*, *56*(1), 274–282.

Zaghloul, R., & Hartman, F. (2003). Construction contracts: The cost of mistrust. *International Journal of Project Management*, *21*(6), 419–424.

Zhao, Q. hong, Chen, S., Leung, S. C. H., & Lai, K. K. (2010). Integration of inventory and transportation decisions in a logistics system. *Transportation Research Part E: Logistics and Transportation Review*, *46*(6), 913–925.

Zhu, K., & Kraemer, K. L. (2005). Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry. *Information Systems Research*.

Zou, P. X. W. (2009). Construction supply chain management handbook. *Construction Management & Economics*, *27*, 1265–1266.

APPENDIX A

PILOT TEST ANALYSIS RESULT

Pilot test analysis: Supplier's Market Competition

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.762	.756	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Supplier's Market Competition	17.53	5.430	.629	.441	.681
2. Supplier's Market Competition	17.17	5.868	.511	.368	.726
3. Supplier's Market Competition	17.37	7.068	.333	.171	.777
4. Supplier's Market Competition	17.37	5.689	.609	.407	.690
5. Supplier's Market Competition	16.97	5.551	.570	.344	.704

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.744
Bartlett's Test of Sphericity	Approx. Chi-Square	34.216
	df	10
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
1. Supplier's Market Competition	.791	.239
2. Supplier's Market Competition	.868	-.069
3. Supplier's Market Competition	.035	.918
4. Supplier's Market Competition	.543	.611
5. Supplier's Market Competition	.676	.336

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Pilot test analysis: Product Demand Uncertainty

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.769	.765	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Demand Uncertainty	11.97	5.620	.617	.453	.688
2. Demand Uncertainty	11.93	7.030	.457	.320	.769
3. Demand Uncertainty	12.17	4.557	.743	.584	.608
4. Demand Uncertainty	12.03	6.102	.494	.421	.754

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.658
Bartlett's Test of Sphericity	Approx. Chi-Square	36.059
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component 1	Component 2
1. Demand Uncertainty	.785	.364
2. Demand Uncertainty	.908	.042
3. Demand Uncertainty	.461	.785
4. Demand Uncertainty	.042	.942

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Pilot test analysis: Supplier-buyer Cooperation

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.828	.829	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Supplier-Buyer Cooperation	12.37	6.585	.667	.476	.776
2. Supplier-Buyer Cooperation	12.33	8.092	.565	.351	.824
3. Supplier-Buyer Cooperation	12.63	5.689	.751	.597	.736
4. Supplier-Buyer Cooperation	12.57	6.461	.664	.510	.778

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.751
Bartlett's Test of Sphericity	Approx. Chi-Square	43.337
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component 1	Component 2
1. Supplier-Buyer Cooperation	.469	.716
2. Supplier-Buyer Cooperation	.180	.917
3. Supplier-Buyer Cooperation	.840	.365
4. Supplier-Buyer Cooperation	.907	.198

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Pilot test analysis: Intention to Adopt (Adoption)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.740	.740	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
6. Adoption	14.13	4.326	.402	.176	.753
7. Adoption	14.37	4.378	.530	.408	.687
8. Adoption	14.07	3.375	.678	.564	.588
9. Adoption	14.03	3.895	.543	.398	.675

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.618
Bartlett's Test of Sphericity	Approx. Chi-Square	29.925
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component 1	Component 2
6. Adoption	.157	.957
7. Adoption	.815	.095
8. Adoption	.901	.181
9. Adoption	.622	.429

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Pilot test analysis: Barriers to VMI adoption

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.726	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Ineffective Organizational Structure	16.23	4.392	.447	.273	.702
Lack of Suitable IT Infrastructure	16.23	3.357	.592	.454	.645
Improper Decision Support Tool	16.30	4.631	.336	.145	.739
Lack of Trust & Mutual Understanding Between Supply Chain Partners	16.37	3.551	.665	.557	.611
Internal/External Integration	16.33	4.437	.444	.367	.703

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.652
Bartlett's Test of Sphericity	Approx. Chi-Square	34.608
	df	10
	Sig.	.000

