

Sustainable Design in Strategic Level of Supply Chain Management: A Review

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Abstract: Environmental protection and climate change are issues which have long been debated but only very recently triggered strong international interest. Sustainability of supply chains has emerged as a major theme in both research and practice since the impacts of climate change have made both producers and consumers more cognizant of their decision-making and how their decisions affect the environment. Since implementation of sustainable design have to start at the earliest stage, this study will discuss the application of sustainable design in strategic level in supply chain. Strategic decisions determine the overall direction of company's supply chain. They should be made in conjunction with the companies' overall objectives and not biased towards any particular product or regional location. The purpose of this study was to discuss the sustainable design issues in strategic level of supply chain. Literature search will be conducted in this study as the research methodology. The aims of this study are (1) to understand in-depth of sustainable design context; (2) to understand current position of supply chain; (3) to understand current position of strategy level in supply chain; (4) to identify possible aspect in strategic level of supply chain to discuss about sustainable design. Lastly, an agenda will set for continuing research which explores the nexus between sustainability and supply chain.

Keywords: *Sustainable Design, Supply Chain management, Strategic Level*

1. Introduction

The issue of sustainability is at the epicentre of international concern with pressure on both commercial operators of all sizes and from all industries, and private citizens to make adjustments to their daily lives which reduce negative impacts on the environment. A range of studies worldwide have shown that customers (whether they are consumers, businesses or public sector organisations), employees and investors tend to favour companies that are perceived to be socially and environmentally responsible – or in short, those that are *more sustainable*. Concern about the environmental and social impacts is not new and has ebbed and flowed over many years. But the overall trend has been towards increased pressure for better environmental and social performance. In the 1970s concern about pollution, resource depletion and population growth impacted key industries such as oil, chemicals and cars. In the mid to late 1980s, there was renewed concern about these issues, which affected a wider range of industries including household products, cosmetics, tourism and food. There was a rush to introduce environmentally 'friendly' or 'friendlier' products or services.

It is clear that current patterns of consumption and production in products or services supply chain are unsustainable. The accelerating processes of globalization and trade liberalization, supported by advances in information technologies, have fundamentally changed the landscape of the private sector in all countries developed and developing providing new opportunities and challenges.

Before any action taken to improve the product or services supply chain, there is a need to conduct a study to understand the context of sustainable design. Therefore, the purpose of this study was to discuss the sustainable design issues in strategic level of supply chain. The aims of this study (1) to understand in-depth of sustainable design context; (2) to understand current position of supply chain; (3) to understand current position of strategy level in supply chain; (4) to identify possible aspect in strategic level of supply chain to discuss about sustainable design. Literature search will be conducted in this study as the research methodology. This study firstly reviews the available literature on sustainable design and supply chain to provide context. Literature from academic is analysed in order to provide a comprehensive summary and analysis of where the supply chain is currently positioned. Lastly, this study will set an agenda for continuing research which explores the nexus between sustainability and supply chain.

2. Basic Terminology

2.1. Sustainable Design

“Sustainable design is more often than not is confused with “Green” or “eco” design. There is a distinction between the two. The “Green/eco” design is the practice of reducing or eliminating environmental impacts of design, whereas sustainable design is concerned with the environment, and also with social and economic issues. Therefore, sustainable design encompasses whatever concept Green/eco design has and goes beyond encompassing ecology, economy and cultural contexts. World Commission on Environment and Development (1987) defines Sustainable Design as “meeting the needs of the present without compromising the ability of future generations to meet their needs” The intention of sustainable design is to “eliminate negative environmental impact completely through skilful, sensitive design”. Manifestations of sustainable design require no non-renewable resources, impact the environment minimally, and relate people with the natural environment. The key to sustainability will be a balance between devices and a modified consumption . . . and products and services that can transparently restore the human capability for caring and coping in all dimensions of life,’ (Ehrenfeld, 2000, pp. 123, 124). Included within this broad rubric of sustainability are such issues as 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 that basic human needs are met (Savitz and Weber, 2006); and assuring the conservation of non-renewable resources (Whiteman and Cooper, 2000). A definition of sustainable event design could then be: ‘. . . taking all ecological, social and economic concerns into account in product and service systems, meeting the needs of the present without compromising the ability of future generations to meet their own needs’ (Keitsch, 2011).

