

The contribution of Enterprise resource system (ERP) on Green supply chain performance – Case study Approach



Exploratory Research on the contribution of Enterprise resource system
(ERP) on Green supply chain performance using Case study Approach

By

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Executive summary

Sustainability and environmental issues are observed to be rapidly emerging as one of the important concerning topics for strategic business management. Firms are developing sustainable programs with the purpose of greening their own products and processes while reducing the impact of their activities. One such practice meeting this objective is the rise of the concept of Green Supply chain management (GSCM). It has lately attracted a lot of attention and scope among researchers and firms with the objective of sustainability and reduction of environmental impact in the supply chain operations of a firm. The last decade, the attention paid to this phenomenon in literature is observed to be slowly increasing. Also, the government has applied strict environmental regulations on companies to reduce the impact on the environment. Therefore, In this research study, we consider GSCM as one of my focus topics in formulating the research question for study.

The second topic concerned with my study is Enterprise Resource Planning (ERP), which is a typical example of enterprise system software application aimed to aid in integration and support for information flows in organizations. It is observed that many big multinational firms have ERP platform installed in their operations. ERP is strongly linked to Business Intelligence (BI) factor because it provides the service to collect and centralize storage of data to create more insights for the business. The expectations of ERP are generally quite high due to the high investment involved in it. Optimization of the supply chain using ERP software is aimed at the improvement of processes and creates greater performances.

I observe a knowledge gap in current research where the above two rarely studied topics of ERP and green supply chain have been studied together. Also, considering the growing business interest in green supply chain management and the adoption of ERP system in the firm's operation. This research is conducted to acquire knowledge on the gap observed between the ERP and green supply chain management. Due to the limited literature available, the following research is mainly exploratory, where an attempt is

carried out to address the lack of information concerned with the relation between two topics of interest.

Goal

The goal is to carry out an exploratory research on the relationship between the benefits of ERP in supply chain and Green supply chain operational performance. Based on the findings, an extended conceptual model is developed, which is referred to provide suitable recommendations for businesses.

Research framework

To achieve the above goal, structured research activities are performed subsequently with the help of the research framework developed. First, the Available literature on ERP and GSCM is investigated and described resulting in the development of a theoretical model on each topic. The advantages of ERP on supply chain relevant information is consolidated to develop a theoretical model. The three main advantages of ERP on supply chain was observed and consolidated with the help of literature as following *Information sharing, Operational efficiency and Integration with stakeholders*. Simultaneously the literature on greens supply chain performance measures was studied in the available literature to develop a consequent theoretical model for my research. The result of which included two major performance measures namely *environmental performance and economic performance*.

Second, the gap is observed between the theoretical models developed is used to construct a conceptual model for the research study. Subsequently, the Research question is formulated to address the gap observed in the conceptual model. Where the question addresses the knowledge gap of the contribution of ERP in Green supply chain operational performance.

Research question: *How does ERP system contribute to Green supply chain operational performance?*

Third, the above research question is attempted to answer through case study research methodology. Due to the lack of information and exploratory study in nature, the case

study was found suitable to answer the research question. Therefore, a multiple case study is carried out by considering the study cases from different industries and markets producing different products to consumers. Multiple cases considered are manufacturing firms which included the *chemical firm, automotive firm and plastic products firm*. The Case study included interviews with open-ended questions carried out with supply chain experts in respective firms and collection of reports and other documents concerned with their supply chain operations.

Lastly, the data collected through interviews and company reports studied was triangulated along with the literature studied in the development of a theoretical model on the topic of study. The results of triangulation of data are referred to develop the extended conceptual model in the research and provide consequent recommendations.

Results

The results of this exploratory research carried out to address the gap between ERP benefits and GSCM performance was consolidated using the different sources of data. The triangulation of data collected from expert interviews, archival records of case firms and past literature studied is analyzed to present the results. The research resulted in the development of an extended conceptual model addressing the benefits of ERP and GSCM performance with the presence of mediating variables. The Mediating variables *Inventory control and delivery frequency control* was analyzed to be influencing the relation between ERP and Green supply chain operational performance.

Conclusions

The aim of this research was to explore the relationship between ERP and GSCM performance and develop an extended conceptual model with the foundation of the conceptual model developed using current literature. As a result, an extended conceptual model is developed which provides an idea regarding how the two supply chain terminologies are related. The research results in two considerable mediating variables Inventory control and delivery frequency control that are observed to influence the relationship of ERP and green supply chain economic and environmental performance.

In addition to the existing literature conducted on both ERP and Green supply chain, the developed conceptual model mainly addresses the gap observed between the topics. This research can be a starting point for researchers in the future to conduct their research through other research methodologies and attempting to increase the validity of results obtained. Further, the conducted research also is an addition to the limited research available on both the topics of study. Where Enterprise system concerned with supply chain and information system influence on green supply chain management have been studied by very few researchers in the past.

In a business perspective, the conceptual model developed as a result of this research gives an idea on the metrics relevant to ERP system to consider in a supply chain operation to measure the Green supply chain operational performance. For firms competing strategically with an objective of sustainability can refer to the conceptual model to be reassured to measure the performance of their respective supply chain in the perception of the green supply chain. The model provides an idea to the organizations on how the investment in ERP can also be measured with green supply chain perceptive.

Overall the results of this research are discussed based on structured research framework and in-depth case study conducted on relevant case firms and experienced professionals. As a conclusion, it can be put that the strength of the developed conceptual model lies within the structured, holistic measurement approach which the framework represents.

The scope of future research on the topic of study in this research is observed in terms of validating and testing the results obtained using a survey among bigger sample unit. Further, the research conducted is subjective in nature limited only in hinting the variables influencing the relationship but does not address the methodology to measure the influence of these variables. Therefore, research on measuring the contribution using a quantitative methodology can be scope for future research.

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Abstract

The increasing awareness towards environmental protection demands industries to enact viable solutions in their operations, one such example is the introduction of the concept of “Green Supply chain management” in supply chain operations. The supply chain process operates as a link connecting firms and industries to deliver a product or service to the end customer. The procurement activity in the supply chain process plays a vital role in providing the materials for production and consequently to business sales of the firm. Over the years, the technological development and integration of information technology in procurement process have transformed manual information sharing to a more automatized system of Enterprise Resource Systems (ERP) in the business to the business operational platform. The growing importance of green practices in manufacturing firms and the research gap reviewed in the literature addressing the relation between ERP systems on green supply chain motivates to carry out this research. In this report, I attempt to answer the research question formulated addressing the relation between ERP and Green supply chain operational performance through a Case study. The research is carried out structurally adhering to the research framework developed in the initial stages of background study. I follow the case study methodology to collect the relevant data to reflect on the conceptual model developed through literature review and to answer the research question. Finally, I conclude the research by providing recommendations based on the analysis and reflect on the limitations and future research prospects.

Chapter 1. Introduction

Industrialization is regarded as important for the economic growth and social development but is also experienced to be harmful to the environment over the years. The increasing environmental concerns and depletion of natural resources, international and national bodies around the world are taking stringent steps to reduce waste across various sectors of business operations by taking stringent steps and redefining company objectives. In 2016, Achim Steiner, the executive director of United Nations Environment Programme (UNEP) stated “If current trends continue and the world fails to enact solutions that improve current patterns of production and consumption, if I fail to use natural resources sustainably, then the state of the world’s environment will continue to decline. It is essential that I understand the pace of environmental change that is upon us and that I start to work with nature instead of against it to tackle the array of environmental threats that face us.” after his review on Global Environmental Outlook (GEO-6) (Shadrack Kavilu, 2016) . This statement by Steiner reaffirms the growing importance and necessity to further proactively enact in adopting green solutions in processes across different industrial sectors and processes. This necessary change in mindset is being realized in business operations; sustainability and environmental issues are observed to be rapidly emerging as one of the most important topics for strategic business, management, manufacturing, and product development decisions. Firms are developing sustainable programs with the purpose of “greening” their own products and processes while reducing the impact of their activities. Besides, in order to eliminate the problems of environmental pollution, the concepts of environmental management, such as green management, green marketing, green production, and green innovation, etc are now being pursued (Sezen & Cankaya, 2013, pp. 154-163). The ecological impacts are experienced in every little decision undertaken in various product design stages such as product conceptualization, design, raw materials processing, manufacturing, assembly, warehousing, packaging, transportation, reusing, and refurbishing is measured and considered in designing the product and the required operations (Nikbakhsh, 2009, p. 195).

One of the prominent links connecting most of the above-mentioned product stages and services in the industry is the supply chain process. The supply chain is regarded as the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer. As defined by the Supply Chain Council, supply chain management (SCM) is a process which “encompasses every effort involving producing and delivering a final product or service, from the supplier’s supplier to the customer’s customer. It includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer” (Nikbakhsh, 2009, pp. 195-220). Currently, there exist multiple paradigms to optimizing the logistics of a supply chain of the manufacturing industry to optimize its operations; supply chain management (SCM), Lean SCM, Green SCM, Resilient SCM, and Agile SCM are few such paradigms that emerged in the manufacturing industry. The multiple paradigms mentioned above differ fundamentally on its final aim. Lean SCM tends to reduce costs and increase the final value delivered to customer (Womack, Jones, & Roos, 1991), Agile SCM tends to make a supply chain responsive to constant unpredictable changes in the environment (Agarwal, Shankar, & Tiwari, 2007), Green SCM tends to incorporate environmental friendly practices in managing the supply chain and Resilient SCM tends to make the supply chain robust and immune to disruptions (Tang, 2006).

As mentioned above, the importance of supply chain management and the ecological impacts of product design have led to defining the concept of Green Supply chain Management (GrSCM). Srivastava, (2007) defines GrSCM as “Integrating environmental thinking into supply-chain management, including product design, material sourcing, and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life” (Srivastava, 2007) . Nikbakhsh in his report addresses three main elements of GrSCM which are green design, green operations and green procurement_(Nikbakhsh, 2009, pp. 195-220)._The procurement activity is considered to be one of the main processes in the supply chain and also in explaining the green supply chain concept. Procurement

activities in a supply chain include inventory management, identifying requirements, determining requirement specifications, finding appropriate supplier(s), contract negotiation and management (price, amount, quality, delivery schedules, etc.), receiving, quality inspection, storage, and inbound distribution (Nikbakhsh, 2009, pp. 195-220). Over the decades, the procurement has undergone stages of improvement towards optimization and simplification of the process. As discussed by Glas and Kleeman, the procurement activity integrated with the IT application has been developing since the 1970s, where initially the demand for production materials was structured using a simple electronic system known as Material resource planning (MRP), which was limited to internal departments of the organization. The next stage of procurement experienced strong inter-company system integration through Enterprise resource planning (ERP), with functionalities focused on administrative and support for operative tasks. The Next development stage was E-Procurement supported with trends in E-Business, internet and supply chain management. The development aiding the procurement function through the Information technological solutions are unique not just because of their growing use in decision-making and knowledge management systems, important as that is. Their use has also yielded significant improvements in the efficiency of energy and materials use. This has contributed to economic expansion without the increases in environmental impacts that would have resulted had the efficiency improvements not occurred.

In this report, I carry out a case study approach involving industries and experts to explore the contribution of Enterprise resource planning in the green supply chain perspective. The following sections showcase the formulation of research objective and research questions. Further, leading to detailed literature research in ERP and Green supply chain operational performance and measures deriving a suitable conceptual model. Further, I collect relevant data to test the conceptual model and build an extended one through case study research by involving industrial experts. The data collected is further analyzed with the scope of answering the research questions formulated. Lastly, the analyzed outcome is referred to provide normative conclusions and recommendations in this research

1.1 Research formulation

1.1.1 Problem Statement

Companies strive to dominate the market with a competitive edge over the other players. The adoption of green motives and sustainability is gaining importance in the global market as a competitive factor and a performance measure. Paul, et.al (2014) mentions in his report that International Organization for Standardization (ISO) has proposed the new quality management system for products and even for Environment management system (Paul, Bhole, & Chaudhari, 2014). The main idea is to minimize the environmental damage due to industries and its operations. Therefore, Green Supply chain management is evolved from Supply Chain Management and is gaining importance both academically and at the industry level. As Chin et al (2015) refer to in his research, the competition between companies intensified in the 1990s, the increased awareness of green practices triggered firms to act in an ethically and socially responsible manner in their supply chains. With these practices in mind, firms develop environmental management strategies in response to the changes in environmental requirements and their impacts on supply chain operations (Chin, Tat, & Sulaiman, 2015). On the other hand, business benefits of ERP systems in procurement, such as controlled spend, reduced requisition to order costs and cycle time, and a reduction in the percentage of maverick spend, improved transparency, and efficiency, are known, proven, and understood (Ramkumar & Jenamani, 2015). However, these enterprise systems have rarely been investigated in the context of green supply chain management.

The increasing awareness of green practices in the firm's operations and the research gap observed in addressing the role of ERP on the green supply chain encourages an exploratory research to be carried out. The outcome of this research is expected to aid the firms and supply chain managers in making informed decisions concerned to their current procurement practices in green and sustainable perspective.

1.1.2 Research Objective

Since the introduction of green supply chain thinking in the supply chain operations, there is minimal research carried out in terms of indirect factors influencing the performance of a green supply chain. ***The main objective of the research project is to address the research gap between the existing theory on ERP systems and Green supply chain operational performance and develop an extended conceptual model and deduce recommendations.*** The recommendations will be based on the case study carried out on firms which have already adopted the ERP system in their supply chain operations. The objective stated above is expected to aid the supply chain managers and firms in their decision making on incentivizing and adopting ERP systems in their supply chain operations from a green supply chain perspective. In order to achieve the main objective, there is a need to construct structured sub-objectives as following.

The Following three Sub-objectives are articulated to attain the main objectives.

- a) *Develop a conceptual model based on the existing theory on enterprise resource system (ERP) and its advantages:* In order to meet this objective, the literature on ERP is reviewed and the consequent conceptual model is developed. The model developed is expected to provide a concrete understanding of the important advantages of ERP adoption in a supply chain.
- b) *Develop a conceptual model based on the existing theory on green supply chain management (GrSCM):* I address this objective by developing a conceptual model through reviewing the literature available on green supply chain management and its measuring parameters. The model developed will showcase the measurable metrics and parameters defined and studied in green supply chain management.
- c) *Address the gap between the above two models through case study methodology:* In this sub-objective, I address the research gap between the ERP and Green supply chain operational performance using the information derived from the above two conceptual models developed. I carry out an explorative case

study with the firms and analyze the findings of the study to address the gap in research.

1.1.3 Research Framework

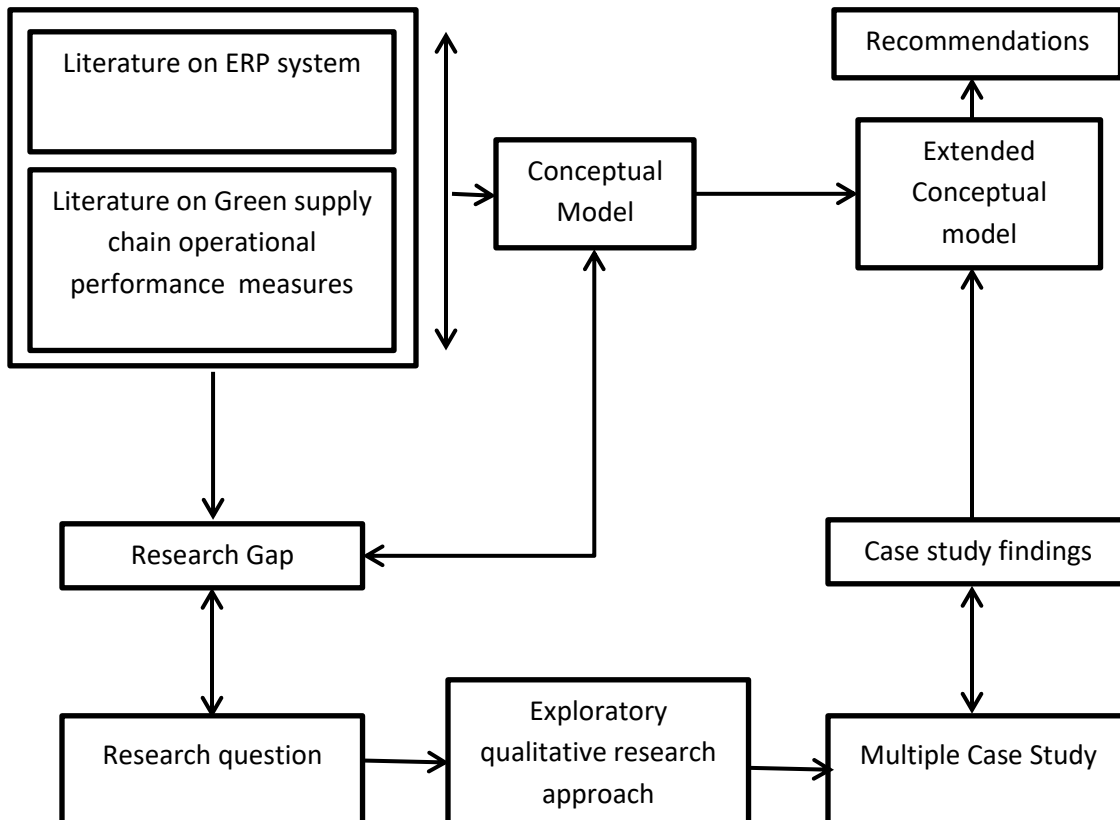


Figure 1 Research Framework

The final objective of the research as stated earlier is to develop an extended conceptual model and offer recommendations based on the analysis carried out in the research. To achieve this, the framework to be followed is visualized above, as guided from the book “Designing a Research Project” by Verschuren & Doorewaard (2010). The research is designed to be initiated with the detailed theoretical literature review on Enterprise resource system and Green supply chain. Based on the literature study, the consequent conceptual model is developed for respective concepts. The gap in research between the

two terminologies studied is further investigated to develop the research question for study. The research question is answered through a qualitative research methodology of the case study. The case study findings are collected and analyzed to answer the research question and meet the objective of developing an extended conceptual model. The extended conceptual model is referred to draw conclusion and recommendations.

1.1.4 Research question

In order to answer the research objective, the following research question and sub-questions need to be defined. The main research question of this project is as following

How does ERP system contribute to green supply chain operational performance?

The above research question answered is expected to provide insights to the managers and motivate their decisions regarding the adoption of ERP system in their firms with respect to the green supply chain perspective. The research question is formulated and aligned in accordance with the main objective, the outcomes of answering this research question will motivate the recommendations provided in this research to the problem owners stated in the main research objective.

