An Integrated Information Systems Framework for Enhancing Reverse Logistics Performance in Supply Chains

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CERTIFICATE

This is to certify that the thesis entitled "An Integrated Information Systems Framework for Enhancing Reverse Logistics Performance in Supply Chains" submitted by Mr. Ankit Mahindroo (Reg. No. 950913014) to the Lalit Mohan Thapar School of Management, Thapar Institute of Engineering & Technology, Patiala towards partial fulfilment of the requirements for the award of degree of 'Doctor of Philosophy' is a bona fide record of the work carried out by him under our supervision and guidance. To the best of our knowledge, the matter presented in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

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DECLARATION

I hereby certify that the work presented in the thesis entitled "An Integrated Information Systems Framework for Enhancing Reverse Logistics Performance in Supply Chains" for award of degree of Doctor of Philosophy submitted to Lalit Mohan Thapar School of Management, Thapar Institute of Engineering & Technology, Patiala, is an authenticate record of my own work carried out under the supervision of Dr. Harsh Vardhan Samalia, Associate Professor, Rajiv Gandhi Indian Institute of Management, Shillong and Dr. Piyush Verma, Associate Professor, Lalit Mohan Thapar School of Management, Derabassi. Any material previously published or written by another author or person in the text is well acknowledge and referenced in the thesis.

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ABSTRACT

The main objective of the current study is to establish a well-rounded Information System (IS) integrated framework which can enhance reverse logistics (RL) performance in supply chains. Reverse logistics is a vital domain in supply chains and of late has been gaining a lot of researcher's and practitioner's attention. The organization's emphasis has gradually shifted from the forward supply chain to the reverse chain because of its ability to generate competitive benefits. Although information and communication technologies supposedly have a positive effect on performance, literature has reported a mixed-bag effect. Hence, it becomes vital to study the role of information technology (specifically information systems) in enhancing RL performance by establishing a well-rounded framework. With RL being affected by other factors as well such as formalised RL processes, government regulations, frequency of product returns, strategic management focus and resource commitment to RL, it becomes important to analyze their effects in the reverse supply chain context as well.

This study, through an extant review of supply chain literature, identified a set of IS and non-IS constructs which lead to an increase in RL performance. After identifying the constructs, possible relationships have been established between the variables and an IS-integrated conceptual framework has been proposed along with the corresponding hypotheses. A questionnaire was developed using the existing scales from the supply chain literature and was circulated to respondents in industries where reverse logistic operations are prevalent. The sampling technique used was a combination of convenience and snowball sampling and the prospective respondents were top / middle management executives in the supply chain / logistics / operations / purchasing / IT / IS domain. The survey instrument was pilot tested in two phases to establish reliability and content validity. The data collected was subjected to confirmatory factor analysis (CFA) to create the measurement model and to establish goodness-of-fit. Convergent and discriminant validity was established and except for two constructs which could not be discriminated, others were found to be within the established norms to be convergent and discriminant. Structural Equation Modeling (SEM) was run on the measurement model to prove direct, mediating and moderating hypotheses and mixed results found.

With respect to direct relationships between IS framework constructs and RL performance, all except IS for logistical operations were found to be significant. The analysis of relationships between the independent factors (formalized processes, government regulations and strategic focus) and the IS framework constructs indicated that formalized processes has a significant

impact on all IS variables and the greatest impact on IS partnership quality. With respect to the government regulations, it was observed that the construct had a significant impact on IS for value creation and IS capability. However, the relationships with the other two constructs were found to be insignificant. The results also showcase that strategic focus on reverse logistics tends to have a positive impact on all IS framework constructs, except IS for logistics. With regards to mediation effects, results indicate that all IS framework constructs except IS for logistical operations completely mediates the impact of formalized processes on RL performance. With respect to government regulations, only IS for value creation was found to completely mediate the impact of government regulations on RL performance. The mediation results also indicate that all IS constructs except IS for logistics partially mediates the impact of RL strategic focus on RL performance. With regards to the moderating effects, it was proved that although both return frequency and resource commitment moderate the impacts of IS constructs on RL performance, resource commitment is supposed to have a stronger effect as compared to return frequency.

ORGANIZATION OF THESIS

The research work presented in this thesis has been organized into the following chapters:

1. Introduction

Includes discussion on supply chain, supply chain management, role of reverse logistics, information systems, supply chain performance measurement and relationships between the constructs of reverse logistics, information systems and performance management from an industrial context.

2. Literature Review

Includes review of the supply chain literature with focused discussions on the studies dealing with reverse logistics, information systems and supply chain performance measurement to establish the research gap in the literature.

3. Research Design and Methodology

Based on the literature reviewed and research gap identified, this section elaborates on the primary and secondary objectives of the study. This section also focusses on the relationship between the constructs identified from the literature to propose an IS integrated research model and formulation of hypotheses.

4. Analysis and Results

Elaborates on sampling methodology used, questionnaire development and procedures of data collection. This is followed by confirmatory factor analysis (CFA) and establishment of convergent and discriminant validity for the measurement model. Finally, structural equation modeling (SEM) is carried out to validate the hypothesized relationships.

5. Discussion and Implications

The section includes elaborated discussion and analysis of results, its managerial implications and the theoretical contributions.

6. Conclusion and Future Scope

Outlines the research conclusion followed by the limitations of the study undertaken. Lastly, it discusses the future scope for researchers working in the area.

7. Appendix

The section includes the questionnaire used for the study undertaken and the list of publications.

CHAPTER I

INTRODUCTION

INTRODUCTION

Managing organizational operations has been playing a vital role in deciding the profitability and market position of organizations and it continues to do so. With a dynamic business environment and fluctuating economic conditions effecting organizational sustainability, it becomes pertinent for researchers and practitioners to investigate business domains which can enable organizations to compete and sustain themselves over a period. The resource-based view of the firm recommends that sustaining the competitive advantage is a function of the capabilities possessed by a firm that can be provided by the firm's supply chain in a given environment (McCarthy & Zald, 1977; Jenkins, 1983; Barney, 1995). Increased customer satisfaction and expectation levels, extensive competition in businesses and products with short life cycles has forced businesses to focus attention on their supply chains. Moreover, due to continuous enhancements in production and information technologies, practitioners have been motivated to concentrate on the supply chain and the methods to manage the supply chain effectively.

1.1 Supply Chain

A supply chain involves purchase of raw materials followed by production of items are at different factory locations of the organization. The produced finished goods are then shipped to the company warehouses for in-between storage, and then subsequently sent to company retailers and customers. Subsequently, in order to reduce cost and better the service performance, organizations must implement effective supply chain strategies which should include the interaction between different nodes of the supply chain. Thus, a supply chain includes suppliers, manufacturing units, warehouses, distributors, retail outlets as well as flow of materials between the facilities which might include raw materials, in-process inventory and finished products.

A supply chain includes elements which are integrated together by the movement of materials along with it. Stevens (1989) defines supply chain as "a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feedforward flow of materials and the feedback flow of information." The various elements as described by Murray (2016) are described below:-

a) **Customer**: The customers are the initiators when they decide to purchase a product offered by a company. To buy the product, the customer gets in touch with the firm, which creates the sales order to be delivered on a specific date to the customer.

b) **Planning**: The customer's order is combined with other orders placed by other customers. The planning function then creates a production plan to produce the products to complete the customer orders and deliver it on time. To produce the planned products, the company sends the list of materials required to the purchasing section which in turn will purchase the materials from its suppliers and vendors.

c) **Purchasing**: Purchasing section receives the list of materials required by production to complete the planned orders. The purchasing department then sends the orders to a selected set of suppliers to deliver the required materials to the manufacturing unit on the pre-decided date.

d) **Inventory**: The supplies received from the pre-selected suppliers are moved into the warehouse after checking them for quality. The supplier then sends the invoice for the items delivered to the production site. An inventory of raw materials is kept in the inventory section until they are used in the manufacturing process.

e) **Production**: The production plan determines the time when raw materials are relocated from inventory to production. The products are manufactured using the raw materials purchased from pre-selected set of suppliers. After the required number of units have been produced, they are stored in the warehouse before delivering them to the company's customer at the desired date and time.

f) **Transportation**: After the finished product is stocked in the company's warehouse, the shipping section determines the right method to ship the goods to ensure that they are delivered on time to the customer. After the goods are received by customers, the company sends the invoice of the delivered products to the customers.

1.2 Supply Chain Management

Supply Chain Management (SCM), as a concept has evolved over time with the concept first being used ever since World War II during the 1965-70 time period. Researchers have tried to explain SCM in different contexts. Ellram & Cooper (1993) defined SCM as a "comprehensive management philosophy designed to control the entire flow of the distribution channel from suppliers to end customers. It is a management technique for integrating different business activities between enterprises." while the Council of Supply Chain Management Professionals (CSCMP) defined it as "the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies" (Stock *et al.*, 2010).

It has been acknowledged that to ensure that the supply chain is operating efficiently and is leading to customer satisfaction at the minimal cost, companies have adopted various supply chain management processes and its associated technologies (Murray, 2016). According to him, supply chain management has three levels of activities as discussed below:

a) **Strategic**: At this level, the management looks at strategic decisions from an organizational context, such as the size of manufacturing sites, location of manufacturing sites, products to be manufactured and partnerships with suppliers.

b) **Tactical**: The tactical decisions emphasize on producing cost benefits for the organization and includes decisions such as using industry's best practices, developing purchasing strategies, working with third-party logistics companies for cost effective transportation and developing warehousing strategies to reduce the cost of inventory.

c) **Operational**: Decisions at the operational level are made every day in businesses which effects how products move along the supply chain. These decisions according to him, involve changing production schedules, generating purchase agreements with suppliers, taking customer orders and moving products to warehouses.

The decisions described are taken across the width of the supply chain which includes several different processes which are managed by supply chain management. The different supply chain processes include: -

a) Inventory Management

In this domain, organizations track their raw material, components, in-process goods, spare parts and finished goods for completing sales orders required by customers. This leads to reduction of waste, frees up valuable resources and minimizes the inventory storage costs.

b) Order Management

Organizations use supply chain management software to facilitate the execution of order-to-delivery cycle by efficiently generating and tracking sales orders. The software can also enable the dynamic scheduling of material from suppliers to meet the demand efficiently.

c) **Purchase Management**

The purchases done from the pre-selected suppliers can be automated across a company's network by deploying a supply chain software package. Therefore, the firms can build collaborative relationships with vendors, better gauge their performance and improve negotiations to attract volume discounts.

d) **Logistics Management**

With companies expanding globally, the coordination between warehouses and transportation channels involved has become challenging and hence require a supply chain package to manage it effectively. A supply chain software can enable businesses to improve on-time delivery of products and enhance customer satisfaction by effectively tracking the delivery of finished goods to customers.

e) **Forecasting and Planning**

With the introduction of highly capable supply chain software packages in the technology market, organizations can predict demand from customers and plan supplies procurement and production processes more precisely. As a result of it, the companiestend to avoid unrequired raw-materials, eradicate manufacturing over-runs and avert the need to store finished products in warehouses.

f) **Product Return Management**

A supply chain management software can make the handling of defective product returns effect on buy side and sell side of the businesses and also automate the claims processing with suppliers in the upstream supply chain and distributors in the downstream supply chain in addition to the insurance companies.

1.3 <u>Reverse Logistics</u>

The logistics management component includes logistical activities in both forward and reverse supply chain. Forward logistics deals with the flow of the product from the supplier of the raw material to the end consumer while on the other hand, reverse logistics deals with reverse flow of the product that is from the customer to the manufacturer and might also reach the supplier in case there is a defect in the raw material of the product.

Reverse Logistics includes all the activities mentioned above, with the difference that these activities are operated in reverse. Poirier (2010) defined reverse logistics as: -

"The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal."

As clear from the definition above, reverse logistics is the process of transporting goods from the final destination (i.e. the consumers) for the purpose of capturing value, achieving a disposal of the product returned to the satisfaction of the customer. Reverse logistics includes processing of returned products due to damage, restock, recalls, products reaching end-of-life and for re-use. It also includes product recycling programs, disposal of hazardous materials, disposal of obsolete machinery and recovery of assets. Poirier (2010) argues that the choice to dispose off products in reverse logistics is determined by evaluating the most profitable alternative and lists the following options:

a) **Reconditioning:** This is an option in which company cleans and repairs a product to make it look as good as new.
b) **Refurbishing:** This state is like reconditioning as described above except with the difference of perhaps more work involved in repairing the product.
c) **Remanufacturing:** This is similar to refurbishing but requires extensive work in terms of complete disassembling of the product.
d) **Resell:** This is a completely different from the above three options and includes selling of returned products as completely new.
e) **Recycle:** In the given scenario, the product is decomposed to its minutest elements which are then reused. It is also stated as asset recovery.

The companies involved in the aftermarket sales / services are also considered examples of reverse logistics. Products in the above business can include accessories, replacement parts, product repairs and service parts. The service section might include a number of options such as product support, technical support, employee trainings, warranty management and claims management. Reverse logistics also provides for exchanges, in-warranty repairs, out-of-warranty repairs, maintenance & upgrades, remanufacturing and end-of-life asset recovery.

The literature considers reverse logistics as one of the hardest areas to manage and operate efficiently (Porier, 2010; Julka & Ganguly, 2015). Reverse logistics is often given little attention (Jayant *et al.*, 2011) with regards to launch of new products, improving customer satisfaction and enhancing company profit margins and hence demands researcher's and practitioner's attention.

Articles and literature further seems to suggest to have a look at this "often neglected part of supply chain" to analyze how a company can foresee the opportunities in reverse logistics and eliminate the factors for returns thereby generating greater satisfaction levels (Porier, 2010).

As stated above, reverse logistics involves product returns for recycling, refurbishing, reuse, repair, remanufacturing and waste disposal. A statistic originating in the US states that product returns constitute 20% of everything that is sold to customers (Kumar & Chatterjee, 2011). This statistic varies by product and channel type. Moreover, due to dynamic economic conditions, addressing product returns and its causes in the reverse supply chain can help firms to cut costs and hence increase their profit margins. As per the Confederation of Indian Industry, logistics is a $12 billion industry in India and contributes 13% of the GDP and with a huge scope to provide the edge the companies are looking for (Cii.in, 2013). Also, over 92 percent of the business in the Indian retail comes from the unorganized retail sector, thus offering tremendous potential for growth, consolidation, and modernization in the Indian context (Atroley & Rajat, 2014). With the degree of returns varying across industrial segments due to varied return policies and legal regulations, the frequency of returns becomes a key aspect which might influence improved profitability and enhanced performances by investing in reverse logistics.

The e-commerce market in India is in boom and is expected to quadruple to $60 to 70 billion by 2019 with the average household income expected to increase from $6,393 in 2010 to $18,448 in 2020 (Singhi & Mall, 2015). Urbanization is being predicted to increase from 31% in 2010 to 40% in 2020 with 200 million households expected to become nuclear by the same period, there by leading to a predicted 25 to 50% increase in consumption per capita spend (Singhi & Mall, 2015). With increased proliferation of smartphones, lower cost of internet connectivity, improved network infrastructure reaching rural areas, higher product discounts and greater user convenience (Singhi & Mall, 2015), the significance of e-commerce has increased manifolds, thereby highlighting the need to have an organized reverse logistics system to handle product returns.

1.4 <u>Industrial Overview of Reverse Logistics</u>

There has been less emphasis on reverse logistics because of its inability to provide benefits in addition to being a cost centre (Rosier & Janzen, 2008; Jayant *et al.,* 2011; Greve, 2013). Industry reports suggest reverse logistics to be a prime area which if used strategically, can lead to potential competitive benefits (Rosier & Janzen, 2008; Julka & Ganguly, 2015). Organizations have been reluctant to engage in reverse logistics operations as a result of which only a few industries exist where reverse logistics is prevalent.

Although no formal literature provides a list of industries where reverse logistics is prevalent, some existing literature, industry reports and articles provide clues about its operations in specific sectors. There have been growing number of recalls in the automotive industry with the number of recalls having risen sharply over the last few years (Bächlin, 2015). The manufacturing organizations are supposed to determine how many vehicles are affected because of the recalls and what is the budget involved in the entire process of reinstallation of the defective component. In addition, they need to make sure the recalls do not occur again by making changes to their production processes and by ensuring the suppliers provide defect free components (Bächlin, 2015). A recent article has indicated that Japanese manufacturer Honda recently had India's biggest product recall when it decided to recall 223,578 vehicles manufactured between 2003 and 2011 because of faulty airbag inflators (Gupta, 2015). A Mint analysis of data given by Society of Indian Automobile Manufacturers (SIAM) indicates that Indian auto makers recalled 2.24 million vehicles between 2012 and 2016, with 1.01 million cars recalled in 2015 alone (Raj, 2016). The discussion and statistics provide evidence about the relevance of reverse logistics in the Indian automotive sector. A detail of vehicles recalled is provided in Figure 1.

