

Supply Chain Sustainability, Efficiency and Effectiveness : An Overview

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ABSTRACT

Global business world has become extremely dynamic and challenging in the past few decades. Modern business practices now demand for a global spread of activities and so business organisations can no longer depend on suppliers within a country. The supply chains have crossed national boundaries and intricacies of businesses demands for complex and sustainable global supply chain. The sustainability, efficiency and effectiveness of any supply chain depends upon a large number of factors. In this research, some key factors for sustainability, efficiency and effectiveness of a supply chain were identified based on available literature like: clarity of goals in internal communication, smooth flow of goods & information, maintenance of due diligence, adequate and effective integration/disintegration of supply chain sub-elements, selection of supply chain partners, constant monitoring of changes taking place in allied industries, continuous improvement in operational performance, instrumental relational and moral motives, IT infrastructure availability, dynamic and structural flexibility, agility of supply chain, managing environmental concerns in the view of increase public awareness, exogenous factors like governmental support etc. In the future, a focus on these activities will help any supply chain in achieving sustainability, efficiency and effectiveness.

Key Words : Supply Chain Management, Sustainability, Efficiency, Effectiveness.

Introduction

The business world today is changing with lightning speed due to collapse of international trade barriers and opening of economies. Liberalisation and multiple trade agreements have given way to an increase in cross border trade for the benefit of all the stake holders. In today's global world, each country or region has a unique combination of natural resources, favourable government policies, competent man power, locational advantage, availability of technology etc. These resources help any region to produce good quality intermediate products/final products at minimal cost. So, organisations across the globe now procure a number of products/components from different countries. An increase in logistics, transportation and distribution facilities has helped in global procurement and distribution of products. This improvement in logistics and transportation facilities is further supported by quick flow of information among all partners of a supply chain. However, these developments have posed some additional challenges for supply chains and have enlarged the dimensions for sustainability, effectiveness and efficiency of any supply chain. The development of a robust supply chain is now essential for global competitiveness. Thus, a study of factors affecting sustainability, efficiency and effectiveness of any supply chain is the need of the hour.

Supply chain structure

Any supply chain may be viewed as a network of multiple interrelated nodes rather than a simple linear chain. A node in any supply chain can be an independent business entity which contributes for its functioning. In this complex network, goods, services, money and information simultaneously flows between all the interlinked nodes. So, managing such complex supply chains is always a difficult task and a systematic five stage hierarchical supply chain outline method can help in this process (Corominas et al.,2015).In addition to a systematic hierarchical outline, moral and responsible values are at the core of any sustainable supply chain.

Every member of a supply chain need to work on these moral values and should carry out responsible deeds. In this process, not only the organisations, but the individuals from these organisations also need to effectively execute their responsibilities and work on ethical values. A clarity of internal communication, clear goals and well defined policies may be considered as prerequisite for moral behaviour, because it helps an individual in discharging his/her responsibilities effectively and efficiently. In a supply chain, clear and convergent goals reduce subjectivity and on the other hand, hypocrisy at any level of the supply chain may adversely affects its sustainability, efficiency and effectiveness. Thus, success of entire supply chain depends on the efficient and effective linking of all the partnering members. A coordinated effort is mandatory for supply chain sustainability i.e. all the partnering organisations must work in synergy and as one team (Brookshire Jung Ha, 2017).

A supply chain is normally built of a network of independent organisations which rely on each other for profitability. In other words, the sustainability of entire supply chain depends on the financial health of each of its partner organisation. A panic button pressed by any one element of a supply chain may trigger a chain reaction and can have a spill over effect on the entire supply chain. This spill over effect may lead to financial implications like: increased information cost, increased credit cost, cost of replacement of a supply chain partner, the cost of reorganisation of supply chain etc. These financial implications can spread in both the directions of a supply chain i.e. upstream or downstream (Kolay et al. 2016). The financial implications of losing a partner in a supply chain may adversely affect sustainability, efficiency and effectiveness.

Any supply chain has wide structural choices like multiple suppliers, few suppliers or vertical integration i.e. buying of a distributor/customer (downstream integration),or manufacturing of components, goods(upstream integration). An evaluation of supply chain was carried out by Jafarnejad et al. (2017) on these three aspects. The results of their study indicate that in the case of supply chain with many suppliers, an integration improved supply chain performance but it adversely affected quality. In the case of multiple suppliers, a long supply chain could not leverage some of the manufacturing benefits like six sigma quality control orlean manufacturing techniques or product quality assurance. A vertical integration was observed to have a moderating effect on the supply chain performance and practices. It can thus be said that shorter supply chains are easy to handle may be due to an improved operational control on individual units. In the case of vertical integration, lean manufacturing and six sigma practices may partially improve supply chain performance (Jafarnejadet al., 2017).