The answers to following sub-questions will lead to solving the main question and also answer the sub-objectives

a. What are the advantages of ERP system in the supply chain?

As introduced earlier ERP is one of the platforms in the information systems. It includes wide applications across different verticals of firms. As a scope of this study, I carry out a detailed study on its application and advantages in the supply chain vertical. The reviewed theory to answer this research sub-question is necessary for the research carried out in order to formulate a reliable conceptual model for the later parts of the research. The outcome of answering

this sub-question is expected to provide inputs regarding the type of data that needs to be collected methodology phase of research.

b. What are the green supply chain operational performance measures?

Green supply chain as defined in the introduction is the incorporation of environmental thinking in supply chain process. Therefore, concrete measures need to be found through literature that explains the organizational performance of the green supply chain. Solution to the above sub-question will be adopted in developing a conceptual model to meet the second research sub-objective. The model developed acts as an input in the research methodology phase to collect relevant necessary data. The organizational measures are important to credibly quantify the concept of green supply chain and also in motivating the recommendations offered at the end of the analysis.

c. How is the ERP system related to Green supply chain operational performance?

This is the final part of this research, where I try to analyze the type of relationship in order to achieve the main research question. In this sub-question, I aim to study the research gap by consolidating the theoretical models and data collected.

1.1.5 Research approach

As inferred by the formulated research question and topic of research, this study will be conducted exploratory in nature. According to Sekaran, (1998) an exploratory study is applicable when few facts are available about the topics that are being studied (Sekaran & Bougie, 2010). Also, Burns and Bush (2006), mentions that an “exploratory research design is defined as the process of gathering valuable information through both informal and unstructured manner”. The exploratory study is advised when the researchers know little about the topic that is being studied. It is not limited to one

specific paradigm but is applicable for either qualitative or quantitative research approaches. An exploratory study is advised to be a valuable means to seek new insights on the unaddressed topics; the methodology, more importantly, relies upon asking questions to assess the phenomenon with a new perspective.

In this research, the key topic of study namely ERP and green supply chain measures has rarely been addressed in the available literature besides the relation between the concepts of ERP and Green supply chain is not encountered in my literature study.

1.2 Academic relevance of this research

This research focuses study mainly on ERP and Green supply chain operational performance. The two topics of interest have vital contributions in the supply chain management of an industry. ERP systems are being widely used across different product based and service-based industries. Despite this, minimal research has been carried out on these topics separately. In this report, my effort is to address the gap in research is Lenny Koh mentions in his bibliometric analysis on ERP throws light on past research conducted on ERP that it mainly focused on its implementation issues (Davenport, 1998; McAfee, 1998; Austin and Nolan, 1999; Loh and Koh, 2004).

The other reason why the focus on ERP and SCM is so interesting is that academics appear to be far less interested in ERP than they are in SCM. For instance, Fine (1998) in his report on information systems in the business environment does not even mention the term, despite the integrative potential of ERP systems. In fact, one can argue that very little academic research has been done on ERP, except for research on topics concerning its implementation and the challenges of the implementation project itself (Upon and McAfee, 2000; McAfee, 1998; Austin and Nolan, 1999; Davenport, 1998). Due to the little research conducted on these phenomena and therefore few well-grounded recommendations could be provided to companies struggling with these complex undertakings.

Chapter 2. Literature Review

The literature referred to this research was found using a systematic literature research approach and further investigating cross-referenced reports. The review was started by looking for existing literature in the area of green supply chain management and enterprise resource planning in order to establish a baseline of the general academic contributions made in this area. The information was retrieved using the keyword search, on search engines including the TU Delft repository, and Google Scholar articles using the following Key terms: “Green Supply chain” & “Enterprise Resource planning”. Due to the limitations experienced in the information available on the above two key search terms associated with this research. The literature was further explored by connecting terminologies like “ supply chain management”, “Information systems”, “MRP”, ”Enterprise systems” and “Lean supply chain”. Further, these key terms were permuted to search under different combinations in the above-mentioned information source.

2.1 Supply chain Management (SCM)

Supply chain management is one of the important function and vertical in a company’s organization as it acts as the main driver for production and in satisfying the customers demand. The object of SCM obviously is the supply chain which represents a “. . . a network of organizations 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 consumer” (Christopher & et.al, 2005). Another interesting definition defined in the book: supply chain management and advanced planning address the different types of link involved in the supply chain “In a broad sense a supply chain consists of two or more legally separated organizations, being linked by material, information and financial flows (Hartmut & et.al, 2015). The Material flow and information flow along the supply chain are opposite in direction and is represented in the figure below.

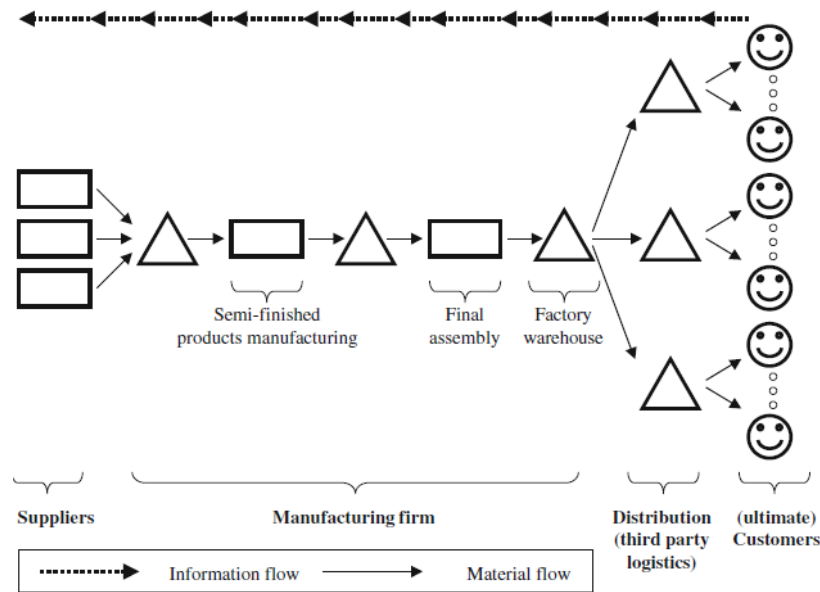


Figure 2 Supply chain flow (Hartmut & et.al, 2015)

Lee (1998) refers to two broad means for improving the supply chain competitiveness. One of them being a closer integration of the organizations involved and the other is a better coordination of material, information and financial flows (Lee and Ng 1998, p. 1). The supply chain is generally divided into two streams, upstream and downstream where the coordination plays a role if there is a long-term agreement or cooperation between stakeholders acting as a part of downstream or upstream of a supply chain. The upstream is generally directed towards the Customers and downstream to the respective suppliers.

Managing a supply chain (SC) includes management of both upstream and downstream activities such as material sourcing, production scheduling, and the physical distribution system, delivery on time, backed up by the necessary information flows (Bovet and Martha, 2003). The coordination in the supply chain is commonly experienced in terms of joint decision making, coordinated operations, mutual agreements, and convergent strategies. Arshinder and Deshmukh (2008) refer to mechanisms in place to aid coordination in a supply chain. Namely Supply chain contracts, information technology, Information sharing, and Joint decision making. Over the years, Successful management of the SC cooperation to gain a competitive advantage has resulted in the

development of management philosophy and associated practices such as enterprise resource planning (ERP) systems which incorporate all the mechanisms referred by (Chopra & Meindl, 2007). The success factors of supply chain management (SCM) are considered to depend on, the closed-loop of planning and execution in regard to the process of minimizing possible gaps between planning and execution. Volkmann in his research refers it to be impossible to remove such gaps entirely from one's supply chain. Because of the unpredictable market; the future is not fully known and decision-makers develop various operational plans under high uncertainty. Those in the industry recognize this critical in operation and production planning (Vollmann et al., 2005). Thus, monitoring how planning and execution are synchronized is critical for operational performance and SCM success.

SCM planning takes supply and demand information and generates a synchronized sales and production plan (Bongsug c. , 2009). SCM execution takes this enterprise-level plan and carries out such activities as a source, production, and delivery, which ultimately generate revenues. Performance metrics or KPIs offer the overall visibility of supply chain and help to assess the accuracy of supply/ demand plan (e.g. forecast accuracy), and the execution performance (e.g. actual sales versus forecast plan). KPIs reveal the gap between plan and execution and offer opportunities to identify and correct potential problems. Bongsug in his research refers to the most commonly considered KPIs are the following - delivery Performance, supply chain responsiveness, assets and inventories, and costs (Bongsug c. , 2009).

In order to achieve the above mentioned KPIs, I need to understand the factors that influence achieving the KPIs in the supply chain. As previously mentioned, supply chain coordination is one of the key elements to have an integrated and well-managed supply chain. Thomas.A(2015) addresses to this key element that sharing information across the supply chain plays an important role in successful coordination among stakeholders in the supply chain (Thomas, Krishnamoorthy, Singh, & Venkateswaran, 2015). Further, in the same report, it was conclusively justified based on analysis of a coal supply chain that production capacity and resource availability were the two key shared information in the producer-distributor decentralized supply chain.

2.2 Enterprise resource system (ERP)

In this section, study on the current literature available on enterprise systems to develop a theoretical conceptual model at the end of my review. The theoretical model developed is expected to answer my first sub-question formulated “*What are the advantages of ERP system in the supply chain?*”. During this study, I encountered a limitation in the database of research literature focusing on the impact or benefits of ERP in the supply chain. The Literature carried out earlier was observed to be motivated towards the adoption of the enterprise system in the firm and respective barriers encountered. Confirming this observation, Schlichter in his bibliography study on ERP refers that the majority of the research carried out in ERP focused on implementation, optimization, and Managing of ERP systems (Schlichter & Kraemmergaard, 2010) rather than other topics. On the other hand, the limitation of the study of ERP on SCM is analyzed to be 7% of the total literature on the ERP system (Schlichter & Kraemmergaard, 2010) . Therefore with the available literature, the conceptual model is developed in accordance with the scope of this research

2.2.1 Introduction

Supply chain management requires the management of materials and information flow in the whole chain, from suppliers through to customers. Competition today is forcing companies to integrate tightly with their suppliers and customers, in order to reduce the time available to ensure the supply chain is flexible to accommodate the market fluctuations. Many companies are attempting to link with suppliers and customers only to find that the relationship twisted due to the lack of control in their own businesses. However, without adequate control of the internal processes, an integrated SC is only as strong as its weakest process link. Koh (2006) hints that ERP is one of the ways to effectively plan and manage all resources of an enterprise and that this enterprise-wide

information system plays a significant role in managing a Supply Chain (Koh & et.al, 2006)

In support with Koh, Emden (2006) argues that if business success is to be achieved, optimization of business processes across the value-added chain must be accompanied by modern processing technology for optimization of enterprise-wide information management. Confirming the above stated importance of information technology and enterprise system I see that during the last decade, innovative business software companies, like the well-known SAP, BAAN, Oracle, and PeopleSoft, utilizing modern technology, have moved into the direction of wide or cross-enterprise integration and developed flexible and multi-functional modular packages in the field of ERP (Stefanou, 1999) with application across different operations in the business. One such ERP vendor SAP, in the year 2000 the company corporate overview states that software is deployed at more than 22,000 business installations in more than 100 countries and is currently used by companies of all sizes, including more than half of the world's 500 top companies (SAP AG Corporate Overview, 2000).

In my literature review, I come across various definitions on ERP, defined by industrialists, users and firms in their own perspective. From a more strategic perspective, JBA, a British consulting firm, describes ERP as a business approach that starts in the boardroom and permeates the entire organization (Koh & et.al, 2006). One way of looking at ERP is as a combination of business processes and information technology. For instance, Akkermans refers to J.D. Edwards, an American ERP system vendor, defines ERP as an umbrella term for integrated business software systems that power a corporate information structure, controlling a broad range of activities, from the procurement of supplies to shop floor control and financial accounting (Akkermans & et.al, 2003). It is defined and meanwhile analogized to the glue that binds management functions across geographic sites and complex heterogeneous networks. In summary, ERP can be explained as a tool that aims to improve internal efficiency by integrating different parts in the organization, while SCM, as introduced earlier, focuses on external relationships with trading partners in the SC. ERP in supply chain management perspective helps the firms to reach beyond their own corporate walls to better connect with suppliers, distributors, and end customers. ERP aids as a tool that also helps in

cross-enterprise application integration, which includes different applications used across different enterprises. Akkermans (2003) gives an example of how companies link their ERP systems directly to the applications of their suppliers and customers. For example, big suppliers are letting their customers dial into their systems and extract select information. Accessing and delivering information in real time helps companies to better react to customers' needs. Therefore, Increase in the adoption of ERP systems forces companies to provide communication and information flow between supply-chain agents, overcoming natural boundaries (Akkermans & et.al, 2003).

Therefore, integration of ERP and SCM is a natural and necessary process in strategic and managerial consideration. Technologically, Koh refers to ERP as the backbone of SC, as they both rely on a very similar framework, such as an intranet, extranet, and electronic data interchange, it is very possible and feasible for their integration. Most ERP system providers enhance their products to include sales-force automation, data warehousing, document management, and after-sales service and support, and the most important trend today is the integration with SCM (Koh & et.al, 2006). The involvement of ERP in a supply chain is well charted by Madanhire(2016) in his research, In the figure below, I can see the ERP flowchart applications in various top-down level functions which involve: top management, operations management, basic computer data and execution of plans (Madanhire & Mbohwa, 2016)

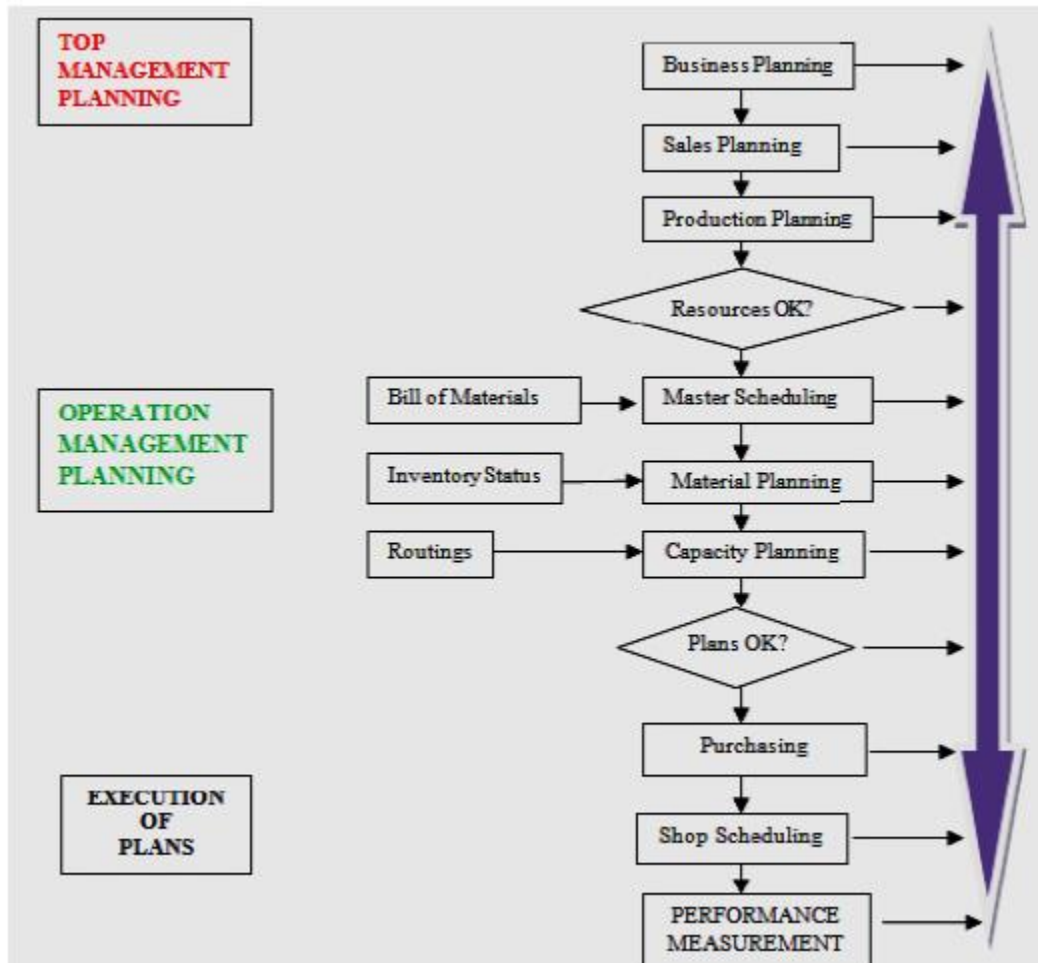


Figure 3 ERP in Supply chain (Hartmut & et.al, 2015)

2.2.2 Advantages of ERP in SCM

As introduced in the previous section ERP offers the possibility to integrate various functions and as supply chain management involving different stakeholders has been seen reap benefits from this system in place. Functionally, the ERP system primarily supports the management and administration of the deployment of resources within a single (though possibly multi-site) organization. As Akkermans puts it across these resources can include materials, production capacity, human labor, or capital

(Akkermans & et.al, 2003). As per the scope of my research, I focus on collecting the literature studied on the benefits or advantages ERP has got to offer in supply chain function of the firm. The adaptation of ERP in Supply chain and its main contribution in terms of the flow of information or data across the supply chain is well explained by Akkermans in the below figure. As the flowchart explains the main foundation for supply chain is the process, organizational structure and enabling technologies across the whole supply chain from Supplier to the customer. The flow of data is vital along the supply chain in terms of financial data – pricing by quantity and respective sales, information flows – the exchange of data aiding the transparency and overview of figures across supply chain stakeholders and the finally the material flows which includes operation concerning with the delivery confirmations, invoice management on orders and forecasting figures of procurement and sales .

