

**EMPIRICAL ANALYSIS ON THE IMPLEMENTATION OF GREEN
SUPPLY CHAIN MANAGEMENT (GSCM) IN THE CONSTRUCTION
INDUSTRY**



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Thank you.

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ABSTRACT

EMPIRICAL ANALYSIS ON THE IMPLEMENTATION OF GREEN SUPPLY CHAIN MANAGEMENT (GSCM) IN THE CONSTRUCTION INDUSTRY

(Keywords: green supply chain management, construction, awareness, challenges, adoption)

Since the construction industry has been identified to be one of the major contributors to the environmental pollution, innovations are made recently which drive to the emergence of sustainability concept. Converging sustainability with the core business functions such as supply, operations, and purchasing strategies has led to a new interdisciplinary field called the green supply chain management (GSCM). GSCM can be explained as the way in which the activities of supply chain management and industrial purchasing being considered in the context of the environment. While other regions have adopted GSCM as their core business strategies, the Malaysian construction industry is still slowly warming up to adapt the concept. Therefore, this research is conducted with the aim to establish the level of adoption of GSCM in the Malaysian construction industry. In order to achieve the aim, three objectives had been highlighted including (1) to investigate the awareness level of industry players towards GSCM concept in the construction industry, (2) to identify the current implementations of GSCM in the Malaysian construction industry, and (3) to analyse the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice. The research methodology adopted includes questionnaire survey and semi-structured interview in order to gain the primary data. While for secondary data, comprehensive literature review was conducted. Data collected were scrutinized using SPSS software and content analysis and presented in various forms of table and figure. From the analysis conducted, it can be summarized that the level of adoption of GSCM in the Malaysian construction industry was still at the development phase. There were still many industry players who are not highly aware on the concept and definitions of GSCM even though they did aware on the environmental impacts of construction supply chain. Besides, the implementation of GSCM in the Malaysian construction industry was not as a whole and restricted on several supply chain phase only. The involvement mainly restricted to those who involved with green projects. Various challenges that hinder the players from adopting the concept are being identified. Some examples of the challenges include leadership and commitment from top management, lack of government support and regulations, and fear of failure. Apart from that, several recommendations were derived from the analysis and are expected to help improve the implementation of GSCM in the Malaysian construction industry. In relation to the findings, there is an opportunity for research to be continued in order to contribute more in sharing ideas and solutions towards these issues. In-depth study can be done for each of the initiatives or approaches under GSCM implementation, antecedents that can motivate organisations to adopt GSCM and the relationship between ISO certified organisations with the implementation of GSCM. It is hoped that, the research information will be useful in promoting GSCM amongst the Malaysian construction industry players.

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ABSTRAK

ANALISIS EMPIRIKAL BAGI PELAKSANAAN PENGURUSAN RANTAIAN BEKALAN HIJAU (GSCM) DI DALAM INDUSTRI PEMBINAAN

(Kata kunci: pengurusan rantai bekalan hijau, pembinaan, kesedaran, cabaran, penerapan)

Memandangkan industri pembinaan telah dikenal pasti sebagai salah satu penyumbang utama kepada pencemaran alam sekitar, inovasi dibuat baru-baru ini yang mendorong kepada kemunculan konsep kemampanan. Penumpuan kemampanan dengan fungsi perniagaan teras seperti bekalan, operasi, dan strategi pembelian telah membawa kepada bidang interdisiplin baru yang dikenali sebagai pengurusan rantai bekalan hijau (GSCM). GSCM boleh dijelaskan sebagai cara di mana aktiviti pengurusan rantai bekalan dan pembelian industri dipertimbangkan dalam konteks alam sekitar. Walaupun rantau lain telah menggunakan GSCM sebagai strategi perniagaan terasnya, industri pembinaan Malaysia masih baru untuk menyesuaikan konsepnya. Oleh itu, kajian ini dijalankan dengan matlamat untuk menubuhkan tahap penerimaan GSCM dalam industri pembinaan Malaysia. Untuk mencapai matlamat tersebut, tiga objektif telah diketengahkan termasuk (1) untuk menyiasat tahap kesedaran pemain industri terhadap konsep GSCM dalam industri pembinaan, (2) untuk mengenal pasti pelaksanaan semasa GSCM dalam industri pembinaan Malaysia, dan (3) untuk menganalisis cabaran yang dihadapi oleh para pemain dalam industri pembinaan Malaysia dalam mengamalkan amalan rantai bekalan hijau. Kaedah penyelidikan yang digunakan adalah soal selidik dan wawancara separa berstruktur untuk mendapatkan data primer. Manakala bagi data sekunder, kajian literatur komprehensif telah dijalankan. Data yang dikumpul dianalisis dengan menggunakan perisian SPSS dan analisis kandungan dan dibentangkan dalam pelbagai bentuk jadual dan rajah. Dari analisis yang dilakukan, dapat dirumuskan bahawa tahap penerimaan GSCM dalam industri pembinaan Malaysia masih dalam tahap pembangunan. Masih terdapat banyak pemain industri yang tidak begitu menyedari konsep dan definisi GSCM walaupun mereka mengetahui tentang impak rantai bekalan dalam industri pembinaan terhadap alam sekitar. Selain itu, pelaksanaan GSCM dalam industri pembinaan Malaysia tidak secara menyeluruh dan terhad kepada beberapa fasa rantai bekalan sahaja. Penglibatannya adalah terhad kepada mereka yang terlibat dengan projek hijau. Pelbagai cabaran yang menghalang pemain daripada meadaptasikan konsep ini telah dikenalpasti. Beberapa contoh cabaran termasuk kepimpinan dan komitmen dari pengurusan atasan, kekurangan sokongan dan peraturan kerajaan, dan takut kepada kegagalan. Selain itu, beberapa cadangan telah diperolehi daripada analisis dan dijangka membantu meningkatkan pelaksanaan GSCM dalam industri pembinaan di Malaysia. Sehubungan dengan penemuan ini, terdapat peluang untuk penyelidikan diteruskan untuk menyumbang lebih banyak dalam perkongsian idea dan penyelesaian terhadap isu-isu ini. Kajian mendalam dapat dilakukan untuk setiap inisiatif atau pendekatan di bawah pelaksanaan GSCM, yang terdahulu yang dapat memotivasi organisasi untuk mengadaptasikan GSCM dan hubungan antara organisasi yang mempunyai sijil ISO dengan pelaksanaan GSCM. Diharapkan, maklumat penyelidikan akan berguna dalam mempromosikan GSCM di kalangan pemain industri pembinaan Malaysia.

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LIST OF ABBREVIATIONS

EMP	<i>Environmental Management Plan</i>
EMS	<i>Environmental Management System</i>
GBI	<i>Green Building Index</i>
GSCM	<i>green Supply Chain Management</i>
ISO	<i>International Organization standardization</i>
MRPP	<i>Mold Reduction Prevention Plan</i>
SCM	<i>Supply Chain Management</i>
WMP	<i>Waste Management Plan</i>

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Nowadays, people are getting more concern regarding the environmental issues. It is one of the problems which have the potential that may lead to the extinction of the mankind on earth if not being addressed seriously at the moment (Ho et al., 2009). It has been acknowledged that the construction industry has created major impacts on the environment. According to the report from United Nations Environmental Program (2007), construction sector accounts for 30% to 40% of the world's total carbon emission which may lead to the severe environmental pollution. The construction industry basically pays inadequate attention to the protection of the environment since the players see the responsibility as lying with others (Ofori, 2000). None of the players basically assumes direct responsibility for protecting the environment since they work in a fragmented nature with different objectives.

As customers are becoming more environmental conscious and governments are making stricter environmental regulations these days, the industries need to reduce the environmental impact of their activities (Mathiyazhagan et al., 2012). The situation leads to the emerging of sustainable construction concept. Ofori (2000) define that the concept basically involves creating constructed items using best-practice, clean and resource-efficient techniques from the extraction of raw materials to the demolition and disposal of its components. Apart from that, the companies nowadays are starting to realize that supply chain need to be re-designed due to the increase in world population and decrease of resource availability (Carter and Jennings, 2002).

Greening the supply chains with the aims to balance marketing performance with the environmental issues had been introduced these days. In order to meet the various environmental challenges such as energy conservation and pollution abatement, enterprises have tried to green their supply chain by creating networks of suppliers to purchase environmentally superior products or building common approaches to waste reduction and operational efficiencies (Chandrakar and Kumar, 2012). According to Sato (2012), to make the supply chain 'green', an effective market-oriented tool known as 'green purchasing' can be

used to promote the development of environmentally conscious products and services. Carter et al. (1998) (as cited by Ofori, 2000) define green purchasing as consisting of purchasing involvement in activities that include reduction, reuse, and recycling of materials.

Malaysia which is one of the developing countries is currently experiencing a rapid economic growth through urbanization and it is expected to rise more and more from year to year. In order to ensure sustainability in the future development, many researchers had come out with the idea of green technology or system. However, in the Malaysian construction industry, the concept is still fairly new where there's only few organization's had implement it (Jin, 2007). This research will look into details on the concept of green supply chain management together with measuring the industry player's awareness and understanding level. The research will also be looking into the current implementation of green supply chain management in the Malaysian construction industry and the challenges faced by organisations to implement it.

1.2 PROBLEM STATEMENT

According to Balasubramaniam (2012), GSCM is one of the best strategies to improve the environmental performance of any organizations in the industry. The concept basically refers to the way in which the supply chain management and industrial purchasing may be considered in the context of environment (Green et al., 1996). By implementing GSCM, it helps the enterprise to focus on cleaner production (Mathiyazhagan, 2012). However, despite the importance of green supply chain in alleviating environmental issues and providing economic benefits to organizations, little is known about green supply chain in Malaysia (Khidir, 2010). Available evidence shows that the concept is still not widely adopted in Malaysia (Eltayeb et al., 2010). Apart from that, he also added that there is a lack of empirical studies that investigates the green supply chain in Malaysia. Based on the literature review, only sparse research on GSCM had been conducted on Malaysian samples (Zailani et al., 2012). In this respect, this research is to investigate the awareness level of industry players towards green supply chain management (GSCM) concept in the construction industry.

Green supply chain management (GSCM) had been practiced globally nowadays, not only across the globe but also across many sectors such as manufacturing, business and production. According to Porter and Kramer (2006), companies are increasingly expected to extend their sustainability efforts beyond their operations to include those of their suppliers and to meet their customer's sustainability expectations. However, this situation is contradicted

with Malaysia. Many of organizations in Malaysia are still struggling to understand and implement the system (Ho et al., 2012). The Green Purchasing Network of Malaysia (GPNM, 2003) reports that: at present, the practice of green purchasing amongst the industries including the SMIs in Malaysia is virtually non-existent. Only few fast forward thinking companies had already taking steps to develop sustainability in their supply chains (Zailani et al., 2012). Thus, this research is to identify the current implementations of green supply chain management (GSCM) in the Malaysian construction industry.

Although Malaysia is among industrially developed countries in the Asian region, the country still faces great challenges in ensuring a balance between development and environmental sustainability (Ho et al., 2012). The situations might be due to green issues are still relatively new and are still developing in Malaysia. In comparison to other developed countries, firms in developing countries like Malaysia are still in the learning process on how to incorporate the green supply chain management practices in their daily operations (Rao, 2012). As stated in the report by GPNM (2003), the implementation of environmental techniques by Malaysian SMIs is based very much on the ad hoc practices and many of them do not actually subscribe to any particular environment concept. Eltayeb et al. (2010) add that the Malaysian firms basically place a high consideration on external pressures and business benefits as the main criteria in deciding whether to adopt green purchasing or not. Therefore, since the implementation is still crucial in Malaysia, this research is being conducted to analyse the challenges faced by players in the Malaysian construction industry in adopting green supply chain practices.

1.3 RESEARCH QUESTION

In order to resolve the research problem, the following research questions are used to investigate the implementation of green supply chain management (GSCM) in Malaysian construction industry. -

1. Do the industry players aware about the concept of green supply chain management (GSCM) in construction industry?
2. What are the current implementations of green supply chain management (GSCM) in the Malaysian construction industry?
3. What are the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice?

1.4 RESEARCH OBJECTIVE

This research study has three main objectives: -

1. To determine the factors that influenced the implementation of green supply chain management practise in the construction industry.
2. To investigate the extent of green supply chain management initiatives in the construction industry.
3. To analyse the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice

1.5 RESEARCH SCOPE

The scope of research will focus on the construction industry players such as contractors and consultants (architect, engineer and quantity surveyor) who are directly involved in the supply chain process. Apart from that, the research will also be carried out on private or government projects that have or currently implement the concept of green supply chain management (GSCM) around Selangor and Klang Valley.

1.6 SIGNIFICANCE OF RESEARCH

The three main benefits contributed by this study are:

- Empirical data on factors that influenced the implementation of green supply chain management practise in the construction industry
- Qualitative data on the identifying the extent of green supply chain management initiatives being implemented together with the challenges faced during the implementation phase

1.7 STRUCTURE OF RESEARCH

This thesis contains five chapters. Chapter 1 covers the aim, objectives, scope of study and the methodology employed to achieve the study of this final report. It also consists of a general outline of the study to enlighten the reader with a brief introduction to this report.

Chapter two consists of brief explanation on the general concept of green supply chain management and its relationships with the sustainable construction. It will be focusing more on the definition, concept, approach, benefits and challenges of implementing green supply chain management. Besides, the chapter also highlights an overview of green supply chain management in Malaysian Construction Industry.

Chapter 3 focuses on the research methodology adopted in this research. The flowchart of research plan will be explained in detail together with the method and approach adopted to carry out this research. The sampling techniques being used and also the sample size will also be explained briefly in this chapter.

In Chapter 4, the analysis will be carried out based on the methodology outlined in chapter three. For this chapter, it focuses on analyzing the data collected from the questionnaire survey. The aim of the chapter is to gather and analyse data for the first and third objectives of the research. All the data gathered during the semi-structured interview will be tabulated, themed and analyse. This chapter focuses on analyzing and gathering data for the second and third objectives of the study.

Chapter 5 is the final chapter that consists of conclusions and recommendations of the entire study that has been analyzed in the stipulated period. It can be used to make an improvement in the future.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter briefly explains the definition and concept of supply chain management (SCM) and its implementation in the construction industry. Activities in each stage of supply chain are being studied together with highlighting the impacts of these activities to the environment. Literatures provide that waste and emissions produce from the activities in supply chain have become one of the main sources for environmental problem. Due to the major resource consumption and contamination generated by the construction industry, it leads to the emergence of sustainable development. The chapter explains in detail the definition and concept of sustainable development and its practices in the Malaysian construction industry.

The relationship between sustainable development and supply chain management will also be explained in this chapter. The implementation of sustainable development concept to the supply chain play both direct and indirect role in helping the organisations to preserve the environment. This leads to the emergence of green supply chain management (GSCM). This chapter will also briefly explain the meaning of green supply chain management, its initiatives towards conserving the environment, outcomes of the implementation and challenges faced by the organisations to adopt the concept. Finally, this chapter explains general overview of the implementation of GSCM in the Malaysian construction industry.

2.2 SUSTAINABLE DEVELOPMENT

2.2.1 General Concept and Definition

There are a number of definitions for sustainable development. According to the Brundtland Commission (1987), sustainable development is defined as ‘the development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. Carter and Rogers (2008) then explain that several issues included within this broad rubric of sustainability are understanding the environmental impact of economic activity in both developing and industrialized economies (Erlach and Erlach, 1991); ensuring worldwide

food security (Lal et al., 2002); ensuring the basic human needs are met (Savitz and Weber, 2006); and assuring the conservation of non-renewable resources (Whiteman and Cooper, 2000). However, since Brundtland Commission's definition is so far reaching, most organisations find it difficult to determine their individual roles within this broader, macro-economic perspective (Srivastava, 1995; Stead and Stead, 1996; Carte and Rogers, 2008).

According to Kibert (2008), the term sustainable development is defined as 'the development that most comprehensively addresses the ecological, social and economic issues of a building in the context of its community'. Kibert also adds that the goal of sustainable construction is to create and operate a healthy built environment based on resource efficiency and ecological design following the sustainable principles that have been highlighted (Table 2.1).

The Principles of Sustainable Construction
Reduce resource consumption (REDUCE)
Reuse resources (REUSE)
Use recyclable resources (RECYCLE)
Protect nature (PROTECT)
Eliminate toxics (ELIMINATE)
Apply life-cycle costing (ECONOMICS)
Focus on quality (QUALITY)

Table 2.1: The principles of sustainable construction

Source: Kibert (2008)

Broad literature review (Elkington, 2004; Savits and Weber, 2006; Carter and Rogers, 2008) suggest that organizational sustainability, at a broader level, consists of three components: the natural environment, society and economic performance. This is shown in Figure 2.1. The intersection between the three components serves as a bottom line to the

activities that organisations can engage with. The activities must not only positively affect the natural environment and society, but which also result in long-term economic benefits and serve as competitive advantage to the firm (Carter and Rogers, 2008).

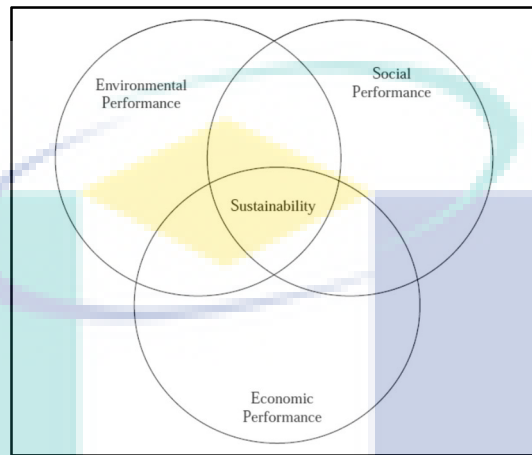


Figure 2.1: The triple bottom line of sustainability

Source: Carter and Rogers (2008)

2.2.2 Sustainable Development Practices in Malaysia

With the global concerns on the environment and sustaining the world resources for the future generations, Malaysia has also embarked on initiatives for sustainable development (Sood et al., 2011). In June 1999, the Construction Industry Development Board Malaysia (CIDB) established a technical committee to look into developing good environmental practice in the construction industry (Kamar and Hamid, 2011). The committee which is known as Technical Committee 9 on Good Environmental Practices in the Construction Industry (TC9) comprises of environmental experts from government agencies, professional bodies, academician and construction related associations. Under TC9, CIDB had published Strategic Recommendations for Improving Environmental Practices in Construction Industry. The document highlighted few recommendations that serve as a strategic way forward for environmental management to be adopted by all players in Malaysian construction industry (Kamar and Hamid, 2011).

Apart from that, the launch of National Green Technology Policy (NGTP) in 2009 is a manifestation of the government's seriousness in implementing 'green' initiatives for the country (Sood et al., 2011). Specifically for building, the government promotes the application

of renewable energy and energy efficiency in buildings such as solar photovoltaic, rainwater harvesting, phasing out of incandescent lights, and the application of green building index. Green Building Index (GBI) is the rating system that has been developed and widely used since 2009. In order for such a building to be recognized as a ‘green building’, the building itself must meet the requirement outlined. Building will be awarded GBI rating score based on the six criteria shown in Figure 2.2.

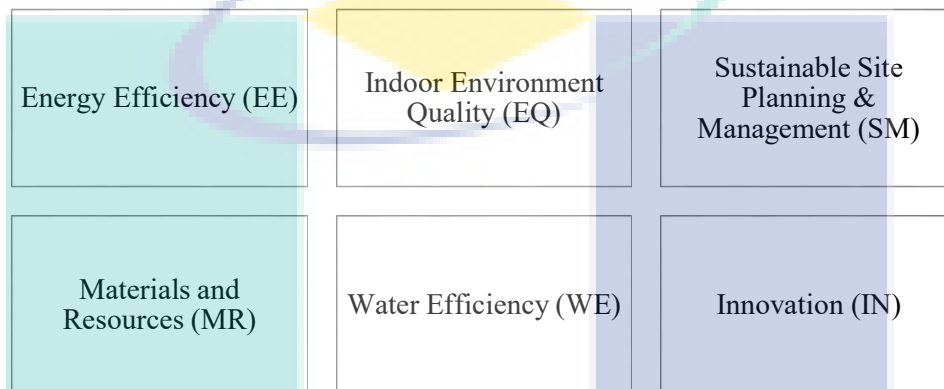


Figure 2.2: Six criteria of Green Building Index (GBI)

Rather than GBI rating system being used in Malaysia, other three major rating systems that use to provide the basis for the assessment of green building and certifications throughout the world are:

- i. Building Research Establishment Environmental Assessment Method (BREEAM)
- ii. Green Building Challenge Assessment Framework
- iii. Leadership in Energy and Environmental Design (LEED)

2.3 SUPPLY CHAIN MANAGEMENT (SCM)

2.3.1 General Concept and Definition

Supply Chain Management (SCM) is a concept that is originated and flourished in the manufacturing industry (Vrijhoef and Koskela, 2000). It was first visible in the Just in Time (JIT) system as part of the Toyota Production System (Shingo, 1988). The system aimed at regulating supplies to the Toyota motor factory in the small amount, just in the right time. Besides, the main goal was to drastically decrease inventories and to effectively regulate the supplier’s interaction with the production line (Vrijhoef and Koskela, 2000). The concept

finally stimulated and evolved year by year. By the early 1990s, due to intense competition and globalization, it forced the organisations to provide a product and service that is right to the customer, at the most appropriate time, with the lowest cost (Li et al., 2003; Altekari, 2005; Thoo et al., 2011;). Due to the circumstances, more and more organisations finally came out promoting supply chain competitiveness in order to attain organizational efficiency (Thoo et al., 2011).

Supply chain can be defined as ‘the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer’ (Christopher, 1992; Vrijhoef and Koskela, 2000). Apart from that, Stevens (1989) describes the supply chain as ‘the interconnected series of activities concerned with the planning and controlling of raw materials, components and finished products from suppliers to the final customer’. Rather than viewing just the certain part or level in supply chain, supply chain management (SCM) views and focuses on the entire level involved. This can be seen in Figure 2.3. Regardless of functional or corporate boundaries, supply chain management (SCM) aimed at increasing transparency and alignment of the supply chain’s coordination and configuration (Cooper and Ellram, 1993). SCM tries to recognize the interdependency in the supply chain, so that it may improve the configuration and control based on such factors as integration of business processes (Vrijhoef and Koskela, 2000).

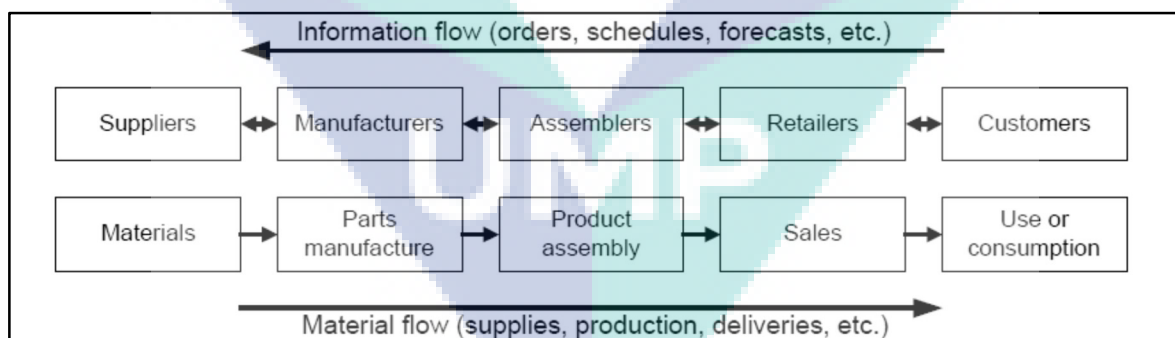


Figure 2.3: Generic configuration of a supply chain in manufacturing

Source: Vrijhoef and Koskela (2000)

2.3.2 Construction Supply Chains

The traditional supply chain shifted, transformed and extended itself into dynamic and ever-changing processes (Shayoh et al., 2002). The transformation goes beyond the physical

boundaries of the whole enterprise and reaches into the global and rapidly evolving series of network (Harland, 1996). The expansion results on more holistic and strategic view of the process of supply chain. Saad et al. (2002) state that a few but increasing numbers of construction organisations are now begin to adopt supply chain management (SCM). This is towards improving their performance and addressing their adversarial inter-organisational purchaser-supplier relationships and fragmented processes (Saad et al, 2002). According to Ofori (2000), the concept of the supply chain basically provides a very useful framework to analyse the construction process. The supply chain in construction includes all the parties who involved in the process from the extraction of raw materials to the eventual demolition of the buildings and also disposal of its components (Ofori, 2000). Figure 2.4 shows the conceptual view of the stakeholders involves in the construction supply chain.