2.2. Supply Chain Management

Bozarth and Handfield (2008) defines supply chain management as an active management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. And Simchi-Levi, Kaminsky and Simchi-Levi (2008) explains supply chain management as a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantity, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements. Wisner, Tan and Leong (2012) has similar definition: supply

chain management as the integration of trading partners' key business processes from initial raw material extraction to the final or end customer, including all intermediate processing, transportation and storage activities and final sale to the end product customer. Yet, M. Felea and Albastroiu (2013) has yet another analogous definition: Supply Chain Management consist of planning organizing, implementing, motivating and controlling efficiently all the of activities involving transportation, processing and storage of raw materials, work-in-process inventory and finished goods from original suppliers, through warehouses, production facilities, stores and other intermediaries to the final customers in order to satisfy customer requirements and achieve a competitive advantage by adding value to products/ services. As the conclusion, supply chain can be define as a network of manufacturing and distribution activities that performs the functions of transforming raw materials into intermediate and finished product, and deliver the products to customers (Fig.1).

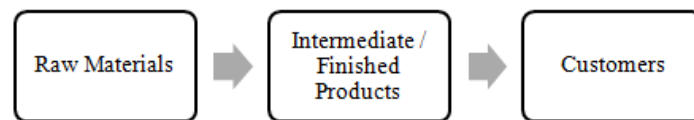


Figure. 1: Supply Chain Process

2.3. Strategic Level

This level refers to a long-term planning horizon and to the strategic problem of designing and configuring a generic multi-stage Supply Chain Management decisions deal with the determination of the number of facilities, geographical locations, capacity of facilities, and allocation of customer demand (Manzini et al., 2006). The strategic planning deals with long-term decisions, a single period modelling: this is the so-called location allocation problem (LAP) (Manzini et al., 2008; Manzini and Bindi, 2009).

At the strategic level, company management makes high level strategic supply chain decisions that are relevant to whole organization. The decisions that are made with regards to the supply chain should reflect the overall corporate strategy that the organization is following. This includes decisions regarding product design, what to make internally and what to outsource, supplier selection, and strategic partnering as well as decisions on the number, location, and capacity of warehouses and manufacturing plants and the flow of material through the logistics network. Melo et al. (2009) classify the literature on strategic planning in accordance with some typical decisions: capacity decisions, inventory decisions, procurement decisions, production decisions, routing decisions, and the choice of transportation modes. As conclusion, strategic supply chain processes that management has to decide upon will cover the breadth of the supply chain and these include location, production, inventory and transport.

3. Research Methodology

In order to carry out this study, a literature review has been conducted to gather existing academy literature of sustainable and supply chain. A literature review is a systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of recorded documents (Fink, 1998). The analysis of documents pursues the aim of opening up material that does not have to be created on the basis of a data collection by the researcher. Literature reviews usually aim at two objectives: first, they summarize existing research by identifying patterns, themes and issues. Second, this helps to identify the conceptual content of the field and can contribute to theory development (Harland et al., 2006). The gathered data was studied to provide comprehensive summary of

sustainable design and supply chain as background information to understand current position of supply chain before more in-depth study has been conducted. Then, the same method had been applied to understand in-depth of sustainable design and supply chain especially in strategic level based on available literature in order to identify possible aspect in strategic level of supply chain to discuss about sustainable design. Data collection involved gathering journal paper published on the websites. A convenience sampling process was used to identify appropriate papers for the study. Sometimes called purposive sampling, the units of study were chosen not for their representativeness but for their relevance to the research questions and analytical framework of the study (Schwandt, 2001). The literature searching was guided by few keywords which are sustainable design, supply chain management and strategic level. Lastly, after the aims of the study been achieved, an agenda for continuing research will be set to explores the nexus between sustainability and supply chain (Fig. 2).