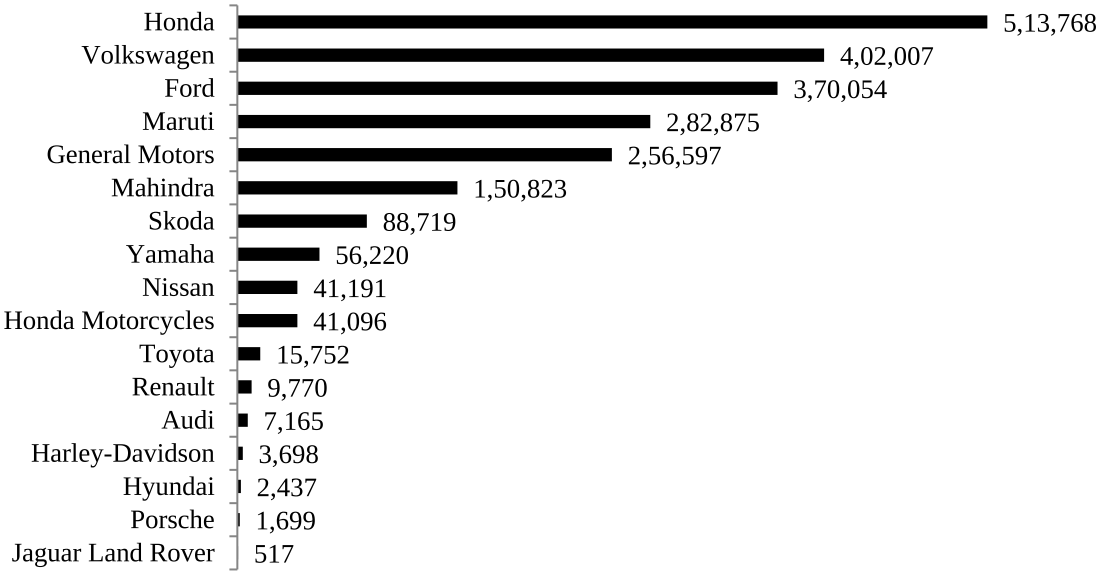

Figure 1 – Vehicles Recalled between 2012 and 2016 (Source: Raj (2016))

Industry reports indicates that 3% of the medications sold in US expires before they are used and that 40% of the people use expired medicines (Tompkins, 2010). A number of studies on reverse logistics have considered pharmaceutical sector for their research (Aghalaya *et al.*, 2012; Narayana *et al.*, 2014; Farooquie & Abbas, 2016), thus depicting the sector to be suitable for research in reverse logistics.

Food processing industry is another domain where reverse logistics is prominent. Studies have reported loss of food at different stages of supply chain and in different quantities. In India, 20% of food loss occurs at harvest stage, 40% of the loss occurs at the post-harvest stage and remaining 40% of loss occurs at consumer stage (Food and Agriculture Organization of the United Nations, 2011). Studies have suggested that wastage of food has a detrimental effect on environment as it increases the greenhouse gas effect, causes environmental degradation as well as pollution (Sathiyagothai & Saravanan, 2017). Hence, reverse logistics is applicable on the food & beverage industries to reduce wastage of food as reported by a few studies as well (Ravi & Shankar, 2005; Vijayan *et al.*, 2014).

Electronics, retail and e-commerce are industries with very short product cycles (Rupnow, 2017). Smartphones and tablets purchases have increased over the last few years with as many as 120 million units sold in the year 2013. Manifold growth in these markets has led to short life cycles and increased competition due to which, reverse logistics operations needs to be agile to capture value otherwise the returned product will lose value because of new products being introduced in the market. With an increase in number of consumer electronic products in households, there is an increased emphasis on reverse logistics as it needs to manage greater product volumes since an increase in number of devices will result in greater returns (Rosier & Janzen, 2008; Rupnow, 2017). With e-commerce sales increasing manifold leading to potential losses due to fraudulent returns (Julka & Ganguly, 2015), reverse logistics has gained in importance in the given sectors.

Studies have also reported presence of reverse logistics in waste management and chemical industry. To achieve sustainability, industries have developed reverse logistics systems to deal with returns and waste management of products along supply chains (Starostka-Patyk & Grabara, 2010). Reports suggest that textile industry face threats in terms of environmental effects the product in its life cycle because of the quantity of textile waste generated for which reverse logistics (RL) is a possible solution which can help the industry to reduce wastage (Sinha *et al.*, 2016).

Global recession has led to the emergence of more cautious and a less loyal consumer which has challenged consumer goods manufacturers to become more agile and responsive to changing customer preferences. Hence, in case of fast-moving consumer goods, there is a huge challenge to satisfy a value-conscious consumer as tastes and preferences might change very quickly. With fast-moving consumer goods companies (FMCG) having large volumes and low margins, they must be able to respond quickly to deliver the in-demand and trending products to customers as and when they require, to avoid getting trapped with undesirable stock (Langley & Capgemini, 2010). Facilitating the argument that firms in the industry are constantly looking to replace unrequired products, the report suggests that reducing logistics costs is the top objective in the FMCG industry, especially reverse logistics. With the industry facing additional challenges including supply chain integration, perfect order fulfilment and a rapid response to changes in consumer demand, the requirement to embed technology in reverse logistics and at the same time make it cost effective becomes critical for the fast-moving durable goods industry (Rosier & Janzen, 2008; Langley & Capgemini, 2010; Greve, 2013).

The above-mentioned sectors are a few industries where reverse logistics is prevalent. They are important in their own contexts and hence becomes critical to take inputs from these industries to evaluate reverse logistics performance outcomes. Hence, the undertaken study circulated an adapted survey instrument to managers in the above-mentioned industries to take their inputs for further analysis.

1.5 <u>Performance Measurement in Reverse Logistics</u>

To measure the performance of supply chain, a performance measurement system is required. Performance measurement can be defined as "the process of quantifying the efficiency and effectiveness of an action" (Neely *et al.,* 1995). A performance measure is "a set of metrics used to quantify the efficiency and effectiveness of an action" (Neely *et al.,* 1995) and plays a decisive role in managing businesses by providing appropriate information required to make decisions at various levels within an organization. The performance measurement in the supply chain context provides the method by which organizations can determine if the supply chain has improved. Measurements are important as it directly controls the behaviour and indirectly the supply chain performance. The key performance indicators will go a long way toward keeping organizations on track towards ensuring that its supply chain improvement objectives are met. The firms need to ensure that performance measurements should be relevant and not cumbersome, which may cause a hindrance towards supply chain performance improvement. Similarly, selecting the wrong metrics and leaving out vital ones could reduce supply chain performance (Lapide, 2000).

Lapide (2000) also states that firms have invested significant amount of organizational resources to redesign their supply chains by making re-engineering its business process change and embedding technology with prime focus on implementing integrated supply chain management (SCM) software packages. Although extensive monetary and human resources have been spent, realization of desired benefits is still an area of concern. Although consultants across the world seems to recommend implementation of supply chain measurement practices, thereare generally no pre-defined approaches to do it. With SCM software package providers developing and deploying integrated solutions to enable companies to considerably integrate their supply chains and hence improve supply chain performance, they do not provide appropriate tools and techniques to measure these performance improvements (Lapide, 2000).

Widely used methodologies for supply chain performance measurement are as follows:

a) The Balanced Scorecard
b) The Supply Chain Council's SCOR Model
c) The Logistics Scoreboard
d) Activity-Based Costing (ABC)
e) Economic Value Analysis (EVA)

a) The Balanced Scorecard

The Balanced Scorecard is a performance measurement method that suggests the use of executive information systems (EIS) to track performance metrics from a strategic viewpoint (Norton, 1996). Although it was not introduced for supply chain performance measurement, the method provides adequate guidelines to be followed when doing it. The approach recommends that the balanced supply chain measures can be tracked based on four perspectives:

i. Financial perspective
ii. Customer perspective
iii. Internal business perspective
iv. Innovative and learning perspective

b) The Supply Chain Council's SCOR Model

The Supply Chain Council's SCOR Model (illustrated in Figure 2 below) provides suggestions about the types of metrics that should be used to get a composed approach towards measuring supply chain performance. The SCOR Model suggests a set of supply chain performance measures comprising of:

i. Cycle time metrics
ii. Cost metrics
iii. Service/quality metrics
iv. Asset metrics

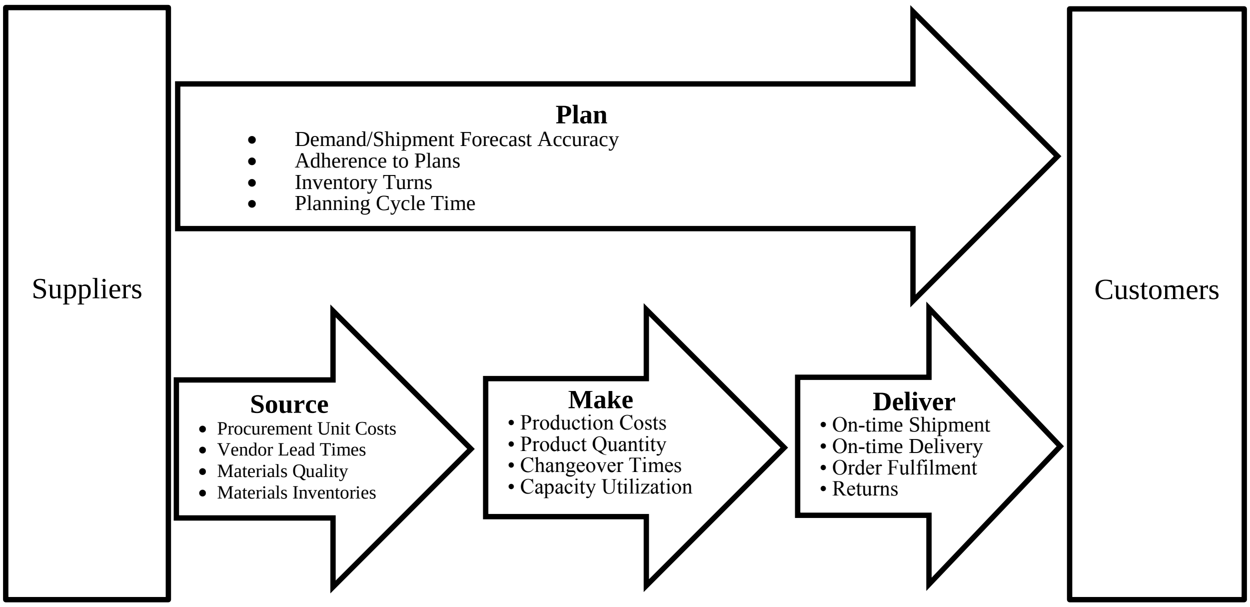

Figure 2 – The SCOR Model (Source: Lapide (2000))

c) **The Logistics Scoreboard**

The Logistics Scoreboard which was developed by Logistics Resources International Inc. (Atlanta, GA), is another method to measure supply chain performance (Lapide, 2000). It recommends the use of a specific set of supply chain performance measures which are inclined towards logistics and have limited focus on measuring the production and procurement activities within a supply chain. The integrated set of performance measures as suggested by the Logistics Scoreboard can be divided into the following categories: -

i. Logistics financial performance measures
ii. Logistics productivity measures
iii. Logistics quality measures
iv. Logistics cycle time measures

d) **Activity Based Costing**

The Activity-Based Costing (ABC) method has been developed to overcome the shortcomings of linking financial measures to operational performance. The method involves dividing activities into individual tasks or cost drivers by evaluating the resources (i.e., time and costs) needed for each activity. Costs are then allocated based on these cost drivers rather than through traditional cost-accounting methods. This approach allows for a better assessment of the actual productivity and costs of a supply chain process.

e) **Economic Value Analysis (EVA)**

Economic Value Analysis is a method developed to overcome the limitations of extended focus on economic performance outcomes like profits and revenues which provide little perception about the success of a firm in terms of generating long-term shareholder value (Lapide, 2000). This method is used to quantify value created by an organization by basing it on operating profits in excess of capital employed. This method can be adopted by companies to measure their executive evaluations as well as the firm's value-additions in the supply chain.

Lapide (2000) also states that while the approaches described above provide guidelines for supply chain performance measurement, they fail to determine the specificperformance metrics that should be used. Hence, it has been stated that measures should be linked to the strategic goals and objectives of the organization. Supply chain strategy, however, is different for every organization and depends on its current competencies and strategic direction. In line with the discussion above, companies will fall into the following categories which manages the types of measures and the degree to which they will need to focus:

a) **Functional Excellence** – Functional excellence is a stage in which firms need to generate excellence within its functional domains including manufacturing and customer service departments. The performance outcomes in such a scenario will emphasize on the performance of individual functional units.

b) **Enterprise-Wide Integration** – It is a stage in which organizations need to emphasize on cross-functional processes rather than the individual functional departments as in functional excellence.

c) **Extended Enterprise Integration** – It is a stage in which a company stresses on developing excellence in inter-enterprise processes. Measures in this category will focus on external and cross-enterprise metrics.

With the introduction of supply chain management (SCM) directed at integrating supply chains for a better performance, organizations have started emphasizing on stage 2 and stage 3 of integration to achieve their business goals and objectives. To achieve them, their performance measurement systems will need to align with business goals and objectives. A major drawback with most of these systems is that they focus on functions i.e. each functional area measures its own performance in terms of meeting objectives consistent with their department's performance measures. These performance outcomes are targetted to be achieved even at the expense of the performance outcomes of other functions. Such a scenario leads to creation of functional silos and contradictory organizational goals which are not valuable for the organizations in the long run.

For example, in customer service and sales departments, employees are measured in terms of their ability to enhance and maintain customer service levels. In such a case, there will be a tendency to carry higher level of inventories by stocking items at multiple locations which are close to the customers. Similarly, in logistics, measurement is done by calculating transportation costs, warehousing costs and inventory levels, thereby tending to have lower inventory levels. In manufacturing, employees are typically evaluated in terms of productivity of manufacturing, thereby tending to make longer production schedules which results in higher inventory of finished goods in warehouses. It is apparent from the behaviour that these measures tend to reinforce development of functional silos, reduction in effectiveness of supply chains and facilitating arms-length transactional relationships among departments.

To enable organizations integrate supply chains, firms have been organizing around cross-functional processes by creating specific functions responsible for measuring the performance of the overall process or by creating cross-functional teams that control and manage the overall process including order fulfilment, new product development and managing total cycle time to name a few (Lapide, 2000). To facilitate these changes, companies are integrating function-based metrics with process-centric performance outcomes. While it does not eliminate function-based measures, it makes an effort to emphasize on the performance of the process to assess what is affecting overall supply chain performance. Such a metrics also reflects on the strategic aspects of supply chain performance, while the functional measures are more helpful in highlighting the problem areas for performance improvements.

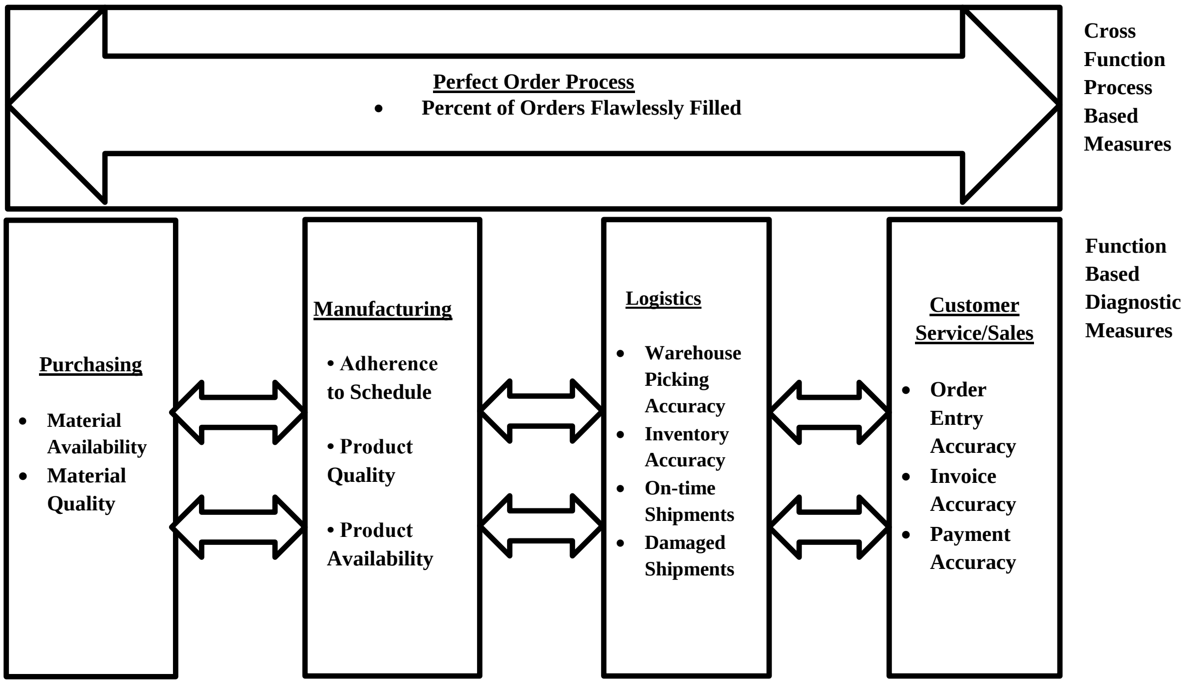

Figure 3 – Benefits of Cross-Functional Process Based Measures (Source: Lapide (2000))

The cross-functional process approach is applicable for processes within and outside the organization. Supply chains typically consist of a number of value-adding trading partners who are responsible for transacting business across the chain. SCM states that benefits can be attained when inter-enterprise processes are put in place to optimize the supply chain. To ensure effectiveness of cross-enterprise processes, organizations should focus on measuring the performance of specific portions of their supply chain which are external in nature and beyond the control of their own firm (Lapide, 2000). Some manufacturers have been implementing programs such as continuous replenishment programs (CRP), vendor managed inventory (VMI) programs, quick-response and forecast sharing programs to provide more weights on cross-firm processes. This leads to the implementing of systems that includes some external measures for processes that lie outside the organization's control.