Rotated Component Matrix[a]

	Component 1	Component 2
Ineffective Organizational Structure	.127	.826
Lack of Suitable IT Infrastructure	.558	.562
Improper Decision Support Tool	.078	.714
Lack of Trust & Mutual Understanding Between Supply Chain Partners	.856	.289
Internal/External Integration	.880	-.017

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

APPENDIX B

RESEARCH TEST ANALYSIS RESULT

Research test analysis: Frequency test results

Statistics

		Position Label	Department Label	Category of contractor	State of Origin	VMI Awareness
N	Valid	97	97	97	97	97
	Missing	0	0	0	0	0

Position Label

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Director	14	14.4	14.4	14.4
	Assistant Manager	41	42.3	42.3	56.7
	Senior Executive	42	43.3	43.3	100.0
	Total	97	100.0	100.0	

Department Label

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Design/Engineering	28	28.9	28.9	28.9
	Procurement	41	42.3	42.3	71.1
	Logistic	28	28.9	28.9	100.0
	Total	97	100.0	100.0	

Category of contractor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Combination of i & ii	14	14.4	14.4	14.4
	Combination of i & iii	28	28.9	28.9	43.3
	Combination of all	55	56.7	56.7	100.0
	Total	97	100.0	100.0	

State of Origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Kedah	28	28.9	28.9	28.9
	Penang	65	67.0	67.0	95.9
	Perlis	4	4.1	4.1	100.0
	Total	97	100.0	100.0	

VMI Awareness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	56	57.7	57.7	57.7
	Yes	41	42.3	42.3	100.0
	Total	97	100.0	100.0	

Research test analysis: Factor Analysis result

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.681
Bartlett's Test of Sphericity	Approx. Chi-Square	64.644
	df	3
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
Competition	.264	.958
Demand	.893	.171
Coopertation	.785	.349

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.736
Bartlett's Test of Sphericity	Approx. Chi-Square	97.205
	df	10
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
1. Supplier's Market Competition	.764	.312
2. Supplier's Market Competition	.886	-.010
3. Supplier's Market Competition	.047	.875
4. Supplier's Market Competition	.378	.661
5. Supplier's Market Competition	.601	.367

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.636
Bartlett's Test of Sphericity	Approx. Chi-Square	90.052
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
1. Demand Uncertainty	.917	-.007
2. Demand Uncertainty	.754	.325
3. Demand Uncertainty	.546	.631
4. Demand Uncertainty	.046	.948

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.779
Bartlett's Test of Sphericity	Approx. Chi-Square	161.010
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
1. Supplier-Buyer Cooperation	.467	.657
2. Supplier-Buyer Cooperation	.879	.315
3. Supplier-Buyer Cooperation	.247	.902
4. Supplier-Buyer Cooperation	.865	.319

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.581
Bartlett's Test of Sphericity	Approx. Chi-Square	90.144
	df	10
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
Ineffective Organizational Structure	.845	-.014
Lack of Suitable IT Infrastructure	.621	.402
Improper Decision Support Tool	.638	.142
Lack of Trust & Mutual Understanding Between Supply Chain Partners	.345	.807
Internal/External Integration	-.011	.867

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.615
Bartlett's Test of Sphericity	Approx. Chi-Square	192.171
	df	6
	Sig.	.000

Rotated Component Matrix[a]

	Component	
	1	2
1. Adoption	.133	.950
2. Adoption	.369	.869
5. Adoption	.896	.233
8. Adoption	.895	.207

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

Research test analysis: Reliability test result

Reliability Statistics: Supplier's Market Competition

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.774	.768	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Supplier's Market Competition	17.64	5.566	.660	.476	.689
2. Supplier's Market Competition	17.25	6.042	.537	.407	.736
3. Supplier's Market Competition	17.48	7.398	.347	.184	.788
4. Supplier's Market Competition	17.48	6.044	.604	.398	.712
5. Supplier's Market Competition	17.07	5.838	.584	.361	.718