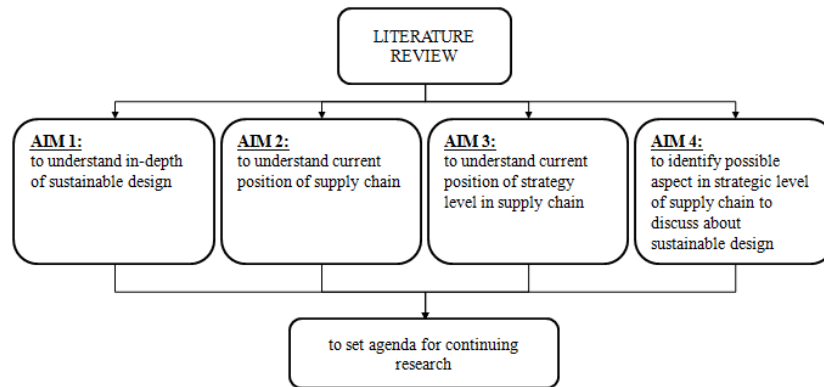


Figure. 2: Research Process

4. Discussions

The overall starting point was mentioned in Section 1 of this paper. Both the definition of sustainability design and supply chain form the background of the review is conducted Section 2. The discussion will be presented in four parts, which based on the aims of this study that mentioned earlier:

- 1) Context of Sustainable design
- 2) Current Position of Supply Chain
- 3) Current Position of Strategy Level in Supply Chain
- 4) Possible Aspect to Discuss Sustainable Design in Strategy Level of Supply Chain

4.1. Context of Sustainable Design

Sustainable design is the philosophy of designing physical objects, the built environment, and services to comply with the principles of social, economic, and ecological sustainability. According to McLennan (2004) the action of design is always informed by the mind-set of the person conducting a particular design activity. Furthermore, the activity of design, rather than being an isolated end in itself, is an applied activity which always answers a purpose (Dorschel, 2003). Therefore, sustainable design leads to the development of more environmentally benign products and processes. Any form of design that minimizes environmentally destructive impacts by integrating itself with living processes is called sustainable design.

Sustainable design is not specifically owned by a profession or a discipline, it is an approach to harmonize and interact with nature. Sustainable design should not be understood as a design discipline such as graphic or industrial design. Its scope is far reaching, extending to architecture, landscape architecture, industrial products,

industrial processes and so on. According to McLennan (2004), it is rather to be seen as an underlying notion which has the potential to inform all design activities. Sustainable design helps us review our designs and people's daily life styles and behaviours. In short, it is an effective fit to, as well as a cohesive combination with natural processes. On this philosophic level sustainable design responds to the concept of sustainable development by raising questions about the optimal transition scenario for a more sustainable future, the idea of well-being, or the optimal status of goods (Vezzoli and Manzini, 2008). By trying to overcome these differences, system design approaches become increasingly important (Vezzoli and Manzini, 2008) especially in supply chain.

Sustainable design should developed from the requirements of the organization to consider economic, social and environmental impact from the production process until the products or services has deliver to customer. Consideration that can be made in the three components are:

- i. **Ecology:** Introduce/take back to basics on the ecosphere. The question is not simply how to recycle materials, but how to see them in the first place--where they come from and where they go to.
- ii. **Economy:** It is economic literacy that is the cornerstone of sustainable design. What do we want to sustain, if not mindless economic growth? What ways can we move in the right direction as economic actors?
- iii. **Social/culture:** The fact that design generally pushes consumerism, and yet, for all its negative impacts, consumerism helps people create meaning. Part of culturally sustainable design is to help find alternatives to consumerism that help people generate meaning.

As conclusion, sustainable design not only focus on environment, but also economy and social. Sustainable design no longer only owned by specific field, yet it suitable to apply in any profession or discipline as long as the it responds to harmonize and interact with environment, economy and social.

4.2. Current Position of Supply Chain

Today, companies are also confronted with a growing trend towards internationalisation. In a series of papers (cf. Wu et al. (2006), Nagurney, Liu, and Woolley (2007), Nagurney and Woolley (2010)), it has been argued that businesses, and in particular supply chains, have become increasingly globalized. Globalisation allows working with a lot of different suppliers to get raw materials and preliminary products (horizontal supplier structure), and each first tier supplier often depends on a multilevel supplier chain for their own production (vertical supplier structure). However, such a structure makes it difficult for a company to handle the whole supplier network and thus increases the complexity of purchasing (Corswant/Fredriksson 2002).