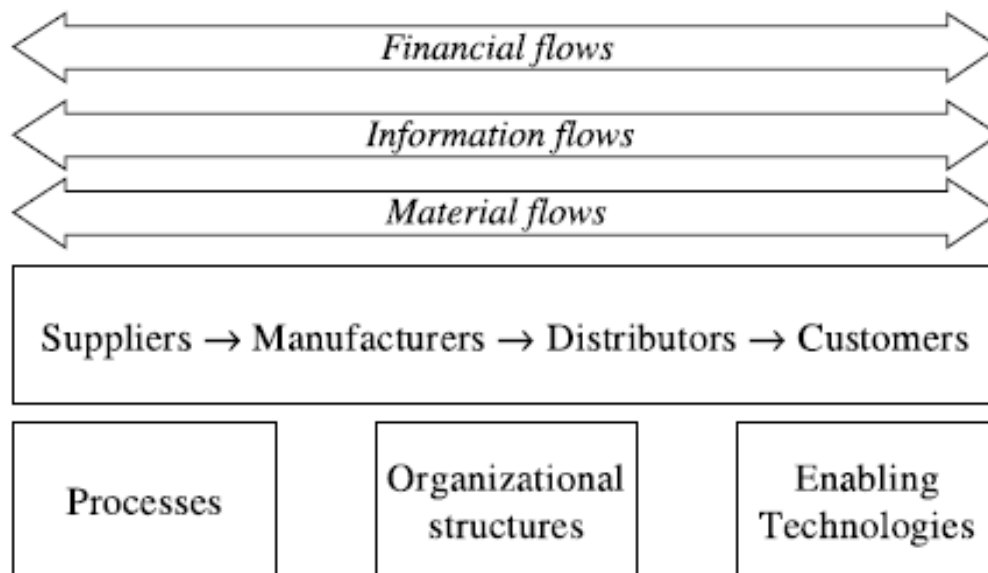


Figure 4 ERP adoption in the integrated Supply chain (Akkermans et.al, 2003)

2.2.2.1 Information sharing

Information sharing in one form or another occurs between every pair of interacting entities in a supply chain. Suppliers, manufacturers, and retailers tend to reveal information about customer demand, inventory, and supplier lead time. In a supply chain, it has generally complained that each function is unaware and uninformed about the operations or information available with the other function. For example, the manufacturing department is unaware of the market scenario and sales represented by the sales department. This raises the necessity of integrated business function where the lack of information is communicated across in order to have common understanding and awareness across the firm. Davenport (2004) reassures this missing link across firms and appreciates the enterprise system function a viable solution to bridge this gap experienced. He reasons out that the lack of information shared influences the manufacturing managers to take safe decisions in order to avoid stock out situations and build ample stock which leads to building up of inventory stock in a product based companies (Davenport & Brooks, 2004). Therefore, I can see that lack of information shared, in turn, has a possibility to lead to the creation of redundant inventory, which comes with a due cost. One of the values realized from adopting an ERP system in integrated business operation is the control over inventory by bridging the gap in information sharing. The functionalities of ERP listed by Akkermans(2003) includes the “A transaction processing engine” allowing for the integrated management of data throughout the enterprise. This basically is explained as the processing of information and linking the data in the background between different functionalities an organization and the processes as well. In the foreground, this information is referred through different transaction codes available through the means of modules offered by the ERP tool (AAkkermans & et.al, 2003). I come across many other researchers stating the integration along the supply chain with suppliers and customers are important for increasing frequency of deliveries and reduction of buffer inventories maintained. This integration is possible through an information system enabled with internet technology like an ERP system (Frohlich, 2002) (Gupta, 2000). After research analysis Frohlichthe (2003) concludes that with ERP benefits of information sharing, joint planning between stakeholders, and inventory management across the chain and improvement in

customer relationship management are to be considered among the improvements of adopting an ERP system with respect to supply chain management.

Madanhire(2016) defines Enterprise Resource Planning (ERP) as “strategic tool which synchronizes, integrates, and streamlines data and processes of the organization into one single system to gain a competitive edge in the uncertain business environment” (Madanhire & Mbohwa, 2016). Yang generalizes on the basis of other research work that it is believed widely to contribute to supply chain in technical areas such as ERP adoption is beneficial to have transparency in information exchange (Su & Yang, 2010). In one of the studies carried out the benefits of information sharing was proved that it can result in a decrease of the average stock level in the supply chain and also ensure to avoid out-of-stock ratio at a retailer (Kelle & Akbulut, 2005). Recent studies have shown that the quick dissemination of relevant information can significantly enhance the performance of a supply chain.

2.2.2.2 Operational efficiency

One other advantage of ERP in SCM mentioned in the literature is the improvement in operational efficiency. Eastman Chemical was convinced to link to ERP vendor namely SAP software in order to achieve the objective of improving the efficiency of internal operations through planning and forecasting advantages the system offered to provide (Davenport & Brooks, 2004). The efficiency advantage is not restricted to internal but also externally in relations with suppliers and customers. Davenport (2004) states that to achieve the effect in the supply chain of a product “Firms that have understood SCM for a long time, that the big game is external”, where he refers to other stakeholders involved like supplier, customers, transport, and others. One such example can be seen in the case study carried out in the 1980’s on Proctor & Gamble and wall-mart relationship. The case study carried out showed results that two firms took out a huge inventory and reaped financial benefits in the supply chain relationship by sharing forecast figures and sales data with each other, while at the same time ensuring to

improve in-stock performance with respect to customer demand (Davenport & Brooks, 2004). One of the key factors noted in this case study is that sharing of information concerned with forecast and sales aided in reducing the inventory for two firms. As mentioned earlier, one of the main function of ERP is automatizing this information sharing. A small industrial example on this Reebok installed ERP systems by linking through EDI (electronic data interchange) in two internal functions of the business marketing and retail and saw a decrease in inventory value. I come across many more researchers who have worked on the topic of ERP's advantages in SCM stating the improvement in efficiency and productivity for its users (Gupta, 2000). In terms of supply chain parameters, Gupta(2002) analyses ERP to aid in reducing non-value added time in a supply chain process, in terms of cycle time and also inventory reduction. (Gupta, 2000)

Frohlich(2002) in his report refers to measures of the information system enabled supply chain , where he concluded that operational factors like delivery lead-times, inter transaction costs, and inventory turns is seen to improve which has led to managers analyze and quantify measures in concrete data like “five-day cars,” frictionless” transactions, and inventory in the pipeline measured in terms of number of days (not months) (Frohlich, 2002). In other research conducted by Yang, he states that it is widely believed by firms that have enterprise system in place that ERP adoption brings with it the benefit of standardization of data maintenance and processes linking across verticals in a business environment (Su & Yang, 2010). Based on the work of Mabert(2000) , Yang (2010) refer to the following outcomes of ERP in terms of supply chain technical parameters of quick response time , increased enterprise to enterprise interaction , optimization of order management and improved customer and supplier interaction, service adherence to time , lowered inventory levels , cash to cycle management and cut down in operating costs (Su & Yang, 2010).

The functionalities of ERP listed by Akkermans(2003) includes the “Workflow management functions” which controls the numerous process flows that exist in the enterprise, such as the order-to-cash process or the purchasing processes (AAkkermans & et.al, 2003). This function encompasses the reportless information exchange and reduction in communication channels and frequency. This function is applicable to both

inter and intra organization activities and also in activities concerned with other stakeholders involved with an ERP system adopted in their business. ERP systems can be instrumental in transforming functionally oriented organizations into process-oriented ones. The very nature of the ERP system forces one to think process-wise, rather than department-wise. Indeed, some of the unexpected benefits of ERP implementations may well stem from improved communication between different departments across business processes (Akkermans & et.al, 2003). According to the above provisions of ERP, I understand that supply-chain capabilities of ERP increase efficiency and productivity for their users. By linking supply-chain applications with other business systems, users can slash cycle times and reduce inventory. The incidences of stock-outs are also found to be significantly reduced and even such incidences are largely due to extraneous delays, rather than planning inaccuracies. In the manufacturing sector, ERP implementation has reduced inventories anywhere from 15 to 35 percent (Gupta, 2000).

2.2.2.3 Integration with stakeholders

I come across some studies, which show that adoption of ERP has improved service to customers in terms of on-time delivery irrespective demand fluctuations. Brooks (2004) refers to studies which show that with well-implemented enterprise system in SCM, manufacturer could see result with 15-40 percent cut in cycle time of customer's order placement and goods arrival , and in total product lead time can undergo reduction of 75% in comparison with lead time calculated without ERP installed (Davenport & Brooks, 2004). This is mainly realized due to the advantage of Integrated data management which the enterprise system has to offer, where data from each process is stored and processed across related functions automatically. Akkermans (2003) highlights this functionality of ERP as "A transaction processing engine" allowing for the integrated management of data throughout the enterprise. This basically is explained as the processing of information and linking the data in the background between different functionalities an organization and processes as well. In the foreground, this information

is referred through different transaction codes available through the means of modules offered by the ERP tool (Akkermans & et.al, 2003).

Frohlich refers to the criticality of controlling the possibilities of amplification of error causing bullwhip effects with regards to the upstream and downstream linked stakeholders (Frohlich, 2002). He expresses concerns of instability can be seen to magnify in the along the chain, even if it appears minimal at the sink or source. Therefore the more integrated the operations and data exchange is between the stakeholders in the supply chain, it is easy to control the balance of supply and demand and effectively. This support is provided by adoption of ERP system in business to business platform, where data is controlled and transferred to minimize errors in both parties and coalition of strategies to achieve better efficiency and performance. This confirms another functionality Akkermans includes in his three basic lists of ERP functionalities “Decision support functions”, assisting in the creation of plans (e.g., by doing an MRP run), or in deciding on the acceptance of a specific customer order (e.g., by performing an available-to-promise (ATP) check) (Akkermans & et.al, 2003). These functions of ERP are explained to be assisting in decision making or confirmations across different processes in the supply chain.

ERP systems are observed to have replaced a tradition of old, undocumented, non-integrated legacy systems by state-of-the-art, integrated and maintainable software. Enterprise system is a platform designed to integrate one business activity to another business activity. Mabert (2001) in his report extends this platform to be used also to optimize many manual processes across business operations such as order entry or planning of production. Yang(2010) the factor aiding the optimization advantage due to investment in ERP , is the availability of simple interface to sharing huge amounts of information along the supply chain which has resulted in collaboration from customer end to the supplier end along with better future visibility , which indirectly has helped in optimizing inventory and distribution of sales (Su & Yang, 2010). With the ERP installed in business organizations, information sharing acts as the key to give more benefits with respect to reduced cycle time, faster financial transactions and in making tacit knowledge concerned to the single operation to an explicit one. It is also believed widely to contribute to SCM in technical areas of standardization of data, maintaining

transparency of data and in globalization through providing integrated connection worldwide which justifies its adoption across the world and also makes it attractive for organizations to invest and bear the risk of process change . Shang and Sheldon classify the ERP benefits to five categories in their study as IT infrastructure, operational management, strategic, managerial and organizational and respective SCM competencies to operational, planning and control and behavioral process . With the basis of these Yang (2010) derived hypothesis to test and found that that major benefit of ERP can be found with respect to operational SCM competency with high beta coefficients found between relevance, responsiveness, and management of supplier parameters of ERP managerial benefits. He went on to conclude from his analysis that the operational process of SCM is observed to be positively enhanced with the operational, managerial and strategic benefits of ERP system adopted (Su & Yang, 2010).

ERP systems provide an enterprise transaction backbone that constitutes the glue between all kinds of best-of-breed solutions for specific processes or business areas. It allows these best-of-breed solutions to leverage the investments made in the ERP systems and partly explains the impressive ROI's achieved by these solutions (AAkkermans & et.al, 2003). Several ERP companies were surveyed to assess the implementation issues related to ERP. The results of my survey indicate that US companies are moving with the ERP implementation in order to reduce lead times and inventory levels and to increase customer satisfaction (Gupta, 2000).

2.2.3 Theoretical Model – ERP Benefits in SCM

The following theoretical conceptual model was developed using the literature studied on ERP and its benefits on supply chain management. As represented in the model, adoption of an enterprise system (ERP) in the supply chain environment provides advantages in three main factors of information sharing, operational efficiency, and Stakeholder integration, which have shown positive outcomes in a supply chain. Based on the literature studied, the three types of advantages are further routed to specific main attributes that ERP offers in benefitting the Supply chain management. These attributes are grouped under each advantage listed below.

In the next section, I further study the literature available on green supply chain management and build a consequent conceptual model.

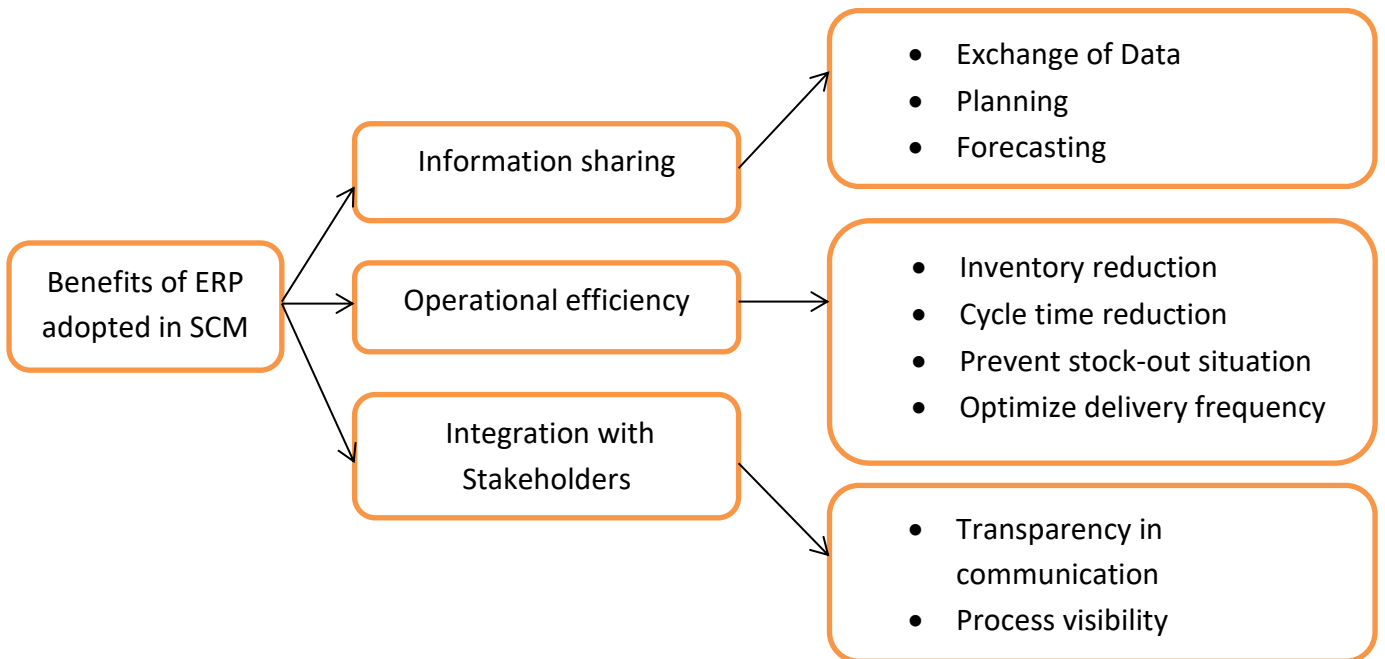


Figure 5 Theoretical model – ERP Advantages in Supply chain

2.3 Green supply chain management

The Literature concerned to the green supply chain is mainly concerned with the organizational readiness and performance change in the firms. Many kinds of literature have addressed to the practices associated with the green supply chain and few have mentioned regarding the scope of this research that is performance measurement of Green supply chain. In this section, I attempt to consolidate key research studies and the respective information acquired to develop a theoretical conceptual model focusing on the performance measures of the green supply chain with help of literature conducted until now.

2.3.1 Introduction

Green Supply Chain Management (GSCM) has emerged as a key approach for enterprises seeking to make their businesses environmentally sustainable. It is recently attracted extensive research due to the environmental demand and also as it is consistent with the sustainability topics being studied rigorously in the last few decades. Srivastava (2007) coins this need in his research of literature review on green supply chain that “Demographics, information explosion, and past environmental degradation are creating organizational pressures and market opportunities for more and more Green products and services”(Srivastava, 2007). I have others confirming this need as well, Lin(2008) mentions that with rapid industrial growth observed in recent years , negative environmental impacts is observed in concerns with greenhouse gas emissions, toxic pollutions, and chemical spills , which has led to growing interest in optimizing operations in every managerial decisions like the case of supply chain and not just limit to quality and research studies (Peng and Lin, 2008). In this research study, I am motivated for the same reasons as mentioned by Srivastava regarding the need and the opportunities firms can bring in by exploring opportunities for adoption measures in delivering green services and products with a goal of green supply chain management.

The concept of GSCM is defined by many researchers in their own word and with respect to collected views from various management personnel working in firms. As Paul describes in his report that “Green supply chain is defined to encompass mainly the idea of minimizing the impact towards environmental degradation through operations in the firms involved in a supply chain”(Paul, Bhole, & Chaudhari, 2014). One of the other definition I found suitable for this research is mentioned by Sezen(2013 “The notion of GSCM implies the insertion of environmental criteria within the decision - making the context of the traditional supply chain management) (Sezen & Cankaya, 2013). Zhu (2005) describes the concept to be emerged in his study “green supply chain management (GSCM) has emerged as a concept that considers sustainability elements and a combination of environmental thinking along the intro and inter-firm management of the upstream and downstream supply chain(Zhu, Sarkis, & Geng, 2005)

2.3.2 Green supply chain operational performance Measures and metrics

I come across significant agreement in research mentioning about are three major elements to a theoretical model of Green Operations Systems. As Chin(2015) lists it as following “Green Management Systems (GMS)” which concerns with top management in a firm with the formulation of policies and procedures that empowers employees in decision making their operations that can positively influence environmental protection. This initiative by top management will motivate the organization and imbibe a culture in the employees and result in identification of environmental waste sources of proposing respective techniques to act upon (Chin, Tat, & Sulaiman, 2015) The Next elements as hinted earlier was design of techniques on , which is coined by Chin as Green Waste Reduction Techniques (GWRT) which are objectified and results are analyzed with the goal to reduce the sources and values of environmental wastes generated in the company’s process operations. Lastly, the implemented results are quantified in terms of metrics which are classified under Green Results (GR) (Chin, Tat, & Sulaiman, 2015).