1.6 Information Systems

Organizations need to formulate and implement a set of well-established business strategies to attain the competitive advantage and enhanced performance. These strategies may include low-cost production systems, innovative product and process designs, superior after-sales services to maximize customer satisfaction as well as investment in information technology (IT) to enhance efficiency and effectiveness of business processes. With performance enhancement becoming critical for organizations and supply chains, organizations have turned to the use of information systems (IS) for handling business process and especially the supply chains very efficiently. Flower (1996) defines information systems as "any of a wide combination of computer hardware, communication technology, and software designed to handle information related to one or more business processes." These systems are used at different management levels and cut across functional and organizational boundaries to enable organizations to get the desired competitive gains by making the processes efficient and enabling organizations take quick and effective decisions. With businesses focussing on inter-enterprise performance measures, Enterprise Resource Planning (ERP) suites such as from SAP and Oracle have become the backbone of such businesses. Sharif *et al.,* (2005) defines ERP as "a software application program that attempts to integrate enterprise-wide business operations. ERP technologies have been designed to address the fragmentation of information across an enterprise's business, to integrate with intra and inter-enterprise information." These software implementations encompasses the company's entire supply chain, from the purchase of raw materials to warranty service of products sold. The complexity of these applications can be gauged from the significant amount of financial and human resources required in addition to the time to implement an enterprise-wide package successfully. Buy-in by senior management and sufficient employee training is the key to success of the implementation. The ERP market is flooded with a number of solutions to choose from and it becomes critical to select the one which fits the needs of a supply chain of a given organization.

Firms across industries have made huge financial investments in developing and deploying information technologies and systems to improve their supply chain performance with very little benefits, while some others have reaped more success with similar investments in information technology and systems (Samadi & Kassou, 2016). The performance enhancing effects of information technology on the supply chain performance has been reported by few researchers (Zhang & Wang, 2011), while some of them have indicated that there is no real common agreement about how competitive advantage for an organization is linked to implementation and subsequent use of IT capabilities (Jin *et al.,* 2014). This phenomenon is widely cited in the literature as the productivity paradox in information technology (Brynjolfsson, 1993) and hence needs more investigation.

This research, through a comprehensive review of the literature, investigates the role of information technology, specifically information systems for enhancing the supply chain performance of organizations. The supply chain performance is being investigated from a reverse logistics context since it is a domain which has received very less research attention and can provide competitive advantage to organizations and industries. To make the research exhaustive and for more meaningful insights, a review of literature has been carried out to derive varied reverse logistics indicators for measuring supply chain performance in the reverse chain. In addition, information system constructs have been reviewed which tend to impact organizational and supply chain performance. A research model has been conceptualised based on the reviewed constructs and appropriate hypotheses have been formulated between the information systems and reverse logistics performance constructs. A questionnaire has been developed by adopting items from existing studies in the supply chain literature and rephrasing them in the reverse logistics context. The draft of the survey was sent to supply chain experts for content validity, and feedback was incorporated to come out with the final set of items to be used for analysis. The sampling technique used for distribution was a combination of convenience and snowball sampling. The questionnaire was administered for pilot testing toindustries where reverse logistics is prominent such as automotive & auto components, electronic & electrical goods, pharmaceutical, apparel & retail, e-commerce and food & beverages. The prospective respondents of the study include supply chain and information system professionals in the middle and top management. Frequent reminders were sent to the potential respondents on a regular basis to ensure timeliness of responses. The collected sample was pilot tested using appropriate statistical tools. After pilot testing the collected sample, the questionnaire was appropriately modified and re-sent to the prospective organizations to validate the proposed research framework. Further, the results from the analysis have been elaboratively discussed in terms of contribution to the literature and meaningful insights for the industry practitioners. Finally, the conclusions from the study have been stated along with possible directions for future research.

CHAPTER II

LITERATURE REVIEW

LITERATURE REVIEW

To establish the research gap, it becomes vital to establish the theoretical background and review the supply chain, reverse logistics and information systems literature from a performance enhancement context. There are a number of different theoretical frameworks which can be utilized to explain the need for improved performance and competitive advantage and have been elaborated subsequently in this chapter. Post setting of the theoretical background, a comprehensive review of the studies in the above-mentioned literatures has been done which has led to the identification of vital constructs and the possible relationships between them. Further, these relationships have led to the formulation of the research objectives, the conceptual framework and the corresponding hypotheses. To validate these hypotheses, appropriate research methods have been utilized to derive implications for the researchers and the practitioners in the reverse logistics domain.

2.1 Theoretical Background

There are a number of different theories which can be used to establish the theoretical background for the research. In a typical supply chain environment, to reduce cost, establish competitive advantage and long-term sustainability, organizations make efforts to implement strategies to manage the inter-organizational transactions in the most effective manner. The term ‘transaction cost’ was first used by Coase (1937) to conceptualize a theoretical framework for evaluating economic value of tasks performed by firms. In a dynamically changing market, Williamson (1981) established the theory of transaction cost economics (TCE). This approach regards the transaction in firms as the unit of analysis and emphasizes that an understanding of transaction cost economics is vital to the study of firms and their performance. This theory emphasizes on the fact that organizations must produce in bulk to gain economics of scale which would help them to achieve better financial positioning due to reduction in transaction cost. But, market trends have changed with respect to manufacturing of a product involving chain of firms and each firm having different production and transaction handling systems. With respect to vertical integration, previous work on transaction cost economics (Williamson, 1985) has argued that IT can reduce transaction costs (Afuah, 2003) and hence it should support firms to include lesser stages of their value chain within their boundaries. Despite producing in bulk, firms have struggled to control the transaction cost due to the presence of disparate nature of IT systems and transactional nature of relationships across organizational boundaries. Hence, the underlying theory forms the basis for organizations to make efforts to devise ways by which the transaction cost can be minimized, especially in an inter-organizational environment cutting across organizational boundaries, specifically by deploying inter-organizational systems which can cut down transactional costs.

Another theory which justifies the need for the current research is the resource-based view (RBV) of the firm. The resource-based view emphasizes on firm's ability to attain competitive advantage by managing their resources in such a way by exploiting transaction specific investments, thereby creating a competitive barrier (Penrose, 1959; Wernerfelt, 1984). The resource-based view combines strategic business insights concerning a firm's unique competencies and heterogenous capabilities. The resource-based approach also provides value-adding theoretical suggestions which can be tested within the literature. Prior work on the resource-based theory (Barney, 1991) has argued that since firms can use IT capital to coordinate their capabilities across different product markets and organizational boundaries, it can enable achievement of economies of scope (Afuah, 2003; Gurbaxani & Whang, 1991). Thus, a firm might reach a sustainable competitive advantage by managing its heterogeneous set of resources and these resources couldn't be easily bought, transferred or copied, thus resulting in adding value to firm’s product (Barney, 1991; Barney, 1995). These resources include technological resources in the form of IT-based systems which if implemented in a supply chain environment, can lead to sustainable competitive advantage.

Another theoretical basis for the current research is the diffusion of innovation theory. It is a theory that explains how and why technologies are adopted by individuals and organizations (Rogers, 1962). It has been argued that diffusion is the process by which an innovation is adopted and communicated over time among the participants in a social system and must be widely adopted in order to self-sustain. With organizations still seeking innovation through technology, specifically through information systems (Mustonen-Ollila & Lyytinen, 2003) and reverse logistics still not getting strategic attention from practitioners (Jayant *et al.*, 2011) and hence lacking acceptance for a wider use of technology innovation across sectors, it becomes pertinent to find reasons for inconsistent adoption of IS in the reverse logistics context and how it can be used in the RL environment for the technology to self-sustain, thereby creating the desired performance and competitive advantage.

2.2 Supply Chain & Supply Chain Management

The organizational emphasis has shifted from manufacturing processes to its supply chain to become sustainable and competitive (Christopher & Towill, 2001). The supply chain of the organization has been able to attract the attention of researchers and practitioners alike to attain sustainability. The literature elaborates on the term supply chain through the following two definitions: -

> "*A system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback flow of information.*"
>
> - (Stevens, 1989)
>
> "*Supply Chain is a system through which organizations deliver their products and services to their customers. It comprises an interlinked network of suppliers, manufacturers, distributors and customers whereby material flows from the suppliers through manufacturers and distributors to the customers.*"
>
> - (Wu & O'Grady, 2004)

Supply chain is a well-researched domain in the past two decades. Bakos & Brynjolfsson (1993) applied the economic theory of incomplete contracts to explore thecauses of change from dealing with a large number of suppliers to a few partners and found that the buyer will maximize profits by limiting its options and reducing its bargaining power. Toni *et al.,* (1995) established that large firms are continuously moving towards comakership systems and that international competitiveness is pushing these organizations towards a more participatory link with its suppliers. Gavirneni *et al.,* (1999) analyzed supplier models to understand the relationships between information, capacity and inventory and how they get impacted by retailer's values and demand distribution. The study by Lee *et al.,* (2000) used a two-level supply chain model to show how the benefits of information sharing can be measured. The study suggested that the value of sharing demand-related information can be quite extraordinary, especially when demand is correlated over time. Subramani (2004) focused on the supplier perspective in IT-specific supplier-retailer interactions and highlighted the benefits of IT use to suppliers. The study concentrated on the use of supply chain technologies for exploration and exploitation and emphasized on the inferences of the choices for relationship-specific supplier investments and benefits. Vlachos &

Bourlakis (2006) examined the impact of trust and duration of collaboration on supply chain performance and illustrated that different food supply chain partners perceive these factors differently which are responsible for supply chain effectiveness. Hence, the study debates the feasibility of existing collaboration efforts which aim to achieve mutual competitive benefits across the supply chain. Banker *et al.,* (2006) emphasized that information technology gives organizations to ensure greater comprehensiveness of buyer-supplier contracts via economical monitoring of supplier performance. The study also found that a significant increase in contract completeness as a result of the low cost of information technology could lead to an increase in the per supplier cost although the cost of coordination between the partners might decrease. Dedrick *et al.,* (2008) examined the relationship between use of IT by the manufacturer and the suppliers associated with its supply chain and found that there is no direct relationship between use of IT in the supply chain and number of suppliers at the macro level but found some impact at the micro level. Speier *et al.,* (2008) used the strategy-structure-performance model to orient information integration in line with the relationships within the supply chain strategies implemented by firms. The framework presented in the study is a more complete approach to understand the association between information integration and supply chain performance.

The study by Klein & Rai (2009) emphasized that the strategic information flows between buyers and suppliers leads to potential financial and operational benefits. According to the study, financial benefits can be measured in terms of improved assets management, reduced operational costs and productivity enhancements while the operational benefits include improved planning, control and flexibility of resources. In another study, Li & Dai (2009) emphasized that by sharing information about demand forecasts, production plans and new technologies, members in a supply chain can support and learn from one other. However, because modern supply chains are dynamic in nature, the performance of the supply chain is affected by addition or withdrawal of firms. Martin & Patterson (2009) also focused on supply chain performance and concluded that operational measures such as inventory and cycle time are more critical as compared to the financial measures, which appear to be less certain. Ross & Buffa (2009) elaborated on supplier post-performance evaluation and indicated that buyer preference weights on supplier performance attributes influence the perception of supplier performance. Hofmann & Locker (2009) used a case-study based approach to investigate the development of a value-centric performance measurement model in supply chains and linked operational activities in a supply chain to shareholder value creation measured in terms of economic value added. The study differs from other performance measurement studies since it matches the operational performance to the value drivers to ultimately measure the amount of value generated. Ross *et al.,* (2009) presented an efficient approach to analyzing a firm's portfolio of sourcing partner relationships in a dyadic and dynamic framework by focussing on transmuting supplier and buyer performance metrics on critical dimensions into actionable relationship management plans. Chan *et al.,* (2009) investigated flexibility level of suppliers and its association with IS automation level of the supply chain and presented an approach for decision-makers to identify the IS automation level in line with suppliers' flexibility level to improve the delivery lead-time. Sardana (2009) discussed ways to measure a supply chain's performance and developed a new approach that considered supply chain as an integrated system to generate a complete performance. The conceptualised model includes four dimensions including process management, organizational design, recipient satisfaction and quality management at the first level of measurement while the second and third levels of measurement considered the sub-systems and the key performance areas (KPAs) respectively.

Wadhwa *et al.,* (2010) used a simulation study to evaluate the effect of information transparency and cooperation on supply chain performance. The experiments demonstrated that cooperation influences the supply chain performance positively. The study further indicated that although cooperation improves the overall performance, the individual node performance may suffer. In another study, Jean *et al.,* (2010) conceptualised a model to understand how a supplier can approach relationship learning with a customer and the resultant outcome can effect the supply chain performance. The study showcased that relationship learning affects the performance of suppliers positively and trust has the strongest impact on the development of cross-border relationships. Allesina *et al.,* (2010) have also contributed to the performance measurement in supply chains by emphasizing on the idea of using network analysis as a method to study supply chain as a complex entity and to understand it from a wholistic point of view. Espinoza *et al.,* (2010) studied supply chain performance measures in the wood product manufacturing industry by developing a set of measures for time performance and product quality and then validating them with historical data.

Kohli & Jensen (2010) assessed the effectiveness of supply chain collaboration through an empirical analysis and pointed out that large organizations that collaborate extensively value the effectiveness of collaboration more highly. The research could not find any link between perceived effectiveness and length of experience with supply chain collaboration efforts. Wu *et al.,* (2011) investigated how high-tech companies use partner relationship management to improve their supply chain performance and indicated that information sharing has a positive effect on partner relationship management and corresponding supply chain performance, thus emphasizing on the role of information systems which enables seamless sharing of vital information across the supply chain. Another study by Mondragon *et al.,* (2011) proposed a set of measures for auditing to generate an complete picture of the performance of a closed-loop supply chain. The methodology presented in the study identified links between product returns to operations in the forward supply chain and indicated how performance is affected because of integration. In a recent study, Vaidya & Hudnurkar (2013) proposed an approach to evaluate the performance of supply chain using a multiple criteria approach. The study used 80 performance measures which were then classified into 12 unique groups and the analysis led to the conceptualization of the supply chain performance number (SCPN) with values varying between 0 and 1.

Managing the dynamic and continuously changing supply chains to attain competitive benefits has become the prime focus of practitioners and researchers alike, leading to the evolution of supply chain management (SCM). Ellram & Cooper (1993) defined supply chain management as “a comprehensive management philosophy designed to control theentire flow of the distribution channel from suppliers to end customers. It is a management technique for integrating different business activities between enterprises.” Stock *et al.,* (2010) brought in the information context and described SCM as “effectively managing the flow of materials and information from supply sources to the final point of sale.” Both statements demonstrate how supply chain management evolved over time with a number of dimensions added to it.

There have been numerous studies in the supply chain management domain. Hobbs (1996) presented a framework from economics literature which described the development of transaction cost analysisand may be useful in understanding the concept of supply chain management. Chandra & Kumar (2000) analyzed issues which are considered vital to supply chain management and provided a broader perspective of supply chain principles. Moreover, the study also discussed the role of information technology, which it suggested, can be used to synchronise the supply chain. Grover & Malhotra (2003) presented a transactional cost framework through analysis of 203 manufacturing firms in the electronics industry and suggested recommendations on the use of the theory and its measurement. Rahman (2004) discussed how internet can be used in the management of supply chain by Indian organizations. The study reported that as a result of analysis of transaction versus material costs, manufacturing has given way to assembling on the shop floor since companies don't find it cost effective to be vertically integrated. Mehra (2005) presented an editorial perspective on the current issues and emerging trends in supply chain management by reviewing seminal works in the area of supply chain management as was done by Kouvelis *et al.,* (2006). Lenny Koh *et al.,* (2006) emphasised that breaking the usage of decentralised systems and introducing the implementation of a single integrated package has enabled organizations to work in collaboration with their suppliers. These applications have resulted in cost reduction, lead-time reduction and increased efficiency in the organizations.

Gunasekaran & Kobu (2007) identified key performance metrics in logistics and supply chain that can be identified for individual firms. The study further suggested that tactical and operational performance measures should be applied at the middle and lower management level while the upper-level managers should be responsible for performance measurement at the strategic level. Bhagwat & Sharma (2007) used the analytical hierarchy process to reveal that strategic performance measurement is the most important where as the measures at tactical levels are rated least important. Mann *et al.,* (2009) analyzed different approaches toward measuring performance in SCM and presented a method to classify supply chains by determining the stage of the supply chain and unit of analysis.

Defee *et al.,* (2010) stated that theories grouped under the competitive and microeconomics categories contribute over 40 percent of the incidences. The research also found that theory was used in 53 percent of the sampled articles and that there is need for theory-based research in the supply chain management discipline. Singh *et al.,* (2010) conceptualised and developed five secondary constructs for supply chain practices, four primary competitive advantage constructs and six primary organisational performance constructs. The results of the study indicated that Indian retailers realise the impact of competitive advantage on supply chain performance, but they failed to match competitive advantage, supply chain practices and firm performance.