With the growing trend of internationalisation, criticism of globalization has also increased, specifically by those concerned about the environment on the basis that global free trade may result in the growth of global pollution. Many countries are started to concern about sustainability of a product or service that provide by companies. Some of the countries proposed environmental friendly regulations or standard that need to follow by companies. For sustainability, companies have to ensure manufacturing of products without creating environmental damage or disobeying social standards (Seuring 2004).

Besides that, legal requirements are placing pressure on manufacturers and distributors to become more environmentally-friendly and to minimize the emissions generated (Ingram, 2002). Indeed, as noted in Nagurney (2006), firms are being held accountable not only for their own environmental performance, but also for that of their suppliers, distributors, and even, ultimately, for the environmental consequences of the disposal of their products.

Nevertheless, companies also feel the pressure from customer tastes. Nowadays, most of the customers started to concern not only the function of the product, they also concerning about what are the material does the manufacturer used to produce the product, as well as the production process and the delivery process. Poor environmental performance at any stage of the supply chain process may, thus, damage what is considered a firm's premier asset, its reputation (Fabian, 2000).

As conclusion, most of the company having pressure to make sure their supply chain are environmental friendly. Therefore, inter-organisational concepts or approaches for environmental or sustainability management have seen a great variety of developments, which incorporate among others green or environmental supply chain management (Seuring 2004). Some companies already come out with their own framework to show their responsibility not only towards environment, but also to economy and social. Focal companies, such as Volkswagen in the automotive industry, often own highly visible global brands, are frequently attacked by NGOs, and are held accountable for environmental and social problems observed in the earlier stages of their supply chain (Seuring and Goldbach 2006).

4.3. Current Position of Strategy Level in Supply Chain

Supply chain management decisions are often said to belong to three levels; the *strategic*, the *tactical*, and the *operational* level. Figure.3 shows the three level of decisions as a pyramid shaped hierarchy. The decisions on a higher level in the pyramid will set the conditions under which lower level decisions are made.

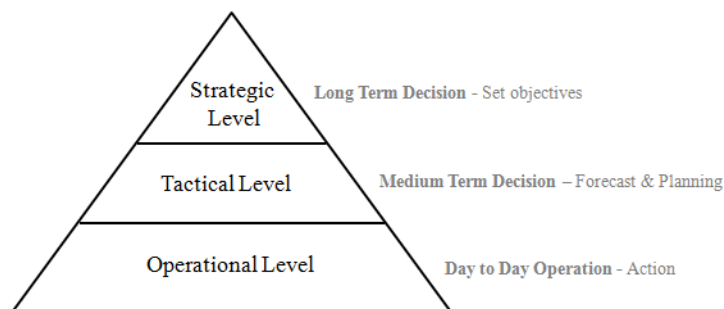


Figure. 3: Hierarchy of supply chain decisions

The *operational* level of supply chain management is concerned with the very short term decisions made from day to day, on the *tactical* level medium term decisions are made, such as weekly demand forecasts, distribution and transportation planning, production planning, and materials requirement planning, and on the *strategic* level long term decisions are made. Since this paper focus on strategic level, this section will only discuss in detail about current position of strategy level.

According to Ganeshan and Harrison (n.p), strategy level are related to location, production, inventory, and transportation. Location decisions are concerned with the size, number, and geographic location of the supply chain entities, such as plants, inventories, or distribution centres. The production decisions are meant to determine which products to produce, where to produce them, which suppliers to use, from which plants to supply distribution centres, and so on. Inventory decisions are concerned with the way of managing inventories throughout the supply chain. Transport decisions are made on the modes of transport to use. Since supply chain are facing internationalism and most of the companies practicing multilevel supplier, there is a need to set objectives in this level to integrate location, production, inventory and transportation.

In order to integrate these four aspect, company will set supply policy and supply strategy to achieve targeted position. The supply policy of a company sets the overall frame and conditions for supply issues, taking into account medium- to long-term effects. Based on the corporate philosophy and strategy, supply policies specify basic rules and conditions for purchasing good or services. Hence, the policy level includes normative judgements, which are binding for the following levels.