One of the researchers, Beamon B categorizes generally the impact of operations on the environment in a green supply chain perspective as 1) all forms of Waste 2) Energy Use

3) Resource Use (Material consumption) (Beamon, 1999) . One other literature by Hervani casts more light on the performance measures concerned with the environment alone and also that acts core GSCM performance measure requirement. It involved the performance indicators with regards to the ISO 14031 (environmental management-environmental performance evaluation of the ISO 14001 accreditation guidelines). The report provides the following as a list of selected metrics of environmental performance: fugitive non-point air emissions; stack or point air emissions; discharges to receiving streams and water bodies; underground injection on-site; releases to land on-site; discharges to publicly owned treatment works; other off-site transfers; on-site and off-site energy recovery; on-site and off-site recycling; on-site or off-site treatment; non-production releases; source reduction activities; spill and leak prevention; inventory control; raw material modification; process modifications; cleaning and decreasing; surface preparation and finishing; product modifications (Hervani, Helms, & Sarkis, 2005) . Greening cost is the overall cost incurred by the company in making sure that its operations are environmentally sustainable. Greening cost is one of the major measures for an efficient green supply chain management. The metrics under this measure are discussed by Olugu, et.al (2011) as Cost associated with environmental compliance, Energy consumption cost, Environmentally friendly material cost. Research by Zhu(2004) analyzes the environmental performance of green supply chain through parameters concerned with solid and water wastes, toxic material usage, energy consumption (Zhu & Sarkis, 2004)

In Chien research on the construction industry and GSCM, he proposes that reducing material usage while designing will lead to minimizing the construction waste generation in the construction industry and consequently It will also eliminate many environmental problems such as disposal(Chien & Shih, 2007). Carvalho (2009) in his study on lean and green supply chain studies , finds similarity in supply chain attributes to both concepts in terms of operational parameters such as capacity surplus, level of integration, inventory stock maintained, total production lead time and logistic transportation time which are studied to improve the measures for lean and green supply chain(Carvalho and CruzMachado, 2009).

Venkat (2006) analyzed the environmental performance of Lean supply chains using CO₂ emissions as KPI. Emissions in a supply chain are subject to the frequency and mode of transportation used, and the type and volume of inventory held at each point in the chain. The emissions of a supply chain highly depend on its length and geographical expansion. A small regional supply chain would therefore almost certainly be Green due to short distances and low levels of inventory required. As the supply chain increases in length and stretches farther geographically, emissions also increase, and Lean and Green practices start to conflict (Wakeland, Venkat, & Wakeland, 2006). Lean practices do not necessarily reduce carbon dioxide emissions. Through the pull system with small batches and JIT delivery, Lean prescribes an increase in the replenishment frequency whereas Green practices aim at reducing transport time and replenishment frequencies (Venkat and Wakeland, 2006; Carvalho and Cruz-Machado, 2009). Transport, as the major producer of CO₂ emissions, plays an important role in pursuing Green practices. When a supply chain is long and geographically widespread, although it may be Lean, it is not necessarily Green due to increased amounts of CO₂ emissions from transport (Green, Zelbst, Meacham, & Bhadauria, 2012).

Nikbhaksh (2009) points out that an organization can enjoy several benefits of making their supply chain greener and more sustainable. Some of these are a) Positive Impact on Financial Performance: Despite the existence of analytically proven facts and empirical evidence, there is a myth that additional expenses are always required to make a supply chain green. But in contrary one of the most fundamental benefits of making a green supply chain is, in fact, long-term impact on the financial performance of the organization. The myth of extra investments stems from a lack of long-term vision and a structured approach to bring about change in the supply chain. b) Sustainability of Resources: A green supply chain supports the effective utilization of available production resources from raw materials to finished goods. If an organization prioritizes sustainability and green supply chain management thought process throughout their decision-making process and business strategy, they will be able to purchase greener input resources that will flow through an environmentally friendly production process and ultimately lead to a greener final product. c) Lowered Costs/Increased Efficiency: Reducing waste by increasing efficiencies is at the core of every supply chain

management system. It is even more pronounced for a green supply chain management system, as effective management promotes recycling and reuse of raw materials and leads to a reduction in production of hazardous materials which also reduces the risk of being fined for violating environmental regulations. Consequently, this leads to a reduction in overall operational costs while improving utilization of resources. d) Product Differentiation and Competitive Advantage: A green supply chain can help an organization to position itself differently from its competitors in the eyes of the customers. Being environment-friendly may also help attract profitable new customers in this age of increased awareness about the degrading environmental impacts of manufacturing organizations. This will ultimately strengthen the brand image and reputation of the organization in the marketplace. e) Adapting to Regulation and Reducing Risk: Organizations adopting Green Supply Chain practices can reduce the risk of being prosecuted for anti-environmental and unethical practices. A demonstrated effort towards creating an effective Green Supply Chain through the sustained dedication of resources, activity, measurement, and management protocol will be highly regarded in the event of questions and audits by authorities. f) Improved Quality of Products: Improved quality of product and services leads to greater customer satisfaction and a better reputation. Apart from the above six benefits, there are additional advantages that can be generated by GSCM: • effective management of suppliers; • dissemination of knowledge, advanced technology, and techniques among the supply chain partners; • transparency across the supply chain; • large investments and risks are shared among partners in the supply chain; • better control of product safety and higher product quality; • increased sales and revenue; • beneficial uses for waste products.

The topic of GSCM in manufacturing sectors in the AEE has received increased attention from industry, academia, regulatory institutions, and customers (Golicic and Smith, 2013; Lai et al., 2013). But according to some researchers, the results of empirical studies on the impact of GSCM practices on firm performance are not conclusive. For instance, Zhu and Sarkis (2004) and Zhu et al. (2005) consistently argued that GSCM practices have not contributed to better economic performance in Chinese manufacturing firms. But the concept of GSCM practices was in its early stages during

those two studies. An early stage of adoption usually requires investment, which increases a companies' operational costs and has a negative impact on a firms' economic benefits. Contrary to these findings, recent studies have examined the positive relationship between GSCM practices and economic performance (e.g. Kuei et al., 2013; Lai et al., 2012).

After reviewing the sample of empirical studies collected for the meta-analysis, four dimensions were developed to analyze the impacts of GSCM practices on firm performance. Following the insight from this review of the literature on performance measurement, firm performance was coded along four dimensions: economic, environmental, operational, and social performance. These are defined below: i. Economic performance refers to profitability in general and is an important and significant reason for companies to implement GSCM practices. Studies that measured economic performance using objective or perceived growth in sales, profit, and market share (Chan et al., 2012; Lee et al., 2013; Kuei et al., 2013; Abdullah and Yaakub, 2014) within the GSCM practice - economic performance relationship were coded and analyzed. ii) Environmental performance encompasses saving energy and reducing waste, pollution, and emissions. When linking supply chain performance with manufacturing sectors, environmental performance also included reducing air emissions, water wastes, and solid wastes, as well as decreasing consumption of hazardous materials (Zhu, et al., 2005; Rao, 2002; Zhu et al., 2005; Chiou et al., 2011; Lee et al., 2012). iii. Operational performance is related to the efficiency of the firm's operations such as decreased delivery times and inventory levels, improved capacity utilization and reduced scrap rates (Zhu, et al., 2012; Wong et al., 2009; Lai et al., 2012; Dou et al., 2013) iv. Social performance is considered as a method to quantify outcomes of the GSCM practices about protecting employee health and safety, enhancing product and company reputation and ensuring customer loyalty and satisfaction (Zailani et al., 2012b; Ashby et al., 2012).

Some practices related to green supply chain like were found to be relevant to the scope of this research Product eco-design (ECO) is explained to be a structural process that

gives an idea on environmental attributes in products and processes as well as the demand communicated by stakeholders in the company for product design and development, (Zhu et al., 2005). This raises the importance of information sharing in the integrated supply chain. Chiou explicitly mentions in his research the importance of Green supplier integration where he mentions that the collaboration of a firm with its suppliers and management of cross-firm operations including information sharing and strategic partnerships have positive effects on Green supply chain operational performance (Beamon, 1999). Nikbakhsh (2009) also adds to the importance of collaborations in his own words as Green customer cooperation (CC) which involves “strategic information sharing and collaboration between a local company and their customers with an aim to improve the visibility in values and enable joint collaborated planning to realize the positive impact on the environment” (Nikbakhsh, 2009).

2.3.3 Theoretical Model – Green supply chain metrics and measures

The following theoretical conceptual model was developed using the literature studied on Green supply chain and its measures. As represented in the model, the research on literature suggests the performance measurement of green supply chain mainly in economic and environmental measures. These measures are further parameterized on the basis of literature on the following measuring parameters as represented in the model below. The literature also lists the practices to adopt in order to positively influence the performance measures in the green supply chain management. The practices are classified under five categories of purchasing, product, manufacturing, operations, and logistics.

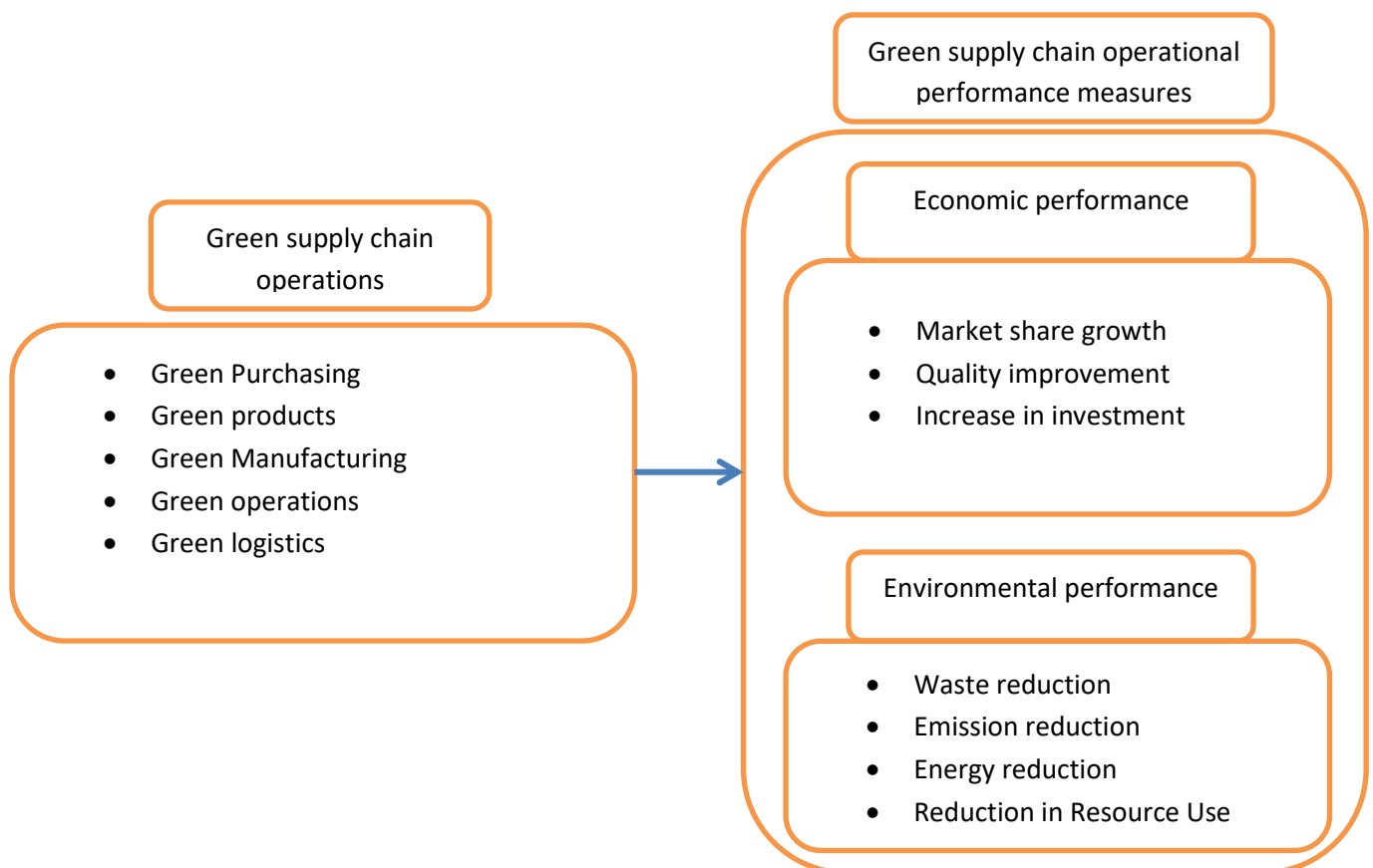


Figure 6 Theoretical model - Green Supply chain Management performance

2.4 Conceptual Model

On the basis of the theoretical model developed after studying the current literature available on ERP and Green supply chain. I observe a research gap in addressing the ERP benefits in greens supply chain performance. I further pursue my methodology to explore this research gap by formulating a research question to collect relevant data. In order to do so, I need a conceptual model to be developed which will be treated as the basis of reference to continue my explorative study. The following conceptual model is developed to study the scope of this research concerning the relationship between the Enterprise system (ERP) and the Green supply chain operational performance. According to the conceptual model developed concerned to the focus of this research, the determinant variable that needs the causal explanation in my study is the Green supply chain operational performance. The presumed Independent variable for the exploratory study will be the Enterprise system (ERP). The conceptual model will be further studied in the next section with an appropriate research methodology.

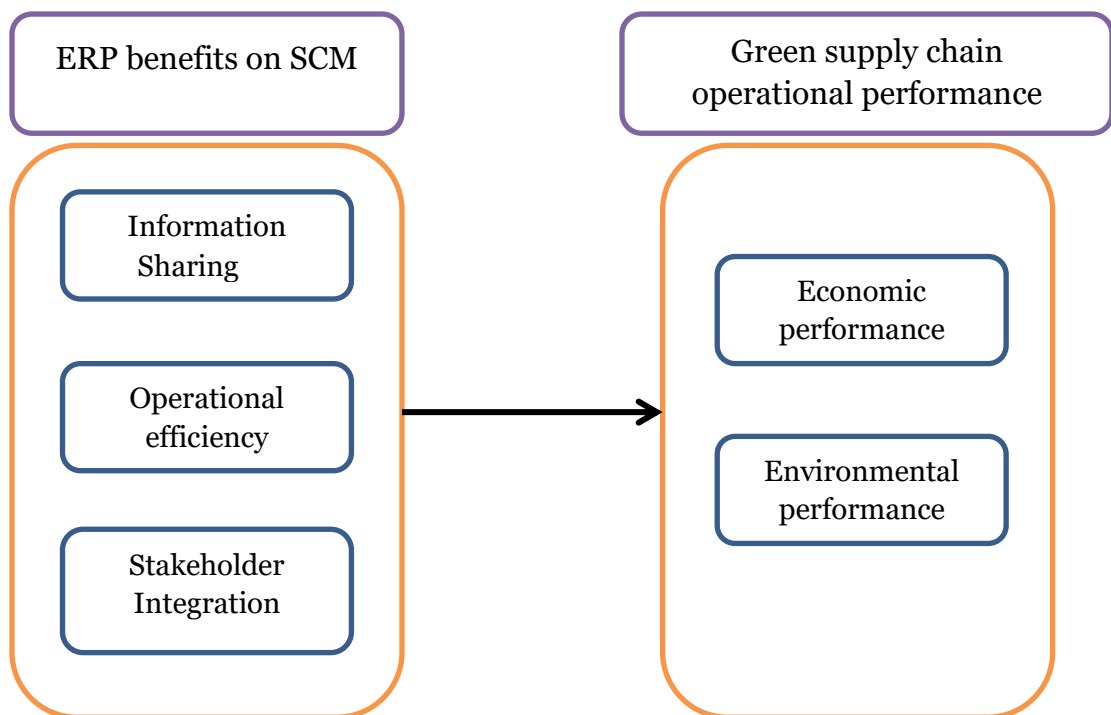


Figure 7 Conceptual Model

Chapter 3. Research Methodology

In this section, I introduce the methodology followed in my research to answer the third sub- research question formulated in the introduction section “*How is ERP system related to Green supply chain operational performance?*”. The study carried out in this research is exploratory in nature as I find no resources researched on the specific study topic chosen. As mentioned earlier in the literature review, I have studies on ERP impact on Supply chain management and also researchers working on analyzing the Green supply chain operational performance. But I observe the research gap in a study relating both the topics of ERP and green supply chain. In order to address the research gap, I carry out an explorative subjective research study in this report to study the connection between the two topics of interest in my study. According to Sekaran, (1998) an exploratory study is applicable when few facts are available about the topic that is being studied (Sekaran & Bougie, 2010). Also, Burns and Bush (2006), mentions that an “exploratory research design is defined as the process of gathering valuable information through both informal and unstructured manner”. The exploratory study is advised when the researchers know little about the topic that is being studied.

3.1 Research Strategy

The research strategy chosen in this research is the case study approach. As Yin mentions in his book on case study that “How” and “why” research questions are more likely to lead to the use of research methodology of a case study, history, survey or experiment as the preferred research method (Yin, 2014). Further, as the research topic is exploratory in nature with a minimal study carried out and unavailable of known research sources. I cannot rely on the data collected with the survey methodology. I would like to carry out an in-depth study on the research question and conceptual model formulated routing to future research on this topic. Doorewaard puts forward his view in his book research methods, that case study is suitable for in-depth examination

(Verschuren & Doorewaard, 2010) I find case study suitable to carry out the initial study to address the research gap between ERP and Greens supply chain. Yin (2014) lists out three conditions to select a research methodology which are as following a) the type of research question posed – Why, What , How b) the extent of control over the events the researcher possess to influence and c) the degree of focus on events occurring at the same time as opposed to entirely historical events because of the questions asked dealing with current operational links rather than incidences in the past (Yin, 2014) . In my research, the question posed qualifies for conducting a case study and as it's a new study topic in research, the observer during the case study need not have the influence or biased to collect the data concerned to the topic of study. Further, the study targets the current operations because as mentioned in the previous sections, the study focusses to explore the contribution of ERP on the green supply chain in the current scenario of technological advancement. To reassure my chosen methodology compared to history method, Yin explicitly mentions that case study strategy is advised if direct observation of an event is demanded by the research and also a collection of data from persons involved in the events. Therefore, for all the above reasons, I proceed with a case study approach to study this topic and answer the research question.

The approach will be qualitative and subjective in nature, where I collect data from the chosen case firm through field research and conduct interviews with the employees. The field research will include observation of the current processes and operations relevant to my study. The Interview will be organized with open-ended questions to gather information from experienced professionals in the firm. In support, Yin refers to the unique strength of case study to give the freedom to collect a full variety of evidence, documents, and artifacts, interview, and observations in comparison to other research strategies (Yin, 2014)

3.2 Case study Design

In this research, as discussed before I will be carrying out a case study approach to answer my research question formulated. I aim to conduct a multiple case study as Yin (2014) mentions that the evidence received from data collected from multiple cases is considered to be more justifiable and robust research study (Yin, 2014). With a selection of multiple cases for case study research, it also raises a new set of questions to consider. When multiple cases are considered it is advised to follow a replication design in my approach.