Reliability Statistics: Demand Uncertainty

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.777	.774	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Demand Uncertainty	11.90	5.593	.635	.476	.695
2. Demand Uncertainty	11.86	6.896	.477	.331	.774
3. Demand Uncertainty	12.11	4.539	.748	.586	.624
4. Demand Uncertainty	11.92	6.097	.496	.404	.767

Reliability Statistics: Supplier-buyer Cooperation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.831	.832	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Supplier-Buyer Cooperation	12.32	6.449	.681	.497	.776
2. Supplier-Buyer Cooperation	12.28	7.849	.574	.364	.826
3. Supplier-Buyer Cooperation	12.60	5.618	.752	.595	.742
4. Supplier-Buyer Cooperation	12.47	6.377	.658	.497	.787

Reliability Statistics: Intention to adopt

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.810	.818	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Adoption	13.91	2.856	.573	.628	.798
2. Adoption	13.68	2.928	.769	.702	.698
3. Adoption	13.30	3.399	.605	.515	.776
4. Adoption	13.45	3.021	.604	.577	.774

Reliability Statistics : Adoption Barrier

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.679	.674	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Ineffective Organizational Structure	16.39	3.949	.393	.233	.646
Lack of Suitable IT Infrastructure	16.30	3.170	.491	.362	.603
Improper Decision Support Tool	16.36	3.941	.340	.178	.667
Lack of Trust & Mutual Understanding Between Supply Chain Partners	16.39	3.095	.596	.463	.545
Internal/External Integration	16.41	4.141	.361	.253	.658

Research test analysis: Correlation & Coefficient test result

Correlations

		Intention	Competition
Intention	Pearson Correlation	1	.312**
	Sig. (2-tailed)		.002
	N	97	97
Competition	Pearson Correlation	.312**	1
	Sig. (2-tailed)	.002	
	N	97	97

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		Intention	Demand
Intention	Pearson Correlation	1	.449**
	Sig. (2-tailed)		.000
	N	97	97
Demand	Pearson Correlation	.449**	1
	Sig. (2-tailed)	.000	
	N	97	97

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		Intention	Cooperation
Intention	Pearson Correlation	1	.630**
	Sig. (2-tailed)		.000
	N	97	97
Cooperation	Pearson Correlation	.630**	1
	Sig. (2-tailed)	.000	
	N	97	97

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		Intention	Competition	Demand	Coopertation
Pearson Correlation	Intention	1.000	.312	.449	.630
	Competition	.312	1.000	.446	.484
	Demand	.449	.446	1.000	.547
	Coopertation	.630	.484	.547	1.000
Sig. (1-tailed)	Intention	.	.001	.000	.000
	Competition	.001	.	.000	.000
	Demand	.000	.000	.	.000
	Coopertation	.000	.000	.000	.
N	Intention	97	97	97	97
	Competition	97	97	97	97
	Demand	97	97	97	97
	Coopertation	97	97	97	97

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.643[a]	.413	.394	1.758	2.531

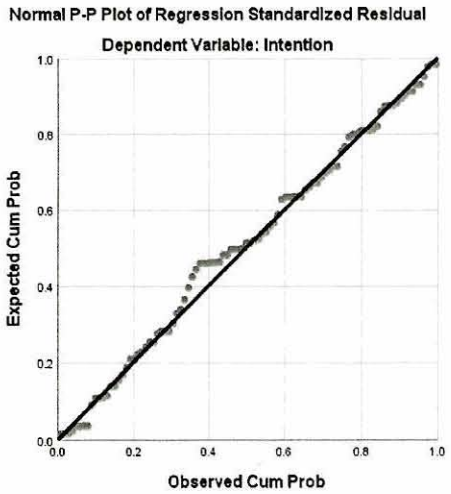
a. Predictors: (Constant), Coopertation, Competition, Demand