Supply strategy sets directions for organisations on supply issues, aiming to achieve a targeted position. Supply strategies should be closely integrated with other corporate strategies to support an overall strategic mission (Harland et al. 1999), which might even contribute to corporate competitive advantage. Supply strategies are often directions for providing operational performance improvements.

As conclusion, supply chain combined three level and each level managing different action. Level one which is strategic level sets directions for organisations on supply issues, aiming to achieve a targeted position. Second level which is tactical level managed and monitored through planning and control and lastly operational level will take action based on direction that had been set in strategic level. Therefore, strategic level is the objectives setter of the supply chain because tactical and operational level will take action based on direction from strategic level. To provide an environmental friendly supply chain or sustainable supply chain, it should start with strategic level which the main objective to achieve sustainable had been set at the first place.

4.4. Sustainable Design in Strategic Level of Supply Chain

As mentioned earlier, this study will only discuss about the sustainable design in strategic level. Simultaneously, sustainability of supply chains has emerged as a major theme in both research and practice since the impacts of climate change have made both producers and consumers more cognizant of their decision-making and how their decisions affect the environment. To achieve sustainability in strategic level it should have set the objectives of company with this concept in mind: *the right products in the right quantities (at the right place) at the right moment at minimal cost*. Figure. 4 (NEVEM-workgroup, 1989) translates this overall objective into four main areas of concern within strategic level in supply chain management. These objectives are parallel with the principles of sustainable design. Renewability in sustainable design produce 'right product' in product process integration and technology properties: ensure that nothing was waste and harm during the product design and development, using low impact materials and with manufacturing processes, equipments, tools, and facilities which require less energy consumption. In term of production and distribution, it should produce in right quantities which meet the demand of market and shift to distributors and customer in right quantities too. Even though if over produce happened, principles of reuse and recycling can applied in this section where it possible to recycle or reuse them. Flexibility in term or time will increase the demand from market and at the same time will decrease the level of inventory because customer will receive their product in the right moment. All this criteria will lead to minimal resources and also reduce the harm to environment because the consumption of resources will decrease yet the objective of supply chain can be achieve.

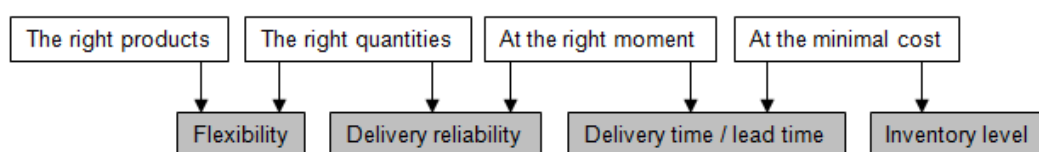


Figure 4: Hierarchy of Objectives

To achieve above criteria successfully, the possible aspect to discuss the issues of sustainability in strategic level are: location, production, inventory and transportation.

i. Location

In order to achieve sustainability in this aspect, impact of production towards environment can be reduce by speeding up the process of supply chain in this level. At the strategic level, a company has to identify the customers location for its products and services. When company management makes strategic decisions on the products to manufacture, they need to then identify the key customer segments where company marketing and advertising will be targeted. Company must decide how and what information it want to share to increase the speed and decrease the costs of supply chain processing. After identify the demand of the market, company able to push the product requirements directly to suitable manufacturer to produce product that meet exact demand without wasting extra energy and time.

ii. Production

At the strategic level, manufacturing decisions define the manufacturing infrastructure and technology that is required. Based on high level forecasting and sales estimates, the company management has to make strategic decisions on how products will be manufactured. The decisions can require new manufacturing facilities to be built or to increase production at existing facilities. However, if the overall company objectives include moving manufacturing overseas, then the decisions may lean towards using subcontracting and third party logistics. As environmental issues influence corporate policy to a greater extent, this may influence strategic supply chain decisions with regards to manufacturing.

Besides that, manufacturer can map the entire cycle of a product to evaluate its environmental footprint. This initiative will require the manufacturer to build new supplier relationships with those who can provide new supply chain routes. This includes materials, packaging, distribution, usage, and disposal. If any step in the cycle does not provide a positive environmental impact, the manufacturer will try to find new routes and technologies that will improve the impact.