Replication involves the logic of sampling for multiple case studies where each case must be carefully chosen so that it either results with similar outcomes or contrasting results backed with suitable theoretical implication. It is advised by Yin(2014) that The logic underlying these replication procedures also should reflect some theoretical interest, not just a prediction that two cases should simply be similar or different. The replication approach to multiple case studies as mentioned by Yin (2014) should indicate that the initial step in designing the study must consist of theory development , and then selecting the case using replication logic explained earlier and further I proceed to define specific measures that are important steps in the design and data collection process (Yin, 2014). Each individual case study consists of a whole study in which convergent evidence is sought out regarding the facts and conclusions for the case, each case conclusions are then considered to be the information needing replication by other individual cases. I follow a similar design In my research design, where each case studied, will be concluded and the replication factor will be asses with respect to other case studies carried out. Yin(2014) advises that for each individual case, the report should indicate how and why a particular proposition as demonstrated (or not demonstrated). And across cases, the extent of the replication logic should be indicated and why certain cases were predicted to have certain results, whereas other cases if any were predicted to have contrasting results (Yin, 2014).

I refer to Yin(2014) to consider the basic attributes desired to conduct a case study research and accommodate with the following requirements before conducting the case study research. He refers to attributes of interpreting the answers fairly by asking good questions, to be an attentive listener without being biased to preconceptions, firm hold over the regarding the issues being studied and perform the research by being sensitive to contrary evidence (Yin, 2014) .

In the case study research carried out I adhere to the care points that national research council points to in gaining consent from all persons wanting to be a part of the case study and ensuring to protect the privacy and confidentiality. Yin (2014) mentions that for a case study research, design of case study research includes mainly five important components, which he lists as follows: a) Questions related to case study b) If any propositions made c) The unit of analysis considered for the case study d) The logic underlying which links the data to the propositions and lastly e) the criteria considered to interpret the findings (Yin, 2014). Based on the guidelines provided by Yin, I address the following case study design components in my research.

3.2.1 Theoretical Implications

The theoretical implications is drawn on the studied topic is based on the conceptual model developed at the end of the literature review section. The implications are used in formulating my research questions and defining the direction of study in my case study methodology. Yin(2014) theoretical implication developed directs attention to specific topics that need to be examined in the scope of the study. The right theoretical background will help in proceeding in the right direction in my case study as Yin mentions it in his book (Yin, 2014).

Based on the conceptual model, I am interested to carry out a case study to collect data relevant to “ERP benefits in SCM” and the “Green supply chain operational performance measures”. In order to focus on the above two factors concerned with my scope of the study, I draw following implication that *ERP contributes to Green supply chain*

operational performance through improvement in operational efficiency based on my observation in the literature review studied and the conceptual model developed in the scope of my research.

3.2.2 Unit of analysis

As referred by many researchers in their studies on the topic of ERP and Green supply chain. I observe that the studies have been carried out with manufacturing firm Involved in the production of product and services in their operations. With this background studies in mind, I define my unit of analysis by selection of manufacturing firms. In order to improve the external validity of the research conducted, a multiple case study will be studied. These multiple cases are chosen to be contributing their products and services to different markets and industrial verticals. This choice of variability in choosing my cases is expected to encourage my research conducted to have the factor generalizability to all types of manufacturing firms. To conduct my research, I chose three case firms which are part of three different type of industries namely chemical, Automotive and Plastics. The three cases were carefully chosen by referring to the products they manufacture and the resulting effect it can have on the environment. These three case firms will be further explained in detail.

Now with the multiple case firms chosen, I focus on defining the unit of analysis based on the context of my study. The context my study involves benefits of ERP, which according to the literature studied is focused on the supply chain and logistics department of a firm. Therefore, with context requirement of Supply chain management, the Unit of analysis in my study will be the individuals experienced with the usage of ERP in their operations. I need to consider multiple units of analysis, which are individuals with different responsibilities in the supply chain of the firm. In this research, I consider individuals as the unit of analysis who contribute to the supply chain in case of firm under different responsibilities.

Case	Unit	Respondent	Industry type	Role in the supply chain
Case A	1	Boscara.I	Chemical	Material planner
Case A	2	Muller.M	Chemical	Project planner
Case A	3	Kostas.A	Chemical	Production Planner
Case A	4	Durupathy.I	Chemical	Hub Manager
Case B	5	Mahadevaiah.J	Automotive	Material Manager
Case B	6	Bagali.G	Automotive	Logistics Manager
Case B	7	Janiwarad.P	Automotive	Senior Engineer
Case B	8	Lukas.H	Plastic	Key Account manager
Case B	9	Anna.H	Plastic	Team leader customer service

3.2.3 Case study questions

The case study questions are open-ended and structured in nature. The structured questions are expected to help in collecting relevant information concerned with the topics of research and also in the direction of proposition formulated in this previous section. The open-ended questions are formulated in order to collect all the information the interviewed individuals have to share in relevance to the research questions formulated. As the research topic entitles to an exploratory study with limited resources or findings in research carried out earlier, the open-ended questions are designed to receive the best results (Yin, 2014). According to Yin, he suggests that the questions in the interview should not exceed more than 10 questions and maximum for a duration of 1 hour classified as short interviews (Yin, 2014).

Below you find the list of case study questions I ask the individuals in the interviews conducted with them.

	Research question
1	what operations do you contribute to the supply chain?
2	What are the advantages you experience with ERP system usage in your operations?
3	what kind of reports do you generate using the ERP system?
4	What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?
5	Do stakeholders in your supply chain have an enterprise system being used? If yes, how do you see the integration of systems beneficial in GSCM?
6	How do you perceive the concept of a green supply chain?
7	what are the different projects in your operations that you think can influence GSCM?
8	How do you think ERP can influence Green supply chain operational performance?
9	How can you measure or analyze the green supply chain metrics in your operations?
10	what operational measures do you suggest and projects to undertake to measure environmental performance?

3.2.4 Logic between Data and Propositions

Yin(2014) represents five techniques to link the data collected in a case study to the propositions developed in his book about case study research methods. The techniques are as follows: Pattern Matching, Time-series analysis, logic models, explanation building and cross-case synthesis (Yin, 2014). I carry out this research with the reference of techniques listed by Yin and I try to follow present my analysis on the logic between data and proposition through means of pattern matching and explanation building and cross-case synthesis. I decide not to consider the other techniques as I find it not suitable for the research carried on my focus of research. The data collected in the research carried out will be in the current scenario and current knowledge from individuals with no intervention of time parameter, therefore Time-series analysis is

found not suitable. The logic models are recommended for complicated links between the independent and dependent variables and also is time dependent as Yin explains the technique applicability to be (Yin, 2014) . Due to the absence of a time variable in my case study research, I do not find it suitable logic to apply in my study.

The case study research will include field observation and interviews conducted on the unit of analysis, which is the supply chain department and employees. I follow a pattern building approach to find a suitable pattern among the response and field observation and also include theoretical model developed on the two concepts. Further, the cross-case synthesis is advised suitable when the cases and context are different in nature. By defining my cases and context different with respect to the type of industry the firms contribute to, I attempt to test the generalizability of the results outcome. Further, as the research includes the unexplored relation between the topics of interest, I try to use the technique of explanation building in justification of my results.

3.2.5 Research design quality

I refer to Yin (2014) to consider the quality of my case study design. He mentions the following tests to be referred to as a framework generally for assessing the quality of a case study in the literature observed. These four tests are generally respected in all types of methodology, but here I refer to the tests and its expectation with respect case study methodology. Yin (2014) states the requirements of these tests in a case study scenario in the following ways :

3.2.5.1 Construct validity

To ensure the Construct validity of the research conducted, the researcher is expected to Identify the correct operational measures for the studied concept. As Yin (2014) mentions that to attain construct validity of design the investigator must ensure to cover two steps in order to attain construct validity in the case research study carried out. One is to define the specific concepts and relate them to original objectives of the study of

research and two identifying operational measures that match the concepts by citing published studies that make similar matches to the measure considered. Also, he advises further on tactics to increase construct validity in case of studies by using multiple sources of evidence and chain of evidence (Yin, 2014). In my research, I follow his guidelines by collecting multiple sources of evidence through observation on the field and also building a chain of evidence through the convergent line of inquiry in my interviews. I carry out a detailed observation of the case firms considered and the respective operations. Also, the questions formulated to respect the conceptual model and research objective considered at the beginning of the study. The question designed to follow a line of inquiry revolving around the conceptual model developed to study on and the main concepts of ERP and Green supply chain defined in the research objective.

3.2.5.2 External validity

In order to meet the external validity of the research designed, I define the domain for this study to be the supply chain in manufacturing firms. I constraint the domain defined to be manufacturing firms supply chain because in the past researchers have carried out studies on ERP application and Green supply chain on supply chain operations of a manufacturing firm. Therefore, I in this research I define the domain on the same basis. In my study, I carry out a multiple case study for the same reason as manufacturing firms can include different industrial sectors. Which is why, I have considered case firms in different industries like chemical, automotive and plastic manufacturing firms in order to build a strong external validity for my research. As Yin (2014) mentions that defining the domain to which a study's findings can be generalized has an influence on external validity (Yin, 2014). Therefore, I consider the supply chain function of manufacturing firms with multiple case study involving different industrial manufacturing firms as a domain while selecting my case firms to conduct research on.

Internal validity is not found to be applicable in this research study as it is exploratory in nature. The research consists of exploring the probable relation between two minimally addressed topic in research. Yin confirms this explanation by hinting that internal

validity is more applicable in cases of explanatory or causal studies only and not considered for research that is descriptive or exploratory in nature.

3.2.5.3 Reliability

The Case study in this research involves data collected through field observations and face to face interviews with experts in the respective domain. Further, I try to analyze the outcomes of data collected and observed with pattern matching technique and explanation building techniques as suggested by Yin(2014). These techniques can be repeated in future research on the defined domain to encounter similar results. The methods to collect data have no intervention from the investigator of this research and the observations are made with factual data collected from the case firms.

3.2.6 Interview Process

The interview was conducted with experienced professionals in the supply chain department of the chose case firmly. The interview consisted of open-ended and structured questions to address to the interviewees. The data collected from the interview was qualitative in nature which was formed from the responses from the expert Interviewed and earlier developed theoretical conceptual model developed using the available sources in the literature. The data collected was further interpreted according to the scope of the research being studied and analyzed accordingly. The analyzed content was coded to find the key point that was expected to aid in achieving the research objective stated.

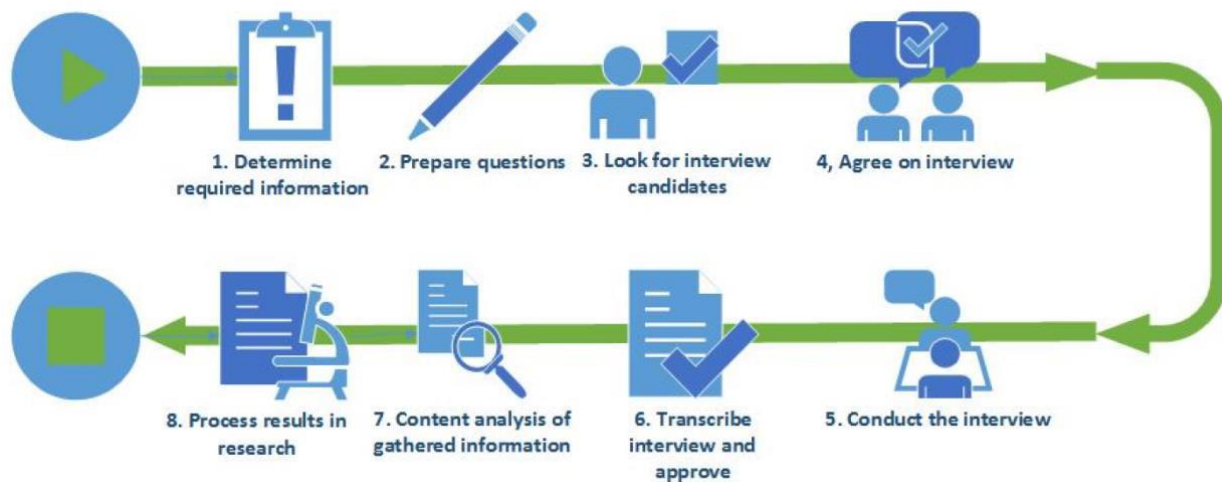


Figure 8 Interview process (Bailey, 2008)

The collection of data was mainly through face to face interviews and conducted with a short time gap between the two rounds. The complete interview process was conducted in a period of one month respecting all the principle of interview research approach. The interview was carried out in each case firm selected. As mentioned already the case firm was chosen with an expectation to replicate similar results. The Case firm selected are companies with a good history in different manufacturing industrial sectors namely automotive, chemical and plastic. The respondent groups in each case firm were chosen from the supply chain department as the main focus topic of this report addresses the supply chain stakeholders. In order to ensure the external validity of the research, I try to select respondents with different operational and managerial responsibilities in the supply chain. The main goal of these interviews conducted was to gain information on the benefits experienced by the firm using ERP and also the insights on how the enterprise system can contribute to the Green supply chain operational performance.

The interview took place in two round. The first round was based on the formal introduction of the topic and literature study carried with the reference of the conceptual model. This round of interview included presenting the topic and theoretical model on the topic of ERP and green supply chain. With the foundation laid in the first round of interview, I further proceeded to conduct the second round. The discussion and collected information in the role and responsibilities helped in structuring the questions for the

second round. Further, parallel the field observations on the operations and reports were taken into account in formulating questions for a second and final round of interview. Finally, the outcome of the second round of interview was used to gain a better idea about the benefits of ERP and its contribution to the Green supply chain operational performance.

Session 1 of the interview process included an introduction to the topic and theoretical model developed and stating the research question to convey the expectation of the main interview. In Session 2 of the process, the interview questions were formulated based on two concepts of study: The benefits of ERP and the Green supply chain operational performance. With reference to the theoretical model and literature studied, the interview questions were formed.

Chapter 4. Analysis and results

In this section, I analyze the outcomes on the cases studied with methods of on field observations and interviews conducted with the expert. I explain in detail on my observations which include reports, projects undertaken and inferences from the interviews conducted with respondent in the case firms. The Inference for the interviews has been summarized based on the personal observations and a key point in the responses provided by the case units of study.

4.1 Case Findings

In this subsection, I discuss the findings in terms of observation carried out on the operations in the case firm and the responses from the respective interview respondent from each case. During my case study, I tried to seek documents related to operations and collect information regarding the operation documents. The main target sources observed concerned with the reports generated through ERP, analysis factors and also the projects considered in each of the case firms. Further, I also interviewed the respondent to collect information relevant to my research study.

4.1.1.1 Case A

This case firm is a chemical company, involved in the manufacturing of paints and decorative coatings. They have production units all around Europe in 12 locations. The company figures provide the information that the production sale in the year 2017 was around 25 million liters across all the sites. They have different types of products produced in their manufacturing to satisfy the various type of customers in the market. Therefore, such huge production portfolio involves equivalent resources procurement from suppliers. The raw material resources procured are of mainly three types as

following, Raw: which includes the chemical components and powders, pack: This portfolio includes the plastic and metal cans and lids and lastly Labels: which obtain artwork of the company to wrap around the cans. The finished product includes a combination of all these items into one final product ready for sales.

The Supply chain department in the context of the case firm mainly operates as a centralized planning department. This centralized planning was observed to use the ERP system-SAP to the maximum in their operations. For the same reason, I conduct a case study in this department of the case firm. The Department involved material planners and production planners along with project managers and departmental managers.

During my case study, I find the following observations related to ERP usage in the employee operations. They procure materials for production from around 72 vendors from all across Europe. Most of the items are delivered through road transport in trucks. The enterprise system used in the case firm is an SAP. I can see the support the system offers in the below figures. I observe the opportunities that ERP has to offer in a supply chain as confirmed by the theoretical model developed on the benefits of ERP in the supply chain. As depicted in the figure below, I see the analysis of inventory for such a huge portfolio supported by the extraction of relevant data from the ERP system transaction code. On further observation, I find the daily operation being only conducted using the ERP system to plan and control the operations of planning.

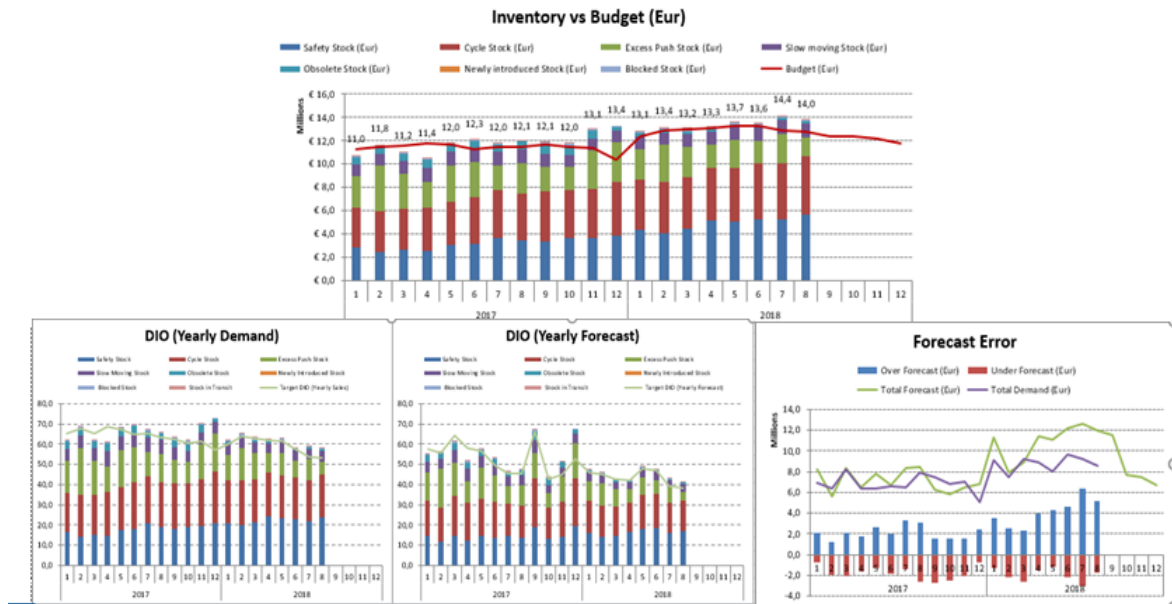


Figure 9 Case A Inventory analysis

Interview outcomes

The Interview was conducted with the material planner, production planner, project manager and hub supply manager in the case firm being studied. The Encoded transcript can be found in the appendix for detailed reference. The question asked were open-ended and unstructured but maintaining the line of inquiry concerned to the conceptual model developed and the research question formulated at the beginning of the thesis. The responses from the experts were analyzed to build the following logic model as per the discussion. The common inferences drawn from the interviews and discussions carried out with Case A firm is as following

- ERP is a supporting tool to supply chain operation
- The green supply chain concept is not introduced in their operations
- ERP assists as a Data storage, information exchange, and integrated planning tool
- ERP is a control tool in order to maintain a check on key measures
- ERP helps to control key measures such as inventory, Stock situation, Forecast accuracy, delivery cycle time
- ERP contributes indirectly to green supply chain through control of inventory and therefore waste reduction.