González-Benito & Alfaro-Tanco (2013) performed a bibliographic analysis on supply chain management studies over a period of 20 years and found that researches during this phase primarily focused on scheduling & logistics and use of IT and information systems from a strategic standpoint, thereby predicting the increasing emphasis to focus on these domains in the future as well. Chan & Chong (2013) argued that the existing literature dealing with supply chain technology adoption is not theoretically-grounded and hence proposed a theoretical model centred on technology–organisation–environment (TOE) framework and the innovation diffusion theory (IDT). The empirical results show that the variables derived from TOE and IDT can explain supply chain technology adoption well and that inter-organisational relationships play a crucial role in the success of technology adoption. Mitra & Datta (2014) conducted an exploratory study on the adoption of sustainable supply chain management practices and its impact on performance and found that collaborative efforts by organizations to achieve sustainability had a positive impact on product design and logistics, which in turn is positively associated to firm competitiveness and financial performance.

Chen *et al.,* (2015) addressed how usage of organizational big data analytics impacts value creation. The study results showed that big data analytics at the organizational level impacts value creation and this impact is moderated by dynamism of the organization's environment. Liu *et al.,* (2015) examined the adoption of electronic supply chain management (eSCM) in chinese firms and found that power is positively associated with competence and goodwill trust which in turn is positively associated with adoption of eSCM.

Avittathur & Jayaram (2016) reviewed studies in the supply chain literature and concluded that very few studies have concentrated on emerging economies such as India and China. The study also suggested that future studies need to emphasize on value creation, value delivery and value sharing, which can lead to economic sustainability. Ivanov *et al.,* (2016) summarised advances in the field of supply chain dynamics from a multi-dimensional operational perspective that included different quantitative methods and information technology. The review of studies in the study undertaken emphasized that companies which need to develop strategies to adapt to supply chain dynamics and moderate disruptions can utilize information technology as one of the means to achieve it. Varsei (2016) reviewed sustainable supply chain management literature by including three dimensions of sustainablity development i.e. environmental, economic and social which were used to create research gaps thus creating new directions for future research. Yang & Fan (2016) compared the disruption mitigation effects of information management strategies showed that supply chains which have implemented the modern strategies are not always more stable as compared to the supply chains with traditional strategies.

The studies in literature have also contributed towards developing supplier networks (Meixell, 2006; Carvalho & Costa, 2007; Simamora *et al.,* 2016), supply chain relationships (Saeed *et al.,* 2005; Vlachos & Bourlakis, 2006; Ounnar *et al.,* 2007), retail productivity (Mishra & Ansari, 2013) and green supply chain management (Liou *et al.,* 2016; Sambrani & Pol, 2016; Shibin *et al.,* 2016). These studies clearly demonstrate that supply chain is a domain that has grabbed the attention of researchers although most of these studies are from a forward supply chain perspective. One of the primary reasons for this can be attributed to the continued emphasis on the forward supply chain as a profit centre and a source for attaining competitive gain for both manufacturing as well as service organizations. However, the recent trends have reflected a significant shift towards the reverse supply chain as also indicated in the supply chain literature as well (Jayant *et al.,* 2011). This change can be credited to changing global economic conditions, organization's sustainability need (Kumar & Chatterjee, 2011), changing return policies (Julka & Ganguly, 2015), stringent regulations and policies regarding disposal of the product (Jayant *et al.,* 2011). Also, the intensification of the belief that the reverse supply chain can be used as a profit-enhancing tool has led to the increased emphasis on reverse logistics.

2.3 <u>Reverse Logistics</u>

Jayaraman *et al.,* (2008) defined reverse logistics (RL) as a process which involves "managing the receipt, handling and disposition of returned merchandise. The reverse logistics functions are comprised of a set of unique, complicated and time-sensitive tasks. Hence, optimal performance of these tasks which include inspection of returned products, crediting customer accounts and resale of the returned merchandise etc. require specialised operations and information technologies (ITs)." Organizations have shifted their focus to RL as a source for providing competitive benefits due to the forward supply chain getting exhausted in providing the same (Jayant *et al.,* 2011).

There have been studies which have focussed their attention on reverse logistics. In one of the initial studies, Kroon & Vrijens (1995) explored the ways to reuse secondary packaging material by using a case study approach. The study designed are turn logistic system and defined a quantitative model that can be used to support planning activities in reverse logistics. The study further states that if the distribution and the collection fees in returns are high, then firms can make a profit on each container distributed or collected. Autry *et* *al.,* (2001) looked at how reverse logistics performance and service satisfaction is affected by type of industry, volume of sales and product disposition responsibility. The results of the study concluded that performance is considerably impacted by sales volume, while the type of industry significantly effects impact satisfaction. Also, neither performance nor satisfaction was found to be significantly impacted by location of responsibility for disposition. Daugherty *et al.,* (2002) used IS support and relationship commitment as constructs to measure operational and financial reverse logistics performance and found no relationship between IS support and operational performance as well as IS support and financial performance. The explanation may be based on the nature of reverse logistics which can involve unpredictable demands. The study also emphasized on the moderating role ofresource commitment to most IS support-performance linkages. Meade & Sarkis (2002) developed a conceptual model for selecting partners for reverse logistics and found that factors that play a vital role in selecting a third party reverse logistics provider such as emphasis on end-of-life product criterions including recycling and reuse, as they differ from traditional factors used for supplier selection process.

Knemeyer *et al.,* (2002) used in-depth interviews to qualitatively examine the factors which effects reverse logistics systems for end-of-life computers. The results of the study suggested that the actual value lies in the ability of research to find critical issues to address the products flowing through these reverse logistics systems and emphasised that qualitative techniques can be used to derive industry-sensitive stakeholder data. Tibben-Lembke & Rogers (2002) compared forward and reverse logistics in the retail context, with focus on reverse flow of material and information. Unlike other studies which focused on organizations which remanufacture or refurbish the product, the paper emphasised on the concerns from the standpoint of the firm generating the reverse flow. Tan *et al.,* (2003) worked on enhancing the performance of a computer company by supporting its reverse logistics operations and found that 50% of the products returned cost less that half the reverse logistics cost. The study further stated that the IT systems used in reverse logistics are not used by managers for decision making but specifically for data collection and that decision making in reverse logistics operations was inconsistent and lacked standardisation. Jain & Moinzadeh (2005) developed a model to analyze reverse logistics information sharing which is a practice in supply chain management in which the manufacturer shares information about supply with the retailers. As per the model developed, the manufacturer gives its retailers the access to inventory due to which, the retailer changes the inventory stocking policies accordingly. Richey *et al.,* (2005) investigated the role of resource commitment and innovation in reverse logistics performance and found that resource commitment makes reverse logistics programs more efficient and more effective although it was found to be insignificantly associated to innovation in reverse logistics in smaller firms. The reasons can be attributed to the amount of organizational resources available in larger firms as compared to small firms. French & Discenza (2006) indicated that reverse networks for handling external returns must use storage conditions and degradability timing. Additionally, the study suggested that there could be critical implications for managers through development of a model which facilitates decision making in reverse logistics. Reyes & Meade (2006) described an approach for bettering operational outcomes in the reverse supply chain in a not-for-profit business scenario. The study formulated a model based on risk pooling using preventive lateral transshipment was presented for improving the sensitivity of not-for-profit organizations responsible for redistributing donated products to enhance revenues.

Tan & Kumar (2006) established a decision-making model for reverse logistics in the computer industry and indicated that replaced computer parts are more profitable than refurbished computer parts. The study also argued that delay in transportation and supplier delay in processing returns have a positive impact on the feasibility of reverse logistics independent of volume of product returns. Mills (2007) focused on the importance of government regulations and sustainability in reverse logistics and emphasised that it is not enough for a company in today's business environment to focus only on profits and growth as environmental and social issues also need to be considered a priority. Bernon & Cullen (2007) used a case study approach to argue that if companies manage their product returns holistically, the level of returns currently experienced by retailers can be reduced significantly. The authors also put forward a framework which can be utilised for managing reverse logistics operations by adopting the management techniques of collaboration, evaluation and integration. Jayaraman *et al.,* (2008) analyzed the role of information technology and collaborative relationships in reverse logistics supply chains. The study deliberated that the processing costs and labour utilisation rates showcase an increasing trend as process complexity has risen in the barcode technology environment. Moreover, it was concluded that organizations which manufacture high value and low volume goods would gain more benefits if they implement RFID than organizations with lower value and high-volume goods. Li & Olorunniwo (2008) highlighted the type of technology innovation and IT a firm needs to operate a RL system effectively and how these are integrated across the supply chain. The study also stressed on the resource commitment that anorganization needs to make to support RL operations, the values companies can extract from RL operations and the key performance measures to attain these values in the RL context.

Deepen *et al.,* (2008) focused on logistics outsourcing performance i.e. the outsourcing arrangements performance in which the organization's management delegates logistics activities to external providers. The research specifically examined the impact of cooperation and proactive improvement on the logistics outsourcing performance achieved by service providers. Ordoobadi (2008) also emphasised on the development of a decision model to help companies make more informed decisions regarding their reverse logistics policies.

According to the model, a strategic analysis should conducted to determine if it is strategically beneficial to outsource the reverse logistics activities. If the activities are core competencies of the organization, then they should be performed in-house. Kumar *et al.,* (2009) elaborated on the reverse logistic process control measures for the pharmaceutical industry supply chain. The study yielded innovative solutions which are being tested presently although there is limited information with regards to the pharmaceutical supply chain. Lau & Wang (2009) suggested that reverse logistics drivers differ from organization to organization while the barriers to reverse logistics are common and may include lack of enforceable regulations or directives to motivate manufacturers, thereby indicating their role in reverse logistics.

Olorunniwo & Li (2010) investigated how use of IT and supply chain management initiatives impact reverse logistics performance. The results indicated that type of IT systems used does not have a significant impact on RL performance but IT used for handling operations positively impacts RL performance. Morover, the study indicated that IT investment alone cannot improve RL performance and managers should consider different IT attributes before deciding the use of IT in RL. The analysis also stressed that companies need to share information and collaborate with their partners in addition to using IT to reap desired benefits. Fugate *et al.,* (2010) modeled logistics performance to simultaneously achieve efficiency, effectiveness, and differentiation in reverse logistics. Through an empirical analysis, the study indicated that significantly positive relationships exist between logistics performance and logistics effectiveness, logistics efficiency and logistics differentiation. Another study by Weeks *et al.,* (2010) analyzed the impact of two reverse logistics business strategies i.e. production mix efficiency and product route efficiency on the profitability of the firm. The study findings indicated that the two RL strategies have a positive impact on profitability and hence can be used by firms trying to improve profitability.

Dowlatshahi (2010) used a case study approach to carry out a cost-benefit analysis for designing and implementing reverse logistics systems. The study analyzed the relevant literature in RL and identified the present state of theory in RL with respect to cost-benefit analysis. Bernon *et al.,* (2011) developed a research framework for practitioners in RL which included operational performance, organisational integration of information and management reporting and control. The study cited that adoption of the framework will assist practitioners by reducing their product volumes and lowering the RL operational costs and hence enhance the product asset recovery values. Genchev *et al.,* (2011) suggested that organizations should make use of process formalization in RL implementation which can become the differentiating factor for them. The study also emphasised that providing structure to reverse logistics may enable organizations to strategically control the RL related operations.

Olorunniwo & Li (2011) studied reverse logistics practices in the United States and indicated that a large number of organizations were still reporting loss of money from their reverse logistics operations which confirmed that reverse logistics is still being regarded as a cost center. The study further vindicated that most of the returned products are returned not because they are defective or damaged, but for other reasons such as customers changing their minds, wrong products ordered or product being shipped to an incorrect destination. Consequently, most of these products are processed and placed back on the shelf with little refurbishing, repair or repackaging. Information technology (IT) is employed for cases where a response to the customers is required with the Internet, enterprise systems, bar code technology, electronic data interchange (EDI) and legacy systems being the tools which are used. In another study in reverse logistics, Gobbi (2011) explored the impact of product residual value (PRV) and the loss of value over time in the reverse supply chain. The findings confirm that low PRV is usually connected with recovery choices such as recycling and energy recovery whereas high PRV is usually linked to recovery options including remarketing and reconditioning.

Jayant *et al.,* (2011) presented a broad literature review of the journal papers on reverse logistics published in last two decades. After surveying more than 100 papers, the study concluded that the research in RL is multifaceted and can be distinguished from forward logistics. The review also justified RL as an emerging domain by stating that the research publications on RL have increased especially after 2004, thereby emphasizing that it requires researcher's attention for future studies. Skapa & Klapalova (2012) indicated an increasing interest in RL performance measurement through a study on Czech companies. As per the results of the study, one third of the Czech companies undertaken reported that RL had a positive impact on their profits margins. The study also identified a positive relation between RL profitability and a company's strategic focus on RL. Shaik & Abdul-Kader (2012) presented a comprehensive and integrated approach to reverse logistics performance measurement through the use of a multi-perspective balanced scorecard which included financial, process / operational, customer-centric and environmental measures for measuring RL performance.

Govindan *et al.,* (2012) used interpretive structural modeling (ISM) methodology to identify and summarize relationships among specific attributes scanned from RL literature to conclude that multiple factors must be used in the selection of third party reverse logistics providers (3PRLP). Huang *et al.,* (2012) constructed a model to understand the empirical impact of task environment on resource commitment in reverse logistics and the resulting reverse logistics performance. From the empirical analysis, it was found that the task environment has a positive influence on resource commitment and resource commitment in turn positively impacts economic performance of reverse logistics. Kumar & Chandra (2012) examined the impact of government regulations, financial incentives for recycling & remanufacturing on cash flows in the reverse logistics context in three regions US, Japan and EU. The results of the study emphasized that government regulations, financial incentives and market pricing have a positive impact on cash flows in the RL context in the given three segments. In another study, Mangla *et al.,* (2012) used an interpretive structural modeling (ISM) approach to create a decision-making model for enriching and initiating flexible product recovery activities in an organization. The study used variables such as cost and government regulations as enablers and variables such as capacity utilization, customer satisfaction and energy consumption reduction as possible performance outcomes. Nativi & Lee (2012) modeled the implementation of Radio Frequency Identification (RFID) in the reverse supply chain to decide if real-time inventory monitoring and information sharing can help the system become environment friendly and attain higher economic benefits. Xiao Yan *et al.,* (2012) identified possibilities for reverse logistics network models application to deal with returned products from customers in companies using e-business.

Another study on reverse logistics by Aitken & Harrison (2013) examined the changes in governance structures which have evolved as reverse logistics systems were developed. Toyasaki *et al.,* (2013) studied the role of information systems in product return management systems by developing analytical models to evaluate if investments in product recovery systems are economically justifiable for manufacturers. The study results indicated that IS investments in reverse logistics systems will lead to higher profit gains if recovery networks and product characteristics are taken into consideration. Huscroft *et al.,* (2013) stated that most logistics information systems are deployed with forward supply chain processes with little focus on the reverse channel, thus emphasizing on the need to explore how implementation of information technology in reverse logistics processes can lead to enhanced performance. The findings indicate that use of information technology and RL technology innovativeness will enhance RL cost and process effectiveness, thus depicting a positive relationship between use of IS in RL and RL performance outcomes. Kumar & Chandra (2013) examined the impact of government regulations, financial incentives for recycling & remanufacturing on cash flows in the reverse logistics context in three regions US, Japan and EU. The results of the study emphasized that government regulations,financial incentives and market pricing have a positive impacton cash flows in the RL context in the given three segments. Vaz *et al.,* (2013) presented the reasons for organizations to implement reverse logistics and proposed six critical dimensions for the implementation of reverse logistics: good income control, standardised reverse logistics processes, reduced cycle time, usage of information systems, planned logistic grid and collaborative partnerships between customers and suppliers.

Hazen *et al.,* (2014) stated that although IS play a significant role in managing reverse logistics (RL) processes, the literature has rarely taken a complete approach to evaluate if the IS deployment in RL is successful and enhances the performance. Using the innovation diffusion theory (IDT), the study results emphasized that utilization of information systems in RL is a significant predictor of net benefits, and hence RL performance. Vlachos (2016) examined the effect of reverse logistics capabilities on firm performance and the mediating impact of logistics strategies. Taking resource-based view, transaction cost economics and institutional theory as the basis in addition to taking logistics information management and supply chain integration as one of the reverse logistic capabilities, the study empirically verified that reverse logistics capabilities influence RL performance and that the organizational factors were found to be more significant than supply chain factors. According to Meng *et al.*, (2017), reverse logistics is a promising strategy for increasing environmental sustainability via remanufacturing and recycling of used components in addition to deriving profits from component recovery. To maximise profits from component recovery, the study proposed a research model with remaining useful life (RUL) used as a measure of quality in the proposed model. Another study by Kovačić & Bogataj (2017) presented a method for estimating cases where energy can be recovered during recycling processes, leading to environmental sustainability through an increase in the net present value.