Nevertheless, manufacturer need to looking into new sources and raw materials. To use hundred percent renewable and/or recycled materials, this will require the manufacturer to build new supplier relationships with those who can provide the raw materials. Having less waste or even zero waste go to landfills will also require new supplier relationships. It is also working to reduce the amount of material used in products and provide education programs to consumers.

iii. Inventory

In inventory aspect, company management has to decide on the strategic supply chain policies with regards to suppliers. Reducing the purchasing spend for a company can directly relate to an increase in profit and strategically there are a number of decisions that can be made to obtain that result. Leveraging the total company's purchases over many businesses can allow company management to select strategic global suppliers who offer the greatest discounts. But these decisions have to correspond with the overall company objectives. If a company has adopted policies on quality, then strategic decisions on suppliers will have to fall within the overall company objective.

iv. Transportation

As well as strategic decisions on manufacturing locations, the logistics function is key to the success of the supply chain. Order fulfilment is an important part of the supply chain and company management need to make strategic decisions on the logistics network. The design and operation of the network has a significant influence on the performance of the supply chain. Strategic decisions are required on warehouses, distribution centres which transportation modes should be used. For company which have sufficient modal, selection of in-house transportation is encourage because this will enables the company to maintain low levels of inventory. Low inventory means the company do not need extra space to keep old product. The higher level of inventory means the high resources are needed.

Besides that, an efficient route of transportation able to help a company to save money by shipping its products to its distributor or even direct to its customers. From the perspective of sustainable, this indirectly reduce the pollution that might be cause by the transportation such as noise pollution and air pollution.

However, decisions made on the four aspect in strategic level are of interrelated. For example, as shown in Figure 5, size, number and geographic location of the supply chain entities will influence the mode of transport to use to transfer the product. Besides that, type of product to produce, where to produce and which supplier to use will influence the way of managing inventories throughout the supply chain. Indirectly, decision-making in this level affect the sustainability of the whole supply chain towards ecology, economy and social/culture.

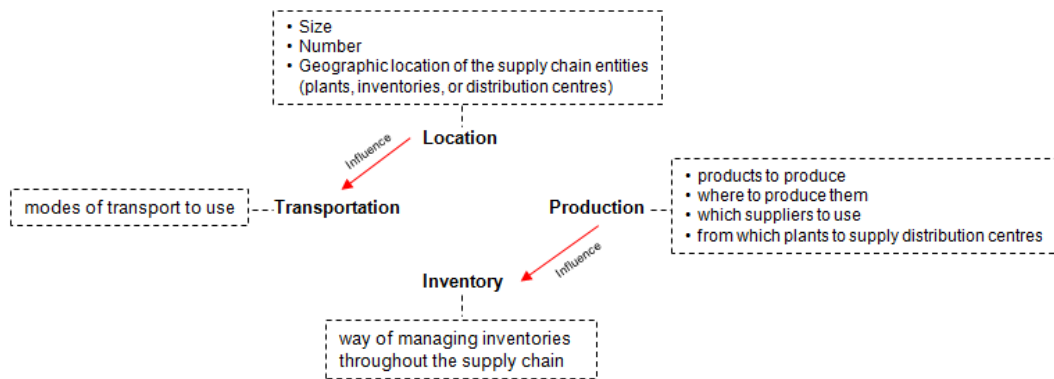


Figure 5: Decision-making in Strategic level

As conclusion, strategic level involved decision-making of top management in a company to set goals, objectives and planning for its business. Strategic level of decision was mean for long term which mean by applying sustainable design concept during this level is suitable because this is the earliest stage of whole process and decision that been made during this level will guide the following level - tactical level and operational level to follow the strategic level decision.

5. Conclusions

This study has taken a broad look at sustainable design and the issues emerging in supply chain. It offers a better understanding on sustainable design in the context of supply chain, current position of supply chain and the possible aspects to discuss the issues of sustainable design in strategic level of supply chain based on a literature review.