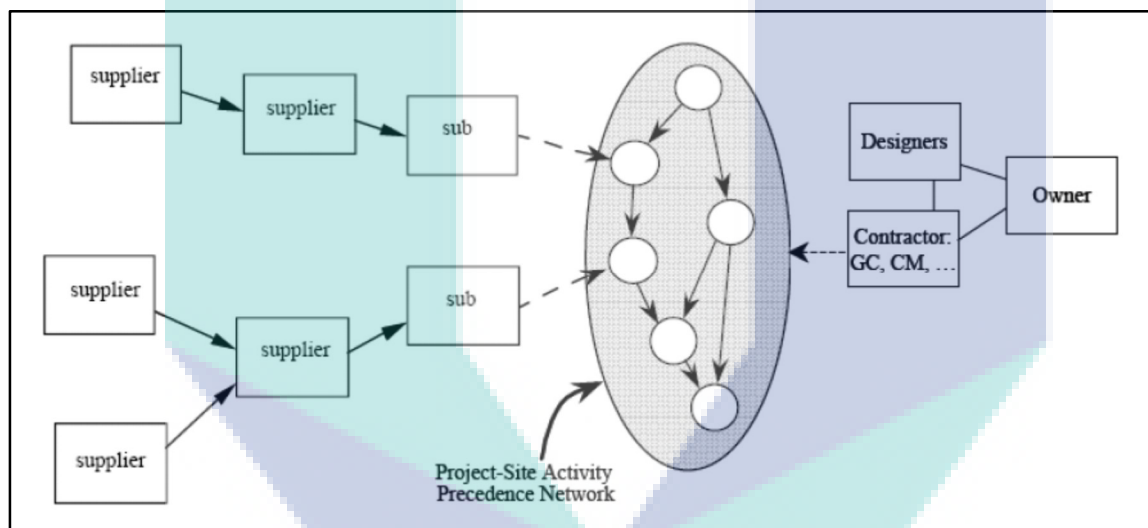


Figure 2.4: Conceptual view of construction supply chain

Source: Trigos (2007) & O'Brian et al. (2002)

According to Vrijhoef and Koskela (2000), the structure and function of construction supply chain are characterized by the following:

- It is a converging supply chain where all the materials are directed to site and object or product will be assembled from the incoming materials. In contrast to manufacturing industry, the 'construction factory' is being set up around the single product itself. The products are not going to pass through the factory and distributed to the customers like what happens in manufacturing industry

- Apart from that, the project organisations are repeated and reconfigured all the time thus results in having a temporary supply chain producing one-off construction projects. This unique elements cause the construction industry to become typified by instability, fragmentation and separation between the design and construction phase of the built product.
- Since every project creates new product or prototype, thus it can be a typical make-to-order supply chain. There is a little repetition, with a very minor exception. For projects that have particular kind, the process somehow can be very similar.

Supply chain management in construction can be viewed as a process where raw materials are converted into final products, and then delivered to the end-customer (Beamon, 1999). This process involves extraction and exploitation of the natural resources (Srivastava, 2007). Supply chain management is said to be able to help improve efficiency and productivity, and reduce overall operating costs (Lambert et al., 1998). Despite the outcomes, many of the researchers highlight that supply chain process in construction give impacts to the environment. According to Kumar and Chandrakar (2012), the waste and emissions caused by the supply chain have become one of the main sources of serious environmental problems including global warming and acid rain. Thus, environmental impacts need to be considered cumulatively over the stages of supply chain which involves considering the impacts of extraction of raw materials, distribution, operation and disposal (Kumar and Chandrakar, 2012).

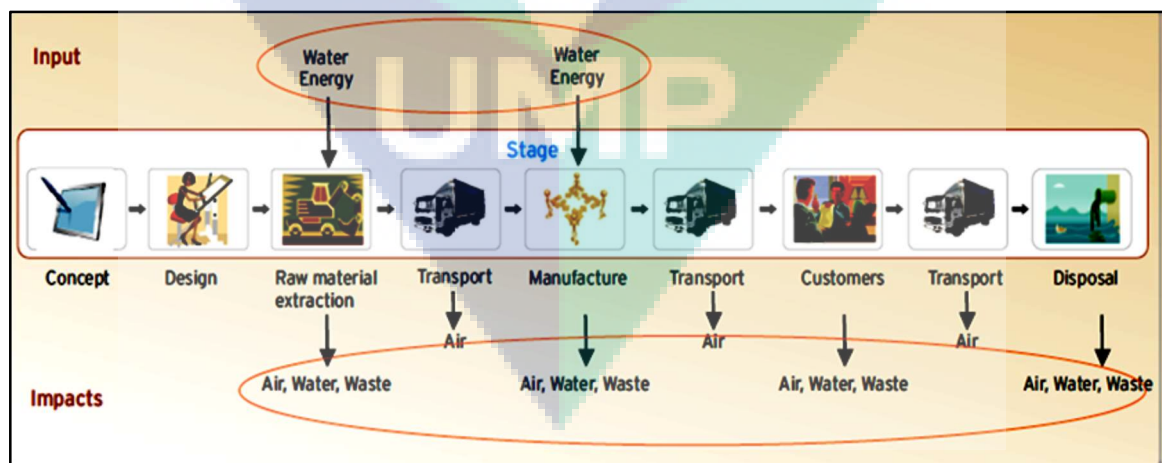


Figure 2.5: Environmental impacts at each stage of supply chain

Source: Kumar and Chandrakar (2012)

Figure 2.5 shows environmental impact at each stage of the construction supply chain. Environmental problems are caused either directly or indirectly by the patterns of production by the industries, patterns of consumption and behavior of the consumers (Said et al., 2003). According to United Nations Environment Program (2007), construction sector is considered as a major contribution to environmental problems, if to be compared with other industries. Due to the major resource consumption and contamination generates by the construction industry, it leads to the need of sustainable development (Korkmaz et al., 2009).

2.4 RELATIONSHIP BETWEEN SUSTAINABLE DEVELOPMENT AND SUPPLY CHAIN MANAGEMENT

Construction has been described as a major exploiter of natural resources, both physical and biological (Spence and Mulligan, 1995). As explained earlier, the process of supply chain in construction industry leads so much to the environmental impacts. The impacts occur across all stages of the product's life cycle, merely from the raw material extraction, to manufacturing, use and reuse, final cycling, or disposal (Zhu and Sarkis, 2006). Since the companies are increasingly realize their environmental responsibilities these days, environmental management had become key strategic issues towards improving their organizational performance (Xiao, 2006). Various sustainable related principles had been developed as a strategy for companies to achieve profit and market advantages (Sarkis, 1995). These strategies are expected to help reducing the organisation's environmental risks and improving efficiency.

Due to the introduction of Environmental Management System (EMS) into the business, the use of various environmental tools also emerged (O'Laire et al., 1998). According to Foster et al. (2001), instead of 'in-house' environmental improvement being used widely, there is a trend that organisations are currently extending the parameters of EMS's outside the factory and move into the supply chain networks. This situation leads to the emergence of 'sustainable' or 'green' supply chain concept and principles. The implementation of sustainable development policy has either direct or indirect bearing on the supply chain, which therefore can serve a key role to play, particularly in protecting and preserving the environment (Bearingpoint, 2008). The following sub-chapter will discuss in details the concept, principles and implementations of green supply chain management (GSCM).

2.5 GREEN SUPPLY CHAIN MANAGEMENT (GSCM)

2.5.1 General Concept and Definition

The combination of corporate environmental management and supply chain management is considered as relatively new area of study and practice (Xiao, 2006; Zhu and Sarkis, 2005). Thus the definition of GSCM is still not clear. According to Green et al. (1996), GSCM is ‘the way in which innovation in supply chain management and industrial purchasing may be considered in the context of the environment’. Apart from that, Narasimhan and Carter (1998) point out that GSCM is ‘the purchasing function which includes reduction, recycling, reuse, and the substitution of materials’. Godfrey (1998) discovers GSCM as ‘the practice of monitoring and improving environmental performance in the supply chain’. Basically, GSCM can be explained as the approach that integrates the environmental thinking into the supply chain management (Srivastava, 2007). Srivastava adds that the environmental integration includes during the product design, material resourcing and selection, manufacturing processes, delivery of the final product to the consumer as well as end-of-life management of the product after its useful life. This is shown in Figure 2.6.

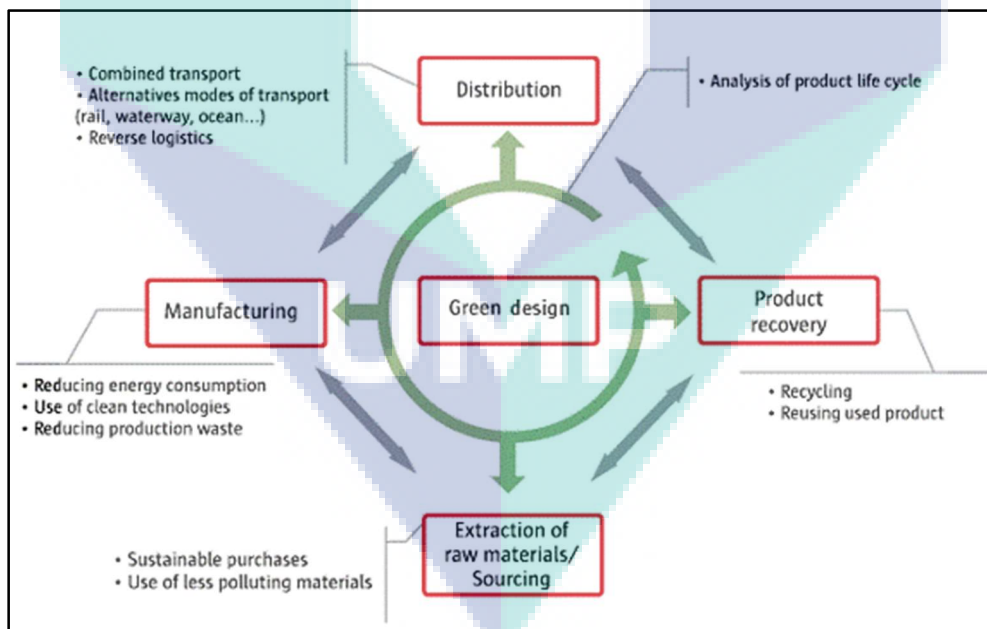


Figure 2.6: General concept of green supply chain management

Source: Bearingpoint (2008)

The approach seeks on reducing and minimizing the product or service’s ecological footprint (Bearingpoint, 2008). The concept is similar with supply chain management (SCM)

where the boundary is dependent on the supply chain concurrently with the product. However, adding the 'green' component to the existing traditional SCM involves addressing the influence and relationships between SCM and the natural environment (Srivastava, 2007). The main aim of GSCM includes identifying benefits, costs and risks associated with the environmental performance (Hanfield et al., 2005; Trigos, 2007).

2.5.2 Classification of Green Supply Chain Management (GSCM)

There are various ways of classifying green supply chain management (GSCM). Zhu and Sarkis (2001) identify four types of GSCM which includes internal environmental management, external GSCM practices, investment recovery and eco-design. Theyel (2001) points out three types of environmental relationships which are setting environment requirements, sharing information and collaboration for improving products or processes. Apart from that, other two categories of green supply chain management process are: 1) process-based and 2) product-based supply process (Brown, 2001; Bowen, 2001; Trigos, 2007; Srivastava, 2007;). Process-based practice is those related with modifications to the supplier's management practices (Trigos, 2007). The most common being practice is the requirement of an environmental policy in order to improve the environmental performance. While product-based practices are related with the modifications to the product purchased or its by-product (Trigos, 2007). Some example includes packaging reduction or modification which refers to actions such as reducing the amount of packaging material, elimination of hazardous materials, facilitate dismantling or recycling (Envirowise, 2001).

2.6 GREEN SUPPLY CHAIN MANAGEMENT (GSCM) INITIATIVES

The implementation of green supply chain management (GSCM) in the construction organisation depends on to what extend the initiative being used. Ghobakhloo et al. (2013) and Dheeraj and Vishal (2012) have come out with a systematic guideline and framework for an effective implementation of GSCM (Figure 2.7).

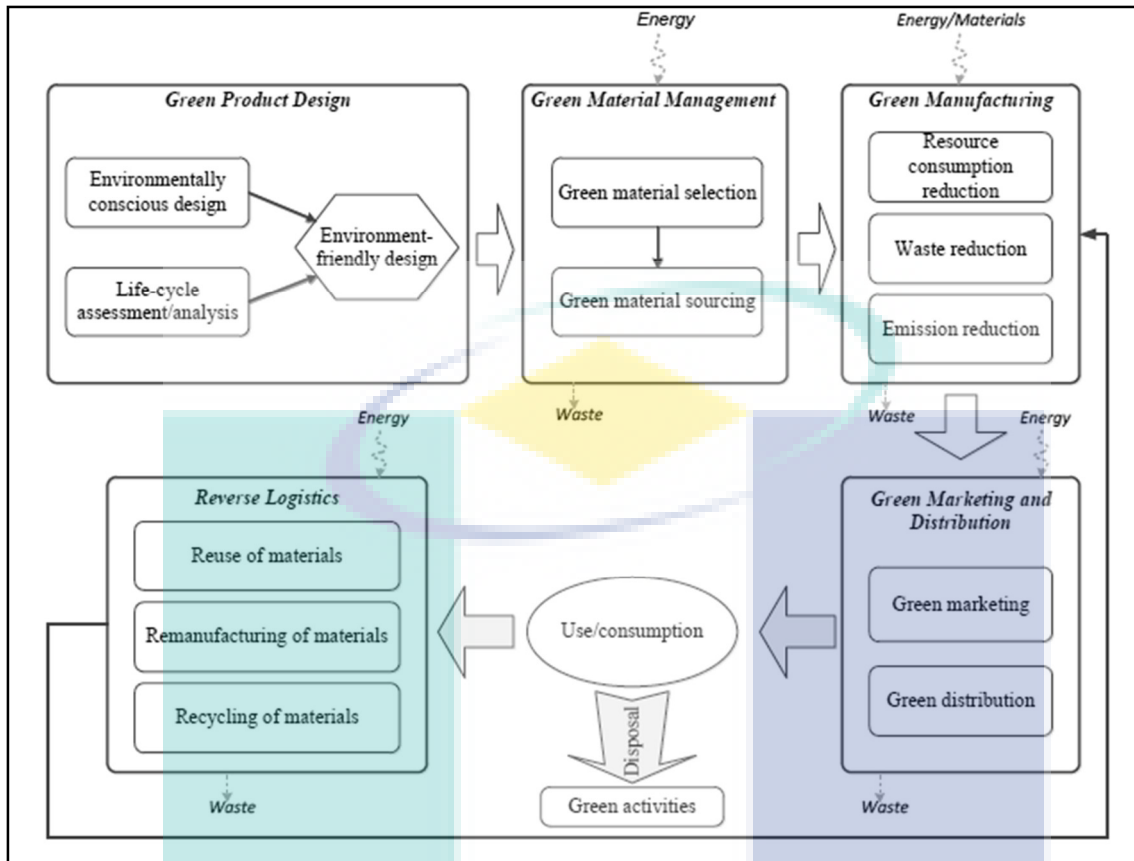


Figure 2.7: Framework of GSCM process implementation

Source: Dheeraj and Vishal (2012) & Ghobakhloo et al. (2013)

Based on the framework, it can be summarized that the implementation of GSCM are as follows:

Green Supply Chain Management (GSCM) = Green Product Design + Green Material Management (Green Purchasing) + Green Manufacturing Management + Green Distribution and Marketing + Reverse Logistics (Dheeraj and Vishal, 2012; Ghobakhloo et al., 2013)

2.6.1 Green Product Design

Green product design is an initiative which seeks to improve a product's ecological quality, by reducing its negative impact on the environment throughout its life cycles (Bearingpoint, 2008). In the context of construction, it is being carried out during the design phase. The approach involves taking into consideration the environment during a product's design or improvement phase. The concept is providing an environmental-conscious design, or simply called as eco-design. According to Johansson (2002), the aim is to minimize the

product's environmental impact during its whole life cycle – from the acquiring of material, to manufacturing, use and ultimately to the final disposal – without compromising other product's criteria such as performance and cost.

Eco-design is being considered as one of the green supply chain initiatives since it integrates environmental aspects into product design process, and takes into consideration entire flow of the product in the supply chain (Eltayeb et al., 2011). An environmental consideration during the design stage is very important. This is due to at this stage, function of product, process or service is defined, and raw materials, supplies and process chemicals are selected (Eltayeb et al., 2011). Thus, energy that will be consumed and waste to be generated from the overall process can be determined. As summarized by Eltayeb et al. (2011), the basic eco-design activities include the following:

1. Design for reduction or elimination of environmentally-hazardous materials (Zsidisin and Siferd, 2001)
2. Design for reuse where the design facilitates reuse of a product or part of it with or without minimal treatment of the used product (Sarkis, 1998)
3. Design for recycling which means the design facilitates disassembly of the waste product, separation of parts according to material, and reprocessing of the material (Lin et al., 2001)
4. Design for remanufacturing, is a design that facilitates repair, rework, and refurbishment activities aiming at returning the product to the new or better than new condition (Beamon, 1999)
5. Design for resource efficiency which includes reduction of materials and energy consumption of a product during use, in addition to promoting the use of renewable resources and energy (APO, 2004)

2.6.2 Green Purchasing

Green purchasing can be explained as an environmentally-conscious purchasing initiatives that tries to ensure that the purchased products or material meets environmental objectives set by the purchasing firm, such as reducing sources of waste, promoting recycling, reuse, resource, reduction and substitution of materials (Carter et al., 1998; Min and Galle, 2001; Zsidisin and Siferd, 2001; Eltayeb et al., 2011). Green purchasing basically deals mainly with controlling environmental performance of suppliers. There are various green purchasing

activities that can be identified from the literature. Hamner (2006) summarized the basic green purchasing activities as follows:

1. Product content requirements: buyers specify that purchased products must have desirable green attributes such as recycled or reusable items
2. Product content restrictions: buyers specify that purchased products must not contain environmentally undesirable attributes
3. Product content labeling (eco-labeling): buyers require disclosure of the environmental or safety attributes of purchased product contents. Such disclosure can be done using green seals and indicators of relative environmental impact such as scientific certification system offered by various commercial organisations
4. Supplier questionnaire: buyers send questionnaire to suppliers asking them to provide information about their environmental aspects, activities and/or management system
5. Supplier environmental management system: buyers require suppliers to develop and maintain an environmental management system (EMS)
6. Supplier certification: buyers require suppliers to have an EMS that is certified as fully compliant with one of the recognized international standards
7. Supplier compliance auditing: buyers audit suppliers to determine their level of compliance with environmental requirements

2.6.3 Green Manufacturing

Apart from addressing environmental product design and material management, issues regarding manufacturing also need to be considered. In construction industry, manufacturing can be explained as the construction phase of the end-product. According to Ghobakhloo et al. (2013), one of the objectives of green manufacturing process is to reduce the use of virgin material and other resources or energies. This is due to it will indirectly help reduce the amount of waste produce during the process phase. Apart from that, other reason of greening the manufacturing process is to minimize the energy and resource consumption by recycling the material involved. One the other hand, emission reduction is another significant reason for green manufacturing (Ghobakhloo et al., 2013). Two primary emission reductions can be achieved by means of (1) control where emissions are trapped, stored, treated and disposed using pollution control equipment; or (2) prevention such as reducing, changing or preventing

the emissions altogether through better housekeeping, material substitution, recycling or process innovation (Hart and Ahuja, 1996; Ghobakhloo et al., 2013).

2.6.4 Green Marketing and Distribution

Cox (2008) define green marketing as an advertisement that presents a corporate image of environmental responsibility, supports a green lifecycle with or without highlighting a product/service and clearly and understandably addresses the relationship between a product/services and the biophysical environment. Apart from that, green distribution can be explained in the context of green transportation. Bjorklund (2010) explains that green transportation is a transportation service that has a lesser reduced negative impact on human health and the natural environment. However, as explained earlier by Vrijhoef and Koskela (2000), construction industry has a unique character where the ‘factory’ is being set up near to the end-product itself. No distribution of product to the end-user which results in the elimination of distribution process.

2.6.5 Reverse Logistics

Reverse logistics incorporates the return of materials, components and products back into the ‘forward logistics’ chain (Toke et al., 2010). Carter and Ellram (1998) further define reverse logistics as an environmentally conscious approach incorporating reverse distribution and resource reduction. Reverse logistics focuses primarily on the return of the products or materials from the point of consumption to the forward supply chain for the purpose of recycling, reuse, remanufacture, repair, refurbishment or safe disposal (Stock, 1998; Carter and Ellram, 1998; Alvarez-Gil et al., 2007; Eltayeb et al., 2011). End-of-life products as an example material from building demolition activities returned into the forward supply chain for three main purposes. The purposes are as follows (Beamon, 1999; Wells and Seitz, 2005):

1. Reuse – the process of collecting used products from the field, and distributing or selling them. The ultimate value of the product is reduced, without additional processing.
2. Remanufacturing – the process of collecting a used product, assessing its condition and replacing the defective or obsolete parts with new or refurbished part. The identity and functionality of the original product is being retained.

3. Recycling – the process of collecting used products, disassembling them, separating them into material categories, and processing them into recycled products, components and/or materials. The identity and functionality of the original materials/ is lost.