2.4 Information Systems

To achieve improved performances in reverse logistics, analysing investment in technology, specifically information technology has been an important domain for researchers. Johnston & Vitale (1988) elaborted on how competitive advantage can be createdby implementing interorganizational information systems across organizations which might deter potential new entrants who are unwilling or unable to match the technological investment. Bakos & Brynjolfsson (1993), through a theoretical study, found that suppliers need to invest in domains which include innovation, responsiveness, and information sharing with primary focus on information technology to enhance buyer supplier relationships. The study further argued that such initiatives will often be stronger when the number of suppliers in the competition is small. In another study, Dutta & Heda (2000) examined the business processes in a typical health care supply chain and identified its architecture requirements. The findings of the study reported that in addition to inter-organizational networking, the architecture must also provide best-in-breed decision support capabilities which is required to increase the productivity of medical personnel, analyze healthcare outcomes and continuously upgrade care delivery processes.

Edwards *et al.*, (2001) suggested that the prime focus of most of the organizations is to build collaborative links with their trading partners across their supply chain and empirically analyzed company data to conclude that firms intend to build new IS capabilities that will assist them to take advantage of the benefits derived from greater collaboration. Kim & Narasimhan (2002) investigated strategies for information systems utilization in supply chain integration and pointed that as the stage of integration moves from independent operations to internal operations to external integration, the focus of information systems utilization shifts from infrastructural support to value creation management and logistical operations, and this variation in IS utilization focus can lead to sustainable competitiveness. The results of the study further pointed that IS utilization for infrastructural support has a positive effect on SCM performance in case of independent operations, whereas IS for value creation and IS for logistical operations have a positive influence on SCM performance in the internal and external stages of integration.

Kotzab *et al.,* (2003) examined the formulation of supply chain strategies in complex environments using an e-SCM framework. They presented an e-supply chain strategy optimization model (e-SOM) to analyze supply chains and concluded that existing relations between distributors and consumers prevents the company from selling and distributing directly to the end-users. Instead, the study recommended the use of electronic integration to deliver vital information about the products and services more effectively to the end-users, leading to creation of efficiencies for the distributors, thereby increasing their profit margins. Kulp *et al.,* (2004) formulated a conceptual framework which associated information integration to profitability of manufacturing organization and found that collaborative planning efforts on replenishment in the form of vendor managed inventory systems is directly related to manufacturer's profit margins. McLaren *et al.,* (2004) used information system (IS) capabilities for improvements in operational efficiency, operational flexibility, internal and external planning & analysis in the forward supply chain.

Richey *et al.,* (2005) used capabilities as customized technologies and stated a significant impact on RL performance. Ravichandran & Lertwongsatien (2005) used the resource-based theory to analyze how information systems (IS) capabilities impact firm performance outcomes. The results recommended that variation in firm performance can be explained in terms of the extent to which IT is utilised to support and enhance a firm's competencies. The study also concluded that a firm's ability to use information technology to support its core competencies is dependent on IS capabilities and quality of IS partnerships. Saeed *et al.,* (2005) integrated operations and information systems literature to create a joint perspective in comprehending the association between the type of inter organizational systems (IOS), buyer–supplier relationships and firm performance. The results of the study concluded that only higher levels of external integration allow organizations to enhance their process efficiencies. In addition, firms having standardized products and processes in a competitive environment are more likely to achieve higher process efficiencies and have higher external integration levels. Helo & Szekely (2005) reviewed the development of information systems and their benefits to supply chain management. According to the study, the need for real time information has become crucial and leads to a continued emphasis on flexible IT-systems which can analyze large amounts of data and are easy to interconnect. This in turn, has led to the growth of highly-capable system integration applications and the process of creating standards. Gosain *et al.,* (2005) reported that enterprises need to develop their execution capabilities by deploying information systems to process information exchanged with its supply chain partners to achieve greater agility and flexibility.

Rai *et al.,* (2006) argued that IT integration for SCM measured in terms of value addition and logistics handling, enables supply chain integration which in turn generates sustained performance, mainly operational performance in addition to growth in revenues. The results also provided evidence that IT integration enables conversion of silo-oriented supply chain processes to cross-functional & interfirm supply chain processes and that a company's IT-based capabilities have a significant effect on supply chain process integration which in turn impacts the supply chain performance. Wang *et al.,* (2006) developed an empirical model to examine the role of virtual integration (information system-centric integration across supply chain partners) plays to facilitate greater manufacturing flexibility and comparative cost advantage. The results of the study revealed that environmental uncertainty forces the manufacturing organization to enhance their flexibility in manufacturing products, with both supplier responsiveness and virtual integration playing a role. Kim *et al.,* (2006) explored how innovations surrounding supply chain communication systems (SCCS) impacts inter-channel relationships and market performance of supply chain. The study utilized the resource-based view of the firm to predict that certain SCCS innovations can be taken as firm resources which enhances channel capabilities, which in turn impacts the performance.

Ho (2007) advocated organizations to consider an integrated approach to evaluate ERP-based supply chains as the performance is significantly impacted by the lot-sizing rule selected. This is required as the presence of lead time uncertainty reduces the performance levels of ERP-based supply chains. Carvalho & Costa (2007) explored ways to find an integrated decision support process for supplier selection in a supply chain environment and concluded that for smaller organizations, lower cost and less complex IT solutions should be developed incrementally to overcome the constraints of small budgets and resistance to change obsolete managerial processes. Stevenson & Hendry (2007) evaluated the effects of improving an existing decision support system (DSS) to enhance the practical applicability of the tool and supply chain integration. The study also highlighted the opportunities to take advantage of web technology which are scarce in the made-to-order firm than in a standardised production environment. In another study, Muller & Seuring (2007) focused on reducing transaction costs by utilizing information technology in supply chains. The analysis in the study recommended that the manufacturers should set the benchmark for using IT in their partnership with suppliers and customers. The results also indicated that small companies might find it difficult to work with several customers that use different IT systems and hence could rely on web-based systems and even e-marketplaces, thus avoiding the risk of investing in highly capable information systems.

Chandra & Grabis (2008) discussed the generic application of IT methodologies and tools while developing integrated supply chain models. The authors argued that the use of standardized IT solutions can lead to wider use of systematic model building approaches and outlined use of IT tools to achieve supply chain integration. O'Leary (2008) reviewed the kind of technology and architecture necessary to create an autonomous supply chain for a real-time enterprise leading to enhanced performance. The study also provided an overview of decision support systems for organizations and then provided a detailed investigation into supporting real-time supply chain decisions with specific emphasis on capabilities built into the system architectures. Swafford *et al.*, (2008) empirically validated the relationships among IT integration, supply chain flexibility, supply chain agility and competitive business performance. Results from the study indicated that IT integration in the supply chain enables a firm to utilize its flexibility which may lead to higher supply chain agility and ultimately result in higher competitive performance. Radhakrishnan *et al.*, (2008) argued that partner firms need to establish both integration capabilities and system wide performance evaluation capabilities to sustain integration in the long run. The results of the study show that supply chains that are highly integrated can sustain the integration by developing both integration and performance evaluation capabilities.

Kim & Kim (2009) did an empirical analysis to validate the relationships among IT investment directions, IT strategies, process innovation capability and firm performance and found out that operations-centric IT strategy significantly effects the process innovation capability which in turn has an impact on both financial and non-financial performance outcomes. Soroor *et al.,* (2009) identified different types of supply chain management information systems (SCMIS) and its characteristics and categorised the critical failure factors of SCM and SCMIS, thereby vindicating the importance of using SCMIS in supply chain systems. Walker (2009) reported higher levels of distributor service and reduced costs on successful implementation of a supply chain management (SCM) system at a Fortune 500 corporation, thereby indicating enhanced performance by utilizing information systems in supply chain processes. Ghani *et al.,* (2009), through a case-study analysis, examined the effects of technology integration with supply chain management as numerous benefits are associated with implementing technology in supply chains. Michelberger & Labodi (2009) provided an overview of the role and feasibility of information security (an IT capability) in supply chains in typical logistic information systems. Bo *et al.,* (2009) suggested that information system integration can be used to increase organizational agility, interoperability and to support the operations on massive organizational information. Jain *et al.,* (2009) addressed issues related to integration of processes across boundaries in a dynamic supply chain through effective communication, inter-organizational partnerships, alliances and cooperation in uncertain conditions with specific emphasis on internet-enabled collaboration among supply chain partners. Kauremaa *et al.,* (2009) used a case study approach to investigate the operational impact and effectiveness of customer initiated inter-organizational information systems for small and medium enterprise (SME) suppliers, particularly the system-to-system and system-to-human integration. The study found that interorganizational system-to-human integration will result operational benefits for enterprises, but lesser than system-to-system integration. Konthong & Ussahawanitchakit (2009) investigated the impact of management accounting information system (MAIS) effectiveness on creating value for businesses. The results further demonstrated that organizations with the greater effectiveness potentially leads to greater business value creation through information quality and managerial performance.

Bayraktar *et al.,* (2010) compared the differences in efficiencies of supply chain management practices and information system practices in small and medium enterprises in food products and beverages in Turkey and Bulgaria. The results of the study suggested that although there were differences between the efficiency level of SCM practices for the considered sample, no significant variations were found between the efficiency levels of both country's IS practices and the aggregate variable of SCM & IS practices. The analysis also indicated that the Bulgarian SMEs emphasize more on managing SCM practices to enhance their efficiencies as compared to the Turkish SMEs, thereby justifying the positive relationship between use of IS in supply chain and SCM efficiencies. Hafeez *et al.,* (2010) conducted an empirical study on Malaysian SMEs and confirmed that e-Business adoption in supply chains is dependent on the implementation of a supply chain strategy, thereby indicating the need to have an IT-centric supply chain strategy for enhanced performance. The results of the study also suggested that the use of technology is a more critical factor which impacts business performance than supply chain strategy for adopter organizations than for non-adopters, thus emphasizing on the need to carry out technology-centric studies in the business performance context. Another study by Furlan *et al.,* (2010) investigated how component technological change impacts buyer-supplier information sharing and found that a high rate of component technological change inhibits information sharing, thereby lowering business performance. Hajkrová (2010) elaborated the selection of an appropriate methodology for implementing information systems in a firm based on existing company processes and organization structure. The study listed the factors which should be given priority in implementation of information systems based on common management requirements such as return on investment in the shortest possible time.

Zhang & Whang (2011) empirically validated the possible linkages among information technology, supply chain robustness and supply chain performance. The results show the significant impact of information technology on supply chain robustness and supply chain performance, and the positive effect of supply chain robustness on supply chain performance. The study also concluded that IT plays an important role in enhancing supply chain's ability to resist risks, and thus help enhance supply chain performance. The study also suggested that companies wanting to do better in its supply chain operations and decrease the risks of disruption in supply chain should apply a better and more effective IT strategy and improve their ability of utilizing IT in their supply chain operations. In another study, Toloie-Eshlaghi *et al.,* (2011) explored the possible relationships between ERP and SCM and emphasized on the need to implement and utilise the ERP systems in the supply chain. The results of the study also indicated that the companies can be more competitive by implementing the advanced information systems like the ERP and the e-SCM systems.

DeGroote & Marx (2013) investigated the impact of IT on supply chain agility and subsequently its performance by collecting data from U.S. manufacturing firms and confirmed that IT improves quality of information on market changes shared with supply chain and the ability of supply chain to respond to market changes. Michalski *et al.,* (2013) extended previous studies on asymmetric relationships by carrying out a comparative supply chain study and suggested that asymmetries in terms of IT investments change the behaviours of participants in supply chain collaborations and hence might affect performance. Xue *et al.,* (2013) examined whether supplier side electronic integration (SEI) effects customer-service performance, over and above organization's investment in customer-side integration and proposed that SEI leads to cost savings and increased cross-selling, thereby enabling organizations achieve cost reduction and greater revenues.

Ghobakhloo *et al.,* (2014) examined the relationships between technical aspects of IS resources in terms of IS capability and advancements, supply chain integration and firm performance and found that integration of supply chain can be used to enhance the value of IS resources for supply chain management, thus resulting in higher gains for the firm. Lee *et al.,* (2014) used resource dependence theory (RDT) and relational view (RV) to develop a framework to investigate the relationships of interorganizational systems (IOS) visibility (defined in terms of coordinated-system usage across the chain) and supply chain performance and empirically proved that IOS visibility positively influences overall supply chain performance, measured in terms of operational performance. Massad & Meirelles (2014) captured the role of information systems in small and medium enterprises (SME's) through a survey-based study and derived that the information systems used in the organizations, including systems in development have a strategic impact, especially with regards to customer loyalty and to increase the barriers of entry for new competitors. Naoui (2014) used a case-study method to emphasize on finding an integrated approach to evaluate customer service performance in an efficient way by using information systems and found that capability of information systems across the chain tends to enhance customer service performance. Park *et al.,* (2014) used the resource-based view to address how the internal and external diffusion of inter-organizational systems (IOS) into a firm's activities leads to enhanced performance and found that IOS integration / diffusion impacts performance. Qrunfleh & Tarafdar (2014) examined the relationship between supply chain strategy and supply chain information systems strategy and its effect on supply chain and firm performance. Considering that IS can be used for increasing efficiency and flexibility in supply chains, the study used confirmatory analysis and structural equation modelling to show a positive association between supply chain performance and firm performance in addition to providing empirical support of how supply chain strategies and IS strategies can be implemented together effectively to enhance supply chain performance. Youn *et al.,* (2014) discussed how supply chain information capabilities are involved in achieving enhanced performance outcomes by identifying critical factors of supply chain information capabilities in terms of cross-organizational information system capacity and competitiveness. The results suggested that manufacturing firms are greatly influenced by the competitiveness in terms of supply chain information capabilities and supply chain flexibility.

Arnold *et al.,* (2015) developed a theory of enterprise risk management (ERM) as an enabler of IT integration, supply chain flexibility and its corresponding performance and provided evidence that enhanced IT integration is the mechanism through which ERM strengthens both flexibility and in turn performance. Bruque *et al.,* (2015) analyzed the effects of cloud computing and Web 2.0 on organization's operational performance. The results suggested that cloud computing requires the mediating support of supply chain integration and provided evidence that Web 2.0 has a positive effect on supply chain integration and operational performance. Eltantawy *et al.,* (2015) addressed the issue of supply management coordination by integrating material and information flow across their supply chain partners to have higher productivity through timely production and distribution of cartons which reduced lead-time and inventory levels in the supply chain. The results indicated that supply chain coordination can be utilized to reduce inventory, improve forecasts, lowering the product delivery lead-times by making use of information systems across the tiers of the supply chain. Huang & Handfield (2015) investigated the impact of implementing enterprise systems and the selection of enterprise system vendors on supply chain performance. The analysis results provided clear indicators of how deployment of ERP and the selection of ERP vendors can benefit a company's supply chain performance. Liang (2015) proposed a framework to measure IOS performance in the supply chain by considering both internal and external organisational perspectives by making use of the balanced scorecard approach, thereby proving that adoption of IOS across the supply chain is critical towards enhanced performance. Srinivasan & Swink (2015) examined the essential capabilities through which organizations utilize information they gain from integration activities by using organizational information processing theory

(OIPT) and indicated that use of supply chain management systems (SCMS) enable organizations to better utilize the information gained from external integration efforts thus enhancing performance outcomes.

Ku *et al.,* (2016) examined how supply chain integration through IS usage across the chain along with customer orientation impacts the operational performance of food service companies by moderating flexibility. The results of the study indicate that there is a need for organizations to redefine their business models by connecting suppliers' and customers' view by implementing information systems for the planning and development of new products. Liu *et al.,* (2016) investigated why firms vary in terms of supply chain technology utilization and how supply chain technology utilization can lead to better supply chain performance. The empirical outcomes suggested that motivation for supply chain technology adoption significantly relates to supply chain technology utilization in organizations and that there is a positive relationship between supply chain technology utilization and firm performance. The results further validated that the supply chain performance increases with increase in level of information sharing amongst the supply chain partners. Van & Van (2016) explored the effect of location of the customer order decoupling point (CODP) on supply chain integration. The results of the study showed a clear relationship between SC integration, location of the CODP and supply chain performance with extended emphasis on supply chain integration through information systems.

Cho *et al.,* (2017) investigated asymmetric information transparency in inter organizational systems (IOS) from a dyadic perspective and found that information transparency in an IOS positively influences supply chain performance measured in terms of SC relationship quality. In another study, Maestrini *et al.,* (2017) conducted a systematic review of supply chain literature to elaborate on different types of supply chain performance management systems (SCPMS). The comprehensive review indicated the use of customer performance management systems, multi-tier supply chain performance management systems and many-to-many supply chain performance management systems by researchers and practitioners for productivity and performance enhancements. Tarafdar & Qrunfleh (2017) examined the mediating impact of supply chain practices on the relationship between agile supply chain strategy and supply chain performance in addition to evaluating the moderating influence of information systems capability for agility on this mediated relationship. The results of the study lead to the conclusion that IS capability for agility has a moderating impact on each of these mediated relationships and that IS capability effects a positive relationship between agile supply chain strategy and supply chain performance.

2.5 Research Gap

The extant review of literature clearly identifies the gaps, trends and opportunities for further studies in the underlying area. The review clearly indicates that there has been a continued emphasis on performance enhancement in the supply chain domain. Researchers have made efforts to measure and boost supply chain performance through different perspectives. A few of them have considered the economic outlook while a few others have considered the operational angle of performance. The financial performance has been measured with regards to profit margins, revenue generated and cost savings while the operational aspect can be categorised in terms of inventory reduction, reduced lead & cycle times and improved productivity & efficiency of supply chain operations to name a few.