Managing flow of materials is one more crucial element for supply chain efficiency. Every supply chain has inbound and outbound materials. A supply chain manager generally has two options, cross docking of inbound and outbound materials or decoupling of inbound and outbound materials (i.e. maintaining inventory). A lot-for-lot cross docking puts operational strain on the supply chain, whereas building inventories has negative financial effect on supply chain performance. Kellar et al. (2016) examined this dilemma of choices on the performance of a supply chain. Their findings indicated that average

throughput rate, i.e. rate at which material travels in the supply chain and average lot size can be used as deciding variable for taking these decisions.

Integration of sub-elements of a supply chain increase its performance but contextual factors do play a role in supply chain effectiveness. Customer order decoupling is one such contextual factor. It includes all type of customer orders companies i.e. “making as per order companies”, “making for stock purpose” companies or “assembling items to fulfil order” type companies. A “make to order company” produce goods after the receipt of an order. So they are more engaged in joint research & development with their customers. On the other hand, “make to stock” companies generally produce standard parts and so they are more vulnerable to fluctuations in demand forecasting. So, these organisations intensively exchange information related to forecasting of future demand with their supply chain partners. The focus of “assemble to order” companies is generally on planning and strengthening of internal supply chain elements (Donk and Doorne, 2016). Thus, every supply chain need to assess their nature of the business and then get involved with its partnering elements in information exchange or demand forecasting.

Supply chain challenges for sustainability

The problems incurred in a supply chain are often complex and diverse in nature. A systematic approach can reduce risk of failure and can make it sustainable and effective. Any complex supply chain problem can be divided into small manageable sub-elements. This exercise may help in understanding the interdependency of various supply chain elements and may make decision making simple and fast. A growing hierarchical self-organising mapping algorithm approach proposed by Chattopadhyay et al.(2016) can be effective in breaking a complex supply chain in small sub-elements. These small sub-elements can then be relinked to develop an improved supply chain model. This method is found helpful in managing complex supply chains (Chattopadhyay et al., 2016).

Supply chain in manufacturing organisation may have multiple drivers. These drivers like inventory, transportation facilities, effective use of information technology, product pricing, outsourcing and awareness among stake holders are key factors for supply chain competitiveness (Matthew and Othman, 2017). Thus, sustainability of a supply chain in manufacturing sector has a unique set of challenges. In a study on the supply chain in the manufacturing sector for “3TG mineral production”(3TG – Tungsten, Tantalum, Tin and Gold, specially from African countries), Kim and Davis (2016)observed that a disintegration of supply chain may help in cost reduction, but may result in lesser monitoring, reduced control over critical processes and lesser accountability.

The complexity of a manufacturing supply chain was found to be a hindering factor in sustainability and accountability (Kim and Davis, 2016). At times, industrial diversification or international diversification of a complex manufacturing supply chain maybe done to distribute the risk among various supply chain partners. However, this move may reduce control over critical processes in a supply chain and may result in less effective environmental assurance. In such cases, the materials may be produced with the violation of human rights or environmental norms. An absence of this assurance (compliance with human rights or environmental norms) might make a supply chain less sustainable over a long time period. In the case of violation of environmental or human right norms, initiatives like increasing company's visibility, pre-existing reputation or voluntary participation in sustainability programs may have minimal or no effect (Kim and Davis, 2016). In other words, the sustainability of a supply chain depends on adherence to human rights and environmental norms.

In supply chain management, the risk alleviation orientation, risk absorption capacity and risk modification competency play an important role. The risk reduction orientation is significantly related to risk reduction competency and is facilitated by risk taking capacity. In other words, a higher risk taking

capacity and high risk taking competency can result in an orientation towards an aggressive and proactive supply chain (Ambulkar et al., 2016). Any organisation when sees the benefits of taking risk may get motivated to undertake risk mitigation program and knowledge enhancement program. These programs then increase the risk absorption capacity of an organisation. This entire exercise may result in an improved supply chain and effective risk reduction (Ambulkar et al., 2016). On the same lines, Taticchia et al. (2015) observed that the sustainability of any supply chain depends on three dimensions viz. economical dimension, social dimension and environmental dimension So, all the three dimensions need to be included in measuring the performance of any supply chain and ultimately in measuring its efficiency or effectiveness.

Information flow and operations in a supply chain

The success of a supply chain largely depends on the information sharing between different sub-elements. An accurate information about future demand and the time of the delivery can reduce overall inventory costs. However, information collection is also an activity which involves a lot of financial and man-hour resources. The cost of information sharing can be linear or exponential and has an impact on supply chain effectiveness. A long term sustainability of a supply chain depends on cost-benefit trade-off between obtaining information and benefits received in terms of improving supply chain effectiveness (Huang et al., 2016).