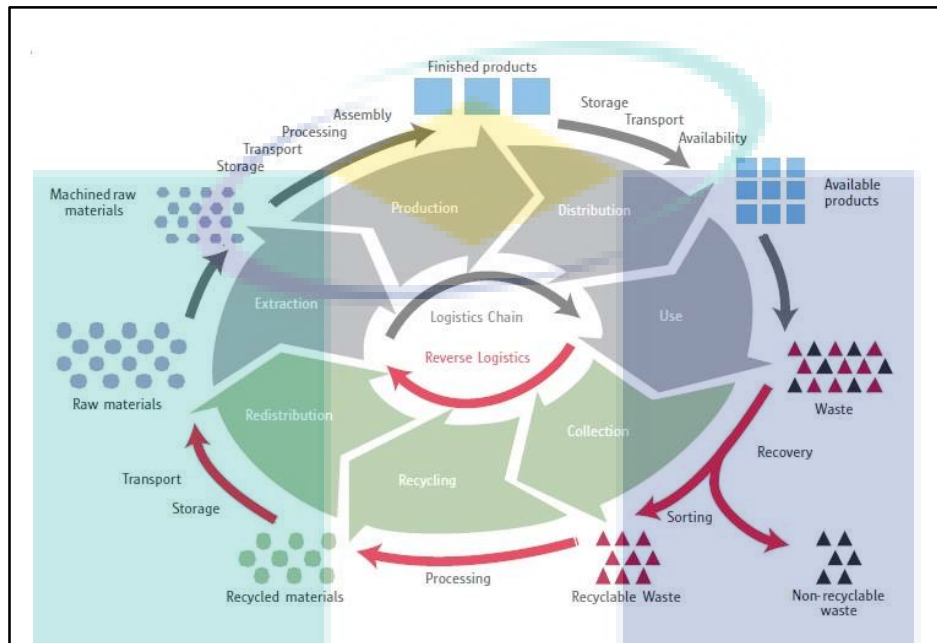


Figure 2.8: Reverse logistics cycle in green supply chain

Source: Bearingpoint (2008)

Figure 2.8 shows the reverse logistics process that happen in the supply chain. Reverse logistics is so much interrelated with investment recovery. According to Chandrakar and Kumar (2012), investment recovery is an organisation’s strategic use of reverse logistics recycling, redeployment, reselling and similar techniques to derive greater value from materials and products. This includes turning surplus assets into revenue by selling idle assets, reducing storage space and deploying idle assets to other locations with the purpose of avoiding purchasing of new equipment and material (Chandrakar and Kumar, 2012).

In conclusion, there are five categories of green supply chain initiatives described in the literature; green product design or eco-design, green purchasing, green manufacturing, green marketing and distribution, and reverse logistics. Each initiative is being summarized accordingly in Table 2.2. For the purpose of this research, the implementation of green supply chain will take into consideration only four initiatives or approaches. They are green product design, green purchasing, green manufacturing and reverse logistics.

Table 2.2: Green supply chain initiatives

INITIATIVES/ APPROACHES	CRITERIAS	SOURCES
Green Product Design (Eco-design)	<ul style="list-style-type: none"> • Design for reduction of hazard materials • Design for reuse, recycling and repair • Design for resource efficiency 	Sarkis, 1998; Beamon, 1999; Zsidisin and Siferd, 2001; Lin et al., 2001; APO, 2004; Rha, 2010; Eltayeb et al., 2011; Thipparat, 2011
Green Purchasing	<ul style="list-style-type: none"> • Product content requirements, restrictions and labeling • Supplier questionnaire • Supplier EMS • Supplier certification • Supplier auditing 	Hamner, 2006; Eltayeb et al., 2011
Green Manufacturing	<ul style="list-style-type: none"> • Waste reduction • Resource consumption reduction • Emission reduction 	Bearingpoint, 2008; Dheeraj and Vishal, 2012; Ghobakhloo et al., 2013
Reverse Logistics	<ul style="list-style-type: none"> • Investment recovery (sales) of excess inventories/materials • Sales of scrap and used materials • Sales of excess capital equipment 	Rha, 2010; Thipparat, 2011; Chandraker and Kumar, 2012

Source: Sarkis (1998); Beamon (1999); Zsidin & Siferd (2001); Lin et al. (2001); APO (2004); Hamner (2006); Bearingpoint (2008); Rha (2010); Eltayeb et al. (2011); Thipparat (2011); Dheeraj & Vishal (2012); Chandraker & Kumar (2012); Ghobakhloo et al. (2013)

2.7 GREEN SUPPLY CHAIN MANAGEMENT (GSCM) OUTCOMES

Outcomes from the initiatives and approaches of green supply chain management can be broadly categorized into four categories as shown in Figure 2.9: (1) environmental outcomes, (2) economic outcomes, (3) operational outcomes, and (4) intangible outcomes.

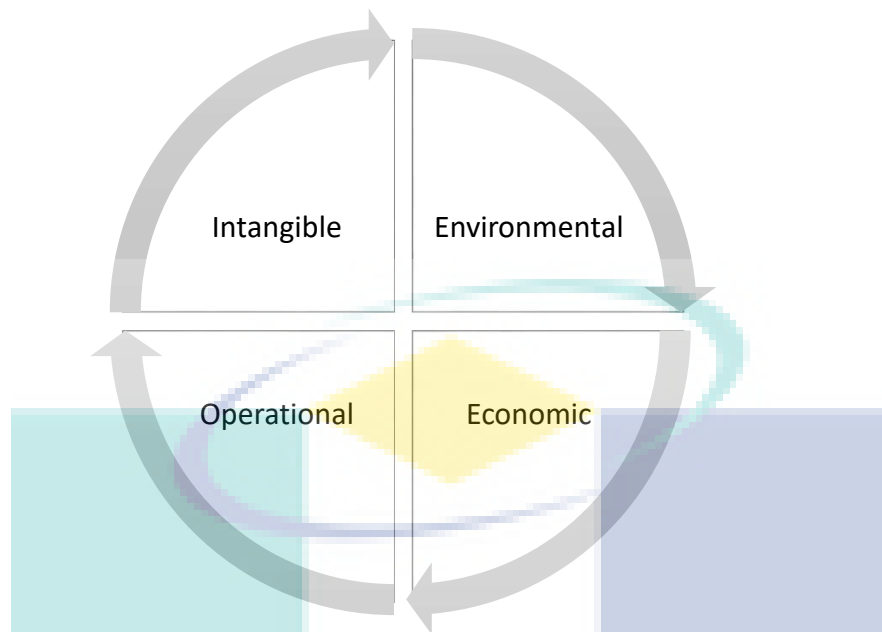


Figure 2.9: Green supply chain management (GSCM) outcomes

2.7.1 Environmental Outcomes

The outcomes represent positive consequences of green supply chain initiatives on the natural environment both outside and inside of the organisations. Examples of the positive outcomes include reduction of solid or liquid waste, reduction of emissions, resource reduction, and decrease of frequency of environmental accidents, and improved employee and community health (Five Winds International, 2003; Geyer and Jackson, 2004; Zhu and Sarkis, 2004)

2.7.2 Economic Outcomes

Green supply chain initiatives can lead to economic outcomes in many ways. This includes profitability, revenue growth, increase in market share, and increase in productivity (Zhu and Sarkis, 2004; Mollenkopf and Closs, 2005; Stock et al., 2006). Min and Galle (2001) found that green purchasing have a negative impact to the organization since it tends to increase the operational costs. However, broad literatures from other studies suggest positive economic outcomes from green supply chain approaches.

2.7.3 Operational Outcomes

Operational outcomes can be explained as direct impact of green supply chain initiatives on operational performance of a firm (Eltayeb et al., 2011). The outcomes include cost reductions, product quality improvements, improvement in the delivery and flexibility (Vachon and Klassen, 2006; Chung and Tsai, 2007). The most discussed operational outcomes of green supply chain is cost reductions. There are various ways of how this initiative may result in cost reductions. This includes (1) materials saving resulting from more complete processing, substitution, reuse, recycle of production inputs, (2) better utilization of by-products, (3) elimination or reduction of cost of activities involves in discharge waste-handling and disposal, and (4) lower energy consumptions (Porter and Van der Linde, 1998).

2.7.4 Intangible Outcomes

Eltayeb et al. (2011) point out that intangible outcomes represent the conceptual or difficult-to-quantify outcomes of green supply chain initiatives. As an example, improved product image and enhanced image and goodwill of a firm in the eyes of stakeholders (customers, clients or employees, and community). Such improved image then is expected able to generate customer satisfaction and loyalty, employee satisfaction, brand value, enhanced publicity and marketing opportunities, and better acceptance of a firm by the local communities (Five Winds International, 2003; Jayaraman and Luo, 2007).

2.8 GREEN SUPPLY CHAIN MANAGEMENT (GSCM) CHALLENGES

Despite the positive outcomes of the green supply chain initiatives, literature has thrown light on the various kinds of challenges or barriers that hinder the industry towards adopting green supply chain management. Some literature (Perron, 2005; Khidir and Zailani, 2009; Mathiyazhagan et al., 2013) categorized the challenges in four broad categories which are (1) institutional challenges, (2) organizational challenges, (3) informational challenges, and (4) economic challenges. While some other literature (Walker et al., 2008; Balasubramanian, 2012) divide the challenges into two parts (1) internal challenges and (2) external challenges. Table 2.3 summarizes the variables found in the literature review for the challenges faced by the industry players to implement green supply chain management.

Table 2.3: Green supply chain management challenges (Internal and external)

Challenges	Min and Galle (2001)	Perron (2005)	Rao and Holt (2005)	Trigos (2007)	Walker et al. (2008)	Khidir & Zailani (2009)	Varnas et al. (2009)	Balasubramaniam (2012)	Mathiyazhagan et al. (2013)
<u>INTERNAL</u>									
Direct cost and transaction cost (financial constraints)	√			√	√	√	√	√	√
Difficult in fundamental change (vision, mission, organizational culture)						√	√	√	
Lack of new technology, materials and processes (resources)		√		√				√	√
Lack of information (standardization and control)		√	√			√		√	
Knowledge and experience									
Fear of failure									√
Awareness level		√							√
Leadership and support (management commitment)	√			√			√	√	
<u>EXTERNAL</u>									
Lack of government support and regulations			√		√	√		√	√
Management of the suppliers									√
Supplier commitment									
Lack of effective environment measure					√			√	
Competition and uncertainty								√	
Lack of demand and public awareness								√	
Availability of green products	√			√			√	√	
Policies and strategies									
Markets of recyclable materials				√			√		

Source: Min and Galle (2001); Perron (2005); Rao and Holt (2005); Trigos (2007); Walker et al. (2008); Khidir & Zailani (2009); Varnas et al. (2009); Balasubramaniam (2012); Mathiyazhagan et al. (2013)

According to Table 2.3, challenges faced by the industry players in adopting green supply chain management in the construction industry is divided into two classifications (1) internal challenges and (2) external challenges.

2.8.1 Internal Challenges

Internal challenges can be explained as the challenges that occur internally within the players or organisations itself. The most significance challenge identified during the literature is in terms of financial constraints. According to Khidir and Zailani (2009), engaging in environmental management in supply chains involves two types of cost; direct cost and transaction cost. Many literatures (Zhu and Sarkis, 2004; Mollenkopf and Closs, 2005; Stock et al., 2006) point out that implementation of green supply chain may lead to increase in economic performance and boost profitability. However, green supply chain involve higher operation costs thus hinder the adoption of it amongst organisations (Min and Galle, 2001; Walker et al., 2008; Khidir and Zailani, 2009; Varnas et al., 2009; Balasubramaniam, 2012; Mathiyazhagan et al., 2013). This is especially for organisations that have limited availability of resources.

Apart from financial challenges, changing the mindset and culture of an organization and the players itself are also significance (Khidir and Zailani, 2009; Varnas et al., 2009; Balasubramaniam, 2012). Changing the fundamentals and core features of organisations (organisational goals, forms of authority, core technology and operational and marketing strategy) are definitely one of the challenging tasks to the organisations. Leadership and commitment from the top management in aligning the organisations into new direction is very crucial. It is important for them to support and create awareness level regarding the importance of environment to their subordinates. Other challenges faced by the industry in implementing green supply chain management includes lack of resources (technical expertise, technology, material and process), lack of knowledge and experience, lack in managing standard environmental control policies within the organization (Perron, 2005; Trigos, 2007; Khidir and Zailani, 2009; Balasubramaniam, 2012).

2.8.2 External Challenges

Apart from internal factors, external environment also serve as a challenge to the industry in implementing green supply chain management. According to the literature, the most

significance challenge faced by the construction industry is lack of support from the government (Rao and Holt, 2005; Walker et al., 2008; Khidir and Zailani, 2009; Balasubramaniam, 2012; Mathiyazhagan, 2013). Government basically serves as catalyst since their support can be both drivers and challenges in implementation of green supply chain. Development of appropriate policies, standard and regulations may encourage the industry players to adopt green initiatives. Since green supply chain interrelated much with supplier, thus management of supplier also one of the challenging part for the organisations (Mathiyazhagan et al., 2013). For activities like green purchasing that require supplier to comply with environmental requirements, their commitment and responsibility are very important.

Trigos (2007) highlights that the availability of green products in the market nowadays also serve as factor that hinders the implementation of green supply chain. In the construction industry, there is not much product that can meet the green requirements. Only few products that can be considered as 'green' and made for the purpose of 'recycle' (Varnas et al., 2009). The most common is concrete and timber. However, the usage is still at an infant stage due to the cost preference. Other challenges include lack of effective environmental measure such as training and development, sustainable auditing, and certifications like ISO 14001 (Balasubramaniam, 2012). Some organisations find it is challenging for them to adopt green supply chain initiatives due to competition and uncertainty (Balasubramaniam, 2012). This is due to construction sector provides high competition between each other. Besides, the nature of industry is uncertain due to possibility for the project to delay, oh hold or cancel and affected directly from the economic crisis and down turn.

2.9 OVERVIEW OF GREEN SUPPLY CHAIN MANAGEMENT (GSCM) IN MALAYSIAN CONSTRUCTION INDUSTRY

In developing countries such as Malaysia, the level of urbanization is still rising and expected to reach 83% in the year of 2030 (Musa et al., 2011). Acknowledging that Malaysia's tropical climate presents its own set of challenges for builders, the industry finally developed its own assessment and registration system (Kaye, 2011). The government, professional bodies and private companies nowadays are beginning to take heed in the necessity to reduce the environmental problem without restraining the need for development (Abidin, 2009). Although the country's green industry is still at its early stage of development, many key participants in the country's real estate sector have starting to become responsible in adopting sustainable

building practices and other related initiatives in order to play a proactive role in mitigating the climate change (Ellis, 2010). Examples of initiatives adopted include green buildings, green roofs, green walls and others. There is no wide literature on the use of green supply chain as one of the sustainable efforts.

In the year 2009, Malaysia had launched its own green building rating system which known as Green Building Index (Kaye, 2011). One of the criteria highlighted by GBI includes materials and resources management. Chua and Oh (2011) describe that for a building to be rated as diamond or platinum (based on GBI rating), some of the criterion that need to be fulfilled is by using an environmentally friendly material from sustainable sources, proper waste management, construction, storage and recycling. The requirements lead to the initiative of green supply chain management. However, based on literature, the most common initiative promoted by the government is green purchasing. Only few fast forward thinking companies had already taking steps to develop sustainability in their supply chains (Zailani et al., 2012). Ho et al. (2012) highlight that many of organisations in Malaysia are still struggle to understand and adopt the concept. The implementation of green supply chain management (GSCM) can be considered as still at infant stage in Malaysia construction industry.

2.10 SUMMARY

Supply chain management in construction can be explained as a process from where raw materials are converted into final products, and then delivered to the end-customer. Supply chain is said to be able to help improve efficiency and productivity of the organisations, and help reduce overall operating cost. However, despite the positive outcomes, literature highlight that stages of supply chain in construction indirectly affect the environment. This is due to the process involves extraction and exploitation of the natural resources. Waste and emissions produced during the process have become one of the main sources of serious environmental problems such as global warming and acid rain. Due to the circumstances, many researchers had come out with the idea of ‘greening’ the supply chain process. Sustainable development principles and policy had been implemented into the supply chain process. It is believed that the efforts will directly or indirectly serve as a key role in protecting and preserving the environment. The concept is being known as green supply chain management (GSCM).

GSCM can be explained as an approach which seeks on reducing and minimizing the product or service’s ecological footprint. It is similar with the traditional supply chain. However, GSCM integrates environmental management throughout the whole process of

supply chain. To implement GSCM, various kinds of initiatives can be adopted starting from the design phase until completion phase. The initiatives are (1) green product design/eco-design, (2) green purchasing, (3) green manufacturing/construction, (4) green marketing and distribution, and (5) reverse logistics. The positive outcomes of GSCM can be broadly categorized into four categories which are environmental, economic, operational and intangible outcomes. Apart from that, industry players also faced challenges in implementing the GSCM concept. The challenges are divided into internal and external challenges. Internal challenges includes in terms of financial constraint, top level commitment, lack of information, knowledge and resources. While external challenges faced include government support, rule and regulations and supplier management and commitment.



CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter explains in detail the research methodology undertaken to complete this research. According to Sekaran (1992), research can be described as a systematic and organized effort to investigate a specific problem that needs a solution. He also adds that it consists of a series of steps designed and followed, with the goal of finding answers to the issues. The steps involve are collecting data by means of various methods, processing and analyzing the data collected. The details of steps done in every stage will be explained later in this chapter. All this series of steps are being carried out systematically, diligently, critically, objectively and logically. Rather than that, research methods also will be carried out. A research method refers to the ways in which research studies are designed and the procedures by which data are analyzed (Sekaran, 1992).

Basically for this research, the data collected will be both qualitative and quantitative data. The data will be in the form of words and observations and also numerical data. As for the method of data collection use for this research, it is divided into two types which are primary and secondary data. For the primary data, semi-structured interview and questionnaire survey are chosen as the data collection method. Observation had been done to identify the current project in the nowadays construction industry that implement the green supply chain management concept. Apart from that, questionnaire is being designed and distributed into several numbers of selected respondents. Literature review by means of reading and extracting data from articles, journals, books and websites are also being conducted in order to meet the objective highlighted.

3.2 RESEARCH METHODOLOGY FLOWCHART

The flowchart can be refers as a research process where it consists of several different stages involved during carrying out the research. The research process is systematic in defining the objective, managing the data, and communicating the findings occur within established

framework and in accordance with existing guidelines (Williams, 2007). According to Rasmuson (2012), the research process involves identifying, locating, accessing, analyzing and then developing and expressing your ideas. It is somehow like a step by step process on how to develop a research paper. Generally, the research methodology for this study consists of three stages, which are Stage 1, Stage 2, Stage 3 and Stage 4.

3.2.1 Stage 1: Topic Selection & Proposal

Generally, this stage is being carried out by doing some readings on the related topic to the Green Supply Chain Management. Readings were carried out from books, journals, articles or any websites from the internet. After selection of topic had been done, it was preceded with the determination of problem statements, objectives and scope of the study. The scope of study means the limitation of this research. While the objectives of the study are as follows:

- i. To investigate the awareness level of industry players towards green supply chain management (GSCM) concept in the construction industry
- ii. To identify the current implementations of green supply chain management (GSCM) in the Malaysian construction industry
- iii. To analyse the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice

In order to meet the objectives highlighted earlier, the scope of study focus on the industry players either contractor or consultant who normally involve in the supply chain process.

3.2.2 Stage 2: Data Collection

In stage two (2), the process involve is the data collection process. This process is to be carried out in various ways by means of collecting both primary and secondary data. Primary data can be explained as the data that collected by self and specifically for the purpose of research. It is being done by using the primary data collection methods available such as questionnaire, interviews, observations and others. As for this research, the questionnaire is designed in order to collect the primary data. The questionnaire survey will be distributed to few numbers of respondents. The respondents selected for this research are contractors and consultants (architect, engineer and quantity surveyor) who practices in the Selangor and Klang valley area.

Semi-structured interview will also be conducted to organizations in the construction industry that have practice green supply chain management or currently involve with any Green Building Index (GBI) rated project. The purpose of interview is to identify the current implementations of green supply chain management concept in the industry together with the challenges faced during the implementation phase. Apart from that, the secondary data is also being collected. Secondary data can be explained as a data that have been already collected by and readily available from other sources (Boslaugh, 2008). Literature review is being carried out in this part. This includes reading and extracting information from various sources such as books, journals, articles and websites.

3.2.3 Stage 3: Data Analysis

After all the data being collected through stage two (2), then the data will be compiled together and being analyzed in order to produce the result. As for the primary data, it will be analyzed by using the data analyzing methods available and then will be presented in the form of figures, tables and charts. Table 3.1 shows the data analysis methods and tools that will be used in order to achieve the objectives.

Table 3.1: Data analysis methods

Data Collection Method	Analysis Method/Tools	Achievement
Questionnaire Survey	<ul style="list-style-type: none"> • Statistical Analysis • SPSS Software 	<ul style="list-style-type: none"> • Objective 1 • Objective 3
Semi-Structured Interview	<ul style="list-style-type: none"> • Content Analysis 	<ul style="list-style-type: none"> • Objective 2 • Objective 3

3.2.4 Stage 4: Report Writing

After that, the next stage in the research process will be the report writing. After all the data been collected and analyzed, the summary and conclusions will be drawn up. Apart from that, some recommendations will be done for the purpose of the future research. The analysis done must met the objectives highlighted earlier. Finally, the report will be formatted

accordingly. Figure 3.1 illustrates the stages or processes of research methodology adopted in this research in order to achieve the objectives.

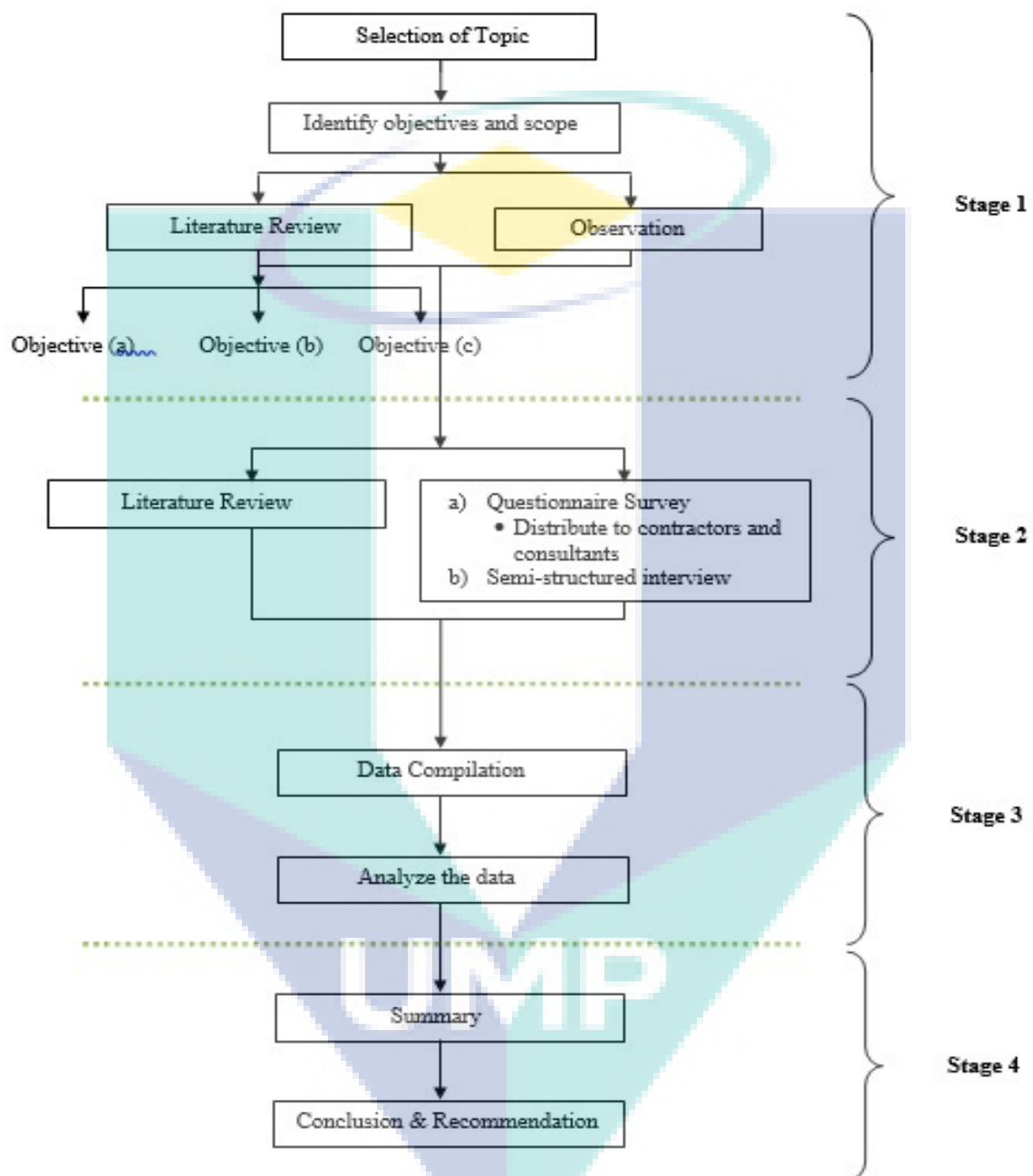


Figure 3.1: Flow Chart of Research

3.3 RESEARCH QUESTION

Research question can be explained as a formal statement of the goal of a study and it basically states clearly what the study will investigate or attempt to prove. According to

Williams (2007), research questions helps researcher to focus thoughts, manage efforts, and choose the appropriate approach, or perspective from which to make sense of each phenomenon of interest. The research question normally will be in the form of logical statement that derived from what is known or believed during literature review. The research questions for this study are developed according to the objectives and literature review done before. Some examples of the research questions are as in Table 3.2.