With businesses turning customer-centric, the review also suggested an increased emphasis on using customer relations as a measure of supply chain performance. Researchers have used addition of new customers, retention of existing customers and improved customer satisfaction levels to measure customer relations. With competitiveness and sustainability playing a huge role, the studies have also emphasized on using strategic benefits, measured in terms of inter-organizational collaboration and market competitiveness, as an indicator of performance. For businesses to be sustainable in the long run, the review of literature suggested that practitioners have been aligning their efforts towards making their supply chains agile, flexible with enhanced coordination across the chain partners. Recent literature also acknowledged the use of supply chain agility as a promising strategy to achieve superior performance and sustained competitive advantage (Li *et al.*, 2008; Gligor & Holcomb, 2012). The performance constructs, their description and supporting references have been tabulated in Table 1.

Although there has been extensive work on performance enhancement in supply chain, most of these studies have been in the forward context. The argument for continued emphasis on the forward supply chain has been the ability of the forward chain to generate competitive advantage for the focal firm with the reverse chain being considered as a cost centre (Jayant *et al.*, 2011). Also, studies and reports have suggested that off late, organizations have utilized reverse logistics to generate the desired benefits (Julka & Ganguly, 2015). The argument for the paradigm shift from forward to reverse supply chain can be attributed to the fact that the forward chain, which has been used by organizations for decades, has got exhausted and can no longer provide the desired performance outcomes and benefits in terms of market positioning. Review studies in the supply chain literature have suggested that future researchers need to emphasize on the emerging economies including India and China as their supply chains are going to form an integral part of the future business environment (Avittathur & Jayaram, 2016). In addition to it, with agencies reporting huge scope of reverse logistics in the Indian context due to unorganized Indian retail, contribution of logistics to the Indian GDP and increase in e-commerce, it becomes pertinent to study Indian reverse logistics from a performance enhancement standpoint.

Table 1 – RL Performance Measures, Description and Supporting References

S No.	Performance Measures	Description	Supporting References
1	Economic Performance	It refers to the performance with regards to reverse logistics, leading to financial benefits such as increased profit margins, revenue generation, improved return on investment and cost savings for the reverse supply chain	Lee *et al.,* (2000); Kim & Narasimhan, (2002); Daugherty *et al.,* (2005); Rai *et al.,* (2006); Wang *et al.,* (2006); Bhagwat & Sharma, (2007); Gunasekaran & Kobu, (2007); Hofmann & Locker, (2009); Kim & Kim, (2009); Klein & Rai (2009); Martin & Patterson (2009); Kohli & Jensen (2010); Hwang (2010); Singh *et al.,* (2010); Wadhwa *et al.,* (2010); Huang *et al.,* (2012); Kumar & Chandra (2012); Nativi & Lee (2012); Shaik & Abdul-Kader (2012); Toyasaki *et al.,* (2013); Mitra & Datta (2014); Avittathur & Jayaram (2016); Varsei (2016)
2	Operational Performance	It represents the performance benefits for the reverse supply chain in terms of improvements in day-to-day operational activities like reduced inventory, reduced cycle time & lead time, operational agility, flexibility, logistical efficiency & effectiveness and resource utilization	Daugherty *et al.,* (2002); Kotzab *et al.,* (2003); Lenny Koh *et al.,* (2006); Reyes & Meade (2006); Gunasekaran & Kobu (2007); Chan *et al.,* (2009); Hofmann & Locker (2009); Klein & Rai (2009); Martin & Patterson (2009); Kohli *et al.,* (2010); Olorunniwo *et al.,* (2010); Singh *et al.,* (2010); Wadhwa *et al.,* (2010); Bernon *et al.,* (2011); Shaik & Abdul-Kader (2012); Tatoglu *et al.,* (2016)
3	Customer Relations	It refers to the benefits achieved by the organization through reverse logistic operations in terms of addition of new customers, retention of existing customer and improved customer satisfaction.	Autry *et al.,* (2001); Daugherty *et al.,* (2003); Daugherty *et al.,* (2005); Rai *et al.,* (2006); Shepherd & Gunter (2006); Mollenkopf *et al.,* (2007); Jean *et al.,* (2010); Singh *et al.,* (2010); Cuthbertson & Piotrowicz (2011); Olorunniwo & Li (2011); Shaik & Abdul-Kader (2012); Vaz *et al.,* (2013); Tajbakhsh & Hassini (2015)
4	Strategic Benefits	The performance benefits realized in terms of collaborative supply chain partnerships and competitive edge because of effective reverse logistics systems.	Subramani (2004); Shepherd & Gunter (2006); Bhagwat & Sharma (2007); Gunasekaran & Kobu (2007); Ordoobadi (2008); Speier *et al.,* (2008); Cuthbertson & Piotrowicz (2011); Genchev *et al.,* (2011); González-Benito & Alfaro-Tanco (2013); Tajbakhsh & Hassini (2015)
5	SC Agility & Flexibility	It refers to the ability of the reverse supply chain to respond to marketplace changes to attain or maintain competitive benefits and includes flexibility and adaptability.	Edwards *et al.,* (2001); McLaren *et al.,* (2004); Gosain *et al.,* (2005); Richey *et al.,* (2005); Wang *et al.,* (2006); Gunasekaran *et al.,* (2007); Swafford *et al.,* (2008); Bo *et al.,* (2009); Klein & Rai (2009); Wadhwa *et al.,* (2010); Zhang & Whang (2011); Mangla *et al.,* (2012); DeGroote & Marx (2013); Qrunfleh & Tarafdar (2014); Youn *et al.,* (2014); Arnold *et al.,* (2015); Giannakis *et al.,* (2016); Ku *et al.,* (2016); Tatoglu *et al.,* (2016); Tarafdar & Qrunfleh, (2017)
6	SC Coordination	It refers to coordination benefits achieved by the supply chain partners through streamlined flow of material and information in the reverse supply chain.	Fleischmann (2003); Aras *et al.,* (2006); Atasu & Cetinkaya (2006); Banker *et al.,* (2006); Lee *et al.,* (2014); Eltantawy *et al.,* (2015)

The literature seems to suggest that one of the primary means to achieve increased supply chain performance is through deployment of inter-organizational information systems across the closed-loop supply chains. The literature defined several different IS constructs which have been used by researchers for achieving better performances in varied supply chain environments. A few studies have emphasized on capability of information systems deployed across the chain to achieve desired outcomes while a few others focused on implementing systems for handling logistical activities. With supply chain and specifically reverse logistics involves logistical operations, it becomes really vital to look at the impact created by the logistical systems. Off late, the researchers have made efforts to use a variety of inter-organizational systems to create value for the stake holders, including the customers (Avittathur & Jayaram, 2016). With e-commerce increasing the businesses manifold leading to fraudulent returns (Julka & Ganguly, 2015), industry reports have suggested that there is a need to develop and implement systems which can minimize these returns. Another important factor considered critical in the literature review is the diffusion of systems across the partners of supply chain to support its core competencies (Park *et al.,* 2014), also referred to as partnership quality in certain studies (Ravichandran & Lertwongsatien, 2005). Diffusion has been found to be critical in the forward supply chain but how impactful it is in the reverse logistics context needs to be analyzed. With IS infrastructural support no longer considered a factor impacting performance by studies (Kim & Narasimhan, 2002), it becomes vital to measure the effects of the above-mentioned factors in the reverse logistics context. The different IS constructs with their description and supporting references have been tabulated in Table 2.

Table 2 – IS Constructs, Description and Supporting References

S No.	Constructs	Description	Supporting References
1	IS Capability	Capability of the IT systems in terms of carrying out system planning, development, process coordination and operations across the reverse supply chain	Daugherty *et al.,* (2005); Ravichandran & Lertwongsatien (2005); Hafeez *et al.,* (2010); Giannakis *et al.,* (2016); Tatoglu *et al.,* (2016); Tarafdar & Qrunfleh, (2017)
2	IS for Logistical Operations	The utilization level of IT-based systems in reverse logistics for carrying out the logistical operations across the reverse supply chain	Edwards *et al.,* (2001); Kim & Narsimhan (2002); Kim & Kim (2009)
3	IS for Value Creation	The utilization of IT-based systems in processes leading to creation of value for the end customer by delivering quality product and service	Kim & Narsimhan (2002); Gunasekaran *et al.,* (2007); Hofmann & Locker (2009)
4	IS Partnership Quality	It depicts the quality of the information systems being used in the reverse supply chain, specifically depicting compatibility and coordination among the supply chain partners with regards to flow of relevant information	Johnston *et al.,* (1988); Kim *et al.,* (2006); Wang *et al.,* (2006); Gunasekaran *et al.,* (2007); Swafford *et al.,* (2008); Wadhwa *et al.,* (2010); Zhang & Whang, (2011)

The effects of these factors on enhancing performance in reverse logistics cannot be studied in isolation as there are a number of industry and organization specific variables which are deemed vital in reverse logistics literature. The literature review above has reflected frequency of product returns as an important factor which varies at the industry level with electronics industry tending to have greater returns as compared to automotive industry. With fraudulent returns in e-commerce industry resulting in huge losses, it becomes critical to include it as a variable in the research undertaken.

The reverse logistics literature also considers resource commitment important as organizations had a continued emphasis on forward logistics for its ability to generate the desired competitive advantage (Jayant *et al.,* 2011). With the gradual shift in focus to reverse logistics, commitment of organizational resources to reverse logistics has been deemed critical (Richey *et al.,* 2005) as it might have an impact on the performance.

Reverse logistics literature and recent industry reports have suggested that reverse logistics, if used strategically can lead to enhanced performance outcomes. Although there has been paradigm shift in focus towards reverse logistics, its impact on performance if emphasized on strategically by organization's top management, still remains to be evaluated. Hence, it needs to be included in the research analysis.

Another dimension of prime importance as reported by literature is government regulations. With literature reporting environmental sustainability to be critical (Zhuo & Wei, 2017; Choi *et al.,* 2017) and organizations looking save on regulatory fines due to waste discharge, involving it in a reverse logistics research becomes important. With firms reporting to integrate their supply chain on top of business processes with the sole objective of creating value for the customers and expected to standardise supply chain processes to have better visibility, integration and performance (Computer Weekly, 2017), the impact of formalising supply chain processes in reverse logistics on performance needs to be analyzed. A brief description of the mentioned constructs along with their supporting references has been presented in Table 3.

Table 3 – Non-IS Constructs, Description and Supporting References

S No.	Constructs	Description	Supporting References
1	Strategic Focus	It refers to the inclusion of reverse logistics in the functional strategy of the organization to derive competitive benefits rather than considering it as just a means to facilitate product returns.	Kotzab *et al.,* (2003); Tan *et al.,* (2003); Ounnar *et al.,* (2007); Li & Olorunniwo (2008); Kumar *et al.,* (2009); Bayraktar *et al.,* (2010); Hafeez *et al.,* (2010); Singh *et al.,* (2010); Skapa & Klapalova (2012)
2	Resource Commitment	It depicts the degree of financial, human and technological resources committed by organizations specifically for handling reverse logistics operations effectively and efficiently.	Daugherty *et al.,* (2002); Richey *et al.,* (2005); Li & Olorunniwo (2008); Huang *et al.,* (2012)
3	Formalized Processes	It refers to the standardisation of the reverse logistics operations and procedures to reap possible benefits associated with formalization.	Baum & Wally, (2003); Tan *et al.,* (2003); Gosain*et al.,* (2005); Genchev *et al.,* (2011); Han, & Cueto, (2016); Ralston *et al.,* (2017)
4	Government Regulations	It refers to the regulations by the government in the context of reverse logistics, specifically dealing with the product returns and the need to refurbish, re-use and re-use product materials.	Green *et al.,* (1998); Gunasekaran & Kobu (2007); Walker *et al.,* (2008); Mangla *et al.,* (2012); Shaik*et al.,* (2012); Choi *et al.,* (2017); Zhuo & Wei, (2017)
5	Return Frequency	It refers to the frequency of product returns by the customers including factors such as product end-of-life, defects and unsold items.	Autry *et al.,* (2001); French & Discenza (2006); Genchev *et al.,* (2011); Mondragon *et al.,* (2011)

To summarize, this study intends to use an integrated approach to evaluate how firms can enhance reverse logistics performance. Using an information system centric approach, the study has identified supply chain performance measures and IS factors through an extant review of supply chain literature. To develop a comprehensive conceptual framework, factors which are critical in the reverse logistics context have also been derived from literature as discussed above. The subsequent chapter elaborates the objectives of the study followed by development of conceptual framework and research hypotheses. The developed hypotheses were tested by using appropriate research methods after collecting primary data by using a research questionnaire adapted from existing supply chain literature.

CHAPTER III

RESEARCH DESIGN

AND METHODOLOGY

RESEARCH DESIGN AND METHODOLOGY

The study undertaken went through a sequence of steps initiating from literature review to questionnaire design to data collection, instrument validation, analysis, results, discussion and implications. The entire flow has been represented in the flow diagram given in Figure 4.

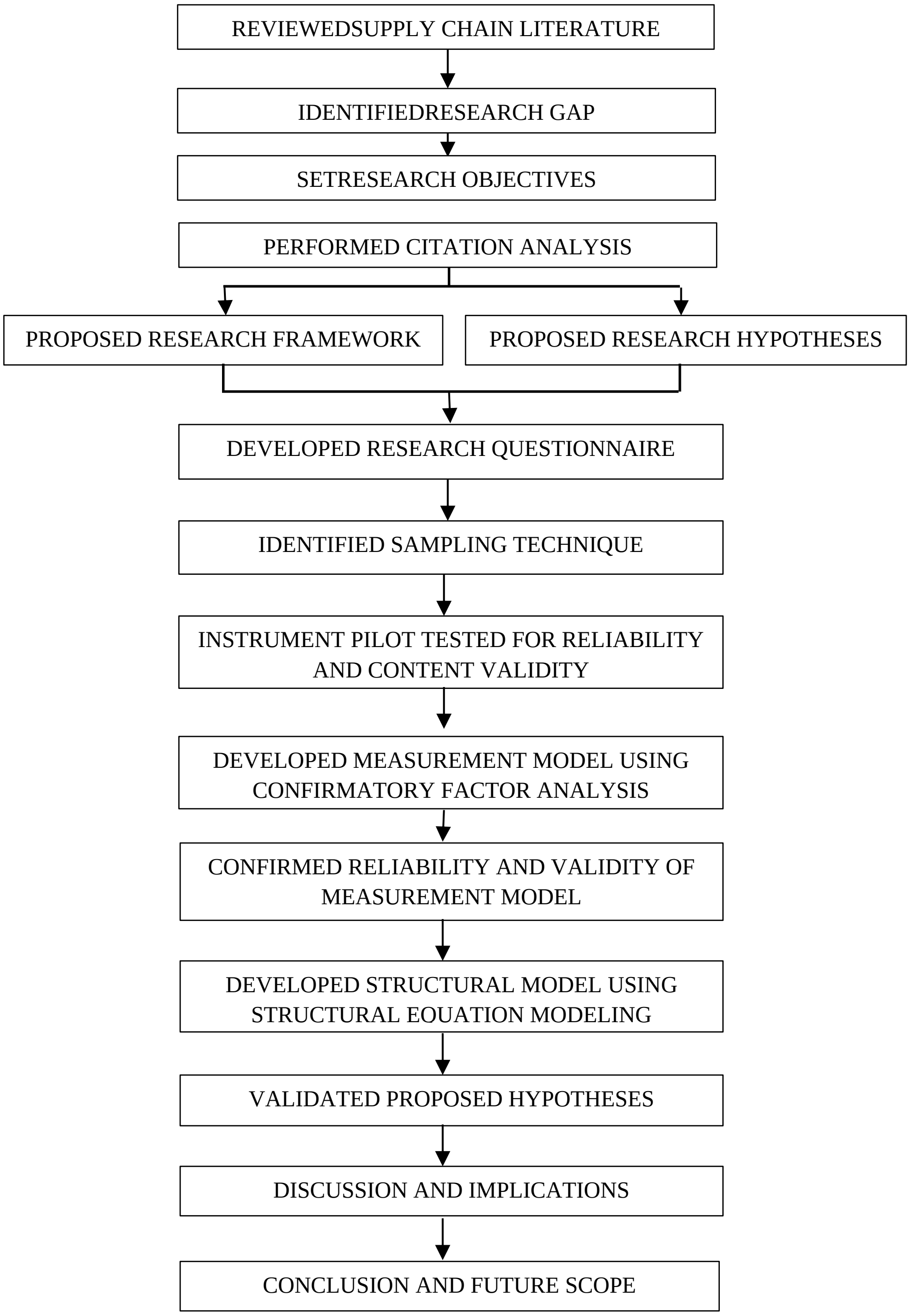

Figure 4 – Research Flow Diagram

This chapter describes the research design and methodology used in the undertaken research. The research objectives establish the directions for the current study. It is followed by citation analysis to ensure that the research constructs are well cited in literature and hence can be used for achieving the research objectives. Subsequently, the conceptual framework and research hypotheses are developed by establishing relationships between constructs. After formulating the research hypotheses, data collection and sampling procedures are described followed by elaboration of the research methods to be used in the study undertaken.