- ERP contributes to Green supply chain operational performance in terms of controlling delivery frequencies
- ERP helps in sharing forecast integrated stakeholders which are seen to help in controlling stock situation and inventory
- ERP assists in preventing obsolete stock creations leading to a reduction in Scrap
- GSCM measures were suggested to be measured in terms of inventory reduction, Reduction of delivering frequency contributing to economic and environmental performance.
- A Logic model is developed on the responses

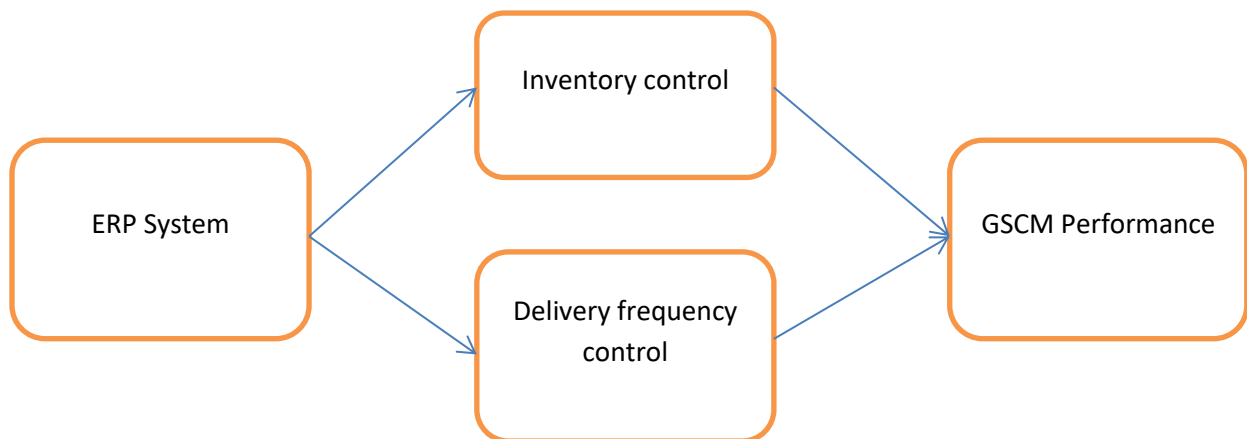


Figure 10 Logic Model - Case A

4.1.1.2 Case B


This case firm is an Automotive company, involved in the manufacturing of automotive electronic components. The production unit is situated in India. The company products include engine control unit (ECU) as the main product. They have other different types of products produced in their production to satisfy different product type demand in the market. Therefore, the product portfolio involves equivalent resources procurement from suppliers. The raw material resources procured are of mainly two types Electronic: which includes various electronic components like the circuit board, resistors, transistors and more. The other types are mechanical: which includes the covers and other covering items which are used to protect the electronic component. Every finished product on an average involves 40 components assembled together to deliver a final product.

The Supply chain department in this context is different from the case A, the case B firm supply chain includes planning and logistics in the same site as manufacturing. So the complete chain exists in one place. The Firm has the ERP system in place -SAP and the department where the operations are observed are considered to use the enterprise system to the maximum in their operations. The Department involved material planners, production planners, customer order planners, logistics along with departmental managers.

During my case study, I find the following observations related to ERP usage in the respondent's operations. They procure materials for production from around 40 vendors from all across the world. Most of the items are imported through air transport. The enterprise system used in the case firm is an SAP. I can see the support the system offers in the below figures. I observe the opportunities that ERP has to offer in a supply chain as confirmed by the theoretical model developed on the benefits of ERP in the supply chain. As depicted in the figure below, I see the analysis of inventory for such a huge portfolio supported by the extraction of relevant data from the ERP system transaction code. On further observation, I find the daily operation being only conducted using the ERP system to plan and control the operations of planning.

TCT 2017-Approach Focus Projects

VSD : Value Stream Design



- Pull with Customers – One Project in each system CIP cycle
- Pull with Local Suppliers – One Project in each system CIP cycle
- Implementation of Consignment or VMI
- GIT reduction projects
- Focus on Prevention and Dilution of Aged parts through out value chain
- Increasing Dispatch frequency of FG and decreasing SA2 factor .

Figure 11 Supply chain projects- Case B

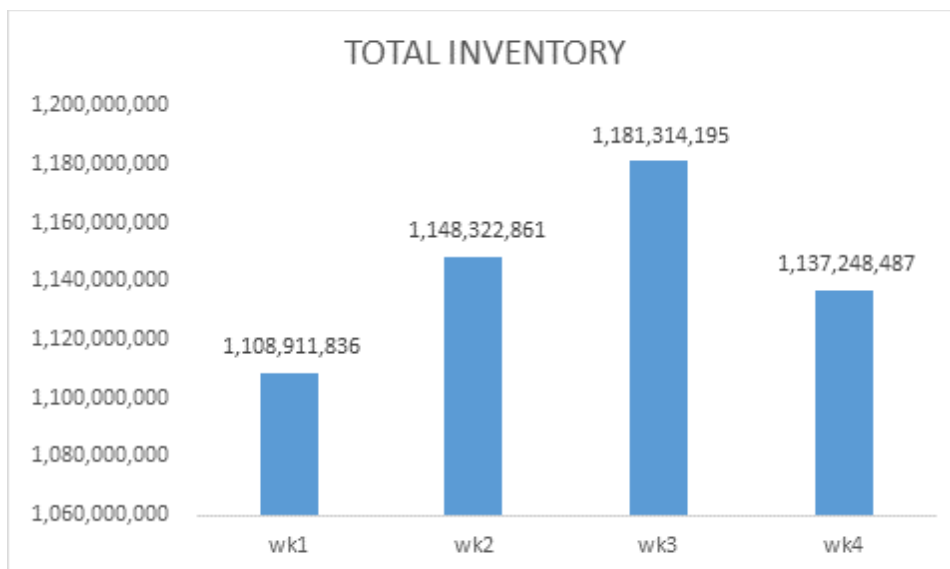


Figure 12 Case B- Inventory tracking

Interview outcomes

The Interview was conducted with the material planner, Material manager, Logistics manager and hub supply manager in the case firm being studied. The Encoded transcript can be found in the appendix for detailed reference. The question asked were open-ended and unstructured but maintaining the line of inquiry concerned to the conceptual model developed and the research question formulated at the beginning of the thesis. The responses from the experts were analyzed to build the following logic model as per the discussion. The common inferences drawn from the interviews and discussions carried out with Case B firm is as following

- ERP is a planning tool to supply chain operation
- The green supply chain idea is introduced as a performance measure to reduce scrapping and maintain minimal inventory
- ERP assists as a Data storage system, to exchange and communicate information and efficiency improvement tool
- ERP is used as a planning and control tool in order to maintain a check on key measures and also automatize processes without manual intervention
- ERP helps to gain control over inventory, Stock maintenance, planning alignment, Forecast accuracy, planning overview, delivery cycle time and automatize operations
- ERP contributes indirectly to green supply chain through all the benefits it has to offer, which collectively lead control and reduction of inventory and therefore waste reduction.
- ERP Offers optimized planning control offered by ERP, scrap reduction is achieved as well.
- ERP offers opportunities to VMI, E-Kanban concepts, which lead to control and reduction of inventory by directing towards just in time concept
- ERP contributes to Green supply chain operational performance in terms of controlling delivery frequencies

- ERP helps in sharing forecast integrated stakeholders which are seen to help in controlling stock situation and inventory
- GSCM measures were suggested to be measured in terms of inventory reduction, Reduction of delivering frequency, new logistic concepts can contributing to economic and environmental performance.
- A Logic model is developed on the responses

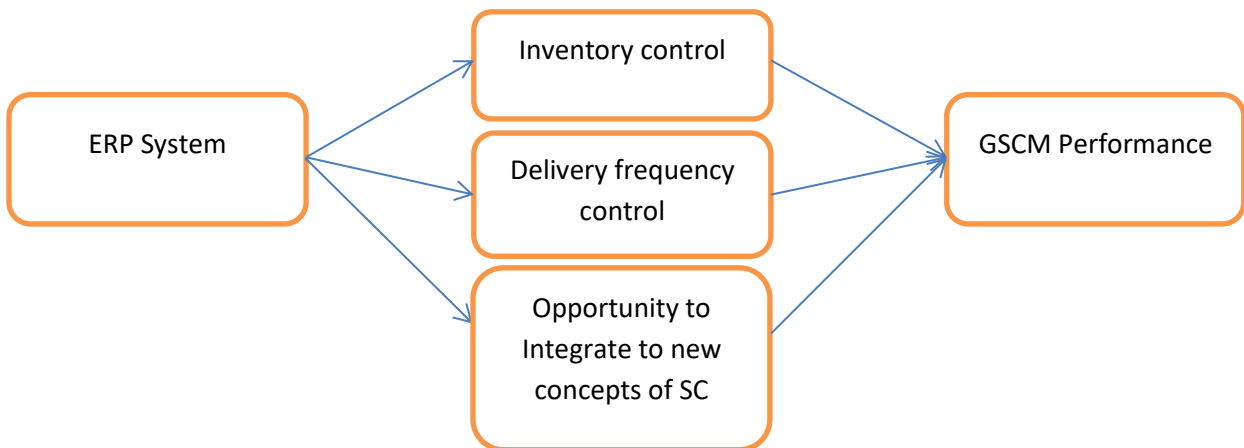


Figure 13 Logic Model - Case B

4.2 Cross-case Analysis

In this section, we attempt to analyze the commonalities and differences between the case findings described in the previous section. As mentioned already, the two cases considered in this multiple case study satisfy the different types of markets and consumers. The case A is a chemical company manufacturing decorative paints and the stakeholders include chemical suppliers, plastic can and metal can suppliers and label vendors. On the other hand case B is an automotive company, dealing with procurement of high-cost electronic items and customers include various automotive companies.

The differences observed between the two cases in consideration are mainly with respect to product and the market base. Case A experiences major market fluctuations due to the more number of competitors as well as due to product sales depending on the taste of customer which is prone to changes. Whereas the Case B products face more stable forecast visibility with regards to market fluctuations, but on the contrary, the product cost is very high. Further, in view of supply chain, operational differences between the two cases were found that Case A has amateur process set up in context of ERP system and technology used, where we refer to planning and controlling in ERP system is partially manual. Whereas the Case B is technologically advanced with the setup of EDI and E-kanban process adopted already which justifies the maturity attained in the usage of the ERP system. Therefore, We observe quite a few differences in the interviews from experienced professionals in both the Case firms as well as in the reporting adopted in the respective case firm. The Case A uses ERP tool as a support tool in 50% of supply chain operations, combining with Excel Macro development to assist in planning and controlling. whereas Case B is effectively used ERP system in 80% of their operations and has minimal use of excel files and manual planning. The Supplier integration with an enterprise system is observed to be still in the initial stages of adoption in the supply chain of Case A, Whereas supply chain in Case B has taken up projects to ensure ERP integration with all its suppliers. Although in support of Case A, the professionals mention that their supplier portfolio includes small suppliers, who do not find it feasible to invest in ERP system in their firm, considering the size and ROI of the investment. One other major difference observed is the projects undertaken in each case firm , we observe that case A projects are mainly focused towards basic key performance indicators of supply chain, Whereas Case B is observed to have extended themselves further in considering projects on specific factors like good receipt per day, day wise inventory calculation, ERP extensions like E-Kanban focused on Just in time concept of lean supply chain. As observed, there are quite a few differences in the usage and effectiveness of ERP system In both cases, which is mainly justified with product produces by each of the case firm and market scenario faced respectively.

In my analysis, we come across major observations with regards to the similarities between the information collected from both Case firms. we find that both find the

advantages of ERP in reporting of data concerned with the supply chain. The two case firms in the scope of this research operate similarly with regards to extraction of inventory reports, delivery reports, stock status. Also, they both agree on the benefits of ERP concerned with information sharing, stakeholder integration, and operational efficiency. Adding to these, the interviews conducted with experienced professionals in both case firms agree to the theoretical model developed for ERP advantages in the supply chain, also refer that inventory control and delivery frequency control could have an influence on the Green supply chain operational performance. These similarities can be found in the logic model developed in each of the case findings. Besides, we also observe the lack of awareness in both firms on imbibing the green supply chain measures in the supply chain operations. At the top level management, sustainability is enlisted in the objectives defined for the company growth, but it is not realized in measures or KPI's in the supply chain department.

4.3 Results

In this section, we discuss the observations and collected information from different data sources. The Observations mainly concerns with the cases in the scope of this study, where different sources of data like company reports, projects and operations were closely observed to collect relevant data. The responses from open-ended interviews conducted with the professionals working in the supply chain operations of the case firms are also considered to triangulate the observations and consequently provide results. Further, the theoretical model developed using the available research studied in the literature review section is also referred to increase the internal validity of the research results presented. So, an attempt to summarize and consolidate the findings from three data sources namely, previous literature theory, company records, and Interview observations are used to triangulate and present the following results.

The case study findings reflect the logic models developed based on the case firm which clearly is in line with literature studied on both the concept of ERP and Green supply chain. In the theoretical model developed in chapter 2 of this report, we see that

inventory, delivery planning are listed as the advantages of ERP in achieving Supply chain operational efficiency. Many researchers have concluded the same in their research regarding these advantages factors of ERP. On the other hand , we also observe in the theoretical model developed to measure Green supply chain operational performance , that inventory reduction is one of the prominent metrics influencing waste reduction measure of Green supply chain operational performance . Further , as presented in the case findings , we see case firms analyze the inventory of stock in their respective firms to take action on the cost performance indicator . The experienced professionals also find the inventory control and delivery frequency control can be effective metric to measure the Green supply chain operational performance.

On referring to the logic model of both case firms, I see that inventory control and delivery frequency act as the mediating variables in defining the relationship between the ERP system and Green supply chain operational performance. This inference is drawn on the basis of responses from interviews and field observation carried out on the operations in the case firm. In order to reassure the logic model, I can see the theoretical model developed based on the past literature carried out on the concept of ERP and green supply chain convey the factors of inventory reduction and frequencies of deliveries as a common parameter. The previous research lists Inventory reduction and delivery frequency optimization are one of the metrics classified under the benefit of operational efficiency offered by the ERP system. On the other hand, the literature on GSCM also refers to inventory reduction as one of the metrics under green operation to have an effect in performance. Also the delivery optimization as one of the factor under the green logistic category impacting the Green supply chain operational performance through reduction in emission.

Based on my findings in the case study and the guidelines of the theoretical model developed, I design the following extended conceptual model to showcase the relation between ERP and Green supply chain operational performance. As represented in the conceptual model the inventory control and delivery frequency control act as mediating variables in the relation between ERP and Green supply chain. Therefore, on the basis of my study, It can be concluded that there is no direct relation between the two researched topics.

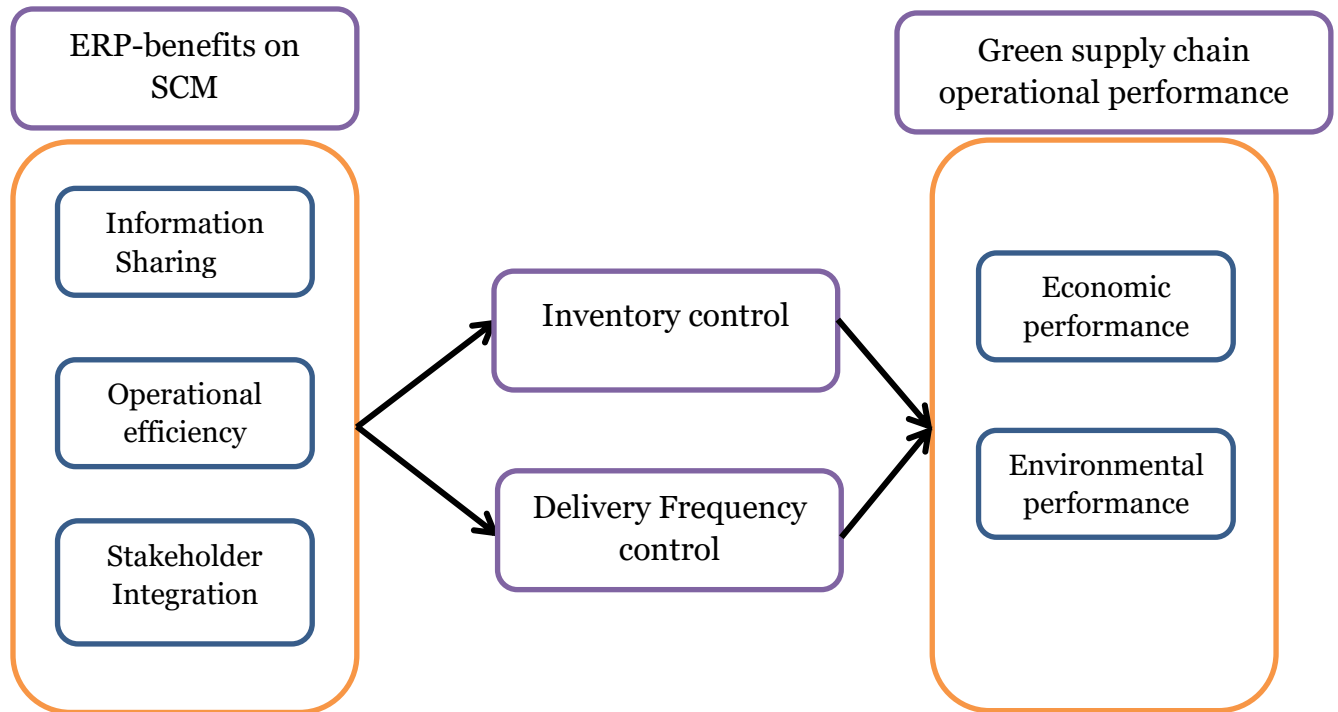


Figure 14 Extended conceptual Model

The Analysis on the observations and triangulation of sources of evidence from case firm archival records, interview responses and literature resulted in development of above extended conceptual model . It is observed that the adoption of ERP in supply chain of a firm has benefits in influencing the performance of green supply chain of the operations through mediating variables of inventory control and delivery frequency control . The same is represented in the above figure, where benefits of ERP is independent variable and the Green supply chain operational performance measure is the dependent variable , and based on my analysis of data collected , the inventory and delivery frequency are the connecting parameters between the two variables which influence the relationship as mediating variables .