Table 3.2: Research questions

Objective 1: Awareness level	Objective 2: Current implementations	Objective 3: Challenges
Do the industry players aware about the concept of green supply chain management (GSCM) in construction industry?	What are the current implementations of green supply chain management (GSCM) in the Malaysian construction industry?	What are the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice?

3.4 QUESTIONNAIRE DEVELOPMENT

Basically, there is no theoretical base or guidelines for the researcher on how to design a flawless questionnaire (Crawford, 2012). In this research, during the developing process of the questionnaire, few stages are involved. These stages consist of preparation of the questionnaire, distribution of the questionnaire and finally, collecting the questionnaire. Detailed processes involved in each stage were explained briefly as follows:

3.4.1 Stage 1: Preparation of Questionnaire

The first step is to decide on what are the things researcher needs to know from respondent in order to meet the research objectives. Apart from that, few questions being developed following the research objectives. After all of the questions had been prepared and organized in a proper manner of questionnaire, the final check of questionnaire will be carried out where the process involve are grouping and sequencing questions into a proper order, numbering questions, and inserting instructions (as in Appendix A).

3.4.2 Stage 2: Field Work

Before decide on distributing the questionnaire to the respondents, the population and sample of the research are also been identified. Specific numbers of sample will be selected from the construction industry to involve with this research. The respondents selected are contractors and consultants (architect, engineer and quantity surveyor). Further explanation on the sampling process will be explained in next sub-heading. Besides, the method on how to collect the responds will be identified. In order to collect the data or responds from the respondents, the questionnaires will be administered through post, facsimile, electronic mail (e-mail) and direct meeting in their office. Listing and contacting the respondents will be done in order to distribute the questionnaires.

3.4.3 Stage 3: Data Collection

This is the final stage of the process. In this stage, the completed questionnaire receipts from the respondents are examined. Data processing and analyzing will be done in order to complete the research and met the objective highlighted. Figure 3.2 illustrates the stages involve in developing the questionnaire in order to meet the objectives outlined for this research.

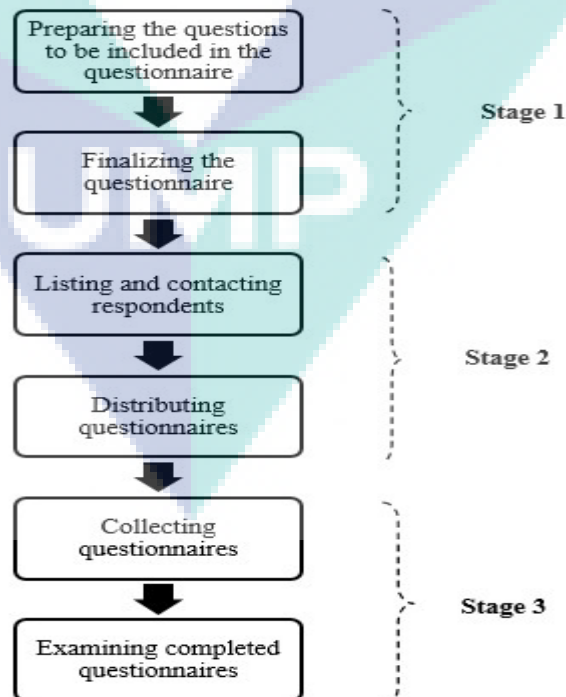


Figure 3.2: Flowchart of process of developing the questionnaire

3.5 SAMPLING

According to Sekaran (1992), sampling is the process of selecting a sufficient number of elements from the population so that by studying the sample, and understanding the properties or the characteristics of sample subjects, researcher will be able to generalize the properties or characteristics of the population elements. He also adds that the reasons of using a sample rather than collecting data from the entire population are fairly obvious since it would be practically impossible to collect data from the whole population.

There are two types of sampling designs which are probability sampling and non-probability sampling. As explain by Elder (2009), probability samples are also known as random sample and it is the most accurate of the sample selection methods. Usually, when using probability sampling, each element in the population has a known and non-zero chance of being selected into the sample (Elder, 2009). Where for non-probability sampling, in contrast, the elements in the population do not have any probabilities attached to their being chosen as sample subjects (Sekaran, 1992). Each of these two types of sampling designs has different sampling approaches (Table 3.6).

Table 3.3: Sampling techniques

PROBABILITY SAMPLING	NON-PROBABILITY SAMPLING
Simple Random Sampling	Convenience Sampling
Systematic Sampling	Judgment Sampling
Stratified Random Sampling	Quota Sampling
Cluster Sampling	Purposive Sampling

3.5.1 Sampling Technique

In order to collect the data, the technique use for this study is probability sampling with approach using stratified random sampling. Stratified random sampling, as its name implies, involves a process of stratification or segregation, followed by random selection of subject from each stratum (Sekaran, 1992). This means the populations are divided into smaller group

known as stratum. The stratum then are formed based on the members or elements characteristics. As for this research, the population is the construction's industry players. Since the population is too big and impossible to get the data from the whole population, then the stratified process is done. The population is divided into two stratum which are Contractor and Consultants.

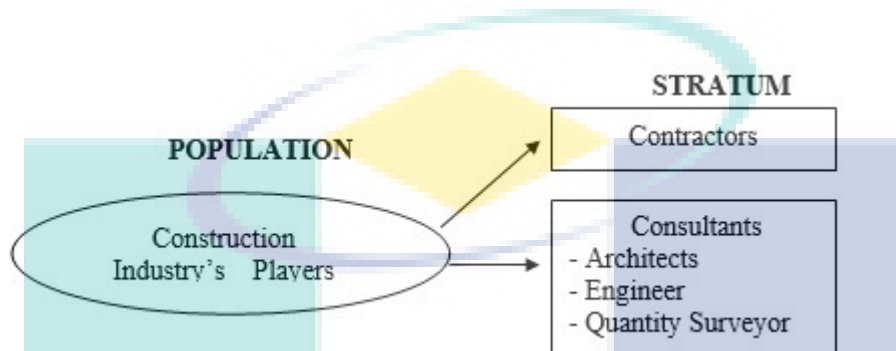


Figure 3.3: Sampling process for questionnaire survey

Whereas for semi-structured interview, purposive sampling techniques is being implemented. In purposive sampling, researchers intentionally select individuals and sites to learn or understand the central phenomenon. In a qualitative study, researcher may decide to study a site or several sites, individual or groups, or some combination of both. Purposive sampling thus applies to both individuals and sites. The individuals chosen in this study are those who used to or currently involve in the green rated project in the Malaysian construction industry. Table 3.4 shows the selection process of samples for semi-structured interview.

Table 3.4: Sampling for semi-structured interview

Type of Respondents	Project A	Project B
	Targeted Interview	Targeted Interview
Main Contractor	√	√
Green Building Consultant	√	√
Architect	√	√
TOTAL	3	3

3.6 RELATED ASPECT WITH RESEARCH DESIGN

3.6.1 Research Purpose

The purpose of the research can be categorized as exploratory, descriptive and explanatory (Yin, 2003; Baxter and Jack, 2008). Table 3.8 summarized the definition of each purpose.

Table 3.5: Categories of research purpose

Exploratory Research	Descriptive Research	Explanatory Research
Used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes.	Used to describe an intervention or phenomenon and the real-life context in which it occurred.	Undertaken if seeking to answer a question that sought to explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies

Source: Yin (2003)

This research is being carried out with descriptive purpose. As its name suggest, the research seeks to provide an accurate description of the adoption of green supply chain management (GSCM) in the Malaysian construction industry.

3.6.2 Type of Investigation

This research basically focuses on establishing the level of adoption of green supply chain management (GSCM) in the Malaysian construction industry. Therefore, it will mainly identify the critical variables and important factors that associated with the research problems, rather than establishing a cause and effect relationship.

3.6.3 Study Setting

According to Sekaran (2003), research studies can be conducted either in non-contrived setting, or in artificial and contrived setting. A non-contrived setting is the natural environment; where the investigated event happens in the way they normally occur. By contrast, contrived setting is explained as an artificial environment created for the purpose of research and the event is strictly controlled. Therefore, for this research, the study setting is non-contrived since

the researcher will follow the normal flow of the construction industry players' roles and services in supply chain management.

3.6.4 Time Horizon

As research resources and time availability is limited, it is not possible to do a longitudinal study. This is due to longitudinal study requires data to be collected from the same sample unit at multiple points in time or a time series of observations (Pamulu, 2010). Hence this study is carried out as a cross-sectional study at a single point of time. Data are gathered over short period of time in order to answer the research questions. In contrast to longitudinal study, cross-sectional study requires less time and cost thus it will be available to meet the timeframe given to complete the research.

3.6.5 Unit of Analysis

Reyna (2013) define unit of analysis as the major entity that is going to be analysed in the research. For instance, unit of analysis in a study can be individuals, groups, institutions, societies and others. The unit of analysis for this research is individuals. The samples selected are the construction industry players such as contractors and consultants (architect, quantity surveyor and engineer) who are directly involved in the supply chain process. Their responses are representing on behalf of their opinions and experiences.

3.6.6 Extent of Researcher Interference with the Study

The research is being conducted in the natural environment of the organisations with minimal interference of the researcher (Sekaran, 2010). The researcher has no intention in changing the normal flow of professionalism of professionals been interviewed. Their opinions, answers, ideas and responses are collected and considered as representing their own situation.

3.7 SUMMARY

According to Leedy and Omrod (2001), research can be explained as a process of collecting, analyzing, and interpreting the data in order to understand such a phenomenon. Each

research method is designed to explore specific research questions and attempts to address the post positivist approach of challenging the traditional belief of absolute truth (Williams, 2007). He also adds that the research will be carried out according to established framework or guidelines. The functions of framework or guidelines is to provide the researchers with an indication on what to include in the research, how to perform the research, and what types of inferences are probable based on the data collected (Williams, 2007).

As for this study, the research starts with originating the research questions. The questions originated must be related to the green supply chain management and developed based on the literature review done. Apart from that, during preparing for this research, there are four stages involved including topic selection and proposal, data collection, data analyzing and dissertation writing. The final stage of dissertation writing includes making conclusions from the whole data that had been collected and analyzed then come up with recommendations regarding the green supply chain management in Malaysia Construction Industry.

Furthermore, for this study, the methodology adopted will be both quantitative and qualitative research method. First method is using questionnaire survey to collect the data. The questionnaire will be sent through various approaches to the respondents consists of Contractors and Consultants. Next method is conducting a semi-structured interview to any individuals that used to or currently involve with any project that use the concept of green supply chain management around Selangor and Klang Valley. This is especially for the projects that use Green Building Index (GBI) rating system.

The logo of Universiti Malaysia Perlis (Ump) is a large, stylized letter 'U' composed of several overlapping triangles in shades of teal, light blue, and yellow. The letters 'UMP' are printed in white, bold, sans-serif font across the center of the 'U' shape.

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CHAPTER 4

DATA ANALYSIS AND FINDINGS

4.1 INTRODUCTION

Chapter 4 presents the results and discussion of the survey and semi-structured interview conducted in this study. Data analysis is carried out using several test from SPSS version 22 software for Windows. Discussion of the results of survey conducted is divided into several sections. This chapter starts with present about the profile of the company and the background of the respondents involved in this research. Next, to find out the status of organization environmental awareness and concern on GSCM, the awareness level, understanding and knowledge of the respondents regarding green supply chain definition, concept, initiatives and outcomes and also the challenges faced by the respondents in implementing green supply chain management (GSCM). Meanwhile, a series of semi-structured interviews were conducted to assure whether the variables found from literature has been implemented or not in the Malaysian construction industry. Besides, any new variables can be extracted too based on the experiences of the respondents.

4.2 METHOD OF DATA ANALYSIS

Sekaran (2010) highlights that the frequency distribution analysis is important in order to obtain all data regarding the personal background or data with classification variables. For this study, frequency distribution is being used to analyses data collected in Section A and B of the questionnaire. Data collected is being presented according to the respondent's nature of work. This was due to the research focus on the individual players involved in the Malaysian construction industry. In the questions that require detail analysis to be done, cross-tabulation method was adapted. For Section C and D of questionnaire, mean will be calculated by means of SPSS.

4.3 RESPONDENT'S BACKGROUND AND COMPANY PROFILE

This chapter describes the background of the respondents This includes nature of their company, working experience, type of project currently involved and also their experience on green projects.

4.3.1 The Respondent Company's Profile

A total 160 numbers of questionnaires have been distributed to selected players that involved in the Malaysian Construction Industry. The parties were Architect, Engineer, Quantity Surveyor and Contractor. From 160 questionnaires distributed, only 50 of the questionnaires replied by the respondents. 14 questionnaires received from contractor, 13 questionnaires from both Architect and Quantity Surveyor respectively and ten (10) questionnaires from the Engineer.

From Figure 4.1, it can be concluded that although most of the responses were received from the contractor where the percentage was the highest with 28%, the rest of the disciplines are very much close to one another. While both Architect and Quantity Surveyor percentage of responses were equal which were 26%. The least responses were received from Civil and Structural Engineer where the percentage of responses was only 20%. All the respondents managed to answer the entire question in the questionnaire without missing value. As mention by Saunders et al. (2007), an average response rate of 30% to 40% is considered as reasonable for a delivered and collated method.

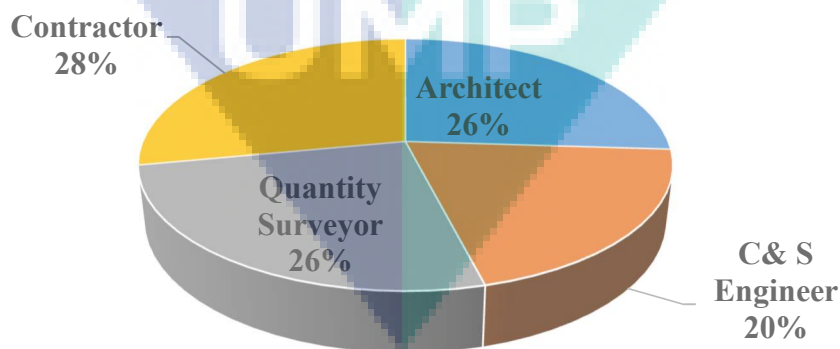


Figure 4.1: Percentage of the respondents

In addition, Figure 4.2 shows that from 50 numbers of respondents, almost half of the respondents (23 respondents) which indicate 46% of the total respondents have working experience from five to ten years. This is followed by 14 numbers of them which explained 28% of the total numbers of respondents that have less than five years of working experience. Meanwhile only 13 numbers of respondents which carried 26% out of all respondents have the working experience more than ten (10) years.

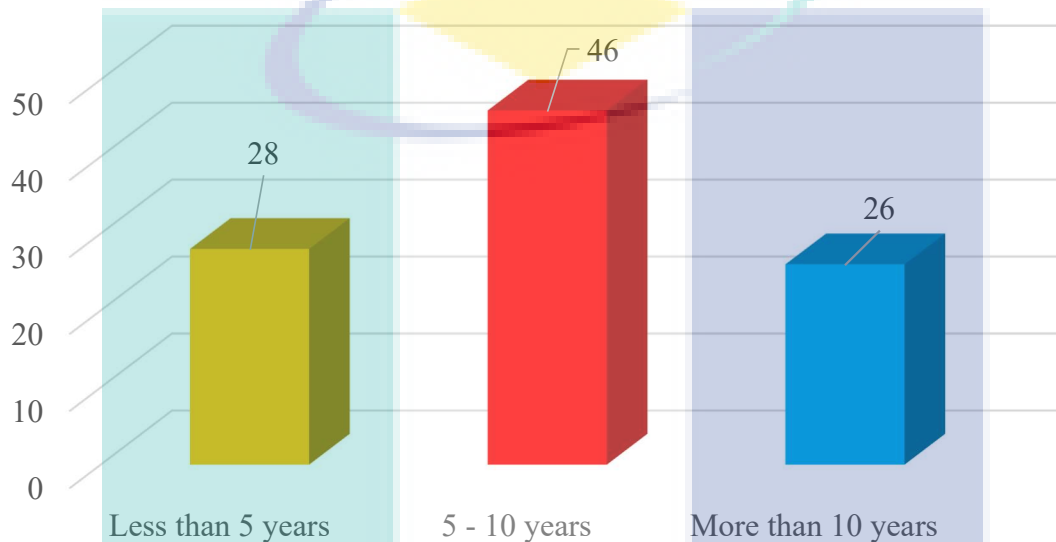


Figure 4.2: Respondents' working experience

It can be summarized that most of the respondents for this research have been working for five to ten years. Five to ten years working experience can be classified as having medium experienced in the industry. The more working experience the respondents have, then the knowledge they had regarding the supply chain management in the construction industry can be considered to be strong. However, it does not mean that they have more knowledge or expert in green concept and technologies. This was due to the green concept is still relatively new and developing in the Malaysian construction industry (Ho et al., 2012).

From Figure 4.3, it can be seen that the respondents had been involved mostly with residential project. This is shown where the frequency and percentage of the residential type of project was the highest with 18 numbers of respondents, 36% of the total respondents. This was followed by commercial type of project as the second highest with 28%. Apart from that, five (5) numbers of respondents were involved with both industrial and institutional type of project respectively. On the other hand, eight (8) numbers of respondents which indicate 16%

of their totals were involved with other types of project. Other types of project include civil engineering projects.

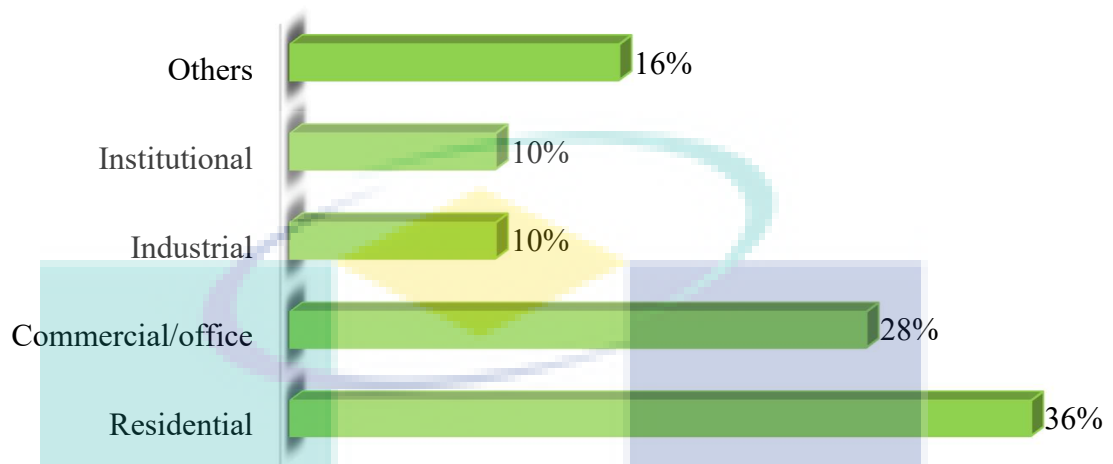


Figure 4.3: Types of project involved

Supply chain can be explained as the interconnected series of activities concerned with the planning and controlling of the raw materials, components and finished products from supplier to the final customer (Stevans, 1989). Thus, it can be simplify that supply chain exists in the development process of any products no matter what kind of the product it is. Construction industry is very broad and consists of various kinds of projects such as residential, non-residential and civil engineering projects. As long as the person involved in the construction industry then they will involve with the supply chain network. Thus, it is believed that all the respondents are familiar and involve with the supply chain process no matter what type of projects they involved.

In this question, respondents were asked whether they have been involved in any green projects or not. According to Figure 4.4, amongst all of the respondents, 70% of them were used to involve with the green projects previously. While the rest 30% never had any experience in any of green projects. Out of 70% of the respondents who used to involve with green projects, 12 of them were contractor, followed by ten (10) numbers of architect and seven (7) numbers of quantity surveyor. The least numbers of respondents who had experience involving in green projects were civil and structural engineer with only six (6) of them.

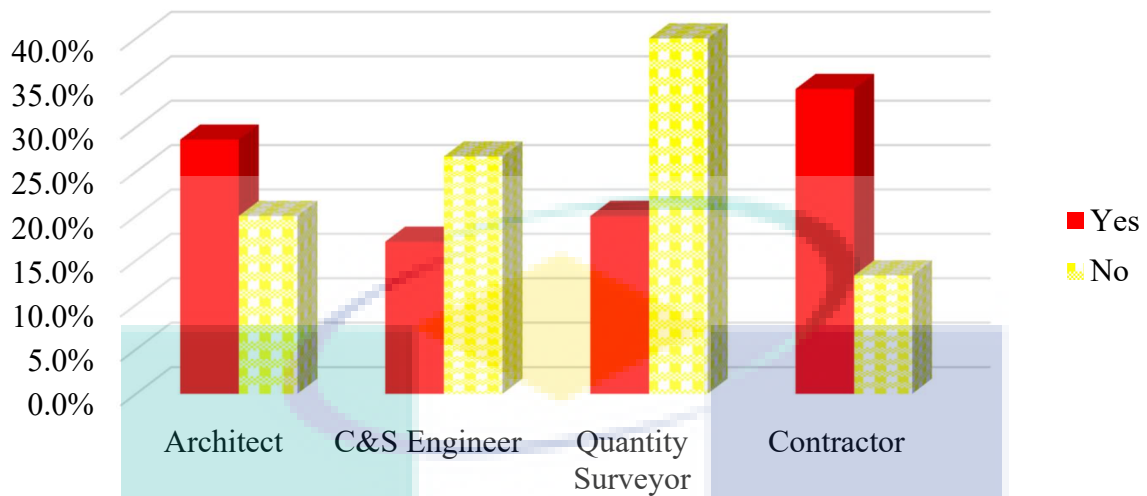


Figure 4.4: Nature of work & involvement in green projects cross-tabulation

The reason why there were still many industry players who have no experience in green projects were due to still not many organization in Malaysian construction industry who involve in green projects. According to Richardson and Lynes (2007), the reason on why there were not many organisations involved with green projects was due to the financial barriers. Even though it was agreed that green projects may help in reducing the life cycle and maintenance cost, but the perception that green projects incur higher initial costs restrict them from involving in this kind of projects.

4.4 ORGANISATION ENVIRONMENTAL AWARENESS AND CONCERN

Table 4.1 shows that out of 50 respondents, 41 respondents (82%) did consider the environment when making the strategic decision. 34.1% of the 41 respondents came from the contractor. All of the contractor take into consideration the environmental issues when making strategic decision. This was followed by architect with 10 respondents (24.4%) who answered yes too. Quantity surveyor ranked as third with nine (9) respondents while civil and structural engineer ranked the last with eight (8) respondents. Quantity surveyor and civil and structural engineer accounted 22% and 19.5% respectively from the totaled 41 respondents who answered yes to the question.