Information processing and sharing with customers is one more key differentiating element between an effective and a non-effective supply chain. In a supply chain, some customers actively share information and in return may expect benefits like increased flexibility or improved delivery performance. In a supply chain, customers are more powerful than the suppliers. A negative communication from them may damage reputation of a supply chain whereas a positive communication may enhance image of a supply chain. In other words, a disparity of power exists among multiple partnering elements of any supply chain. Organisations need to effectively share Information with its customers and should leverage this information openness for supply chain efficiency and sustainability (Huo, et al., 2016). Some other researchers like Madhani (2016) also emphasised on customer focus for a sustainable and competent supply chain. A consensus and coherence in a supply chain may be built by focusing on responsiveness, reliability, resilience, continuous realignment for customer focus and value addition Madhani (2016).

Any supply chain need to continuously improve its operational performance in order to remain competitive and sustainable. The operational performance of a supply chain depends on multiple supply chain practices like customer relationship, use of information technology and quality of Information. A study by Kumar and Kushwaha (2018) on fair price shops in India indicated that all these three elements directly result in supply chain operational performance. Among these three practices, quality of information has highest impact on supply chain effectiveness whereas customer relationship has least impact on supply chain effectiveness. On the same lines, Mathu and Tlare (2017) observed that effective use of information technology may help in supply chain integration particularly for small and medium enterprises. Organisations which adopted new information technological drives are able to integrate supply chain effectively and this initiative helped them in improved supply chain collaboration.

Supply chain efficiency and effectiveness

In addition to the sustainability, any supply chain need to be efficient and effective. The efficiency of a supply chain can be improved with the use of a number of tools. Moghaddam (2015) observed that close loop hybrid Monte Carlo simulation and goal programming are such useful tools in optimisation of a supply chain on parameters like total profit optimisation, management of defective parts, management of delivery challenges, and in the analysis of economic risk. These tools may help in increasing the overall

efficiency and effectiveness of a supply chain particularly for supplier selection and order optimisation. Oláh et al.(2018) observed that integration of supply chain sub-elements helps in the reduction of inventories & cost and ultimately helps in increasing efficiency. In addition to integration of sub-elements, an effective information sharing is also found helpful in increasing the efficiency and effectiveness. Oláh et al.(2018) further suggested that real time collection and processing of information may help in fast decision making, long term stability and long-term partnership of a supply chain.

The world is moving towards dynamic supply chain management and factors like instrumental motives, relational motives, moral motives, environmental performance, financial performance and sustainable practices are some key determinants for efficiency and effectiveness. In the event of a lack in awareness of these elements, efficiency and effectiveness of a supply chain may reduce making it unsustainable in long run (Paulraj et al. 2017). The supply chains for small and medium enterprises (SME) are more susceptible for market challenges in the view of their small size. So they need even better efficiency and effectiveness. In a study on SME supply chains in Australia, Bi (2017) observed that factors like IT infrastructure, business partnership, customer power and supply chain coordination capabilities are some essential elements for efficiency and effectiveness. An efficient management of these factors may result in an outstanding performance of a SME e-Supply chain and may make them sustainable in long run.

In the fourth generation industrial revolution, which is commonly referred as “Industry 4.0”, the efficiency of a supply chain is often replaced with dynamic flexibility, structural flexibility, and agility. In the future, these parameters shall determine efficiency and effectiveness of any supply chain (Szozda Natalia, 2017). In the same lines, Usui et al. (2017) conducted a research on supply chain of “Uniqlo” in China. They suggested that flexibility is one major factor in managing efficiency and effectiveness of a supply chain. Thus, in modern dynamic business world, sustainability, efficiency and effective supply chain will decide future of any business.

External challenges in supply chain

The performance of any supply chain may depend on the changes taking place in the business environment, particularly in the allied and supporting industries. Transportation and trucking business has been an integral support function in any supply chain across the globe. In a research on trucking business in the USA, Kulchania and Thomas (2017) observed that change in governmental regulations like deregulation of trucking industry resulted in lower transportation costs. In addition to the reduction in costs, other technological developments like bar coding of shipment and JIT implementation enabled transportation of goods in small lots. These changes in transportation pattern influenced supply chains as the goods can be procured or despatched in multiple small lots rather than one single big lot. This increase in number of shipments resulted in lower inventory levels, decrease in inventory holding costs and reduced working capital requirement. This move indirectly contributed in effectiveness of supply chains. However, this move may result in an increase in supply chain disruptions or uncertainty, and in order to effectively handle disruptions or uncertainty, supply chain firms may start holding larger amount of cash. Thus, an operational change in an allied industry not only changes the logistic practice of a supply chain but may lead to a change in the composition of current assets or financial practices (Kulchania and Thomas, 2017).