Generally, sustainable design no longer specifically owned by certain field. It suitable to apply in any profession or discipline as long as it able to eliminate negative environmental impact yet meeting the needs of the present and also responds to harmonize and interact with environment, economy and social. In another word, sustainable design in the context of supply chain means the development of supply chain from the requirements of the organization to consider economic, social and environmental impact from the production process until the products or services has deliver to customer. This shown that the definition and understanding of the term sustainable design is same which focus in harmonize the environment, economy and social.

In the context of supply chain, nowadays, most of the company having pressure to make sure their supply chain are environmental friendly. this is because companies are confronted with a growing trend towards internationalisation. Most of the companies having difficulty to handle the whole supplier network and increases the complexity of purchasing thus maintain environment friendly when working with multilevel of supplier to get raw materials. Besides that, some of the businesses and in particular supply chain have become increasingly globalized which make the companies need to ensure manufacturing of products without creating environmental damage or disobeying social standards. Nevertheless, the legal requirement from government and evolving of customer taste also placing pressure on manufacturers and distributors to become more environmentally-friendly and to minimize the emissions generated by performing better environmental performance at any stage of the supply chain because it involve the company's reputation. This proven that it is important to have a systematic supply chain to manage multilevel supplier and the company need to set objective at the early stage which is strategic level to follow by other supplier which belong to the same supply network to work together to achieve sustainability in supply chain.

Supply chain combined three level and each level managing different action. Level one which is strategic level sets directions for organisations on supply issues, aiming to achieve a targeted position. Second level which is tactical level managed and monitored through planning and control and lastly operational level will take action based on direction that had been set in strategic level. Based on literature, strategy level are related to location, production, inventory, and transportation. In order to integrate the four aspect, company need to set supply policy and supply strategy to support overall mission. Therefore, strategic level is the objectives setter of the supply chain because tactical and operational level will take action based on direction from strategic level. To provide an environmental friendly supply chain or sustainable supply chain, it should start with strategic level which the main objective to achieve sustainable had been set at the first place.

After the understanding of sustainable design in the context of supply chain and current position of supply chain and strategy level of supply chain has built in this study, the possible aspect to discuss sustainable design in strategic level of supply chain has identified. Based on this study, there are four aspect to discuss the issue in strategic level which are location, production, inventory and transportation. In the aspect of location, impact of production towards environment can be reduce by speeding up the process of supply chain . For production, company need to define the manufacturing infrastructure and technology that is required, look for alternative material and reduce amount of material used in products, and determines a product's entire environmental footprint from raw materials to end disposal. In term of inventory, company need to decide on the strategic supply chain policies with regards to suppliers in order to get the best offer which able to reduce purchasing spend and at the same time increase company profit. Finally, in transportation, strategic decisions are required on warehouses, distribution centres which transportation modes should be used which may help the company to decrease the level

of inventory. Other than that, applying efficient route of transportation able to help company to save money by shipping its products to its distributor or even direct to its customers and reduce pollution that cause by transportation such as noise and air pollution. In the area of supply chain management especially in strategic level it is clear that progress can be made in terms of incorporating these four aspects for environmental impact within a multi objective optimization framework. However, great challenge still lies in properly accounting for the uncertainties in this level because these four aspects are interrelated and influencing one and another. Therefore, integration between these four aspects had to further examined by both the academic and industrial community in future research in order to have a more realistic analysis of the systems and develop an effective ways to produce sustainable supply chain.

Sustainability of supply chains has emerged as a major theme in both research and practice since the impacts of climate change have made both producers and consumers more cognizant of their decision-making and how their decisions affect the environment. Since implementation of sustainable design have to start at the earliest stage, applying sustainable in strategic level of supply chain is the first step for company to show their responsibility towards environment, economy and social. Strategic decisions determine the overall direction of company's supply chain. They should be made in conjunction with the companies' overall objectives and not biased towards any particular product or regional location. These high level decisions can be refined, as required, to the specific needs of the company at the lower levels which allow for tactical and operational supply chain decisions to be made.

Future work might improve this study by taking a closer look at particular sub-bodies of publications, i.e., discuss issues of sustainable design in tactical level and operational level since these three components form the entire of supply chain. This might allow specific features to be identified in greater detail.

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