Table 4.1: Nature of work & environmental concern

Nature of work	Environmental concern		
	YES	NO	Total
Architect	3	10	13
Engineer	2	8	10
Quantity Surveyor	4	9	13
Contractor	0	14	14

The respondents then were further asked for how long they had already considered environmental aspects in their strategic decision-making process. Based on Table 4.2, out of 41 respondents, 34.1% (14 respondents) had been considering it for between three (3) to five (5) years. This was followed by 29.3% (12 respondents) for between one (1) to three (3) years and 19.5% (8 respondents) for less than one year. Only 17.1% (7 respondents) had been considering the environmental aspects in their decision-making process for more than five (5) years.

Table 4.2: Period of taking environmental consideration when making strategic decision

Group	Nature of work	Environmental consideration	
		Frequency	Percentage
1	Less than 1 year	8	19.5
2	1 - 3 years	12	29.3
3	3 - 5 years	14	34.1
4	More than 5 years	7	17.1

Next, respondents were asked either their organization have a department dedicated to environmental issues. Table 4.3 shows that from 50 respondents, 44% (22 respondents) of the respondents'. While the other 56% respondents' organisations have no specific department dedicated to environmental issues. Out of 44% respondents who answer yes to the question, most of them (nine respondents) were contractor, followed by the second highest were civil and structural engineer with five (5) numbers of respondents. While both architect and quantity surveyor consists of four (4) respondents respectively.

Table 4.3: Nature of work & environmental department

Nature of work	Environmental department	
	YES	NO
Architect	18.2%	32.1%
Engineer	22.7%	17.9%
Quantity Surveyor	18.2%	32.1%
Contractor	40.9%	17.9%

Only 24 respondents which totaled 48% from the total numbers of respondents whose organisations implement the Environmental Management System (EMS). Most of the respondents who implement Environmental Management System (EMS) in their organisations were contractor. This is shown where the frequency and percentage for this group of respondents were the highest with ten (10) respondents (41.7%) answered yes. Both architect and quantity surveyor were the second highest with five (5) numbers of respondents respectively. While civil and structural engineer ranked the last with only four (4) respondents answered yes.

The respondents were asked whether the organisations they associated with did practice the green supply chain management (GSCM) concept or not. Forty percent of the totaled respondents were working with the organisations that practice green supply chain management (GSCM) concept. From that totaled amount of percentage, seven (7) of them were contractor, five (5) were both architect and civil and structural engineer respectively while the least numbers of respondents (three) was quantity surveyor. 60% of the respondents were working with organisation that did not practice the green supply chain management (GSCM) concept.

It can be summarized that more than 50% of the respondents were working with the organisations that have no specific department dedicated to environmental issues and did not practice Environmental Management System (EMS). However, despite of working in that kind of environment, almost 80% of the respondents factor environmental concerns when making a strategic decision. According to the report produce by Bearingpoint (2008), this high level of consideration is the organisations evidence of a wider awareness towards environment. This will drive the organisations and their subordinates, if not to act, at least express an interest in the environment. Organisations effort will definitely influence their subordinate's awareness level.

Apart from that, mostly the organisations that have high concern for environmental issues will actually take into account of this into the management of their supply chain

(Bearingpoint, 2008). However, the finding seems to be contradicting with the literature review. Even though most of the respondents were allied with organisations that factored environmental concern into their strategic decision-making process, but still not many of them implement the green supply chain management (GSCM) concept in their practice. For respondents who answer yes to the question, they were further asked on what drives their organisations to adopt the GSCM concept and practice. Figure 4.5, highlighted that more than half of the respondents (75%) practice green supply chain management (GSCM) due to comply with the regulations. While two (2) respondents (10%) practice GSCM respectively due to pressure from client and by volunteering themselves. Only one (1) respondent accounted at 5% of totaled respondents practice GSCM due to pressure from the competitors.

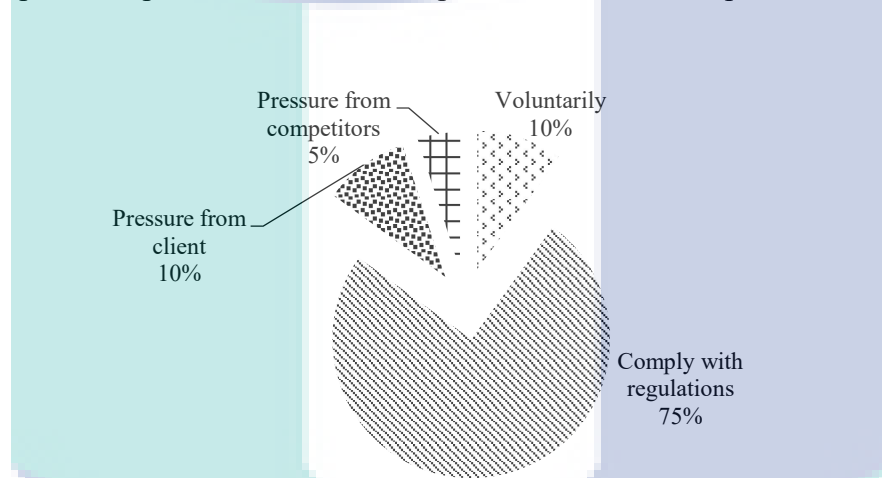


Figure 4.5: Reasons for the organisations to implement GSCM

The findings is in lieu with the literature review that many organisations get involved in the green supply chain management (GSCM) just to avoid violations of regulatory law (Min and Galle, 2001). Besides, Rao (2002) also notes that the adoption of Green Supply Chain Management (GSCM) is encouraged by the government and market forces. Zhu and Sarkis (2004) also mention that one of the drivers to implement green supply chain management (GSCM) is competitive and regulatory pressures. From the discussion above, it seems that the organisations in Malaysian construction industry adopt GSCM practice in order to comply with the regulations. Since the adoption was merely due to external factors, the awareness level of the industry players towards GSCM are being queries.

4.5 CHALLENGES FACED IN IMPLEMENTING GREEN SUPPLY CHAIN MANAGEMENT (GSCM)

Figure 4.6 shows the ranking of mean score for the variables under the challenges Pertaining to the implementation of green supply chain management (GSCM). The variables were divided into two categories: the topmost of the chart were internal challenges whilst below shows the external challenges. All of the respondents seem to agree with the variables from the literature review. In terms of internal challenges, the most significant variable was leadership and commitment from top management. The variable recorded highest mean score between both categories which was 3.88. Where for external challenges, the most significant challenges faced by the construction industry players was due to lack in government support and regulations. Amongst all of the variables, availability of green products and materials and collaboration and management of third party recorded the lowest mean score which were 3.56.

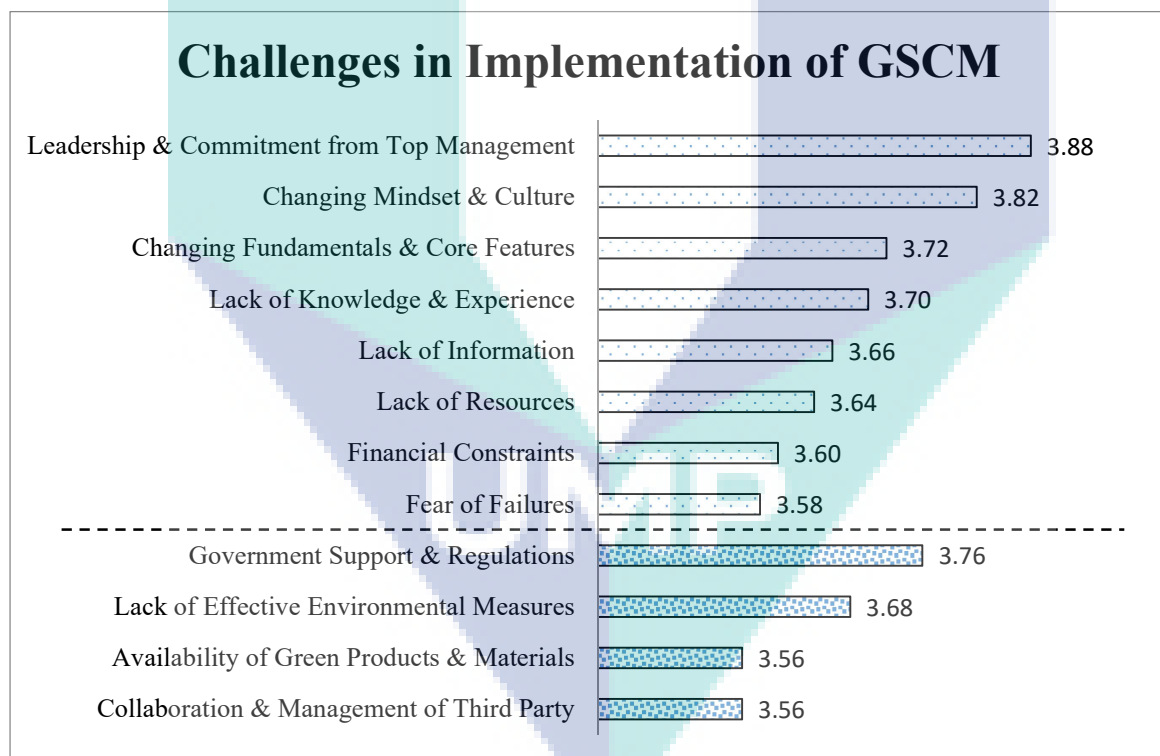


Figure 4.6: Overall ranking of mean score for challenges faced in implementing GSCM

The finding was in line with the literature review. Khidir and Zailani (2009) explain that engaging in environmental management in the supply chain involves two types of cost;

direct cost and transaction cost. Even though GSCM may lead to increase in economic performance and boost profitability, green supply chain involve higher operation costs thus hinder the adoption of it amongst the organisations in the construction industry (Min and Galle, 2001; Walker et al., 2008; Varnas et al., 2009; Khidir and Zailani, 2009; Balasubramaniam, 2012; Mathiyazhagan et al., 2013).

The finding shows that all of the respondents agree that one of the internal challenges faced by them was difficulty in changing the mindset and culture of the organisation itself. It is not easy to incorporate new culture in adopting innovative ideas and technology to the organisation (Khidir and Zailani, 2009; Balasubramaniam, 2013). Green supply chain management (GSCM) can be considered as still new in our construction industry. Therefore, not many of the industry players or organisations willing to change their culture of working and practice in order to suit with the new management practice.

The finding shows that all of the respondents agree that it was not easy for them to implement green supply chain management (GSCM). One of the internal challenges faced by them includes difficulty in changing the fundamentals and core of the organisation. The finding is in line with the literature where according to Khidir and Zailani (2009), organizational fundamentals and cores serve as one of the barriers to successfully implement GSCM. It is not easy for an organisation to change their organizational goals, forms of authority, core technology and operational and marketing strategy (Khidir and Zailani, 2009).

Respondents were required to rate their level of agreement whether lack resources served as challenges for implementation of GSCM or not. All of the respondents agreed that one of the reasons that hinders the adoption of GSCM was due to lacking in resources regarding environmental management. Total mean score for the variable was 3.64.

The finding was in lieu with the literature review conducted earlier. Lack of resources includes lack in the technical expertise available, new technology, materials and processes (Ofori et al., 2000; Perron, 2005; Mathiyazhagan, 2013). Lack of technical expertise can be explained as technical support available in the industry is not updated and unable to find an alternative way to design a pollution-free product to fulfill environment requirements.

The finding shows that all of the respondents; architect, civil and structural engineer, quantity surveyor and contractor agreed that one of the challenges faced in implementing green supply chain management (GSCM) was lacking in information regarding standardization and control of environmental management. The problems include lack in the establishment of proper environmental management system and informational flows of process and procedures (Rao and Holt, 2005; Perron, 2005; Khidir and Zailani, 2009, Balasubramaniam, 2012)

From the finding, it can be summarized that all of the respondents agreed that level of knowledge and experience served as challenges for them to implement green supply chain management (GSCM). Some of the industry players refuse to implement GSCM because of little knowledge they had on the environmental impacts on supply chain process and measures to mitigate the impacts (Mathiyazhagan et al., 2013).

The finding was in line with the literature review where according to Balasubramaniam (2012), top management support and commitment plays a big role in implementing successful GSCM. Mathiyazhagan (2013) also adds that some of the top management resisted in changing the existing practice, information and habits to the new sustainable supply chain practice since it involved a lot of costs and time.

The finding was in lieu with the literature review conducted before. Mathiyazhagan et al. (2013) in his research state that one of the reasons that hinder the industry players or organisations to implement green supply chain management (GSCM) is due to the fear of failures. Most of them fear that once they adopt green supply chain management (GSCM) concept, it could lead to monetary losses for the organisations particularly hence leading to losing the competitive advantage (Rao and Holt, 2005; Mathiyazhagan, 2013).

From the finding, it can be summarized that government plays a big role in encouraging the implementation of green supply chain management (GSCM). As explained by Khidir and Zailani (2009), there is limited institutional support for the ideas embodied in environmental management. Besides, there is not much efforts by the government regarding the legislation and regulation with regards to environmental practice (Mathiyazhagan, 2013).

However, contradict with Kaye (2011), since the launched of Green Building Index in Malaysia in the year 2009, various efforts had been taken by the government and professional bodies in adopting sustainable building practice. The efforts include establishment of green guidelines, tax exemption and others.

The finding shows that all of the respondents agree that difficulty in the collaboration and management of third party also served as a challenge to implement GSCM. This is in line with the literature that it is difficult to manage and ensure high commitment from the third party such as sub-contractor and supplier to implement GSCM (Sarkis, 2003; Mathiyazhagan, 2013). Many of them are still reluctant to change their environmental information, management and practice.

The finding is in line with the literature review. Trigos (2007) highlights that the availability of green products and materials in the market nowadays also serve as factor that hinders the implementation of green supply chain. Aside from being limited, green products

may also not always be available (Varnas et al., 2009). Apart from that, there is not much materials used in the construction industry that can meet the green requirements. Only few products that can be considered as ‘green’ and made from recyclable content with the purpose for recycle (Varnas et al., 2009).

The finding suggests that all of the respondents agree that one of external challenge to implement GSCM is lack of effective environmental management measures. Balasubramaniam (2012) in his research highlights that the measures include training and development, sustainable auditing and certifications method like ISO 14001. These measures are essential in implementing and maintaining the green concept in the industry (Mathiyazhagan, 2013).

4.6 GREEN SUPPLY CHAIN MANAGEMENT (GSCM) CONCEPT AND PRACTICES IMPELEMENTATION

This section highlights on the analysis of the data gathered from the semi-structured interviews that have been conducted among the construction industry players. This interview was conducted to investigate the measures and initiative of the respondents in implementing green supply chain management (GSCM) concept and practices (second research objective). These includes measures undertaken by the respondents in practicing green design, green purchasing, supplier involvement and evaluation together with green manufacturing. Different designation background of respondents will be having different measures and initiative.

Table 4.5 elucidates the sampling of the respondents that have been successfully interviewed by the researcher. The respondents are categorized into two based on the project; project A and B. Both projects were a commercial and office project and come from two different organisations. The data collected were analysed by using content analysis technique.

Table 4.5: Background of respondents

Project’s Background	Respondents’ Code	Designation	Years of Experience
Project A Commercial and office building located in Shah Alam, Selangor. The project is still under construction and aiming for platinum rating.	A1	Snr. Engineer Sustainability and Energy (<i>GBI Consultant</i>)	15 years
	A2	Project Manager/GBI Coordinator (<i>Main Contractor</i>)	8 years
Project B Commercial and office building located in	B1	Mechanical/Environmental & Sustainable Design Engineer (<i>GBI Consultant</i>)	5 years

Klang Valley. The project has been completed and achieved silver rating.	B2	Snr. Project Manager (Main Contractor)	15 years
	B3	Architect	5 years

The overall results of the interview session have been summarized in a Table 4.6. The interview session was conducted based on the interview questions that have been drawn up earlier. However, the interview was not too rigid and can always deviate from it. Most of the interviewees which have vast experiences in handling green projects have given more information and ideas regarding the research topic.

Green Design/Eco-design

Green design can be explained as the integration of environmental aspects into the design of the building and its entire flow of supply chain. The aim of producing an eco-design is to minimize the development's environmental impacts starting from the acquiring process of the material, to construction or manufacturing, use and final disposal. Since design phase is the most initial phase in the construction supply chain, environmental consideration at this stage is very crucial. Based on the interview, the basic eco-design activities in the Malaysian construction industry can be summarized as follows:

a) Design for reduction or elimination of environmentally-hazardous materials

Based on the interview, Respondents A1, B1 and B3 agreed that one of the important criteria to consider when preparing the design is the type of materials to be used for the design. The materials selected for the design must especially in the long run, do not react easily with the atmosphere within the building. This was due to this kind of materials, if not being treated from the early stage, will cause significant effects towards the building users' health. Respondent A1 highlighted that some example of the materials that can easily cause chemical reactions to happen includes carpet, pipe fittings and painting. Thus, during the design stage, it is important for the design team to consider all of the materials to be used later for these elements.

b) Design for resource efficiency (Energy and material)

Based on the interviews, both projects were focusing on achieving the energy efficiency of the buildings. According to Respondents B1:

“Green projects will normally follow the assessment criteria highlighted in the GBI requirements. There are six aspects of criteria in order to achieve green rating which includes

energy efficiency, indoor environmental quality, sustainable site planning and management, water efficiency and innovation. Each criterion have own point and have what is the do's and don'ts. Most projects will focus on energy efficiency since it has the highest score point to achieve the rating”

Basically, Respondent B1 was explaining on why most of the green projects in Malaysia were focusing on the energy efficiency. This was due to energy efficiency provides the highest maximum score for the building to achieve green rating. Design prepared for the development must consider the energy that is to be consumed by the building. Respondents A1 highlighted that the considerations include the material used particularly for building envelope and the building coordination itself. Material used for building envelope such as glass may have different heat absorption and solar reflective rate thus it is important to select the most suitable material. Whilst for building coordination, Respondent A1 explained on the impact of the sun and wind to the building and allowance for natural ventilation.

Apart from that, Respondent B1 emphasised that energy efficiency focused on the mechanical and electrical appliances designed for the building. He also added that for Project B, digital power meter is placed in order to measure the capacity of energy being used in each floor. Respondent B3 added that each of the design developed will go through various simulations to measure the efficiency rate being produced by both the design and mechanical and electrical appliances proposed.

c) Design for reuse, recycle or remanufacturing (renovation or re-construction)

Based on the interviews, both projects did not implement the approach of designing for reuse, recycle or remanufacturing. As explained by Respondent A1:

“It is not easy to modify or expand or renovate the building in the future. It will affect the entire building integration concept of natural airflow.”

Respondent A1 emphasised that for a green building, it was not easy to allow for renovation or reconstruction. During the design stage, the building coordination has been determined in order to allow for natural ventilation and impact of the sun and wind to the indoor parts of the building. The position of the building itself will create wind and air circulation in the building which may lead to reduction of energy consumption. Thus, it was not easy to modify the building since it will affect this entire integration concept. Whilst according to Respondent B3:

“The approach is more on the recycling or reused of the product. It may not be suitable for construction.”

Table 4.6: Implementation of green supply chain management (GSCM)

Descriptions	A1	A2	B1	B2	B3
Green Design/Eco-design					
Design for reduction use of hazardous materials	The materials for the design must contains low chemical reaction, incorporates materials that is reused, can be recycle. Apart from that, materials must be achievable and easy to get in order to reduce the logistic cost.	N/A	All of the materials used for the building are determined based on the design. The design need to consider that any materials to be used is environmental friendly and do not produce any chemical reaction in the future.	N/A	Yes. The design incorporates the concept to reduce the use of hazardous materials. Elimination of the materials that may contribute to chemical reaction. Materials that can be recycle and used materials.
Design for resource efficiency (Energy and material)	The design focused mainly on the energy efficiency which aims on reducing the energy consumption during the building use phase. Consideration on the building envelope especially the material used. Building coordination – the impact of the sun and wind in order to allow for natural ventilation.	N/A	The building must be energy saving so we focus on how to reduce the heat entering into the building. It focused mainly on the mechanical and electrical appliances designed for the building.	N/A	Design need to comply with the requirements from GBI and integrate all the GBI philosophy into the design. Design for resource efficiency which focused mainly on energy and material consumption. From the design, various simulations will be done to study on what the efficiency rate is produced.
Design for reuse, recycle or remanufacturing (renovation or reconstruction)	No. It is not easy to modify or expand or renovate the building in the future. It will affect the entire building integration concept of natural airflow.	N/A	No.	N/A	No, the design does not consider for reconstruction or future renovation. That is more on the recycling or reused of the product. Maybe not suitable for construction.

Descriptions	A1	A2	B1	B2	B3
Green Purchasing					
Familiarities and adoption of 'green purchasing' approach	N/A	Yes	N/A	Yes	N/A
Procurement of materials with eco-labeling	N/A	Yes	N/A	Yes	N/A
Procurement of materials from a supplier with EMS	N/A	Yes but it depends on the types of materials. As example materials where in the long run will produce chemical reaction and able to mould with the building atmosphere.	N/A	Yes	N/A
Procurement of materials from ISO certified suppliers	N/A	Yes. Also depends to types of materials.	N/A	Yes	N/A
Others	N/A	Procurement of regional materials must be within 500km from the site, and checking the supplier's Material Safety Data Sheet (MSDS)	N/A	Procurement of regional materials within 500km from the site, and checking supplier's Material Safety Data Sheet (MSDS)	
Supplier Involvement and Evaluation					
Suppliers involvement in 'green purchasing' approach	N/A	Yes	N/A	Yes	N/A
Provide specific material content requirements	N/A	Yes but it depends on the types of materials. Example: Concrete	N/A	Yes but it depends on the types of material. Example: Paint	N/A
Provide specific material content restrictions	N/A	Yes. As an example for adhesive sealant materials must have low volatile organic compound (VOC)	N/A	Not specific. As long as material does not affect the environment.	N/A

Descriptions	A1	A2	B1	B2	B3
Supplier Involvement and Evaluation (Cont'd)					
Evaluation of supplier's performances	N/A	Yes. It involves checking the suppliers MSDS, ISO and green certification. Checking of material done at the early stage of selection, constantly and at every batch of delivery throughout the project duration.	N/A	Yes. It involves checking the suppliers MSDS, ISO and green certification. List of suppliers registered into the organisation's database. Yearly assessment done to update the list of suppliers. Material checked at every batch of delivery.	N/A
Specific Performance Indicator (KPI) to the supplier	N/A	Not toward that extend.	N/A	No specific KPI, just a checklist on what that needs to be comply by the suppliers.	N/A
Provision of education or assistance to the suppliers on environmental matters	N/A	No.	N/A	No.	N/A
Green Manufacturing					
Measures undertaken to conserve environment during construction phase	N/A	Construction Waste Management Plan, Mold Reduction Prevention Plan, Environmental Management System.	N/A	Waste Management Plan, all common measures under Environmental Management System. Check and reported on monthly basis	N/A
Provision of education or assistance to the nominated sub-contractor	N/A	Yes. Create memo, awareness and workshop to the NSC, required them to provide daily report.	N/A	No.	N/A
Reverse Logistics					
Sales of excess inventories, scrap materials, used plant and equipment	N/A	No.	N/A	No.	N/A

Basically, Respondent B3 was giving his opinions regarding the approach. It is not suitable to apply the approach concept to the context of construction. This was due to the unique characteristics of construction. The construction industry supply chain is temporary and producing one-off construction projects. It is not easy to modify or reconstruct the building due to minor reasons. Besides, the output of construction normally has a life-cycle up to 60 years.