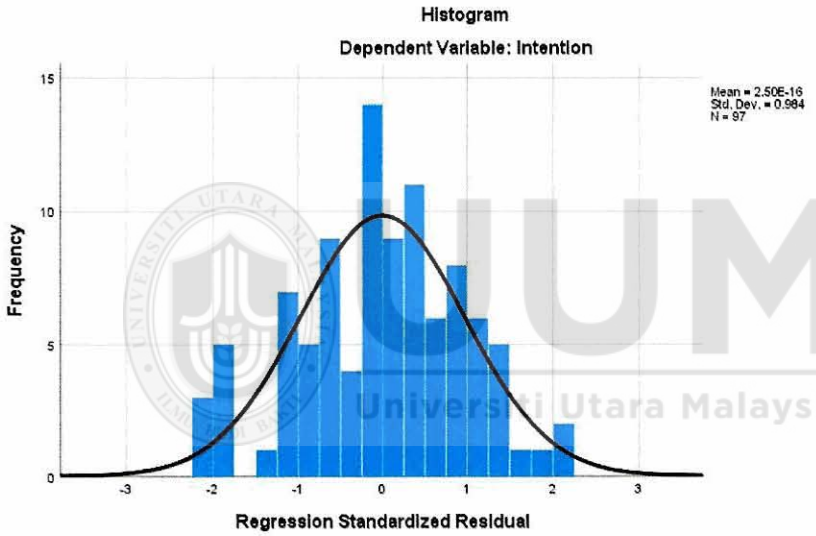
b. Dependent Variable: Intention

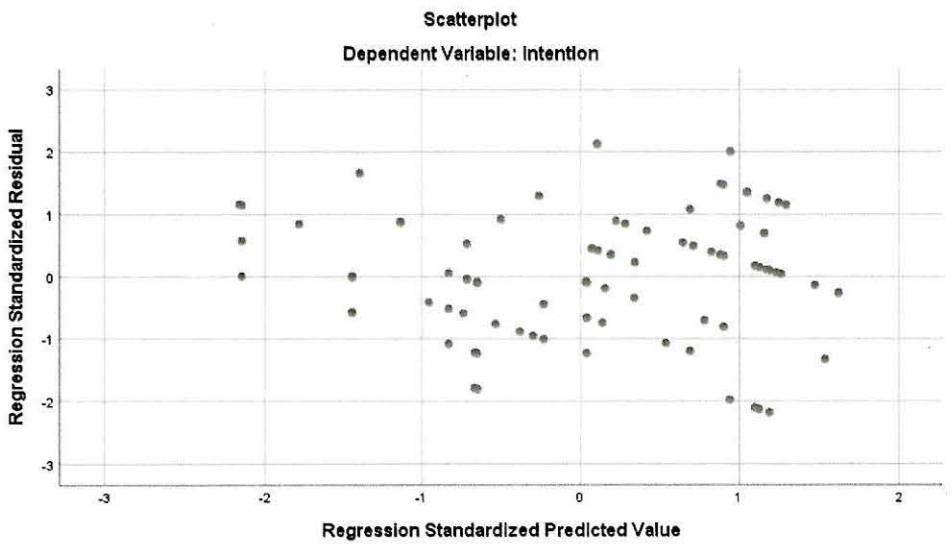
Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	7.430	1.664		4.465	0.000
	Competition	-0.024	0.079	-0.028	-0.301	0.764
	Demand	0.131	0.083	0.156	1.590	0.115
	Coopertation	0.436	0.078	0.558	5.571	0.000

a. Dependent Variable: Intention







APPENDIX C

QUESTIONNAIRE SURVEY FORM

A SURVEY ON VENDOR MANAGED INVENTORY (VMI) ADOPTION IN MALAYSIA CONSTRUCTION INDUSTRY

MALAYSIA CONTRACTORS

Dear Sir/Madam,

I am a Master student at School of Technology Management and Logistic, Universiti Utara Malaysia (UUM) conducting a research on the adoption of Vendor Managed Inventory (VMI) in Malaysia construction industry. The survey aim to have your opinion on the external factors and barriers that influence your decision as a contractor to adopt VMI and the readiness of your valuable company in adopting VMI. The survey is for the purpose of academic exercise and part of the requirement for the award of Master's degree. Therefore, this questionnaire is aim at obtaining your valuable opinion in order to obtain the information needed for the success of the study. Your responses will be treated with ultimate confidence and used strictly for academic purpose only. The questionnaire is expected to take only 10 minutes of your precious time to complete.