3.1 Research Objectives

The primary objective of the study is to identify constructs that affect the reverse logistics performance in industries across India where reverse logistics is prominent and establish an integrated IS framework that enhances the reverse logistics performance in supply chains. Based on the discussed primary objective further sub-objectives can be stated as:

- To identify information systems (IS) factors impacting the reverse logistics performance of the supply chain.
- To identify Non-IS factors impacting the reverse logistics performance of the supply chain.
- To develop an integrated IS framework involving IS and Non-IS factors for enhancing reverse logistics performance of the supply chains.
- To validate the developed integrated IS framework using appropriate methodology.

The sub-objectives dealing with identification of IS and Non-IS factors for enhancing reverse logistics performance have been accomplished through review of literature and subsequent identification of research gaps. The rest of the objectives would be subsequently achieved through development of conceptual model and research analysis using appropriate research methods. It is followed by discussion of results leading to development of significant contributions & implications for researchers and industry practitioners.

3.2 Citation Analysis

The constructs to be used for analysis were derived through an extant review of the supply chain literature. To justify their applicability in the context of the current research, citation analysis was carried out to ensure that the variables are well cited and hence critical and relevant for the undertaken study. Literature defines citation analysis as “a way of measuring the relative importance or impact of an author, an article or a publication by counting the number of times that author, article, or publication has been cited by other works" (Short, 2017). The application of citation analysis as stated in literature is to evaluate research and to identify research fronts (Price, 1965). Garfield & Merton (1979) listed 15 reasons for using citation analysis which included identification of methodology, equipment and variables and substantiating claims of variables from literature. To substantiate the relevance of the selected constructs, citation analysis was performed on all IS, non-IS and RL performance variables by taking latest Google Scholar citations as on June 2, 2017. The recent references from the year 2016 and 2017 were not considered for the citation analysis as they had no or too few Google Scholar citations and would not actually present the true relevance of the constructs being considered.

The results of the citation analysis substantiate the importance of the selected constructs. In the citation analysis for IS constructs, citation scores of 14 studies were taken for the four variables from Google Scholar. The average citation score across studies was found to be 286 while scores for individual constructs were found to be 434, 84, 304 and 307 respectively. These scores are relatively high and hence highlight the relevance of the selected variables considerably well (tabulated in Table 4).

Table 4 – Citation Analysis of IS Constructs

References	Google Scholar Citation Scores	ISCP	ISLO	ISVC	ISPQ
Daugherty *et al.,* (2005)	**294**	✓			
Edwards *et al.,* (2001)	**150**		✓		
Gunasekaran *et al.,* (2007)	**550**			✓	
Hafeez *et al.,* (2010)	**37**	✓			
Hofmann & Locker (2009)	**57**			✓	
Johnston *et al.,* (1988)	**947**				✓
Kim & Kim (2009)	**7**		✓		
Kim & Narsimhan (2002)	**96**		✓		
Kim *et al.,* (2006)	**256**				✓
Ravichandran & Lertwongsatien (2005)	**971**	✓			
Swafford *et al.,* (2008)	**403**				✓
Wadhwa *et al.,* (2010)	**36**				✓
Wang *et al.,* (2006)	**183**				✓
Zhang & Whang (2011)	**14**				✓
Average Citations	**183**	**430**	**345**	**51**	**83**

In the citation analysis for Non-IS constructs, 23 studies were considered for analysis excluding the studies from 2016 and 2017 as explained earlier. The average citation score across studies was found to be 183 while scores for individual constructs were found to be 430, 345, 51, 83 and 144 respectively. These citation scores are significant and hence substantiates the relevance of the selected Non-IS constructs. The citation scores for non-IS constructs are presented in Table 5.

Table 5 – Citation Analysis of Non-IS Constructs

References	Google Scholar Citation Scores	FPRO	GREG	SFOC	RFRE	RCOM
Autry *et al.,* (2001)	**173**				✓	
Baum & Wally (2003)	**817**	✓				
Bayraktar *et al.,* (2010)	**30**			✓		
Daugherty *et al.,* (2002)	**249**					✓
French & Discenza (2006)	**10**				✓	
Genchev *et al.,* (2011)	**57**	✓				
Gosain *et al.,* (2005)	**415**	✓				
Green *et al.,* (1998)	**338**		✓			
Gunasekaran & Kobu (2007)	**550**		✓			
Hafeez *et al.,* (2010)	**37**			✓		
Huang *et al.,* (2012)	**20**					✓
Kotzab *et al.,* (2003)	**43**			✓		
Kumar *et al.,* (2009)	**78**			✓		
Li & Olorunniwo (2008)	**92**			✓		✓
Mangla *et al.,* (2012)	**30**		✓			
Mondragon *et al.,* (2011)	**66**				✓	
Ounnar *et al.,* (2007)	**55**			✓		
Richey *et al.,* (2005)	**213**					✓
Shaik *et al.,* (2012)	**26**		✓			
Singh *et al.,* (2010)	**31**			✓		
Skapa & Klapalova (2012)	**15**			✓		
Tan *et al.,* (2003)	**80**			✓		
Walker *et al.,* (2008)	**780**		✓			
Average Citations	**183**	**430**	**345**	**51**	**83**	**144**

The citation analysis for RL performance measures involved 30 studies from the supply chain performance literature and involved different performance attributes including financial, operational and customer centric performance. The average citation scores across these studies was evaluated to be 315 while scores for individual constructs were found to be 357, 90, 607, 300, 223 and 274 respectively. These citation scores (tabularized in Table 6) are significantly high and justifies the significance of the selected RL performance variables for the undertaken research.

Table 6 – Citation Analysis of RL Performance Measures

References	Google Scholar Citation Scores	EPER	OPER	SBEN	CREL	SCAF	SCCO
Aras *et al.*, (2006)	**91**						✓
Atasu & Cetinkaya (2006)	**69**						✓
Autry *et al.*, (2001)	**173**				✓		
Bhagwat & Sharma (2007)	**117**	✓		✓			
Cuthbertson & Piotrowicz (2011)	**84**				✓		
Daugherty *et al.*, (2002)	**249**		✓				
Daugherty *et al.*, (2003)	**59**				✓		
Daugherty *et al.*, (2005)	**294**	✓			✓		
Edwards *et al.*, (2001)	**150**					✓	
Fleischmann (2003)	**253**						✓
Gunasekaran & Kobu (2007)	**550**	✓					
Gunasekaran *et al.*, (2007)	**550**					✓	
Hofmann & Locker (2009)	**57**	✓					
Hwang (2010)	**6**	✓					
Kanda & Deshmukh (2008)	**682**						✓
Kim & Kim (2009)	**7**	✓					
Kim & Narasimhan (2002)	**96**	✓					
Klein & Rai (2009)	**301**	✓					
Kohli & Jensen (2010)	**18**	✓					
Kotzab *et al.*, (2003)	**43**		✓				
Lee *et al.*, (2000)	**2282**	✓					
Martin & Patterson (2009)	**69**	✓					
Mollenkopf *et al.*, (2007)	**159**				✓		
Rai *et al.*, (2006)	**1303**	✓			✓		
Singh *et al.*, (2010)	**31**	✓	✓		✓		
Subramani (2004)	**1097**			✓			
Swafford *et al.*, (2008)	**403**					✓	
Wadhwa *et al.*, (2010)	**36**	✓	✓			✓	
Wang *et al.*, (2006)	**183**	✓				✓	
Zhang & Whang (2011)	**14**					✓	

3.3 Conceptual Framework & Hypotheses Development

The literature review proposes several constructs which tend to affect reverse logistics performance in organizations directly or indirectly. The variables include information system factors which tend to impact the performance measured in varied dimensions including economic, operational and strategic benefits. The literature also emphasizes on industry-specific factors such as frequency of returns, resource commitment, government regulations and formalized RL processes which can impact RL performance. To evaluate these effects, possible relationships need to be reviewed to develop the research framework which will measure the direct and the indirect effects. To generate important contributions and implications for researchers and practitioners, the analysis is being proposed for each IS construct individually as well as the entire IS framework.

3.3.1 IS Framework and RL Performance

Studies in literature suggest a direct relationship between information system factors and supply chain performance. Johnston & Vitale (1988) emphasized on how deployment of highly capable inter-organizational information systems across organizations can lead to creation of competitive advantage, thus enhancing performance. Kim & Narasimhan (2002) suggested that a shift of focus from IS infrastructural support to the use of IS for value addition and logistical operations will lead to competitive supply chain benefits for organizations. Another study by Kulp *et al.,* (2004) developed a framework that related information integration initiatives to manufacturer profitability and found that collaborative information integration is positively related to manufacturer's profit margins. McLaren *et al.,* (2004) used information system (IS) capabilities for improvements in operational efficiency, operational flexibility, internal and external planning & analysis in the forward supply chain. Helo & Szekely (2005) emphasized on the need for deploying real time and highly-capable information systems as it would benefit the supply chain in terms of better performance. Ravichandran & Lertwongsatien (2005) emphasized organizations to use capable IS for enhancing supply chain performance. Richey *et al.,* (2005) used capabilities as customized technologies and stated a significant impact on RL performance. Another study by Wang *et al.,* (2006) developed an empirical model to evaluate the role of information system-centric integration in facilitating greater manufacturing flexibility and comparative cost advantage and found integration to be having a significant effect. Ghobakhloo *et al.,* (2014) examined the relationships between IS capability & advancements and supply chain performance and found the impact to be positively significant. A few recent studies have also suggested that IS capability leads to greater agility and flexibility in supply chain, thereby enhancing supply chain performance (Tatoglu *et al.,* 2016; Tarafdar & Qrunfleh, 2017). Hence, to analyze the relationship between the constructs in proposed IS framework and RL performance, the following hypotheses and sub-hypotheses are being proposed:

Hypothesis

H_3: Usage of IS framework in RL significantly impacts RL performance

Sub-Hypotheses

H_{3a}: Usage of capable IS in RL significantly impacts RL performance

H_{3b}: Usage of IS for logistical operations in RL significantly impacts RL performance

H_{3c}: Usage of value creating IS in RL significantly impacts RL performance

H_{3d}: Usage of IS to enhance partnership quality in RL significantly impacts RL performance

3.3.2 Formalized Processes and RL Performance

Richey *et al.,* (2005) indicated that formalized RL procedures along with customized information technologies have a significant effect on RL performance. Genchev *et al.,* (2011) suggested that formalization of processes as a means for making RL efficient and effective, leading to enhanced financial and operational performance. Some recent studies in literature have also emphasized on the importance of process formalization in RL (Han & Cueto, 2016; Stevens & Johnson, 2016; Ralston *et al.*, 2017). Hence, it becomes vital to analyze the combined impact of formalized processes and IS framework on performance in the RL context. To get deeper insights, hypotheses for individual constructs in the IS framework have also been proposed:

Hypotheses

H_1: Formalised Processes in RL significantly impacts RL performance

H_2: Formalised Processes in RL significantly impacts usage of IS framework in RL

Sub-Hypotheses

H_{2a}: Formalised Processes in RL significantly impacts usage of capable IS in RL

H_{2b}: Formalised Processes in RL significantly impacts usage of IS for logistical operations in RL

H_{2c}: Formalised Processes in RL significantly impacts usage of value creating IS in RL

H_{2d}: Formalised Processes in RL significantly impacts usage of IS to enhance partnership quality in RL

3.3.3 Government Regulations and RL Performance

Mangla *et al.*, (2012) stressed that favourable regulations by the government can have a significant effect in the RL context through enhancements in terms of capacity utilization, customer satisfaction and energy consumption reduction. Shaik & Abdul-Kader, (2012) proposed government regulations as a driver which may lead to improved financial, operational and stakeholder-centric performances in the RL context. Mirkovski *et al.,* (2016) revealed that the institutional context (i.e. environmental uncertainty) has significant indirect influence on use of information and communication technology (ICT) in collaborative supply chains. With organizations looking to reduce government fines to waste discharge, reduce regulatory costs (Zhuo & Wei, 2017) and gain environmental benefits (Choi *et al.,* 2017) due to material re-use, evaluating the impact of government regulations becomes critical in the reverse logistics context. Hence, the following hypotheses are being proposed:

Hypotheses

H_6: Government Regulations in RL significantly impacts RL performance

H_7: Government Regulations in RL significantly impacts usage of IS framework in RL

Sub-Hypotheses

H_{7a}: Government Regulations in RL significantly impacts usage of capable IS in RL

H_{7b}: Government Regulations in RL significantly impacts usage of IS for logistical operations in RL

H_{7c}: Government Regulations in RL significantly impacts usage of value creating IS in RL

H_{7d}: Government Regulations in RL significantly impacts usage of IS to enhance partnership quality in RL

3.3.4 Strategic Focus and RL Performance

Daugherty et al. (2005) used certain key strategic decisions and IS support to analyze the impact on reverse logistics performance, thereby proving them to be related. A few other studies have used certain strategic dimensions in addition to using IS constructs in the reverse logistics context to enhance performance (Daugherty, *et al.,* 2002; Jayaraman, *et al.,* 2008; Genchev, *et al.,* 2011). Some recent industry reports on reverse logistics have also stressed on giving strategic focus to reverse logistics (Rosier & Janzen, 2008; Greve, 2013; Johns, 2014). Hence the following hypotheses are proposed:

Hypotheses

H_8: Strategic Focus in RL significantly impacts RL performance

H_9: Strategic Focus on RL significantly impacts usage of IS framework in RL

Sub-Hypotheses

H_{9a}: Strategic Focus on RL significantly impacts usage of capable IS in RL

H_{9b}: Strategic Focus on RL significantly impacts usage of IS for logistical operations in RL

H_{9c}: Strategic Focus on RL significantly impacts usage of value creating IS in RL

H_{9d}: Strategic Focus on RL significantly impacts usage of IS to enhance partnership quality in RL

3.3.5 Return Frequency and RL Performance

Reverse logistics may result in product returns in the form of warranty returns (Gary Teng*et al.*, 2005), product lifecycle returns (Tibben-Lembke & Rogers, 2002), container recycling (Kroon & Vrijens, 1995), operational systems (Knemeyer *et al.*, 2002; Tibben-Lembke, 2002; Tibben-Lembke & Rogers, 2002), ordering inappropriate products, changing customer preference, and delivery to the incorrect destination (Olorunniwo & Li, 2011). French & Discenza (2006) used the return frequency to measure product degradability timing and observed that reverse networks for external product returns must consider storage conditions and degradability timing for better efficiency and effectiveness. Similarly, Tan & Kumar (2006) used the frequency and volume of product returns and developed a dynamic decision model for RL to evaluate new RL policies. Due to industry-specific returns, quality policies and dynamic business environments, the frequency of returns vary across industries (Tan & Kumar, 2006). The more frequent the returns, the greater the probability that the organization has standardised and well established RL processes. The product return frequency (low or high) can be critical in the RL context due to variations across industries (French & Discenza, 2006; Julka & Ganguly, 2015) and is an area which needs attention. Thus, in the RL context, it becomes pertinent to analyze the effect of the level of return frequency as it might play a role in achieving improved performance in the RL context.

Hence, the following hypotheses and sub-hypotheses have been proposed:

Hypothesis

H_4: The frequency of product returns significantly moderates the relationship of IS framework and RL performance

Sub-Hypotheses

H_{4a}: The frequency of product returns significantly moderates the relationship of IS capabilities and RL performance

H_{4b}: The frequency of product returns significantly moderates the relationship of IS for logistical operations in RL and RL performance

H_{4c}: The frequency of product returns significantly moderates the relationship of IS for value creation in RL and RL performance

H_{4d}: The frequency of product returns significantly moderates the relationship of IS partnership quality in RL and RL performance

3.3.6 Resource Commitment and RL Performance

With organizations beginning to use RL strategically, it becomes important to allocate resources to overcome logistical hurdles due to product returns (Kumar and Chatterjee, 2011). Researches in the supply chain literature have emphasized that resource commitment makes RL networks more efficient and effective but must be used in a manner to develop innovative capabilities for handling product returns (Richey *et al.,* 2005). Li and Olorunniwo, (2008) concluded that resource commitment is required to support the RL efforts across the chain. Huang *et al.,* (2012) emphasized that resource commitment positively and significantly influences the economic and environmental performances of RL separately.

Although RL performance specific impacts have been observed, the commitment of resources to RL is still a concern due to a gradual shift in attention from forward to reverse supply chain (Jayant *et al.,* 2011), due to which there are variations in the commitment of resources to RL across organizations and industries. With firms across industrial sectors still not committed to allocating resources to RL, the degree of resources allocated (low or high) might have an influence on RL performance and needs further probing. Hence, the following hypotheses and sub-hypotheses have been proposed: -

Hypothesis

H_5: The resource commitment in RL significantly moderates the relationship of IS framework and RL performance

Sub-Hypotheses

H_{5a}: The resource commitment in RL significantly moderates the relationship of IS capabilities and RL performance

H_{5b}: The resource commitment in RL significantly moderates the relationship of IS for logistical operations in RL and RL performance

H_{5c}: The resource commitment in RL significantly moderates the relationship of IS for value creation in RL and RL performance

H_{5d}: The resource commitment in RL significantly moderates the relationship of IS partnership quality in RL and RL performance

Based on the relationships elaborated in the discussion above and subsequent formulation of the research hypotheses, the entire research model can be divided into 3 sub-models (one each with formalized processes, government regulations and strategic focus as independent variables) for a systematic analysis of the relationships between the selected constructs. The integrated conceptual framework has been presented in Figure 5 while the sub-models have been depicted in Figure 6, 7 and 8 respectively.