As long as the maintenance cost of the building does not exceed the cost of the new building then it can be still considered as usable.

Green Purchasing

Based on the interviews conducted with the Main Contractor for both projects, each of them were familiar with the green purchasing approach and claimed to adopt the approach in their projects. Green Purchasing can be explained as an environmentally-conscious purchasing initiatives that tries to ensure that the purchased materials meet the environmental objectives set by the organisations. The respondents were asked on the initiatives undertaken by them regarding the green purchasing approach. The variables of initiatives were gathered from the literature review conducted earlier in this research.

a) Procurement of materials with eco-labeling

From the interviews, both Respondent A2 and B2 procured materials with eco-labeling for the projects. Eco label can be defined as label which identifies the overall environmental preference of materials or products based on the life cycle considerations. It is basically an environmental certification programme that is to provide a set of environmental friendly and safe for long-term products or materials. The reasons for eco-labeling was due to the buyers may require disclosure of the environmental or safety attributes of the purchased materials. Thus, such disclosure can be achieved by using green seals and indicators of related environmental impact such as the certification system offered.

In Malaysia currently, the certification system of the materials is officially handled by SIRIM with the conjunction of Global Eco-Labeling Networks (GEN) and now have been upgraded to National Eco-Labeling Scheme. Some examples of construction materials that have eco-labeling are painting, masonry units, fiber cement board, cement and tiles.

b) Procurement of materials from supplier with Environmental Management System (EMS) and ISO certification

As shown in Table 4.6, both respondents undertake the approach of buying the materials from the supplier with Environmental Management System and certified ISO. However, according to Respondent A2:

“It depends on the types of materials. As example materials where in the long run will produce chemical reaction and able to mould with the building atmosphere. Besides, it focuses specially on the materials within the building envelope.”

Respondent A2 highlighted that the procurement of materials from the supplier with EMS however depends on the types of materials. GBI normally is more concern on the materials that is being used within the building envelope. This is especially for materials where in the long run will produce sort of chemical reaction to the environment and has the ability to cause mould within the atmosphere of that particular building. If it is not being treated from the earlier, then it will cause significant effects towards human's health.

c) Others

The respondents were asked whether is there any other approaches undertaken aside from the one extracted from the literature review. Both respondents A2 and B2 responded with the same answers. In order to comply with the GBI requirements, regional materials purchased must be harvested and manufactured within 500 kilometres from the site area. This applies especially for materials like timber. The reason was to reduce the environmental impacts during transportation and logistics phase.

Supplier Involvement and Evaluation

Supplier involvement in a green purchasing approach enables a better understanding of client and buyers needs and enhance the parties' environmental performance and encourage innovation. Based on the interviews, both respondents claimed that their suppliers involved in the construction supply chain process.

a) Provide specific material content requirements and restrictions

This includes stipulating the specific content required or restricted in the materials. As an example, the materials must have desirable green attributes such as recycled and reusable items. Both respondents seem to have adopted the initiatives. However, it still depends on the types of materials.

According to Respondent A2, for the material like concrete, the supplier was required to have at least 30% of ground granulated blast-furnace slag (GGBS) in order to ensure the concrete used on site to contains minimum 30% of recycle content that is extracted from the recycle materials. Whilst, material like adhesive sealant that is being used for carpet and pipe fittings must contains low volatile organic compound (VOC) in order to reduce chemical reaction with the atmosphere. Respondent B2 added than for paint that is to be used as external finishes, it needs to has Solar Reflective Index (SRI) to eliminate heat absorption.

b) Evaluation of suppliers' performances

Based on the interviews, the most common approaches included were checking on the supplier's ISO certification, green eco-labeling certification and Material Safety Data Sheet (MSDS). However, the evaluation process was slightly differs between the two organisations.

According to Respondent A2, few suppliers will be called to provide their quotations and materials justification. Then, study will be conducted where each of the respondents' backgrounds will be go through one by one. This includes checking the green certification of the suppliers, Material Safety Data Sheet (MSDS) and materials' contents. Once the supplier had been selected, proceed with the purchasing. Supplier's performances will be evaluated constantly throughout the project duration. Apart from that, materials delivered to site will be inspected thoroughly by the person in-charge. This was explained by Respondent A2 during the interview session.

“Every single batch of material delivery will be inspected and must be according to what was agreed earlier during the award stage. Delivery Order (DO) from the supplier for each delivery needs to match with what was claimed by them during the award and negotiation stage.”

Respondent A2 also added that the purpose of doing so was to ensure the control of quality and avoid supplier to misbehave.

Where for Respondent B2, the criterion during the selection of suppliers was basically the same, following the GBI requirements. The selection of suppliers focused mainly on the existing suppliers in the organisation's database. New supplier will be appointed in the case where existing supplier cannot comply with the green requirements. The supplier will be added to the organisation's database and the assessment of the supplier's performance is done yearly. Supplier that fails to comply with the requirements or maintain the overall performance will be omitted from the database. Similarly with Respondent A2, every batch of materials delivery will be checked and evaluated.

c) Specific Key Performance Indicator (KPI) to the suppliers

Based on the interviews, there was no specific KPI provided by both respondents' organisations to the supplier. However, Respondent B2 noted that aside from KPI, there is a specific checklist on what need to be complies by the suppliers and to evaluate their performances.

d) Provision of education and assistance to the suppliers

Similarly with KPI, both respondents' organisations do not provide specific education and assistance to the suppliers. Aside from providing specific material contents required and restrictions, there was no other approach being undertaken.

Green Manufacturing

In the context of construction industry, green manufacturing takes place during the construction phase of the building. Based on the interviews, both respondents seem to have undertaken the common approaches for construction environmental management. The approaches include Waste Management Plan (WMP), Environmental Management Plan (EMP) and for Respondent A2, one additional approach called Mold Reduction Prevention Plan (MRPP).

Environmental Management Plan (EMP) includes all the measures to reduce the waste and emission produce during the construction phase. This includes noise control, vibration control, use of less-polluting plants and equipment, minimizing the use of material, water and energy used during the construction and others. EMP mainly deals with environmental planning and control during the construction phase.

Waste Management Plan (WMP) simply aimed to improve the efficiency and profitability by promoting reuse, recycling and recovery of materials. Besides, it helps to increase the environmental awareness of the workforce and management. WMP will be implemented throughout the project duration based on the actual site condition. One specific area in the site will be specified and centralized bin is provided for waste dumping. WMP will be handed over to all nominated sub-contractor to inform them what should be done in respect to their waste. Segregation is done depending on the type of waste materials.

Mold Reduction Prevention Plan (MRPP) focused on the prevention and cleanup of mold exist within the construction site. The plan includes measures designed to protect the health of the workers and building occupants. Mold can grow virtually on anything as long as moisture, oxygen and certain temperature ranges are present. Such example can be growing on wood, paper or insulation. Prevention measures include covering all the materials on site, clean and dry wet damp spots around the site, keep heating and ventilation flowing properly. Other strategies include ensuring each truck or lorry entering the site area to be mold-free. Besides, any materials delivered on site with mold will be rejected right away.

In terms on the provision of assistance and education to the nominated sub-contractor, both respondents have different responds. Based on the interviews, Respondent A2 did provide

the assistance and education whereas it is not provided by Respondent B2. According to Respondent A2:

“Main contractor will always monitor the performance of nominated sub-contractor. Create awareness amongst them; provide assistance, workshop and presentation – showing what need to be done and consequences of not doing the right thing.”

Reverse Logistics

Based on the interviews, both respondents did not implement the approach of reverse logistics during the implementation of green supply chain management (GSCM).

4.7 SUMMARY

The research had been carried out in proper which numbers of respondents had been selected to participate in this research by answering the questionnaire given. Out of 160 numbers of questionnaire distributed, 50 numbers (31.25%) had been returned. From the analysis, 28% of the respondents were Contractor, followed by 26% were Quantity Surveyor and both architect and civil and structural engineer 20% respectively. The data collected was normally distributed. All of the respondents managed to answer the questionnaires without missing value recorded.

Data collected had been analysed by using frequency distribution method and presented in the tabulated form. Some of data were cross-tabulate to show the relationship between the data. Out of 50 respondents, 70% of them have an experience involving with green projects. Most of them were Contractor and Architect. Based on the analysis too, Contractor was the highest group that factored environmental consideration when making strategic decision, had a department specific for environment and had Environmental Management System (EMS) in their organisations. The reason might be due to the numbers of respondents for Contractor was higher than the other groups.

Section C and D of the questionnaire was focused to answer the first and third objective of the research. The attitude of the respondents towards the question was being measures using the Likert scale. From the data shown in this chapter, most of the respondents were moderately aware on the green supply chain management (GSCM) concept and agree with the variables given regarding the challenges faced in implementing green supply chain management (GSCM).

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This is the final chapter of the dissertation entitled 'Green Supply Chain Management (GSCM) in the Malaysian Construction Industry'. In this chapter, all the data that had been tabulated and analysed in the previous chapters were concluded and summarized briefly according to the objectives. The objectives of the research were as highlighted before in Chapter 1.

- i. To investigate the awareness level of industry players towards green supply chain management (GSCM) concept in the construction industry
- ii. To identify the current implementations of green supply chain management (GSCM) in the Malaysian construction industry
- iii. To analyse the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice

Rather than developing conclusion for each objective, the recommendations for a better implementation of green supply chain management (GSCM) in our country are also discussed. The recommendations are purposely to ensure continuity of the issue for effective solution and development. Besides, it is hoped that the recommendations will be able to encourage the industry players to go for this option during planning for a project. The limitations or gap that are not covered by the researcher will also be explained briefly to provide opportunities for future research.

5.2 SUMMARY OF METHOD AND RESEARCH FINDING

All of the three objectives have been attained throughout the study. In order to assess whether this research has successfully achieved its objectives or not, critical examination on each aspect of research achievement is performed against the objectives.

From the analysis that had been carried out previously, it can be concluded that all of the respondents including architect, quantity surveyor, civil and structural engineer and

contractor were moderately aware towards the GSCM concept. All of the respondents significantly aware on the environmental impacts of construction supply chain and mostly did consider the green supply chain concept in their strategic decision-making process.

However, when being asked to rate their level of awareness and understanding on the definitions, outcomes and measures under GSCM, the results were slightly lower compared to their awareness and understanding on the environmental impacts of construction supply chain. In fact, the respondents are just moderately aware about the existence of green supply chain management (GSCM) concept and practice.

Based on the findings, it is believed that respondents who used to or currently involved with green projects and attached to the organisations that implement Environmental Management System (EMS) are more likely to aware on the GSCM. However, despite the awareness, some respondents have little in-depth knowledge about the practice and concept itself.

As for the second objective, the data were collected through the semi-structured interview conducted with selected respondents who have experiences in dealing with green projects. Variables of initiatives or measures to implement GSCM that had been extracted from the literature review were then compared to the one gathered during the interviews. Initiatives of implementation for each phase of construction supply chain had been studied.

Generally, all of the green projects in the Malaysian construction industry will follow the assessment guideline provided by the Green Building Index (GBI). Particularly, because the highest maximum score point to achieve green rating is energy efficiency, thus all projects aimed at reducing the energy consumption of the building. When preparing for eco-design, the design team will significantly design for resource efficiency which includes energy and material efficiency. Besides, the design will also consider the reduction or elimination of hazardous materials used.

The next phase after green design is the purchasing of materials. The term used for the initiatives is called 'green purchasing'. Contractors are quite familiar in adopting this initiative. The procurement of the materials were mainly from the supplier with eco-labeling, implement EMS system and have a certified ISO. However, it still depends on the types of materials. Some additional initiatives aside from literature review include purchasing of material harvested and manufactured within 500 kilometers from site. This approach aimed to reduce environmental impacts from the transportation activities.

Besides, contractors also include the supplier involvement in ensuring supply chain activities is green and sustainable. This includes by providing specific material contents

requirements and restrictions to the suppliers together with evaluation of the suppliers' environmental performances. During the construction phase, contractors did implement the Environmental Management Plan (EMP), Waste Management Plan (WMP) and Mold Reduction Prevention Plan (MRPP) in reducing the environmental impacts from the construction industry. However, the initiatives of reverse logistics were not implemented.

It can be concluded that the implementation of green supply chain management (GSCM) in the Malaysian construction industry currently almost similar with the literature review. However, the implementations were still at infant stage and mainly implemented according to the GBI assessment criteria guidelines. Besides, most of the industry players who implement the practice are those who only associate with green projects.

The third objective of the research is to analyse the challenges faced by the players in adopting green supply chain practice. The findings were divided into two; based on the questionnaire survey and semi-structured interview. Challenges extracted from the interview were mainly based on the experience from the respondents who did involve in the implementation of GSCM.

Based on the survey, the challenges can be internal or external challenges. The most significant challenge was leadership and commitment from top management, followed closely by difficulties in changing the mindset and culture of the organisation. Meanwhile, for external challenges, all groups of respondents significantly agree that the lack of government support and regulations served as barriers for them to implement GSCM.

However, the findings based on the interviews seem to be contradicted with the surveys. According to the respondents who had directly involved with the implementation of GSCM, the challenges faced include facing with many players who reluctant and having lack of knowledge, experience and familiarities with green features, and difficulty in the management of supplier. Besides, other challenges include difficulty in procuring the green materials since most of them were not available in the Malaysian market. Thus, it leads to the additional cost incurred and time consuming.

The challenges pertaining the implementation of GSCM gathered from the survey and interviews were compared to the ones extracted from the literature review. All of the challenges identified seems significant and served as barriers for the industry players to implement GSCM.

The conclusions of each objectives of the research had been discussed and explained accordingly. Basically, the objective highlighted in the first chapter had been achieved from this research. From the conclusion of each objective, it can be summarized that the level of adoption of GSCM in the Malaysian construction industry was still at the development phase.

This was due to there were still many industry players who not highly aware on the concept and definitions even though they did aware on the environmental impacts on construction supply chain.

Besides, the implementation of GSCM in the Malaysian construction industry was not as a whole and restricted on several supply chain phase only. Amongst all of the industry players, contractors were the only parties who mostly involved in GSCM. However, the involvement mainly restricted to those who involved in green projects. Meanwhile, various challenges had been identified that restrict the players in adopting the concept.

Even so, this data may not be representing the actual scenarios that happen in the Malaysian construction industry. Data seems reliable for the purpose of study. This was due to the numbers of samples selected was not sufficient to represent the industry as a whole. To get a clearer picture, more rigor research needs to be conducted in the future.

5.3 RECOMMENDATION

In order to improve the implementation and adoption of green supply chain management (GSCM) concept and practice in the construction industry, several recommendations had been outlined.

i. Financial Incentives

One of the challenges in implementing GSCM was due to financial constraint. Thus, the idea of providing incentives may reduce the financial burden suffered by the players. Example of financial assistance that can be offered by the municipal of governments can be grants. Besides, a low-interest or interest-free loan can also be introduced to encourage the contractor mainly to implement the concept and practice.

ii. Development of Rules and Regulations

One of the measures for the government to ensure the implementation of GSCM as part of the construction standard is through development of rules and regulations. This can applied through mandate compulsory of GSCM approach for public or government buildings.

iii. Framework and Bechmarking System

Even though there was already Green Building Index (GBI) Rating System being used to analyse the criteria of sustainable developments, but still the implementation of GSCM does not evolve so much in this country. The government or any regulated body should interpret the

policy and regulatory framework specifically for green supply chain management (GSCM) itself. Besides, a proper guideline on how to implement GSCM should be introduced since most of the players in the construction industry does not familiar with the concept.

iv. Public Programs

In order to increase the awareness and concern level from various parties, initiatives and public programs can be conducted. Besides, reliable technical data on the implementation of GSCM need to be generated and presented. The existing Green Building Index (GBI) available in the country shall be explained more to the public particularly construction industry players in order to acknowledge them regarding the systems.

5.4 CONCLUSION

The research has been carried out to achieve the stated research objectives in the early stages of the study. The findings of this study will contribute to increase knowledge and awareness on the obstacles that may face by the construction company in GSCM. Nevertheless, no matter how sophisticated the knowledge and framework has been developed, it will barely ineffective without willingness to change and full involvement and support from all parties in the industry mainly from top management.



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The logo for UMP (Universiti Malaysia Perlis) is a large, stylized letter 'U' composed of several overlapping triangles in shades of blue, green, and yellow. The letters 'UMP' are printed in a bold, white, sans-serif font across the center of the 'U' shape.

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APPENDIX A

QUESTIONNAIRE ON THE IMPLEMENTATION OF GREEN SUPPLY CHAIN MANAGEMENT (GSCM) IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Malaysia is one of the developing countries currently experiencing a rapid economic growth through urbanization. In order to ensure sustainability in the future development, greening the supply chain with the aims to balance marketing performance with the environmental issues had been introduced these days. This survey is aimed at understanding the level of adoption of green supply chain management (GSCM) in the Malaysian construction industry.

Green supply chain management (GSCM) can be explained as an approach that integrates the environmental thinking into the supply chain management.

Section A: Background Information *(Please tick in the section allocated for your answer)*

1. Nature of work

- Architect
 Quantity Surveyor
 Contractor
 Sub-contractor

2. Working experience

- Less than 5 years
 5 - 10 years
 More than 10 years

3. Types of project currently involved

- Residential
 Commercial/Office
 Industrial
 Institutional
 Others *Please specify:* _____

4. Have you been involved in any green rated projects?

- YES
 NO
If NO, why? _____

Section B: Organisation Environmental Awareness and Concern *(Please tick in the section allocated for your answer)*

1. Does your organisation take environmental concerns into account when making strategic decision?

- YES
 NO
 Not sure

2. If YES *(in previous question)*, how long has your organisation considered environmental concerns into strategic decision making?

- Less than 1 year
 1 - 3 years
 3 - 5 years
 More than 5 years

3. Does your organisation has a department dedicated in addressing environmental issues?

- YES
 NO
 Not sure

4. Does your organisation implement Environmental Management System (EMS)?

- YES
 NO
 Not sure

5. Does your organisation practice Green Supply Chain Management (GSCM) concept?

- YES
 NO
 Not sure

6. If YES *(in previous question)*, your organisation practice GSCM concept due:

- voluntarily
 to comply with the regulations
 under pressure from client
 under pressure from competitors

Section C: Individual Environmental Awareness and Concern

(Please indicate your awareness level by encircling the number that match closest to your opinion)

	<u>Very Low</u>			<u>Excellent</u>	
	1	2	3	4	5
1. Environmental impacts of supply chain	1	2	3	4	5
2. Knowledge on green supply chain (GSCM)					
Existence of green supply chain management (GSCM) concept & practice	1	2	3	4	5
Definitions of green supply chain management (GSCM)	1	2	3	4	5
Concept of green supply chain management (GSCM)	1	2	3	4	5
3. Take into consideration the concept of GSCM when making strategic decisions	1	2	3	4	5
4. Measures and initiatives involved when practicing green supply chain	1	2	3	4	5
5. Outcomes from practicing green supply chain management concept	1	2	3	4	5

Section D: Green Supply Chain Management (GSCM) Initiatives

(Please indicate your frequency of use of the following initiatives by encircling the number that match closest to your opinion)

Part 1 & 2 are for Architect and QS while part 2, 3 & 4 are for Contractor who involved in construction phase

	<u>Never use</u>			<u>Use everytime</u>	
	1	2	3	4	5
1. Green Design					
Design of end-product for optimum consumption of material and energy	1	2	3	4	5
Design of end-product for reuse, recycle and recovery of materials	1	2	3	4	5
Design of end-product that avoid or reduce the use of hazardous materials	1	2	3	4	5
Design of end-product that reduce waste and costs	1	2	3	4	5
End-product are design and develop to meet the environmental regulation	1	2	3	4	5
End-product are design and develop for ease of dismantling and renovation	1	2	3	4	5
Co-operation and feedback with client in developing eco-design	1	2	3	4	5

Others :

2. Green Purchasing and Supplier Involvement					
Procurement of materials with eco-labelling	1	2	3	4	5
Procurement of materials mainly from ISO certified suppliers	1	2	3	4	5
Procurement of materials mainly from suppliers with recognized standards of EM	1	2	3	4	5
Provide specifications to supplier that include specified environmental requirements	1	2	3	4	5
Provide specific material content requirements to the supplier	1	2	3	4	5
Provide specific material content restrictions to the supplier	1	2	3	4	5
Provide key performance indicators to the suppliers	1	2	3	4	5
Continuous supplier compliance auditing	1	2	3	4	5

Others :

3. Green Manufacturing (Construction Phase)					
Avoid or minimize the amount of hazardous materials used during the construction	1	2	3	4	5
Reduce material, water and energy used during the construction	1	2	3	4	5
Use of less-polluting materials	1	2	3	4	5
Use of less-polluting equipments, plants or machineries	1	2	3	4	5
Minimizing the use of natural resources	1	2	3	4	5
Take into considerations the environmental issues during construction phase	1	2	3	4	5

Others :

Section E: Challenges Faced in Implementing Green Supply Chain Management (GSCM)

(Please indicate your answer by encircling the number that match closest to your opinion)

	<u>Strongly Disagree</u>			<u>Strongly Agree</u>	
	1	2	3	4	5
1. Internal Challenges					
Financial constraints (direct cost and transaction cost)	1	2	3	4	5
Changing the mindset and culture of the organisations	1	2	3	4	5
Changing the fundamentals and core features of organisation	1	2	3	4	5
Lack of technical expertise	1	2	3	4	5
Lack of new technology, materials and processes (resources)	1	2	3	4	5
Lack of information (standardization and control)	1	2	3	4	5
Knowledge and experience	1	2	3	4	5
Leadership and commitment from the top management	1	2	3	4	5
Fear of failures	1	2	3	4	5
2. External Challenges					
Government support and regulations	1	2	3	4	5
Collaboration and management of suppliers	1	2	3	4	5
Third-party commitment (suppliers, sub-contractor etc.)	1	2	3	4	5
Lack of effective environmental management measures	1	2	3	4	5
Competition and uncertainty	1	2	3	4	5
Availability of green products and materials	1	2	3	4	5
Green policies and strategies	1	2	3	4	5
Markets for recyclable materials	1	2	3	4	5

Other challenges/issues :

End of Questionnaire

Thank you very much for your cooperation and contribution in this research. It would be much appreciated if the filled questionnaire can be returned by e-mail or post to the self-addressed envelope provided.
 Email: fatimahm@ump.edu.my

APPENDIX B

PUBLICATION

1. SCOPUS JOURNAL

Nur Syamimi Zulkefli & Leo Yu Ling (2018), Drivers in the Implementation of Sustainable Construction Management among Main Contractors, *International Journal of Engineering & Technology*, Science Publishing Corporation, Vol 7, No 3.30, DOI 10.14419/ijet.v7i3.30.19085

2. INDEXED CONFERENCE

Nur Syamimi Zulkefli, Fatimah Mahmud, and Nurhaizan Mohd Zainudin, (2019), A Survey on Green Supply Chain Management (GSCM) Challenges in the Malaysian Construction Industry” in FGIC 2nd Conference on Governance and Integrity 2019, *KnE Social Sciences*, pages 1202–1213. DOI 10.18502/kss.v3i22.5120

3. Chapter in book (will published in Dec 2019)

Fatimah Binti Mahmud and Nur Syamimi Binti Zulkefli, Sustainable Development: Green Supply Chain Management (GSCM) In The Construction Industry, "Manufacturing Technology and Management: A Collection of Readings " 2nd Series, UTHM Publisher.