I greatly appreciate your participation in the study. Thank you for your cooperation and giving part of your time for the survey.

Best regards

Andrew Triasmoro Pamungkas

Msc. Operation Management

School of Technology Management and Logistic

Universiti Utara Malaysia

Sintok, Kedah

Email: andrewpamungkas@gmail.com

Phone: +601131510455

Section A – Demographic Information

Please provide some demographic information below:

1. My position within my company (please tick the appropriate)
   - □ Director
   - □ Senior Manager
   - □ Assistant Manager
   - □ Senior Executive

2. Department (please tick the appropriate)
   - □ Design/Engineering
   - □ Operation
   - □ Procurement
   - □ Logistic
   - □ Other, please specify.....

3. Category of contractors registration (please tick the appropriate)
   - □ i. Building construction
   - □ ii. Civil engineering construction
   - □ iii. Mechanical and Electrical construction
   - □ Combination of i and ii
   - □ Combination of i and iii
   - □ Combination of ii and iii
   - □ Combination of all

4. Company State of origin (please specify)
   a. _____

5. Company gross annual revenue worldwide (please specify)
   - □ RM _____ million

6. Total number of employee worldwide (please specify)
   a. _____ person

7. Are you aware about Vendor Managed Inventory (VMI) integration? (please tick the appropriate)
   a. Yes □ No

Section B - Supplier's market competition

1. To what extent do you agree with each of the following statements regarding competition level of a frequent supplier?

Please indicate the extent of agreement with the following item	1	2	3	4	5	6
Competition in the supplier's market is high						
There are frequent new competitive moves by suppliers in the market						
There are many "promotion wars" on the supplier's market						
There are price competitions in the supplier's market						
There are few bigger firms in this supplier's industry						

**1: Strongly Disagree – 6: Strongly Agree*

Section C - Demand Uncertainty

1. To what extent do you agree with each of the following statements regarding the demand uncertainty level of your construction materials?

Please indicate the extent of agreement with the following item	1	2	3	4	5	6
Material demand are unpredictable						
Material demand forecasts are unreliable						
Material demand trends are difficult to monitor						
Material supply requirement varies drastically from week to week						

**1: Strongly Disagree – 6: Strongly Agree*

Section D - Supplier-buyer cooperation

1. To what extent do you agree with each of the following statements regarding the cooperation with your frequent supplier?

Please indicate the extent of agreement with the following item	1	2	3	4	5	6
Continue						

Supplier actively involved in your operation activity						
We can count on this supplier's support when it comes to important needs and requirement						
We are convinced this supplier will live up to all deals and agreements						
In general, we are satisfied with this supplier performance						

**1: Strongly Disagree – 6: Strongly Agree*

Section E - Adoption level

1. To what extent do you agree with each of the following statements regarding your intention to use/implement VMI in your construction company?

Please indicate the extent of agreement with the following item	1	2	3	4	5	6
I will implement VMI in the future						
Given the chance, I predict I will implement VMI in the future						
I expect to implement VMI in the future						
It is likely that I will implement VMI in the future						

**1: Strongly Disagree – 6: Strongly Agree*

Section F – Obstacles of VMI adoption

Please indicate the obstacles that were observed while adopting VMI initiatives. *(Rank the Obstacles on the scale 1 to 5; 1 = "To no extent", 5 = "To a great extent")*

Obstacles	Rank
a) Ineffective organizational structure	
b) Lack of suitable information technology infrastructure	
c) Improper decision support tool	
d) Lack of trust and mutual understanding between supply chain partners	
e) Internal /external integration	

Section G – VMI readiness

Please indicate the extent of importance with the following items:
(Rank the importance on the scale 0 to 4; 0 = Not important at all, 4 = Highly important)