The resulting extended conceptual model developed is referred to development of consequent propositions in this study. As already mentioned , the conceptual model developed with the help theoretical model designed from the literature study is considered as a foundation in carrying out the case study observations . The

observations lead to development of extended conceptual model , which resulted in the variables Inventory control and delivery frequency control that influence the relation between ERP and green supply chain operational performance. These results are taken into account to develop following propositions .

Proposition 1 : *Inventory control mediates the relationship between ERP benefits and green supply chain operational performance .*

Proposition 2 : *Delivery frequency control mediates the relationship between ERP benefits and green supply chain operational performance.*

Chapter 5. Conclusions and recommendations

In this section , we conclude the conducted research study and give recommendations for future scope of research by taking into account the limitations in this research. The theoretical contributions and practical implications are discussed in this section as well. The objective of the study was to address the research gap between the existing theory on ERP systems and Green supply chain operational performance and develop an extended conceptual model and deduce recommendations. To meet the objective , the main research question was formulated followed by sub-questions which would help in structural advancement towards answering the main question. In this section , we conclude by re-visiting the questions formulated at the beginning of our research and presenting the answers based on the observations and results found through explorative study and case study approach .

The main research question formulated in this study is

“How does ERP system contribute to Green supply chain operational performance ?”.

The above question was answered through structured answering of the sub-questions formulated to support the study. I summarize the results for each sub-question as following.

What are the advantages of ERP system in the supply chain?

The past research carried out on ERP advantages on supply chain was found to be limited in scope. Therefore, the literature was studied by referring to different connections of keywords concerning ERP and supply chain. Based on the available and accessibility to literature, it was found that ERP system adopted is beneficial in supply chain can be classified mainly under three categories of information sharing , operational efficiency and stakeholder integration. These measures were further classified according to the literature to specific metrics such as data storage and

exchange , Planning assistance , forecasting , inventory reduction , cycle time reduction , optimization of delivery frequency , provision of better process visibility and communication assistance with stakeholders. These above measures and metrics studied through exploratory literature studied was used in developing a consequent theoretical model as presented in section 2.2 , which was later taken into account for development of conceptual model and case study carried out .

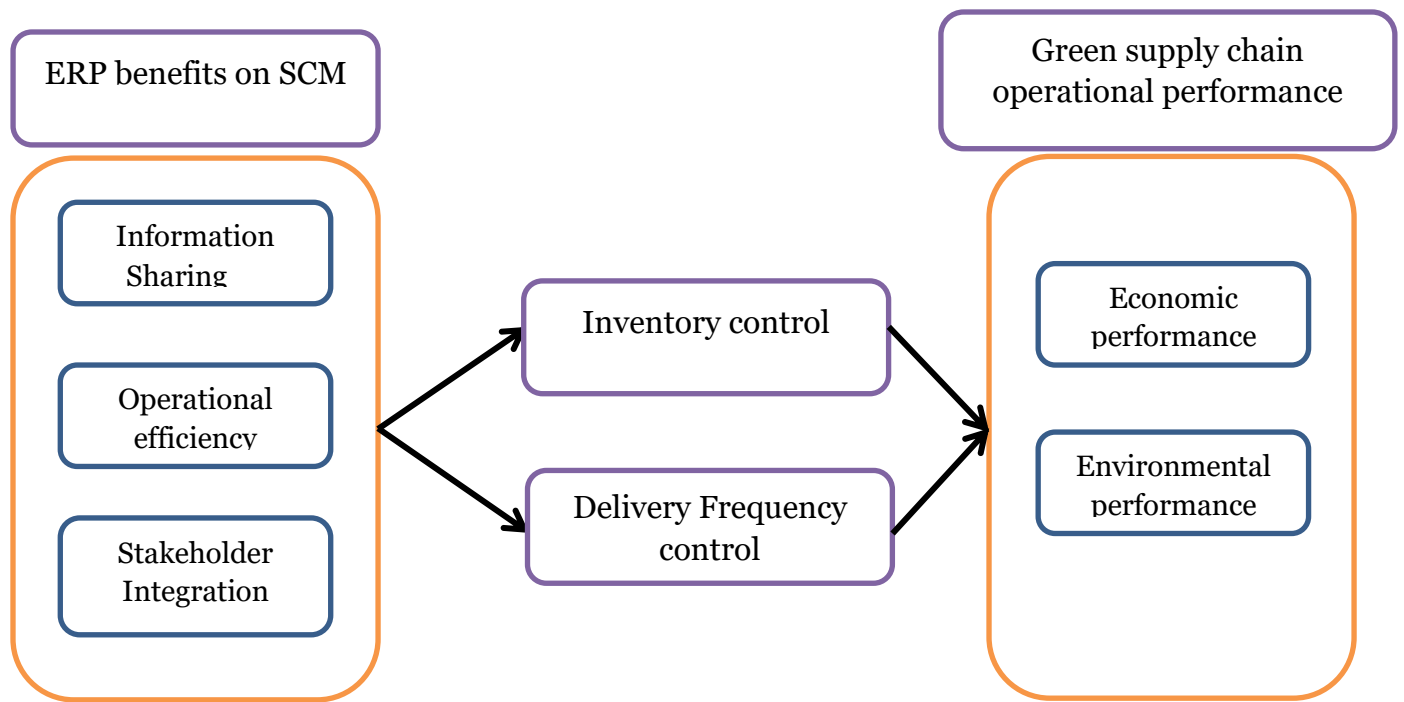
What are the green supply chain operational performance measures?

The green supply chain management is a recently studied concept in academic research , which limits the number of studies conducted in scope of our research . The available research was studied and the observations concerning the objective studied in this research was consolidated to answer the above sub-question. In my literature review of available research , I observed many researchers concluding the following operational performance measures of green supply chain . Firstly , I study the green supply chain operations which include green purchasing , green product , green manufacturing , green operations and green logistics. These operations are further concluded by researchers to influence two types of operational performance measures , namely Economic and Environmental performance . The economic measures is measured through market share growth , improved quality and increase in investment. Whereas the environmental performance is measured through achieved reduction in inventory , CO₂ emissions , energy and resource usage . The above listed measures and metrics observed in the current literature was considered to develop a theoretical model in section 2.3 to answer the sub research question and was referred to carry out our case study .

How is the ERP system related to Green supply chain operational performance?

The theoretical models developed on ERP and Green supply chain led to the development of conceptual model for our study, The conceptual model showcased the relation between ERP system and green supply chain operational measure which is represented in section 2.4 of this research. The conceptual model represented was further explored using the case study methodology, where two industrial firms were considered as a case units . Based on the observations carried out in case firms , the

document sources and interviews conducted with experienced professionals in supply chain and triangulating the information collected through case firms with the available literature. It was analyzed that two prominent mediating variables inventory control and delivery frequency control influence the relationship between ERP and green supply chain operational performance. These findings answered the third sub-research question formulated in this research study and the consequent extended conceptual model was developed and represented in the section 4.3 and represented below.



Based on the structural findings for the above three sub-questions, we finally answer the main research question

How does ERP system contribute to Green supply chain operational performance ?

The adoption of ERP system is found to be influencing the green supply chain performance through the mediating variable of inventory control and delivery frequency control. Where both the variables are analyzed to be the benefits of the ERP system in supply chain and they also influence the measurement of green supply chain operational

performance economically in terms of cost reduction and environmentally through reduction in waste and emission. Following which, this exploratory research study carried out contributes to the research by providing following theoretical propositions , which are supported by the findings in the research conducted . The theoretical propositions are formulated as a result of extended conceptual model developed in the result section .

Proposition 1 : *Inventory control mediates the relationship between ERP benefits and green supply chain operational performance .*

Proposition 2 : *Delivery frequency control mediates the relationship between ERP benefits and green supply chain operational performance.*

Based on this result, I would like to conclude that ERP offers advantages in analyzing the inventory in the supply chain and other important parameters such as delivery frequency , planning of procurement and production , forecast visibility and more. These advantages have been reassured in all sources of evidence collected in this research. But only the main variables of inventory control and delivery frequency control was analyzed to have an effect on Green supply chain operational performance according to the data sources collected . I would also like to add , the other benefits of ERP as mentioned above indirectly influence the variable of inventory or delivery , for eg : the forecast analysis is referred to have an indirect influence in managing inventory. Further, based on this conclusion of this research where I answer the main research question formulated through development of extended conceptual model , I try to provide following recommendations based on my conclusion.

It is recommended for businesses to adopt the objective of environmental impact in each of their supply chain operations . It was observed in the case firms chosen that, they have no awareness or KPI's focused specifically on this measure . Referring to the conclusion of this research study , we can understand the possibility to measure the impact in terms of inventory reduction or delivery frequency reduction achieved in supply chain operations in specific range of time . Therefore , for businesses who have invested in the ERP , it is recommended to have such measures in place in order for it to be considered in the return on investment on enterprise platform . Also , we observed in my research

few stakeholders involved in the supply chain of case firms , had not invested in any type of enterprise system to coordinate and exchange reliable information in the supply chain. It is also recommended for those firms , to consider the green benefits that ERP has to offer besides other advantages in order to make an informed decision on investment in adopting ERP system in their operations. In the academic perspective ,this research is carried out using a qualitative case study methodology , therefore it is recommended for the future researchers to carry out a quantitative analysis to test the propositions developed in this research.

Theoretical contributions and practical implications

The theoretical contributions of this research is most importantly realized in filling the knowledge gap observed in the current literature available. It was experienced during the literature review that limited research is carried out on ERP in the context of supply chain and no research with respect to green supply chain . Lately, with increase in importance given to green supply chain by researchers and strategic business requirements , I find the exploratory research carried on the benefits of ERP in perception of Green supply chain operational performance adds value to the theoretical database of green supply chain research . As we conclude in this research , we found that adoption of ERP does influence the Green supply chain operational performance through mediating variables such as inventory control and delivery frequency control .

The practical implications of this research can be realized by businesses in terms of including additional measures in their supply chain operation by considering the environmental performance of the supply chain. These measures can be represented to the market and its customers in terms of greenness achieved. Additionally, in a business scenario for small and medium scale firm , who are hesitant to invest in enterprise system for their operations can also include the environmental or sustainability measure to make and informed decisions .

Limitations and Future scope

The research carried out in this report is exploratory in nature, due to the limited availability of resources and information in the research done in the past. I had to develop the theoretical model by collecting the information available in different sources of the research study. One of the limitations of this research is that, it is conducted in a qualitative case study approach for in-depth study of the research topic in its exploratory stage. But future research on this topic can attempt to address the same research question with a different methodological application like survey among the firms with ERP system in usage.

In this research, I limit my study to the domain of supply chain of manufacturing firms. I find this limitation to be explored further in future research, through a study conducted on non-manufacturing service-oriented firms like logistics industry, where ERP is adopted. Also, one another limitation seen in this research is the exclusion of concepts like VMI and E-kanban and advanced planning systems, which are adopted by very few firms in the world. These concepts are an updated version along with ERP, which has a scope to be researched in the future research.

Further with respect to the design methodology, I see scope for future researchers to explore other methodologies like quantitative research tools like a survey in order to generalize the results to the larger population. In my research, the case study carried out restricts the results to the chosen firm in the study, but the more broad sense of study can be done focusing on one particular industry type. Also, I observe a limitation with regards to the operational measures considered in my research. According to the theoretical model developed in my literature, I have other parameters, which have a scope to be chosen exclusively to carry out a study in the future.

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Appendix

Thesis Topic: *ERP system adoption on Green supply chain operational performance*

Respondent: *Boscara. I*

Job Role: *Material procurement planner*

Interviewer: *Jayanth PV*

Date of interview: *18th May 2018*

1 what operations do you contribute to the supply chain?

I am responsible for Material planning for France site. I plan procurement of materials for production, by contacting vendors . I place orders and follow up till it is available on site . My communications is with suppliers and coordinating with them to deliver Raw materials like chemicals

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP to place orders and plan the deliveries to plant , so it helps me in automatic planning and controlling of order placement and tracking . It is also used by me to see the forecast requirements for production and help me in my planning . Using transaction codes it helps me to extract data and analyze it to support in planning and control inventory and deliveries.

3 what kind of reports you generate using the ERP system ?

Reports related to inventory, missing material , out of stock situations , open orders , confirmation on deliveries. Also I use it for analyzing set planning parameters like safety stock , safety time , lot size and minimum order quantity which has an effect in optimal planning

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are Vendor on time in full (v-OTIF) measure , Inventory control and instances of missing material status and number of projects completed. In these I find inventory control concerns to be effective on GSCM performance

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you perceive integration of enterprise systems beneficial in GSCM ?

Yes and no , we have close to 80% of my suppliers using enterprise system to exchange data. But around 20% we have small suppliers in terms of capacity or establishment wise who rely on excel and mails to plan their production and communicate the information with us. I find integrations of ERP systems supports as a tool in achieving cost performance and also few parameters of GSCM in terms of operations.

6 How do you perceive the concept of green supply chain ?

I am not so informed about it , but by the name I would say environmentally friendly and sustainable supply chain products and processes

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of minimum order quantity for materials and inventory reduction projects respect to slow moving stocks or obsolete stocks , standardization of master data in SAP

8 How do you think ERP can influence on Green supply chain operational performance ?

Based on my understanding of green supply chain related to environmental impact , I think reduction of wastes in terms of inventory is supported by ERP , where enterprise system has major role in optimizing and keeping a check on stocks

9 How can you measure or analyze the green supply chain metrics in your operations ?

The waste reduction can be objectified in terms of inventory reduction, which basically is ensuring less material is ordered and stocked at site as safety . And I can think of planning properly to optimize the deliveries in order to reduce emmissions from truck deliveries. Economically metrics are measures in terms of cost of inventory and scrap cost.

10 what operational measures do you suggest and projects to undertake to measure envinronmental performance ?

Reduction of total inventory in terms of items and quantity can be measured to meet the objective of environmental performance, which can be further linked with the dead stock maintained . And also analyzing the number of deliveriesand optimization can be included as one of the operational measures in perception of environmental performance

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Muller.M*

Job Role : *Project planning Manager- Integrated Supply chain*

Interviewer: *Jayanth PV*

Date of interview : *16th May,2018*

1 what operations do you contribute for the supply chain ?

As a project manager for planning , I contribute in analyzing , optimizing and eliminating the non value added process or waste in my daily operatinos. Projects concerns automizing the planning process , inventory reduction , cycle time reduction , order proposals . I coordinate with various stakeholders internally to implement the projects taken up .

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP mianly for analysis , like forecast analysis , order status , inventory analysis at site. Also we have many projects that are taken up include exploring functions of ERP to integrate better with my stakeholder with interest in automatization of processes.ERP projects like Kanban , VMI , centralized vendor planning.

3 what kind of reports you generate using the ERP system ?

In short , we collect every operational data from ERP for my analysis purposes. Reports related to stock status , Material resource planning (MRP) settings , inventory status, missing material , forecast accuracy , Vendor delivery frequency. Also we use it to test and implement integration with stakheolders upstream and downstream in supply chain.

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are dependent on successfull project completions and the respective timeline of implementation. Process optimization achieved is a benchmark for my performance measure . I find projects taken up with objective of integration with stakeholders are concerned with GSCM performance.

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you see integration of systems beneficial in GSCM ?

Yes , we do have 22 vendors using enterprise system and small suppliers around 9 of them with no system in place. Integrated system helps us to exchange data efficiently and automatize many processes in my operations. It also avoids documentation processes which are generally used by my suppliers who do not use an ERP system. These suppleirs rely on excel and mails to communicate the exchange of data.

6 How do you percieve the concept of green supply chain ?

I have come across the concept in different terminologies like sustainability in supply chain and lean supply chain. It is noble concept in the current scenario with objective of reducing environmental impact by simulataneously ensuring to be cost effective for the firm. It is necessary to have the mindset along all the opertions of the supply chain.

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of scrapping of materials and inventory reduction projects respect to slow moving stocks or obsolete stocks , standardization of master data in SAP.

8 How do you think ERP can influence on Green supply chain operational performance ?

Based on my understanding of green supply chain related to environmental impact , I think reduction of wastes in terms of inventory and scrapping is supported by ERP , which helps in optimizing the planning and keeping a check on stock status across the supply chain

9 How can you measure or analyze the green supply chain metrics in your operations ?

The waste reduction can be objectified in terms of scrapping of obsolete materials , inventory reduction, which basically is ensuring less material is ordered and stocked at site as safety . And I can think of planning properly to optimize the deliveries in order to reduce emmissions from truck deliveries . Economically metrics are measures in terms of inventory , scrapping and logistic cost .

10 what operational measures do you suggest and projects to undertake to measure envinronmental performance ?

Reduction of total inventory in terms of items and quantity can be measured to meet the objective of environmental performance, which can be further linked with the dead stock across the supply chain .These data can be further linked with environmental effect they cause in terms of production or scrapping .Analyzing the number of deliveries and optimization of the frequency in terms of carbon emissions can be included as one of the operational measures in perception of environmental performance.

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Kostas.I*

Job Role : *Production Planning*

Interviewer: *Jayanth PV*

Date of interview : *24th May,2018*

1 what operations do you contribute for the supply chain ?

I am responsible for production planning for france site . I plan the production schedule for production to meet the demands entered by marketting team , I coordinate between material planning, production unit and marketting in my operations . I plan and place production orders and forecast visibility based on marketting requirement.

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP to view demand forecast and place orders with planning parameters ERP offers , so it helps me in automatic planning and controlling of order placement and tracking. It is also used by me to analyze the the forecast requirements for production and help me allign and control production planning . Using transaction codes in SAP it helps me to extract data and analyze for optimized production requirements

3 what kind of reports you generate using the ERP system ?

Reports related to Finished products inventory , missing material status for production, production batch size requirements, customer open orders , confirmation on deliveries to customers. Also I use it for analyzing set planning parameters like release horizon for production, safety time , lot size and production status.

4 What are key performance measures adopted in your responsibilities ?

The KPI's defined for me are production on time in full (P-OTIF) measure , Inventory control for finished products and improvement projects in operations and number of projects completed

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does integration of systems beneficial in SCM ?