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Drivers in the Implementation of Sustainable Construction Management among Main Contractors

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Abstract

Sustainability practice has been introduced world widely across many industries including construction sector with the aims to balance between the development of country and our Mother Nature. However, despite having various benefits, this practice has not been widely implemented. The situation has resulted climate change or global warming to become more serious compared to what happen previously. Therefore, this research has been conducted to identify what drive the organization to implement sustainable construction in their projects. Comprehensive review of pertinent literature and questionnaire survey were used to collect the research data. A total of 339 G7 contractors who registered under CIDB located in Johor Bahru have been selected as respondents with only 53.10% of them respond to the survey. All the data were analyzed by using Statistical Package for the Social Science (SPSS). Findings from the research explain that introduction series of tax incentives is the most significant driving factor for contractors to implement sustainable practices in construction industry.

Keywords: Sustainable, Sustainable Construction, Sustainable Construction Management

1. Introduction

Construction industry is one of the important sectors in Malaysia due to it progressively contributes to the country's Gross Domestic Product (GDP). Together with other sectors, Malaysia had a positive growth which had achieved 4.7% of economic grew in 2013 [21]. However, a coin has two sides; many researchers claimed that construction activities bring negative impacts to the social and environmental. As mentioned by [17], both developed and developing countries consume 40% of global energy annually and building sector releases 30% of greenhouse gas (GHG). So, in order to reduce the harm towards the environment, sustainability practices being encouraged to implement in the construction industry [10]. Kibert (1994) explains seven principles which may help construction life cycle to minimize the negative impact of construction activities. They are (1) Reduce resources; (2) Reuse resources; (3) Recycle resources; (4) Conserve natural environment; (5) Diminish use of hazardous substances; (6) Focus on life cycle costing; and (7) Emphasize on quality. Green building is also an approach of implementing sustainability practice as the building is efficient use of natural resources such as energy, water and raw materials. It also provides a comfortable, healthy and productive indoor environment for the users.

Unfortunately, research from [1] revealed Malaysia construction industry is still at infancy stage in applying sustainability matters. Besides, most developers prioritize

more towards economic issue rather than environmental issue [10]. Moreover, statistic from Construction Industry Transformation Program (CITP) for year 2016-2020 shows that Malaysia's buildings and infrastructures being rated for environmental sustainability was less than 2%. If these situations still continue, the climate change will become more serious and critical in our planet. Heat remains trap inside the planet which may cause global temperature to increase thus results Arctic ice to melt. Increment of sea level may increase the probability of flood to happen. Thus, in conjunction with these issues, this research is conducted to identify the drivers that may influence Main Contractors to implement sustainable construction management.

2. Literature Review

Sustainable development was introduced around thirty years ago by the World Commission on Environment and Development. The definition of sustainable development was given by "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report 1987). In other words,

sustainability focuses on three aspects which are environment, society and economy. Malaysia government had volunteered to reduce 40% of carbon dioxide emission by 2020 and it had advocated sustainability concept in Eleventh Malaysia Plan (2016-2020) and Construction Industry Transformation Programme (CITP). Some example of sustainable construction concept includes: First, using

biodegradable oil instead of diesel in construction machines which can reduce pollution and take care of worker's health [19]. Second, using green-mix concrete can help to reduce wastes in construction process because it made up of recycled concrete aggregated and aluminium can fibres [26]. Third, using prefabricated construction method (IBS) can also reduce waste at construction site as building materials are made in factory and workers do not need to stay long time at site ([14]; [23]; [29];[31]). Fourth, using waste management such as reduce, reuse and recycle throughout construction process which efficient use of raw materials and take care environment ([20]; [25]; [27]). Fifth, usage of green technologies in the building such as solar panel which may help to reduce the electricity consumption ([7]; [9]).

3. Drivers on Implementation of Sustainable Construction Management

3.1 Government Regulation, Policies, Tax Incentives and Penalties

Government effort has a crucial role in bringing the sustainability to the forefront [10]. Government not only advocate sustainability through regulation and policy such as National Green Technology Policy (NGTP) and Chapter Six in Eleventh Malaysia Plan is Pursuing Green Growth for Sustainability and Resilience but also incorporate it in tax incentive and penalties. When more tax breaks and subsidies were provided by the government, this will indirectly increase the implementation of sustainable or green construction ([6]; [3]). [15] mention that green materials and technologies always been recognized as high cost. So, it became a burden for contractors in pursuing sustainability practices. However, when appropriate financial incentives are providing for them, they will try to implement sustainable construction management in their construction process. While, UK government introduced landfill tax and climate change levy to urge their local people to generate less waste and use renewable energy during construction process [22].

3.2 International pressure

Global warming and climate change became an important topic at international level. Several developed countries have increased the control of carbon footprint that produced by each developing countries such as India for the development purpose. Furthermore, international protocols and expectations have brought significant effects on the implementation of green practices such as increase the awareness and understanding of green construction [16]. For instance, 17 Sustainable Development Goals (SDGs) is a shared vision for every country to let our planet become better and healthier in 2030. So, every country will try to increase the implementation of sustainability practices for protecting the planet.

3.3 High Fuel Prices Increase Energy Cost

Energy consumption for construction industry considers higher than other human activities. Together with rising energy cost, the organization tends to shift from conventional construction to sustainable construction, in order to save money and consider more towards the

environment [28]. Besides that, subsidies given by the government for fuel or energy getting lesser and lesser which mean they encouraged all the organizations adopt energy efficiency in their construction process (MIDA, 2016). Research from [6] also mentioned that increase in India's fuel prices causing people start to look for lifecycle cost implications of products and services.

3.4 Cost Saving

As mentioned by [28], reduce energy consumption will lead to financial benefits as a building consumed 73% electricity based on the result provided by United States Energy Information Administration (EIA). Therefore, in order to cut down the cost, reduce energy consumption is the best way. At the same time, it also reduces the emissions of carbon dioxide from the construction activities which have less deteriorated to the environment.

3.5 Client's Awareness and Demands

Sustainable construction should not only base on the supply side which are developers or contractors, but also demand side from clients [22]. Clients have the power to create a market for supporting sustainable construction if they have enough of knowledge and awareness about the sustainability concept [24]. However, customer demand also interrelated to the cost. When clients realize the advantages of implement sustainable practices such as saving cost in operation and maintenance, they will request developers to fulfill their want, thus, demand of implementation of sustainable construction will increase [24]. For instance, produce sustainable or green housing. By giving fiscal incentives to clients, it helps them to reduce the expenses of sustainable practices [5].

3.6 Increase Organization Image and Reputation

Any companies that have primarily adopted sustainable construction will be known as the industry trendsetter. They can take this as an opportunity to build up their company name in the market and high probability they will become the market leader [8]. Industry rating system is an intermediary for the companies to proof that they had integrated sustainable element in their construction process. In Malaysia, Green Building Index (GBI) will certify the green building projects in four categories which are certified, silver, gold and platinum. Buildings that have been certified have different status from others normal buildings. So, companies who want to have a good image and reputation will frequently implement the sustainable practices in their project. [28] explained when the companies have good or green image; it can also directly increase the sales of the company which brought financial benefits to the company. The public will also appreciate their acts as they provide the society with a clean and green environment. This shows that those companies not only focus on profit but also social and environmental responsibility [12].

Table 1 shows clearly various drivers on implementation of sustainable construction management derived from the literature.

Table 1 Driver in Implementation of Sustainable Construction Management

Drivers	Arif et al. (2009)	Abidin, N.Z. (2009)	Pitt et al. (2009)	Liu et al. (2012)	Diyana & Abidin (2013)	Windapo, A.O. (2014)	AlSanad, S. (2015)	Bohari et al. (2016)
1. Government regulation/ policies/ laws - incentive/tax/ penalties	✓	✓	✓	✓	✓	✓	✓	✓
2. International Pressure	✓							
3. High fuel prices > energy cost	✓					✓		
4. Cost saving	✓			✓	✓	✓	✓	
5. Client awareness and demand			✓		✓	✓		✓
6. Increase organization image and reputation	✓		✓	✓	✓	✓		✓

4. Results and Discussion

Statistical analysis by using SPSS software has been conducted. Out of 339 questionnaire distributed, 180 (53.1%) G7 contractors from Johor Bahru respond to the survey. As shown in the figure (refer with Figure 1), out of 180 respondents, only 24.4% (44) of contractor had

previously involved in sustainable or green project. This indicates main contractor in Johor Bahru are somehow similar with other states or countries which is less likely implement sustainable method. However, when being asked whether they have any intention to implement sustainability practices in future construction project, 59.4% (107) of respondents answered yes.

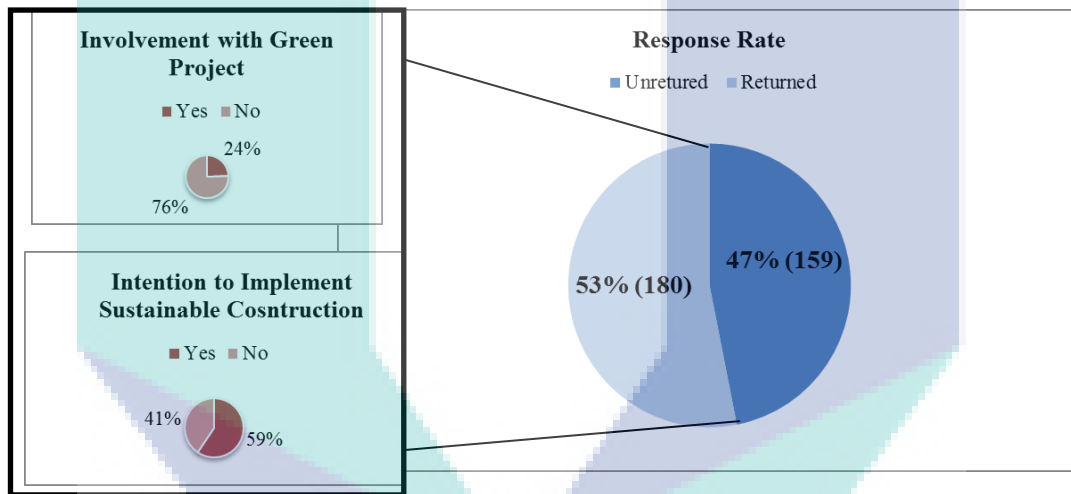


Figure 1 Summary Of Response

Nine drivers have been identified in this research and mean analysis has been conducted to identify the significant level of the drivers (refer with: Table 2 and Figure 2). The most significant driving factor is *“Introduction series of tax incentives help to reduce the burden in implementing sustainable method”* with a mean value of 4.5889. This result is in lieu with research conducted by [8] which stated that green or sustainable projects involving high cost result in demotivate stakeholders. To overcome this demotivation, government had provided direct and indirect incentives for stakeholders which can reduce their burden in venturing green industry. The second effective driving factor is *“The launch of National Green Technology Policy has motivated the construction industry to adopt sustainable practices”* which has a mean value of 4.2722. This finding is similar with research conducted by [8] which stated that Malaysia government took initiative to reduce carbon dioxide, so by formulating new policies, code of practices and guidelines enable to urge stakeholders in implementing sustainable

practices. The third effective driving factor is *“Awareness to global warming and pollution have influence construction industry to apply sustainable approach”* with a mean value of 3.8889. This finding is in line with research conducted by [2], which stated that sustainable approach has been applied due to its ability to mitigate the risks of global warming. By using environmental friendly materials and reducing usage of natural resources, global warming can be controlled. Furthermore, interviewee in [6] mentioned that the benefit of sustainable construction which is tackling climate change has attracted them to implement this concept. While, the less significant driving factor of implementing sustainable practices is *“Increasing in the price of energy causing people change to use renewable energy such as solar energy”* which has a mean value of 2.3278. This indicated people are still prefer conventional methods instead of apply and learn a new technology method. As a result, they are willing to pay for the high price.

Table 2 Mean for Drivers in Implementation of Sustainable Construction Management

Keywords	Drivers	Mean
Tax Incentives	Introduction series of tax incentives help to reduce the burden in implementing sustainable method in construction process	4.5889
Launch of NGTP	The launch of National Green Technology Policy has motivated the construction industry to adopt sustainable practices	4.2722
Awareness	Awareness to global warming and pollution have influence construction industry apply sustainable approach	3.8889
Image and Competitive Advantage	Sustainable practices boost up companies image in market and at the same time achieve competitive advantage	3.7167
Information Available	High availability of information encourage people to adopt sustainable practices	3.6778
GTFS (loan)	Green Technology Finance Scheme (loans) promotes the local producers and users employing more sustainable or green method	3.6167
Industry Rating System	Industry rating system such as LEED and GBI has induced buildings in attaining sustainable criteria	3.5056
Lower life cycle cost	Lower life cycle cost attracts people to implement sustainable methods	3.4778
Energy price increase	Increasing in the price of energy causing people change to use renewable energy such as solar energy	2.3278

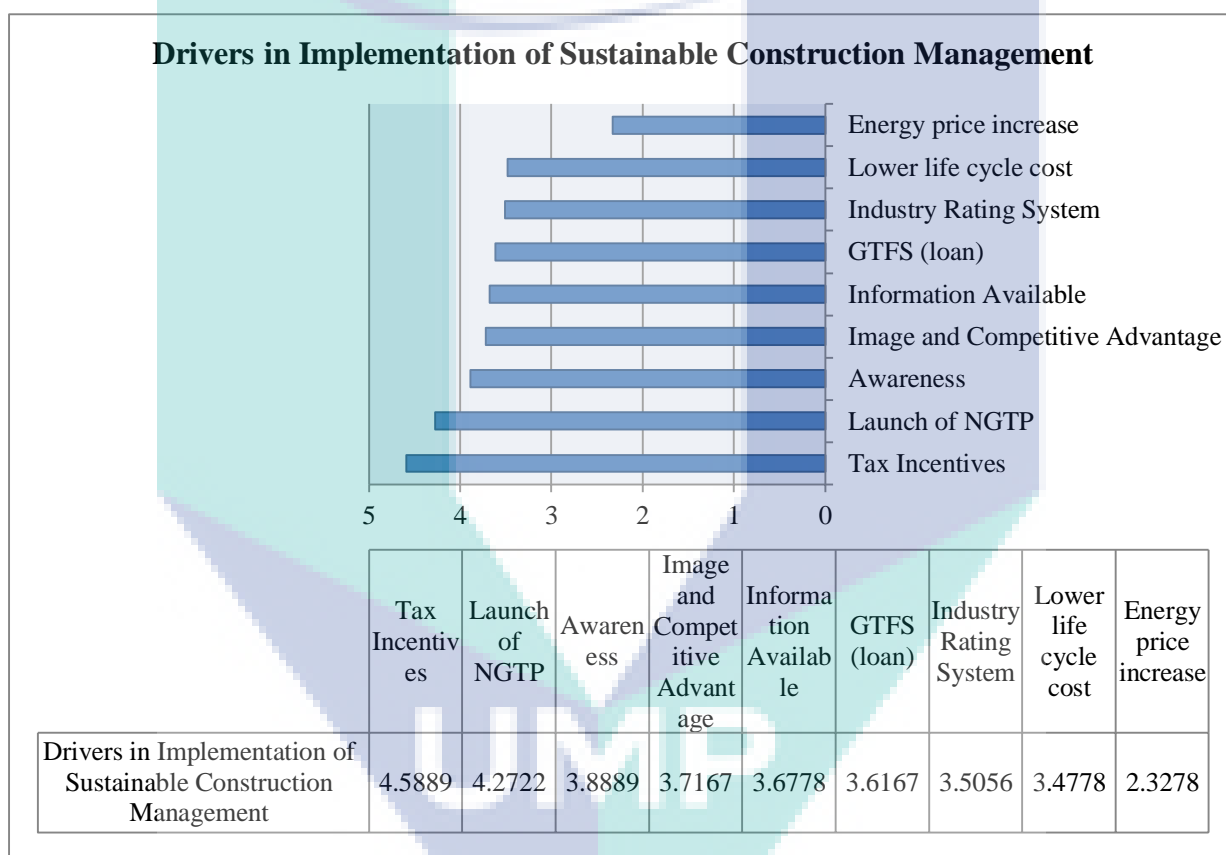


Figure 2 Mean Analysis Drivers in Implementation of Sustainable Construction Management

5. Conclusion

Construction industry has a direct impact towards country's growth and development. However, various literatures point out that activities which perform in construction industry bring adverse effects to the environment. The situation has finally led to emerging of sustainability practices to help alleviate the environmental issues. Unfortunately, most of the journals revealed that this practice is less applicable in the industry particularly in Malaysia. This concept is normally practiced by large companies which have strong financial, experience and expertise. Finding shows that many respondents agree that they may adopt the sustainable construction practices if they were provided by many tax exemptions from the government. Many researches have been conducted and it is proven that green practices involve higher cost as compared to conventional practices. This

situation has indirectly influence many main contractors to avoid using the practice. Involvement of government nowadays in providing various kinds of tax incentives has significantly becoming a driving factor to the main contractors to implement sustainable construction management.

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Conference Paper

A Survey on Green Supply Chain Management (GSCM) Challenges in the Malaysian Construction Industry

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Abstract

In recent years, mounting environmental and sustainability concerns are driving the construction industry players to adopt green supply chain management (GSCM) in their organizations. GSCM is a converging sustainability approach that integrates environmental thinking and initiatives into the traditional supply chain management (SCM) practices. However, despite having various benefits, this approach has not been widely implemented. Therefore, this paper aims to reveal the challenges faced by Malaysian construction companies in implementing GSCM. A total of 160 questionnaires were distributed among contractors and consultants in Malaysian Construction Companies. Only 50 questionnaires completed by the respondents resulting in a response rate of 32%. The research found that leadership and commitment from top management as the main challenges among construction players in implementing GSCM, in addition to changing mindset and culture and government support and regulation. This finding will allow practitioners to acknowledge and prioritize the challenges embedded with GSCM implementation, thus come out with strategies to overcome the challenges. This research can be further enriched by including an in-depth study on the GSCM challenges through qualitative research.

Keywords: green supply chain (GSCM), sustainability, challenges, construction industry.

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1. Introduction

The construction sector accounts for about 39% of the world's total carbon emission, which may lead to severe environmental pollution (United Nations Environmental Program, 2017). Reasonably, the industry needs to take actions to reduce environmental impacts in their activities, especially when the customers are becoming environmental conscious and stringent environmental regulations are being imposed by the government (Mathiyazhagan, Govindan, NoorulHaq, & Geng, 2013). This situation leads to the emerging sustainable construction concept. The green supply chain was introduced to balance marketing performance with environmental issues. Several companies had

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implemented green supply chain by creating networks of suppliers to purchase environmentally superior products or building conventional approaches to waste reduction and operational efficiencies to tackle various environmental challenges such as energy conservation and pollution abatement, (Kumar & Chandrakar, 2012). As a developing country, Malaysia is currently experiencing rapid economic growth through urbanization, and it is expected to rise more and more from year to year. In order to ensure sustainability in future development, many researchers had come out with the idea of green technology or system in its supply chain management. However, in the Malaysian construction industry, the concept is still relatively new where there is only a few organization's had implemented this concept, and there are reasons hindering the implementation (Wooi & Zailani, 2010). Therefore, the challenges in green supply chain management (GSCM) implementation by the Malaysian Construction Industry will be investigated in this research.

2. Literature Review

2.1. GSCM Concept and Initiative

Green supply chain management (GSCM) can be explained as an approach that integrates environmental thinking into supply chain management (SCM) (Srivastava, 2007). The main focus of GSCM includes identifying benefits, costs, and risks associated with environmental performance (Handfield, Sroufe, & Walton, 2005; Trigos, 2016). The implementation of GSCM in the construction organization depends on to what extent the initiative being used. Ghobakhloo, Tang, Zulkifli, and Ariffin, (2013) and Dheeraj and Vishal, (2012) have introduced a guideline to ensure the systematic and effective GSCM implementation. This guideline embedded the 'green' concept in several activities, which include product design, material management, manufacturing management, distribution and marketing, and reverse logistics.

The objectives of green product design are to minimize the product's environmental impact during its whole life cycle and reinforce the product expansion by providing an environmental-conscious design or called as eco-design (Ghobakhloo et al., 2013; Johansson & Glenn, 2002). Meanwhile, Nur, Handayani, and Wibowo (2018) stated that green material management (purchasing) commonly associated with managing the environmental performance of suppliers by eliminating hazardous materials or harmful activities in their operations. This initiative required the supplier to meet certain

specifications such as product content requirements, product content restrictions and product content labeling (eco-labeling) (Hamner, 2006).

According to Wibowo, Handayani, & Mustikasari, (2018), there are three main phases in green manufacturing processes: resource utilization decrement, waste decrement, and emission decrement. Cox (2008) defined green marketing as an advertisement in promoting the reputation of a company towards environmental responsibility, supporting a green lifecycle of a product or service, and addressing the relationship between a product or service and the biophysical environment. Reverse logistics focuses primarily on the return of the products or materials from the point of consumption to the forward supply chain for recycling, reuse, remanufacture, repair, refurbishment or safe disposal (Carter & Easton, 2011; ElTayeb, Zailani, & Jayaraman, 2010).

2.2. GSCM Challenges

The green supply chain initiatives have shown positive outcomes for many companies, but it is not without facing some challenges in its implementation. The literature has thrown light on the various challenges or barriers that would impede the industry in adopting GSCM. Some literature (Government & Perron, 2014; Khidir & Zailani, 2009; Mathiyazhagan et al., 2013) categorized the challenges in four broad categories: (1) institutional challenges, (2) organizational challenges, (3) informational challenges, and (4) economic challenges. Meanwhile, some other literature (Balasubramanian, 2012; Walker, Di Sisto, & McBain, 2008) divided the challenges into two parts: internal challenges and external challenges.

2.2.1. Internal challenges

Internal challenges are defined as the challenges that occur internally within the players or organizations itself. The most significant internal challenge identified in the literature was financial constraints (Ojo, Mbowa, & Akinlabi, 2014). Khidir and Zailani (2009) stated two types of cost involved in the environmental management of supply chains: direct cost and transaction cost. Precedent literature has mentioned that the implementation of the green supply chain might result in increased economic performance and profitability (Mollenkopf, Closs, Twede, Lee, & Burgess, 2005; Zhu & Sarkis, 2004). However, green supply chain management involve higher operation costs thus hinder the adoption of the approach amongst organizations (Balasubramanian, 2012; Benachio, Freitas, & Tavares, 2019; Khidir & Zailani, 2009; Mathiyazhagan et al., 2013; Min & Galle, 2001;

Varnäs, Balfors, & Faith-Ell, 2009). This is especially true for organizations that have limited availability of resources.

Apart from the financial challenges, changing the mindset and culture of an organization and the players itself proved to be a significant challenge in implementing GSCM. Changing the fundamentals and core features of organizations (organizational goals, forms of authority, core technology, and operational and marketing strategy) are one of the challenging tasks to the organizations. Leadership and commitment from the top management in aligning the organizations into a new direction are crucial. It is important for the management to support and create environmental awareness among their subordinates. Other challenges faced by the industry in implementing GSCM include lack of resources (technical expertise, technology, material and process), lack of knowledge and experience, and lack in managing standard environmental control policies within the organization (Balasubramanian, 2012; Government & Perron, 2014; Jabbour, Mauricio, & Jabbour, 2017; Khidir & Zailani, 2009; Trigos, 2016).