Some exogenous factors (like government subsidies)also play a role in supply chain practices. A study by Hong I-Hsuan et al. (2016) in Taiwanese context indicated that at times, the individual elements in a supply chain behave in their own interest rather than in the holistic interest of integrated supply chain. In the case of recycling of electronic waste materials, a subsidy is provided at different stages for recycling of waste material. This government subsidy pattern varies from country to country. The subsidy policy

may have variations for different sub-elements like: no subsidy, subsidy for processor of E-waste, subsidy for the collector of the E-waste, subsidy to both the collector and processor of E-waste in equal proportion, subsidy both to collector and processor of E-waste in different proportions etc. This disparity in government subsidy pattern may encourages some supply chain elements to stock intermediate material for their own interest. It then negatively affects the holistic approach in an integrated supply chain (Hong I-Hsuan et al., 2016). A study in Taiwanese context by Hong I-Hsuan et al. (2016) concluded that government subsidies given to the processor of the E-waste proved to be more effective, whereas a higher government subsidy given to the collector of E-waste resulted in stock piling of E-waste and negatively affected smooth functioning of supply chain.

Among all type of supply chains, food supply chains have an additional challenge due to the perishable nature of the product. In a study on food products supply chain in the United States, Lacagnina et al. (2017) observed food desert in many localities i.e. an area where a customer has to travel a large distance to access a food store. This geographical food desert varied from a few miles in the case of urban areas to more than 10 miles in the case of some country side localities. The main reasons identified for this food desert were, low product turnover, financial non-viability and higher break even costs. In this situation, a direct financial incentive scheme along with some other non-traditional measures like mobile markets, local food banks etc. may help in reduction of food deserts (Lacagnina et al., 2017).

In any supply chain, due diligence is one key element for its efficiency, effectiveness and sustainability. A study on due diligence of conflicting mineral supply chains in five industrial sectors (Aerospace/Defence, Automobile, Electronics, Engineering and Jewellery) was carried by Hofmann et al. (2018). They observed that a reasonable due diligence approach is applied by large automotive and engineering companies in supply chain management, but on the other hand, a low level of diligence in supply chain implementation was observed in the case of Jewellery sector companies. Thus, organised sector companies (automotive and engineering) appeared to be more responsible in management of their supply chains as compared to the partially organised sector companies (Jewellery sector).

An increased public awareness and fast depletion of natural resources has posed additional environmental challenges on a modern supply chain. A new concept of green supply chain has emerged in last few decades for sustainability, efficiency and effectiveness. In this context, Lake et al. (2015) observed that the environmental assessment of a supply chain may be done using Life Cycle Assessment (LCA) concept but with some limitations. Their study on a steel plant producing pre-stressed concrete strand wires revealed a high level of greenhouse gases emission during processing. In the future, adherence to the environmental norms will be necessary from legal perspective and for building a positive public opinion. Future studies in supply chain sustainability, efficiency and effectiveness may be conducted in this area.

Findings

Supply chain sustainability, efficiency and effectiveness is the need of the hour for competitive advantage. An effective supply chain can help in exponential growth of a business whereas an inefficient supply chain may doom any business. The key areas which play a major role in supply chain sustainability, efficiency and effectiveness are observed to be:

- Adherence to ethical and moral values
- Maintaining due diligence
- Careful selection of supply chain partners
- Clarity of goals, clear internal communication and well defined policies for each member of supply chain.

- Smooth flow of goods and information
- Interdependency of supply chain elements with adequate integration/disintegration of supply chain sub-elements
- Good financial health of each supply chain partner organisation along with sustainable practices
- Customer turnover, financial viability and break even costs
- Nature and type of inventory
- Contextual factors like customer order coupling or decoupling
- A cost-benefit trade-off for obtaining information and its use for improving supply chain effectiveness
- Use of proper tools in measurement of efficiency and effectiveness of any supply chain.
- Dynamic flexibility, structural flexibility, and agility
- IT infrastructure, business partnership, customer power and supply chain coordination capabilities.
- Instrumental motives, relational motives, moral motives.
- Careful monitoring of changes taking place in allied industries
- Continuous improvement of operational performance
- Managing environmental concerns in the view of strict environmental laws and increased public awareness.
- Exogenous factors like governmental support, change in government rules, regulations and subsidies

Conclusion

This paper provides an overview of different elements which are helpful in supply chain sustainability, efficiency and effectiveness in this competitive world. The paper has summarised the factors which are responsible for success of any supply chain in today's competitive business world based on available literature studies. The findings of this research can be used as a base for future studies on supply chain management practise across the globe and may be used for the development of a contemporary instrument for measurement of supply chain sustainability, efficiency and effectiveness.

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