Dimensions	Items	Rank
Company Related	1. Our company revenues have been stable over the years, neither growing nor falling rapidly.	
	2. Transaction costs pertaining to purchase are high.	
	3. Information and communication systems are good.	
	4. The company has no problem sharing inventory/forecast information with the suppliers.	
	5. Purchasing is a core competence of our organization.	
Product Related	6. Products are standardized, and customization is minimal.	
	7. Products are repetitive with infrequent changes in product specification by customer.	
	8. Products have standard product identification throughout the supply chain.	
	9. Demand variance is low.	
	10. Demand is forecasted and stock levels are monitored closely.	
Supplier Related	11. High levels of trust and long-term relationships with the suppliers exist.	
	12. VMI benefits are evident to both our company and our suppliers.	
	13. Key suppliers constitute a high percentage of purchase orders.	
	14. Suppliers are willing to cooperate with a VMI initiative.	
	15. The company's information system is integrated with the suppliers.	

Thank you for completing this survey. Your time and effort is greatly appreciated and will be valuable contribution to educational and industrial community. Please return your survey as soon as possible using the postage-paid return envelope that was provided. If you have misplaced the postage-paid return envelope, then the completed survey should be mailed or emailed to:

DPP Tradewind 407, Universiti Utara Malaysia, Sintok, Kedah, Malaysia 06010

Or email to andrewpamungkas@gmail.com or
andrew_triasmoro@oyagsb.uum.edu.my

APPENDIX D

Jadual 1.1 - Kontraktor Berdaftar Mengikut Gred Pendaftaran dan Negeri
Table 1.1 - Registered Contractor by Registration Grade and State.

Pada Akhir Tempoh *End of Period*	Jumlah Kontraktor Berdaftar *Total Contractors Registered*	Kontraktor Berdaftar Mengikut Gred *Registered Contractor by Grade*						
		G1	G2	G3	G4	G5	G6	G7
2016	**79,883**	**35,555**	**16,125**	**10,728**	**3,823**	**5,095**	**1,689**	**6,868**
Johor	7,711	3,056	1,921	1,311	367	431	135	490
Kedah	3,838	2,083	842	381	137	128	56	211
Kelantan	3,942	2,018	1,240	254	108	114	58	150
Melaka	2,486	1,089	526	373	139	145	49	165
Negeri Sembilan	3,606	1,847	867	403	144	168	44	133
Pahang	4,314	2,228	1,050	425	230	162	68	151
Perak	5,000	2,617	1,034	577	221	243	89	219
Perlis	1,184	856	197	54	18	24	6	29
Pulau Pinang	3,984	1,446	655	809	238	278	119	439
Sabah	11,249	7,244	2,150	812	190	241	93	519
Sarawak	6,133	3,009	1,459	573	203	223	109	557
Selangor	13,351	4,064	2,324	2,587	920	1,349	412	1,695
Terengganu	4,223	2,315	909	322	174	207	82	214
Wilayah Persekutuan	8,862	1,683	951	1,847	734	1,382	369	1,896
Jun-17	**81,301**	**35,468**	**16,817**	**11,198**	**3,936**	**5,173**	**1,696**	**7,813**
Johor	7,985	3,022	2,087	1,386	399	448	137	506
Kedah	3,881	2,065	906	380	134	128	58	210
Kelantan	3,946	1,992	1,274	261	111	100	59	149
Melaka	2,539	1,095	554	390	138	149	48	165
Negeri Sembilan	3,666	1,825	908	436	150	167	44	136
Pahang	4,253	2,184	1,054	421	226	152	64	152
Perak	5,121	2,606	1,134	599	225	244	86	227
Perlis	1,171	848	195	53	18	20	6	31
Pulau Pinang	4,071	1,436	691	843	241	285	111	464
Sabah	10,974	7,074	2,063	792	191	228	94	532
Sarawak	6,540	3,266	1,551	582	218	233	118	572
Selangor	13,982	4,070	2,531	2,806	960	1,435	406	1,774
Terengganu	4,216	2,310	912	328	180	194	87	213
Wilayah Persekutuan	8,956	1,675	957	1,929	745	1,380	378	1,892