Yes, in my responsibility marketting are my main stakeholders and material planners both of them use enterprise system to transfer data. I find it beneficial with respect to the possibility of effortless exchange of lots of information , which cannot be imagined to be handled without the system. We have stock information , bill of material linked with production of finished products, planning of stock across supply chain.It is impossible task according to me to manage without a system helping you with planning and controlling of material flow in a supply chain

6 How do you percieve the concept of green supply chain ?

Green supply chain is a closed loop chain with the environment and sustainability mindset in my products and processes . Reduction of waste , energy , pollution and recyclable products.

7 what are the different projects in your operations that you think can influence GSCM?

I believe , reducing the scrap products especially in a chemical industry like ours can influence green supply chain . optimising the forecast accuracy can be expected to help in ensuring stable planning and production and therefore avoiding overproduction to scrap. Also focus on slow moving stocks or obsolete stocks and projects for maximum utilization of produced products

8 How do you think ERP can influence on Green supply chain operational performance ?

Based on my understanding of green supply chain related to environmental impact , I think reduction of wastes in terms of inventory is supported by ERP , which helps in optimizing and keeping a check on stocks. Further I can also think that transparent and reportless information sharing with the stakeholders has its effect on Green supply chain operational performance

9 How can you measure or analyze the green supply chain metrics in your operations ?

The scrap reduction can be objectified in terms of obsolete stock reduction, which basically is ensuring only actual demand is produced to deliver my customers . And I can think of planning properly to optimize the deliveries in order to reduce emissions from truck deliveries. Economic metrics are measures in terms of cost of inventory and scrap cost. Also reportless information sharing also helps according to me to the GSCM

10 what operational measures do you suggest and projects to undertake to measure environmental performance ?

Scrap items and Inventory in terms of items and quantity can be measured in terms of environmental impact those items have to meet the objective of environmental performance, which can be further linked with the dead stock maintained . And also analyzing the number of logistic deliveries and optimization of deliveries can be included as one of the operational measures in perception of environmental performance

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Durupathy.I*

Job Role : *Hub supply manager*

Interviewer: *Jayanth PV*

Date of interview : *18th May,2018*

1 what operations do you contribute for the supply chain ?

I am the responsible for centralized planning for four sites across europe. I focus on creating a road map for improvement projects and performance indicators defined from the top management. I communicate as a mediator between my team and top management in implementation of projects and overview of results achieved.

2 What are the advantages you experience with ERP system usage in the operations ?

In my experience , ERP system is a revolutionary system which acts as a platform for interchange of data through integrated systems. It support as a tool in operations to link data across functionalities and also in automization of information exchange among the stakeholders connected

3 what are the functionalities of the ERP system ?

Forecast sharing , Stock overview , planning and control , data links , information exchange, information storage , automatic communication

4 What are key performance measures adopted in the firm's supply chain ?

The KPI's defined are Vendor on time in full (V-OTIF) , production on time in full (P-OTIF) measure , Inventory reduction for finished products and improvement projects related with optimization of process and supplier improvement

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does integration of systems beneficial in SCM ?

Yes, We try to push my purchasing team to choose vendors with enterprise system as it gives us many opportunities to connect with them in terms of system and data exchange . We define projects to connect my integrate my system better with them through Elemica or through common interface system. It is beneficial in terms of keeping a check and automatization of operations and has an effect in improving efficiency in chain. The benefits of improved efficiency and visibility through integration of systems has an effect to control the measures of SCM like cost and capacity utilization.

6 How do you percieve the concept of green supply chain ?

Green supply chain is understood to be a sustainable supply chain in my firm. A supply chain with minimal impact on environment by procuring environment friendly products and a mindset of reducing waste and other environmental degrading element in production and process

7 what are the different projects in your team that you think can influence GSCM?

scrap reduction project especially in a chemical industry like ours can influence green supply chain . Optimising the forecast accuracy can be expected to help in ensuring stable planning and production and therefore avoid unnecessary overproduction or over procurement leading to scrap. Also focus on slow moving stocks or obsolete stocks and projects for maximum utilization of produced products.

8 How do you think ERP can influence on Green supply chain operational performance ?

ERP acts as a system tool has a major part in supporting the planning and control of operations, which further leads to controlled inventory and efficiency in supply chain. The overview ERP has to offer my planners to analyze and freedom it provide to change the parameters can influence in keeping a check on defined objectives of inventory , scrap ,delivery frequencies and other unexplored benefits to GSCM.

9 How can you measure or analyze the green supply chain metrics in supply chain operations ?

By Measuring Inventory , controlling Scrapping of obsoletes , fensuring orecast accruacy to plan production for exact size ,reduction of delivery frequency , projects aiding integration with stakeholders , supplier maturity with enterprise system , reduction of report communication

10 what operational measures do you suggest and projects to undertake to measure envinronmental performance ?

Inventory reduction , Scrapping of obsoletes , forecast accruacy , delivery frequency , projects aiding integration with stakeholders , supplier maturity

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Mahadevaiah.J*

Job Role : *Material planning manager*

Interviewer: *Jayanth PV*

Date of interview : *25th May,2018*

1 what operations do you contribute for the supply chain ?

As a material manager for planning , I manage material planners in my team to define performance measures and projects concerned to meet the objectives defined by the top management. I take charge of supply chain improvement and optimization Projects , supplier improvement projects , Inventory reduction projects .

2 What are the advantages you experience with ERP system usage in operations ?

ERP is a tool that supports in transfer of information to my stakeholder internally and externally . It is beneficial as a information storage interface to provide overview and connect data from all related functionalities. It gives an opportunity to connect with my vendors and other functionality internal to organization and has a major importance to have a check and control over the status of stock , requirement , demand , inventory , lead time , vendors , prices , production recipe and more.

3 what kind of reports you generate using the ERP system ?

Reports related to stock status ,range of coverage of materials, forecast requirements , delivery history , MRP settings , inventory status, missing material , forecast accuracy , Vendor delivery frequency. Also we use it to introduce new supply chain concepts of VMI , E-Kanban through implementation of integration with stakheolders upstream and downstream in supply chain.

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are dependent on successfull project completions and the respective timeline of implementation. Process optimization achieved in whole.

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you see integration of systems beneficial in SCM ?

Yes , all my international suppliers have enterprise system being used , so we share information through the ERP -ERP interface with them . Few of my local mechanical suppliers have no system installed , so we use excel and mails to share the relevant information with them. Integrated system helps us to exchange data efficiently and automatize many processes in my operations. It also avoids documentation processes which are generally used by my suppliers who do not use an ERP system. as These suppliers rely on excel and mails to communicate the exchange of data.

6 How do you perceive the concept of green supply chain ?

According to me green supply chain mainly focusses on reduction of waste and scrapping in landfill which harms the environment . It is concept with a motive to protection of environment.

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of minimum order quantity for materials and inventory reduction projects respect to slow moving stocks or obsolete stocks , standardization of master data in SAP . Also new technology related projects like E-Kanban which has effects on controlled inventory through which supplier has access to my stock status .

8 How do you think ERP can influence on Green supply chain operational performance ?

ERP acts as a supporting tool to achieve the performance . With diverse and vast portfolio of items to manage and plan , we are prone to commit errors which might result in unwanted stock procurement and overproduction of products. With ERP it helps in optimizing this error through automatic planning and control . It also aids in having an overview on these parameters in orders to point the gap and act on it .

9 How can you measure or analyze the green supply chain metrics in your operations ?

Based on my experience , I believe that environmental performance can be measured through inventory stock (dead stock) across the supply chain which has an effect on waste status in a supply chain. The control over scrapping can be a measure for waste . The carbon emissionis and energy reduction linked with waste reduction , can also be measured in terms of transport frequency or number of deliveries parameter .

10 what operational measures do you suggest and projects to undertake to measure environmental performance ?

It is difficult to measure the impact in terms of value unless we have complete data on it . The measures like inventory and scrap surely reduce waste across supply chain , but to measure it in terms of environmental impact , we need more information to link it . But surely with such information I believe performance can be valued . The measure of number of deliveries can be measured in terms of emmissions experienced by the truck .

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Bagali.G*

Job Role : *customer logistics and planning manager*

Interviewer: *Jayanth PV*

Date of interview : *29th May,2018*

1 what operations do you contribute for the supply chain ?

I am logistic manager in my company and I manage the team responsible for inbound and outbound deliveries of materials and finished products. I also take care of warehouse management and stock status . Packaging is also managed by me and respective projects .

2 What are the advantages you experience with ERP system usage in operations ?

ERP acts information exchange tool , and as a storage data base . 90% of my operations and analysis and reporting is supported by ERP system and the modules . It provides easy communication exchange between different operations across the firm and also with external stakeholders. It provides a lot of opportunities in integrating with my staekholders through business to business platform .

3 what kind of reports you generate using the ERP system ?

Reports related to stock status ,No of pallets , No of deliveries and receipts ,delivery status , inventory status, missing material . Also we use it to introduce new supply chain concepts of VMI , E-Kanban through implementation of integration with stakheolders upstream and downstream in supply chain. It also acts as a notification tool to hint on core parameters influencing the sustainability of supply chain

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for my team are dependent on successfull project completions and the respective timeline of implementation. Process optimization achieved in whole with respect to warehouse management , Good receipt cycle time , stock accruacy , space management .

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you see integration of systems beneficial in SCM ?

Yes , all my international suppliers have enterprise system being used , so we share information through the ERP -ERP interface with them . Few of my local mechanical suppliers have no system installed , so we use excel and mails to share the relevant information with them. Integrated system helps us to exchange data efficiently and automatize many processes in my operations. It also avoids documentation processes which are generally used by my suppliers who do not use an ERP system. as These suppliers rely on excel and mails to communicate the exchange of data.

6 How do you percieve the concept of green supply chain ?

According to me green supply chain mainly focusses on sustainability in terms of products and process . waste reduction and emission reduction which harms the environment . It is concept with a motive to protection of environment.

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of minimum order quantity for materials and inventory reduction projects respect to slow moving stocks or obsolete stocks , standardization of master data in SAP . Also new technology related projects like E-Kanban which has effects on controlled inventory through which supplier has access to my stock status .

8 How do you think ERP can influence on Green supply chain operational performance ?

ERP acts as a supporting tool to achieve the performance . With diverse and vast portfolio of items to manage and plan , we are prone to commit errors which might result in unwanted stock procurement and overproduction of products. With ERP it helps in optimizing this error through automatic planning and control . It also aids in having an overview on these parameters in orders to point the gap and act on it .

9 How can you measure or analyze the green supply chain metrics in your operations ?

Based on my experience , I believe that environmental performance can be measured through inventory stock (dead stock) across the supply chain which has an effect on waste status in a supply chain. The control over scrapping can be a measure for waste . The carbon emissionis and energy reduction linked with waste reduction , can also be measured in terms of transport frequency or number of deliveries parameter .

10 what operational measures do you suggest and projects to undertake to measure envinronmental performance ?

It is difficult to measure the impact in terms of value unless we have complete data on it . The measures like inventory and scrap surely reduce waste across supply chain , but to measure it in terms of environmental impact , we need more information to link it . But surely with such information I believe performance can be valued . The measure of number of deliveries can be measured in terms of emmissions experienced by the truck .

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Janiwarad.P*

Job Role : *Material procurement planner*

Interviewer: *Jayanth PV*

Date of interview : *29th May,2018*

1 what operations do you contribute for the supply chain ?

I am responsible for Material planning for france site . I plan procurement of materials for production , by contacting vendors . I place orders and follow up till it is available on site . My communications is with suppliers and coordinating with them to deliver Raw materials

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP to place orders and plan the deliveries to plant , so it helps me in automatic planning and controlling of order placement and tracking ^{OPR}. It is also used by me to see the forecast requirements ^{INF} for production and help me in my planning . Using transaction codes it helps me to extract data and analyze it to support in planning^{INF}

3 what kind of reports you generate using the ERP system ?

Reports related to inventory^{(OPR)(ENV)} , missing material , out of stock situations , open orders , confirmation on deliveries ^{(OPR)(ENV)} . Also I use it for analyzing set planning parameters like safety stock , safety time , lot size and minimum order quantity ^(INF)

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are Vendor on time in full (v-OTIF) measure , Inventory control ^{(OPR)(ENV)} and instances of missing material status^(OPR) and number of projects completed

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you perceive integration of enterprise systems beneficial in GSCM ?

Yes and no , I have close to 80% of my suppliers using enterprise system to exchange data ^{INT}. But around 20% I have small suppliers in terms of capacity or establishment wise who rely on excel and mails to plan their production and communicate the information with us. I find integrations of ERP systems supports as a tool in achieveing cost performance and also few parameters of GSCM in terms of operations ^{OPR ENV ECO}

6 How do you percieve the concept of green supply chain ?

I am not so informed about it , but by the name I would say environmentally friendly supply chain products and processes

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of minimum order quantity for materials and inventory reduction projects ^(ENV) respect to slow moving stocks or obsolete stocks , standardization of master data in SAP ^(OPR)

8 How do you think ERP can influence on Green supply chain operational performance ?

Based on my understanding of green supply chain related to environmental impact , I think reduction of wastes in terms of inventory is supported by ERP , which helps in optimizing and keeping a check on stocks

9 How can you measure or analyze the green supply chain metrics in your operations ?

The waste reduction can be objectified in terms of inventory reduction ^{ENV}, which basically is ensuring less material is ordered and stocked at site as safety . And I can think of planning properly to optimize the deliveries in order to reduce emissions from truck deliveries ^{ENV} . Economically metrics are measures in terms of cost of inventory and scrap cost ^{ECO}

10 what operational measures do you suggest and projects to undertake to measure environmental performance ?

Reduction of total inventory in terms of items and quantity ^{OPR} can be measured to meet the objective of environmental performance ^{ENV}, which can be further linked with the dead stock maintained . And also analyzing the number of deliveries ^{OPR} and optimization can be included as one of the operational measures in perception of environmental performance

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Lucas.H*

Job Role : *Key Account manager*

Interviewer: *Jayanth PV*

Date of interview : *9th May,2018*

1 what operations do you contribute for the supply chain ?

As a project manager for planning , I contribute in analyzing , optimizing and eliminating the non value added process or waste in my daily operatinos. Projects concerns automizing the planning process , inventory reduction , cycle time reduction , order proposals . I coordinate with various stakeholders internally to implement the projects taken up

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP mianly for analysis , like forecast analysis , order status , inventory analysis at site ^{OPR}.Also I have many projects that are taken up include exploring functions of ERP to integrate better with my stakeholder with interest in automatization of processes ^{INT}.

3 what kind of reports you generate using the ERP system ?

In short , I collect every operational data from ERP for my analysis purposes. Reports related to stock status , MRP settings , inventory status ^{(OPR)(ENV)} , missing material , forecast accuracy , Vendor delivery frequency^{(OPR)(ENV)} . Also I use it to test and implement integration with stakheolders upstream and downstream in supply chain^{(INF)(INT)}

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are dependent on successfull project completions and the respective timeline of implementation. Process optimization achieved in whole ^{OPR}

5 Do stakeholders in your supply chain have an enterprise system being used ? If yes , how does you see integration of systems beneficial in GSCM ?

Yes , I do have 22 vendors using enterprise system and small suppliers around 9 of them with no system in place ^{INT}. Integrated system helps us to exchange data efficiently and automatize many processes in my operations. It also avoids documentation processes which are generally used by my suppliers who do not use an ERP system ^{ENV}. These suppleirs rely on excel and mails to communicate the exchange of data.

6 How do you percieve the concept of green supply chain ?

I have come across the concept in different terminologies like sustainability in supply chain and lean supply chain. It is noble concept in the current scenario with objective of reducing environmental impact by ensuring to be cost effective for the firm. It is necessary to have the mindset along all the operations of the supply chain ^{OPR ENV}

7 what are the different projects in your operations that you think can influence GSCM?

The projects are like , reduction of scrapping of materials and inventory reduction projects ^(ENV) respect to slow moving stocks or obsolete stocks , standardization of master data in SAP ^(OPR)

8 How do you think ERP can influence on Green supply chain operational performance ?

Based on my understanding of green supply chain related to environmental impact , I think reduction of wastes in terms of inventory ^{OPR ENV} is supported by ERP , which helps in optimizing and keeping a check on stocks

9 How can you measure or analyze the green supply chain metrics in your operations ?

The waste reduction can be objectified in terms of inventory reduction ^{ENV}, which basically is ensuring less material is ordered and stocked at site as safety . And I can think of planning properly to optimize the deliveries in order to reduce emissions from truck deliveries ^{ENV} . Economically metrics are measures in terms of cost of inventory and scrap cost ^{ECO ENV}

10 what operational measures do you suggest and projects to undertake to measure environmental performance ?

Reduction of total inventory in terms of items and quantity ^{OPR} can be measured to meet the objective of environmental performance ^{ENV}, which can be further linked with the dead stock maintained . And also analyzing the number of deliveries ^{OPR} and optimization can be included as one of the operational measures in perception of environmental performance

Thesis Topic : *ERP system adoption on Green supply chain operational performance*

Respondent : *Anna.H*

Job Role : *Team Leader Customer service*

Interviewer: *Jayanth PV*

Date of interview : *9th May,2018*

1 what operations do you contribute for the supply chain ?

As a project manager for planning , I contribute in analyzing , optimizing and eliminating the non value added process or waste in my daily operatinos. Projects concerns automizing the planning process , inventory reduction , cycle time reduction , order proposals . I coordinate with various stakeholders internally to implement the projects taken up

2 What are the advantages you experience with ERP system usage in your operations ?

I use ERP mianly for analysis , like forecast analysis , order status , inventory analysis at site ^{OPR}.Also I have many projects that are taken up include exploring functions of ERP to integrate better with my stakeholder with interest in automatization of processes ^{INT}.

3 what kind of reports you generate using the ERP system ?

In short , I collect every operational data from ERP for my analysis purposes. Reports related to stock status , MRP settings , inventory status ^{(OPR)(ENV)} , missing material , forecast accuracy , Vendor delivery frequency^{(OPR)(ENV)} . Also I use it to test and implement integration with stakheolders upstream and downstream in supply chain^{(INF)(INT)}

4 What do you identify as key performance measures adopted in your responsibilities concerned with GSCM performance?

The KPI's defined for me are dependent on successfull project completions and the respective timeline of implementation. Process optimization achieved in whole ^{OPR}

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I have come across the concept in different terminologies like sustainability in supply chain and lean supply chain. It is noble concept in the current scenario with objective of reducing environmental impact by ensuring to be cost effective for the firm. It is necessary to have the mindset along all the operations of the supply chain ^{OPR ENV}

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