2.2.2. External Challenges

In addition to the internal factors, external factors also posed some challenges to the industry in implementing GSCM. According to the literature, the most significant external challenge faced by the construction industry is lack of support from the government (Rao and Holt, 2005; Walker et al., 2008; Khidir and Zailani, 2009; Balasubramaniam, 2012; Mathiyazhagan, 2013, Ojo, 2014). The government basically catalyzes since their support can be both drivers and challenges in the implementation of the green supply chain. Development of appropriate policies, standards, and regulations encourage the industry players to adopt green initiatives. The fact that GSCM involved much interaction with suppliers, the management of suppliers also proves to be a challenge for many organizations (Mathiyazhagan et al., 2013). For example, green purchasing requires a supplier to comply with environmental requirements; thus, it is crucial for the supplier to be responsible and to provide a strong commitment to achieving GSCM.

Trigos (2007) highlighted that the availability of green products in the market nowadays also serves as a factor that hinders the implementation of GSCM. In the construction industry, there is a limited product that meets the green requirements. Only a few products can be considered as 'green' and made for 'recycle' (Varnas et al., 2009). Two most popular green products are concrete and timber. However, the usage of a green product is still at an infant stage due to the cost preference. Other external challenges include lack of adequate environmental measures such as training and

development, sustainable auditing, and certifications like ISO 14001 (Balasubramaniam, 2012). Additionally, some organization found it is challenging to adopt the green supply initiatives mainly because of the competitive and uncertain nature of the construction industry. Generally, the construction players are highly competitive among themselves in pitching for projects and in providing reputable performance for their projects. Given the fact that construction projects involve a lot of unknowns and uncertainties, the chance of project delays, put on hold or terminated, or affected by economic situations are significantly high for construction projects.

3. Methodology

The quantitative research design was applied for this research. A hundred sixty self-administered survey questionnaires were distributed through the mail, facsimile, electronic mail (e-mail) and pass by hand to contractors and consultants (architect, engineer and quantity surveyor) whose practice were in the Selangor and Klang Valley area. Listing and contacting the respondents were done before the distribution of questionnaires. The questionnaires were developed to answer the research question on 'what are the challenges faced by the players in the Malaysian construction industry in adopting green supply chain practice?'. Respondents were asked to indicate their level of agreement to the statement as per indicator is shown in the questionnaire with 1.00 as strongly disagree and 5.00 as strongly agree. A total of 50 questionnaires were returned and completed by the respondents. The questionnaires were analyzed using SPSS version 20.

4. Results and Discussion

4.1. The Respondents' Background

Table 1 presents the respondents' nature of work, years of employment, and types of project involved. Altogether, 50 of the questionnaires replied by the respondents from both fields and giving a response rate of about 32%. As mentioned by Saunders et al. (2007), an average response rate of 30% to 40% is considered reasonable for a delivered and collated method. All respondents were assumed to have a broad knowledge and sufficient experience for the firm's operational and practices, and 70% of them were used to involve with the green projects.

TABLE 1: General background of the respondents in their company.

Nature of work	Years of employment			Types of the project involved				
	N	%		N	%			
Architect	13	26	< 5 years	14	28	Residential	18	36
C&S Engineer	10	20	5 - 10 years	23	46	Commercial/office	14	28
Quantity Surveyor	13	26	> 10 years	13	26	Industrial	5	10
Contractor	14	28				Institutional	5	10
						Others	8	16

From the survey conducted, there are 43% of the respondents' companies are implemented Environmental Management Systems, EMS. Figure 1 elucidates the respondents' feedback on the four main reasons why the construction companies adopt the GSCM concept and practice in their organization. They are to comply with regulation, pressure from the client, pressure from competitors, and voluntarily. It is found that more than half of the respondents (75%) adopt green supply chain management (GSCM) due to complying with the regulations. The findings are in lieu with the previous study conducted by Min & Galle, (2001), that many organizations get involved in the green supply chain management (GSCM) to avoid violations of regulatory law.

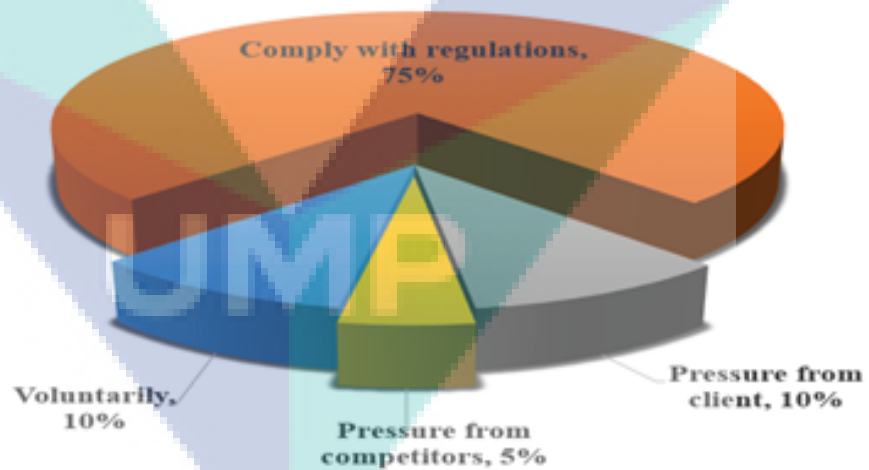


Figure 1: Reasons for the organization to implement GSCM.

4.2. Identification of GSCM Challenges

Generally, challenges are any obstacle, pitfall, drawback, barrier, limitation, difficulty, or factors constraining the adoption of GSCM. The challenges were grouped into two groups; i.e. internal challenges and external challenges. The internal challenges were considered to be the pressures within a company that hindered the implementation of

GSCM. External barriers were reflected to be external forces that are obstructing the companies from implementing their GSCM. Overall, there twelve challenges (8 internal challenges and 4 external challenges) were identified and studied in this research.

Figure 2 presents the mean score ranking for the identified twelve challenges under the challenges in the implementation of GSCM. It can be seen clearly from Figure 2, that almost all the challenges give a mean value more than 3.00. These results show that these challenges are consensually agreed by the respondents as critical in obstructing the effectiveness of GSCM implementation in the construction industry.

For internal challenges, the three most critical challenges perceived by the respondents are Leadership & Commitment from Top Management (3.88), Changing Mindset & Culture of the Organization (3.82) and Changing Fundamentals & Core Features of the Organization (3.72). The finding was in line with the literature review where, according to Balasubramaniam (2012), top management support and commitment plays a significant role in implementing successful GSCM. Mathiyazhagan (2013) also adds that some of the top management resisted in changing the existing practice, information, and habits to the new sustainable supply chain practice since it involved a lot of costs and time. While Financial Constraint and Fear of Failure become the lowest challenges ranked for internal challenges. The respondents felt that by implementing GSCM, cost-saving could be realized by reducing energy consumption and subsequently, reducing the emissions of carbon dioxide from the construction activities which have less deteriorated to the environment (Zulkefli & Ling, 2018).

Where for external challenges, the most significant challenges faced by the construction industry players was due to Lack of Government Support and Regulations. As explained by Khidir and Zailani (2009), there is limited institutional support for the ideas embodied in environmental management. Besides, there are not many efforts by the government regarding legislation and regulation with regards to environmental practice (Mathiyazhagan, 2013). It is not easy for an organization to change its organizational goals, forms of authority, core technology, and operational and marketing strategy (Khidir and Zailani, 2009). Amongst all of the variables, availability of green products and materials, and collaboration and management of the third party recorded the lowest mean score, which was 3.56.

5. Conclusion and Recommendations

Overall, the survey findings revealed that leadership and commitment from top management, changing mindset, and culture of the organization and lack of government support



Figure 2: Overall ranking of the mean score for challenges faced in implementing GSCM.

and regulations as the most critical challenges faced by the construction industry in GSCM implementation. However, other challenges identified in this research also need to be tackled systematically. The authors believe that the challenges found in the research together with their influence power will help practitioners to plan for appropriate actions to be taken and strategies to overcome those challenges and strengthen the activities involved in GSCM implementation. In doing so, Jabbour et al., (2017) suggested that all top leaders and managers be equipped with sufficient knowledge on GSCM practices and employed green concept in staff recruitment, training, performance evaluation, and rewards. This will help organizations to cultivate and institutionalize green culture and lead to the success of GSCM implementation. There is a need for coordination between all members involved in the construction chain beside industry leaders, governments, and consumers before the successful GSCM implementation. Besides that, with appropriate financial incentives like tax incentives and subsidies from the government, it will indirectly encourage and increase construction sustainability through the GSCM implementation. One of the measures for the government to ensure the implementation of GSCM as part of the construction standard is through the development of rules and regulations. This can be applied through a compulsory mandate of GSCM approach for public or government buildings. Ultimately, by reducing or eliminating the presence of these challenges will increase the level of success of GSCM implementation in the construction industry. This research can be further

enriched by including an in-depth study on the GSCM challenges through qualitative research.

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Special thanks are due to those who directly and indirectly involved with this study. Thank you for all the commitment and strong support especially for those who have spent their precious time to respond to the survey, including financial funding from UMP internal grant RDU1603135.

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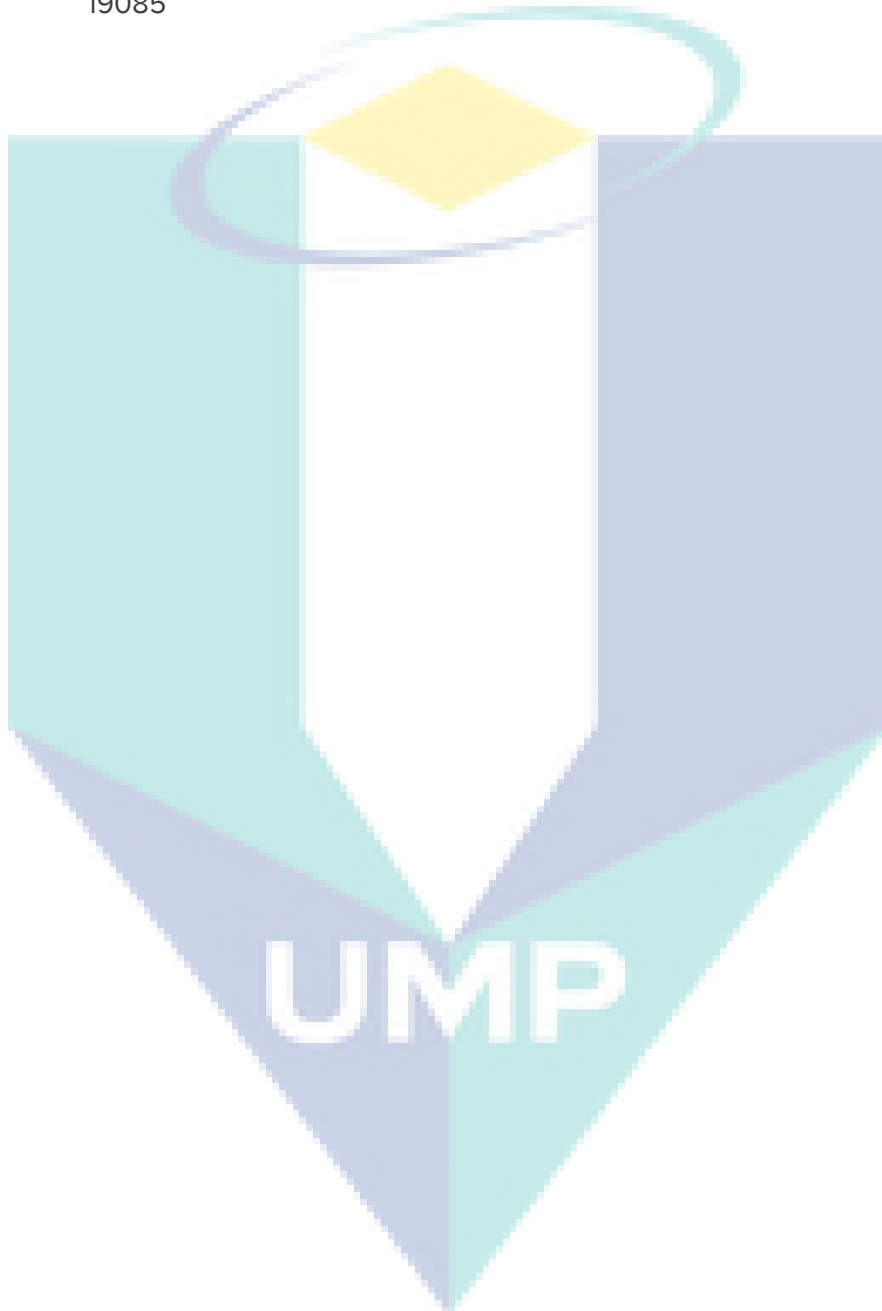
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**MANUFACTURING AND TECHNOLOGY
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Chapter X

Sustainable Development: Green Supply Chain Management (GSCM) In The Construction Industry

Fatimah Binti Mahmud and Nur Syamimi Binti Zulkefli

INTRODUCTION

Recent developments in the world economic climate had created uncertainty in the business environment, which creates the necessity for the organizations to reconstruct and restructure their strategy to sustain their business and profit while remaining competitive in the marketplace (Zailani et al., 2012). This is especially in their supply chain strategy since the resources are limited now due to increase in the world populations. Green supply chain management (GSCM) is said to be able to improve the performance of construction by eliminating or minimizing various negative environmental impacts. In Malaysia, green supply chain management (GSCM) can be considered as still at an infant stage; especially in the construction sector. Only few organizations had already taking steps to practice this system towards achieving sustainable development. Therefore, the predicted outcomes are still vague. With regards to this matter, this research is expected to help Malaysian to understand and appreciate how green supply chain management (GSCM) could benefit the environment.

Sustainable Development: General Concept and Definition

There are a number of definitions for sustainable development. According to the Brundtland Commission (1987), sustainable development is defined as ‘the development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. Carter and Rogers (2008) then explain that several issues included within this broad rubric of sustainability are understanding the environmental impact of economic activity in both developing and industrialized economies (Erlich and Erlich, 1991); ensuring worldwide food security (Lal et al., 2002); ensuring the basic human needs are met (Savitz and Weber, 2006); and assuring the conservation of non-renewable resources (Whiteman and Cooper, 2000). However, since Brundtland Commission’s definition is so far reaching, most organisations find it difficult to determine their individual roles within this broader, macro-economic perspective (Srivastava, 1995; Carter and Rogers, 2008).

According to Kibert (2008), the term sustainable development is defines as ‘the development that most comprehensively addresses the ecological, social and economic issues of a building in the context of its community’. Kibert also adds that the goal of sustainable construction is to create and operate a healthy built environment based on resource efficiency and ecological design following the sustainable principles which are Reduce, Reuse, Recycle, Protect, Eliminate, Economics and Quality. Broad literature review (Savits and Weber, 2006; Carter and Rogers, 2008) suggest that organizational sustainability, at a broader level, consists of three components: the natural environment, society and economic performance. The

intersection between the three components serves as a bottom line to the activities that organisations can engage with. The activities must not only positively affect the natural environment and society, but which also result in long-term economic benefits and serve as competitive advantage to the firm (Carter and Rogers, 2008).

Supply Chain Management (SCM)

Supply Chain Management (SCM) is a concept that is originated and flourished in the manufacturing industry (Vrijhoef and Koskela, 2000). It was first visible in the Just in Time (JIT) system as part of the Toyota Production System (Shingo, 1988). The system aimed at regulating supplies to the Toyota motor factory in the small amount, just in the right time. Besides, the main goal was to drastically decrease inventories and to effectively regulate the supplier's interaction with the production line (Vrijhoef and Koskela, 2000). The concept finally stimulated and evolved year by year. By the early 1990s, due to intense competition and globalization, it forced the organisations to provide a product and service that is right to the customer, at the most appropriate time, with the lowest cost (Li et al., 2003; Altekar, 2005; Thoo et al., 2011;). Due to the circumstances, more and more organisations finally came out promoting supply chain competitiveness in order to attain organizational efficiency (Thoo et al., 2011).

The traditional supply chain shifted, transformed and extended itself into dynamic and ever-changing processes (Shayoh et al., 2002). The transformation goes beyond the physical boundaries of the whole enterprise and reaches into the global and rapidly evolving series of network. The expansion results on more holistic and strategic view of the process of supply chain. Saad et al. (2002) state that a few but increasing numbers of construction organisations are now begin to adopt supply chain management (SCM). This is towards improving their performance and addressing their adversarial inter-organisational purchaser-supplier relationships and fragmented processes (Saad et al, 2002). According to Ofori (2000), the concept of the supply chain basically provides a very useful framework to analyse the construction process. The supply chain in construction includes all the parties who involved in the process from the extraction of raw materials to the eventual demolition of the buildings and also disposal of its components (Ofori, 2000).

According to Vrijhoef and Koskela (2000), the structure and function of construction supply chain are converging, where all the materials are directed to site and object or product will be assembled from the incoming materials. In contrast to manufacturing industry, the 'construction factory' is being set up around the single product itself. The products are not going to pass through the factory and distributed to the customers like what happens in manufacturing industry. Apart from that, the project organisations are repeated and reconfigured all the time thus results in having a temporary supply chain producing one-off construction projects. These unique elements cause the construction industry to become typified by instability, fragmentation and separation between the design and construction phase of the built product. Since every project creates new product or prototype, thus it can be a typical make-to-order supply chain. There is a little repetition, with a very minor exception. For projects that have particular kind, the process somehow can be very similar.

Supply chain management in construction can be viewed as a process where raw materials are converted into final products, and then delivered to the end-customer. This process involves extraction and exploitation of the natural resources (Srivastava, 2007). Supply chain management is said to be able to help improve efficiency and productivity, and reduce overall operating costs. Despite the outcomes, many of the studies highlighted that supply chain process in construction give impacts to the environment. According to Kumar and Chandrakar (2012), the waste and emissions caused by the supply chain have become one of the main

sources of serious environmental problems including global warming and acid rain. Thus, environmental impacts need to be considered cumulatively over the stages of supply chain which involves considering the impacts of extraction of raw materials, distribution, operation and disposal (Kumar and Chandrakar, 2012). Environmental problems are caused either directly or indirectly by the patterns of production by the industries, patterns of consumption and behavior of the consumers (Said et al., 2003). According to United Nations Environment Program (2007), construction sector is considered as a major contribution to environmental problems, if to be compared with other industries. Due to the major resource consumption and contamination generates by the construction industry, it leads to the need of sustainable development (Korkmaz et al., 2009).

Green Supply Chain Management (SCM): Concept, Initiative and Outcomes

The combination of corporate environmental management and supply chain management is considered as relatively new area of study and practice (Xiao, 2006; Zhu and Sarkis, 2005). According to Green et al. (1996), GSCM is 'the way in which innovation in supply chain management and industrial purchasing may be considered in the context of the environment'. Apart from that, Narasimhan and Carter (1998) point out that GSCM is 'the purchasing function which includes reduction, recycling, reuse, and the substitution of materials'. Godfrey (1998) discovers GSCM as 'the practice of monitoring and improving environmental performance in the supply chain'. Basically, GSCM can be explained as the approach that integrates the environmental thinking into the supply chain management (Srivastava, 2007). Srivastava adds that the environmental integration includes during the product design, material resourcing and selection, manufacturing processes, delivery of the final product to the consumer as well as end-of-life management of the product after its useful life. The approach seeks on reducing and minimizing the product or service's ecological footprint (Bearingpoint, 2008). The concept is similar with supply chain management (SCM) where the boundary is dependent on the supply chain concurrently with the product. However, adding the 'green' component to the existing traditional SCM involves addressing the influence and relationships between SCM and the natural environment (Srivastava, 2007). The main aim of GSCM includes identifying benefits, costs and risks associated with the environmental performance (Hanfield et al., 2005; Trigos, 2007).

The implementation of green supply chain management (GSCM) in the construction organisation depends on to what extend the initiative being used. Ghobakhloo, Tang, Zulkifli, and Ariffin, (2013) and Dheeraj and Vishal, (2012) have introduced a guideline to ensure the systematic and effective GSCM implementation. This guideline embedded the 'green' concept in several activities which include product design, material management, manufacturing management, distribution and marketing and reverse logistics. The objectives of green product design are to minimize the product's environmental impact during its whole life cycle and reinforce the product expansion by providing an environmental-conscious design, or simply called as eco-design (Ghobakhloo et al., 2013; Johansson & Glenn, 2002; Bearingpoint, 2008). Meanwhile, Nur, Handayani, and Wibowo (2018) stated that green material management (purchasing) commonly associated with managing the environmental performance of suppliers by eliminating hazardous materials or harmful activities in their operations. This initiative required supplier to meet certain specifications such as product content requirements, product content restrictions and product content labeling (eco-labeling) (Hamner, 2006).

According to Wibowo, Handayani, & Mustikasari, (2018), there are three main phases in green manufacturing processes: resource utilisation decrement, waste decrement and emission decrement. Cox (2008) defined green marketing as an advertisement in promoting the reputation of a company towards environmental responsibility, supporting a green lifecycle of

a product or service, and addressing the relationship between a product or service and the biophysical environment. Apart from that, green distribution can be explained in the context of green transportation. Bjorklund (2010) explains that green transportation is a transportation service that has a lesser reduced negative impact on human health and the natural environment. Reverse logistics focuses primarily on the return of the products or materials from the point of consumption to the forward supply chain for the purpose of recycling, reuse, remanufacture, repair, refurbishment or safe disposal (Carter & Easton, 2011; ElTayeb, Zailani, & Jayaraman, 2010).

Outcomes from the initiatives and approaches of green supply chain management can be broadly categorized into four categories namely, (1) environmental outcomes, (2) economic outcomes, (3) operational outcomes, and (4) intangible outcomes. The environmental outcomes represent positive consequences of green supply chain initiatives on the natural environment both outside and inside of the organisations. Examples of the positive outcomes include reduction of solid or liquid waste, reduction of emissions, resource reduction, and decrease of frequency of environmental accidents, and improved employee and community health (Five Winds International, 2003; Geyer and Jackson, 2004; Zhu and Sarkis, 2004)

Green supply chain initiatives can lead to economic outcomes in many ways. This includes profitability, revenue growth, increase in market share, and increase in productivity (Zhu and Sarkis, 2004; Mollenkopf and Closs, 2005; Stock et al., 2006). Min and Galle (2001) found that green purchasing have a negative impact to the organization since it tends to increase the operational costs. However, broad literatures from other studies suggest positive economic outcomes from green supply chain approaches. Meanwhile, operational outcomes can be explained as direct impact of green supply chain initiatives on operational performance of a firm (Eltayeb et al., 2011). The outcomes include cost reductions, product quality improvements, improvement in the delivery and flexibility (Vachon and Klassen, 2006; Chung and Tsai, 2007). The most discusses operational outcomes of green supply chain is cost reductions. Eltayeb et al. (2011) point out that intangible outcomes represent the conceptual or difficult-to-quantify outcomes of green supply chain initiatives. As an example, improved product image and enhanced image and goodwill of a firm in the eyes of stakeholders (customers, clients or employees, and community). Such improved image then is expected able to generate customer satisfaction and loyalty, employee satisfaction, brand value, enhanced publicity and marketing opportunities, and better acceptance of a firm by the local communities (Five Winds International, 2003; Jayaraman and Luo, 2007).

CONCLUSION

This paper reviewed the definition and concept of supply chain management (SCM) and its implementation in the construction industry. Activities in each stage of supply chain are being studied together with highlighting the impacts of these activities to the environment. Literatures provide that waste and emissions produce from the activities in supply chain have become one of the main sources for environmental problem. Due to the major resource consumption and contamination generated by the construction industry, it leads to the emergence of sustainable development. The paper also explains in detail the definition and concept of sustainable development and its practices in the Malaysian construction industry. The implementation of sustainable development concept to the supply chain play both direct and indirect roles in helping the organisations to preserve the environment. This leads to the emergence of green supply chain management (GSCM). The meaning of green supply chain management, its initiatives towards conserving the environment and the outcomes of the implementation has been culminated in this paper.

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