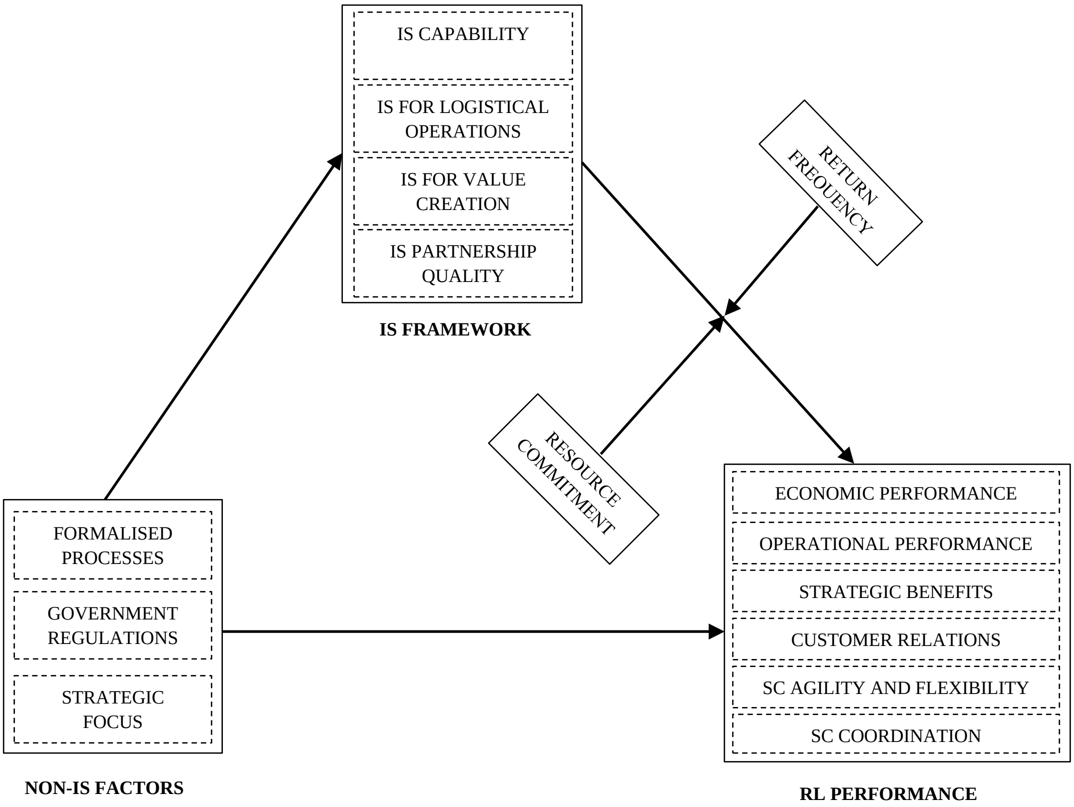

Figure 5 –Conceptual Framework for RL Performance

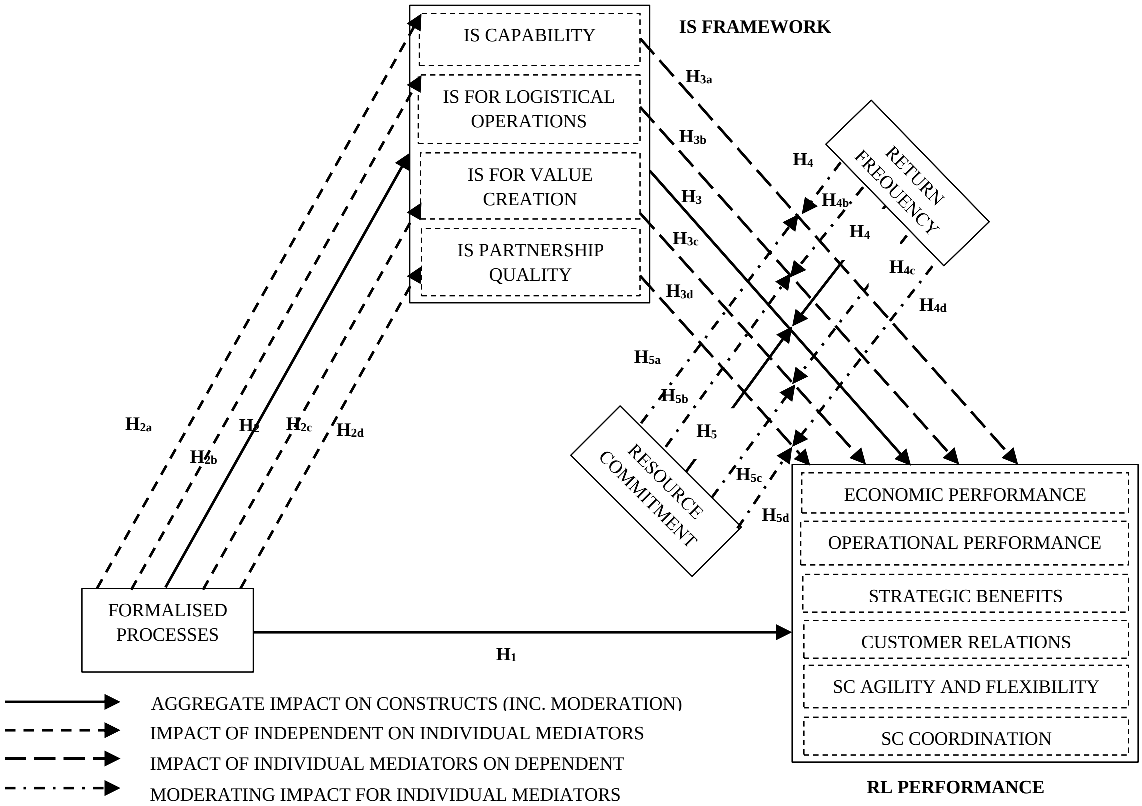

Figure 6 – Formalized Processes Model for RL Performance

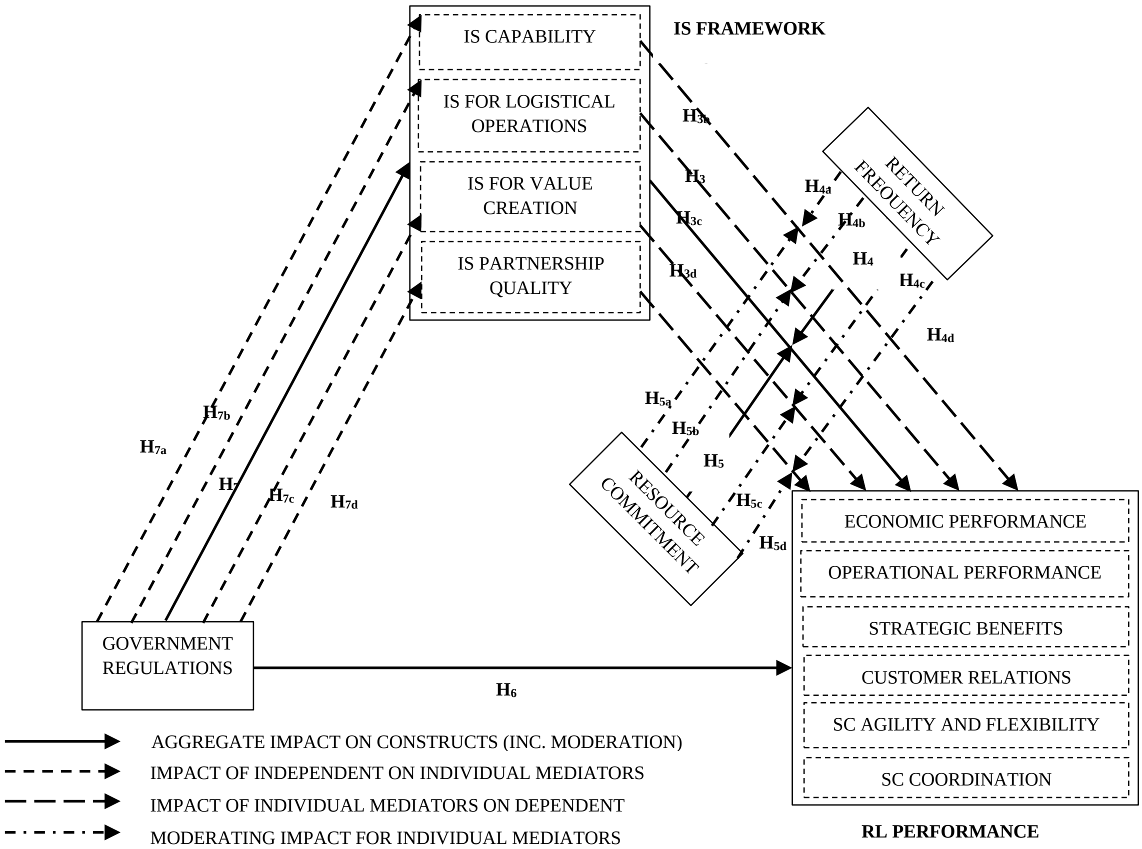

Figure 7 – Government Regulations Model for RL Performance

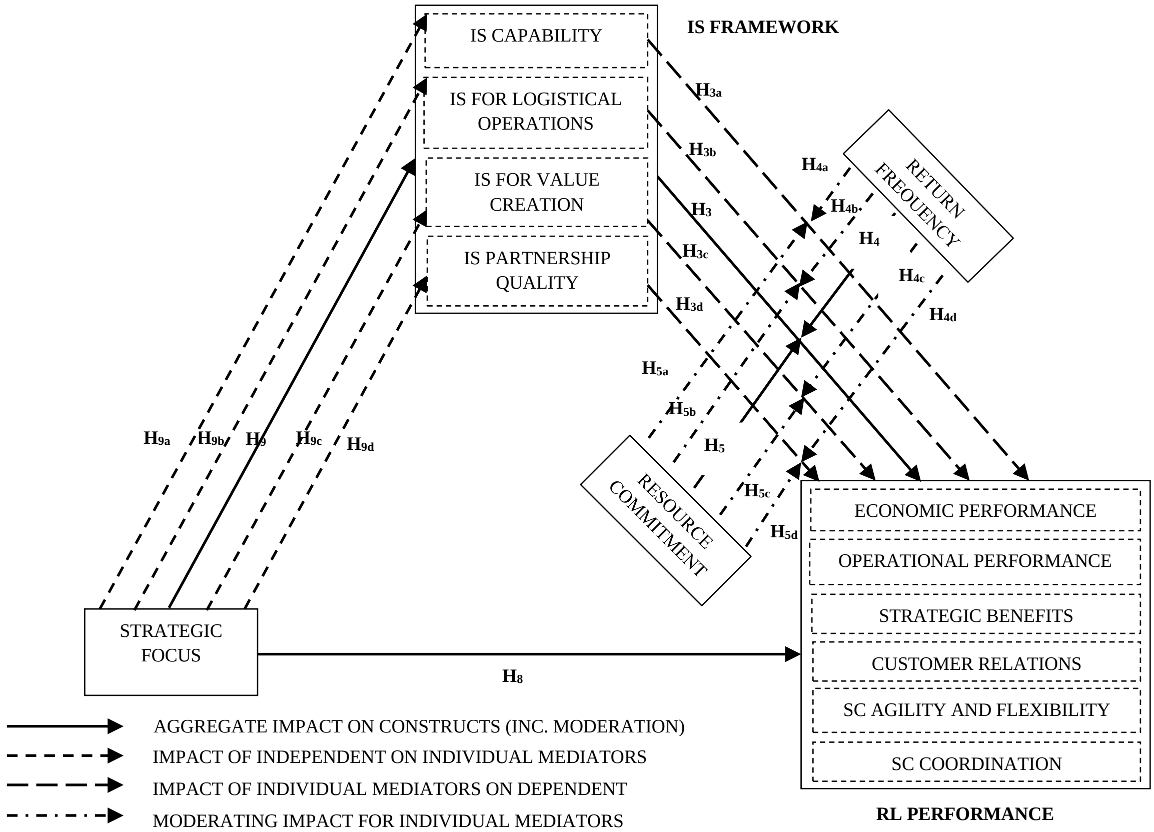

Figure 8 – Strategic Focus Model for RL Performance

3.4 Instrument Design

To test the proposed hypotheses and validate the conceptual framework, a questionnaire was developed by adapting survey items from existing studies in the supply chain literature to use it in the RL context (Tallon *et al.,* 2000; Kim & Narasimhan, 2002; Subramani, 2004; Zhu *et al.,* 2004; Daugherty *et al.,* 2005; Ravichandran & Lertwongsatien, 2005; Zhu & Kraemer, 2005; Beheshti *et al.,* 2007; Bhagwat & Sharma, 2007; Chang & Shaw, 2009; Genchev *et al.,* 2011; Hong &Yeh, 2012). The instrument included a section to capture the demographic details of the organization including revenue, number of employees and industry classification in addition to a 5-point Likert scale (1 - Strongly Disagree, 5 – Strongly Agree) to capture perception of respondents with regards to the items of respective constructs. It was then distributed to organizations through electronic emails and personal visits for pilot testing and analysis. Frequent follow-ups were carried out and reminders were sent to facilitate the process to ensure that respondents respond to the survey instrument. The research constructs, their respective scale items and associated references have been tabulated in Table 7 while the complete instrument including the demographic section is presented in Appendix I.

Table 7 – Questionnaire Constructs, Items and References

S No.	Construct	Item Code	Item Description	References
1	Economic Performance (EP)	EP1	Reverse Logistics operations in the company effectively handles the recovery of assets for the products returned by the customer.	Autry *et al.,* (2001); Daugherty *et al.,* (2002)
		EP2	Reverse Logistics operations in the company has an impact on containing the cost of operations in the company.	Autry *et al.,* (2001); Daugherty *et al.,* (2002)
		EP3	The investment in inventory has reduced due to the reverse logistics operations in the organization.	Autry *et al.,* (2001); Daugherty *et al.,* (2002)
		EP4	The organization is incurring lower compliance costs with environmental regulations due to the returns handling method.	Autry *et al.,* (2001); Daugherty *et al.,* (2002)
2	Operational Performance (OP)	OP1	The cycle time of the returned products has reduced as a result of handling the returned merchandise in the organization.	Bayraktar *et al.,* (2010)
		OP2	The organization's reverse logistic operations have a positive impact on the internal efficiency of the processes within the organization.	Bayraktar *et al.,* (2010)
		OP3	The reverse supply chain enables the organization to efficiently track products.	Olorunniwo & Li (2010)
		OP4	The productivity levels of the organization have been benefitted by the reverse logistic operations.	Bayraktar *et al.,* (2010)
		OP5	Reverse logistic system has an impact on improving the organization's forecasting accuracy.	Bayraktar *et al.,* (2010)
		OP6	The capacity utilization improves by the use of well-defined reverse supply chain processes.	Bayraktar *et al.,* (2010)
3	Customer Relations	CR1	The quality of re-work and repair of the returned products has shown improvement due to an efficient returned merchandise handling strategy.	Daugherty *et al.,* (2002); Richey *et al.,* (2005)
		CR2	The reverse logistics system in the organization has led to timely rework and repair of the returns.	Daugherty *et al.,* (2002); Richey *et al.,* (2005)
		CR3	The organization's reverse logistic operations are able to handle the reconciliation of charge-backs effectively.	Daugherty *et al.,* (2002); Richey *et al.,* (2005)
		CR4	The customers value the organization more if quick action is taken on the returned products and the customers are kept informed about its status.	Daugherty *et al.,* (2002); Richey *et al.,* (2005)
		CR5	The customer satisfaction levels have increased as a result of efficient reverse logistic operations in the organization.	Daugherty *et al.,* (2002); Richey *et al.,* (2005)
4	Strategic Benefits	SB1	Carrying out the reverse logistic operations in an organized manner gives the organization an edge over its competitors.	Subramani (2004)
		SB2	Having a well organized product return system helps the organization in forming strategic partnerships with its supply chain partners.	Bhagwat & Sharma (2007)
		SB3	Organization also gets strategic benefits like reduced delivery lead time and customer query time by having a systematic reverse logistics process.	Bhagwat & Sharma (2007)
5	Supply Chain Agility & Flexibility (AF)	AF1	The reliability of the product being delivered is increased through the use of a systematic product return process.	Swafford *et al.,* (2008)
		AF2	The organization is able to launch new products quickly due to an organized reverse-logistics operations.	Swafford *et al.,* (2008)
		AF3	The organization is able to offer customized products quickly by studying the customer's product return patterns.	Swafford *et al.,* (2008)
		AF4	The organization gains flexibility in the manufacture of its products as a result of having a well-defined reverse-supply chain strategy.	Swafford *et al.,* (2008)
		AF5	Reworking and re-using the returned products provides the organization flexibility in terms of product range and product volume.	Swafford *et al.,* (2008)

S No.	Construct	Item Code	Item Description	References
6	Supply Chain Coordination (CN)	CN1	Improved coordination with distributors and wholesalers is enabled by efficient reverse supply chain practices of the organization.	McLaren *et al.,* (2004)
		CN2	The duration of interaction between the organization and its suppliers as a result of the product returns, has reduced to quite an extent due to the organized product return process of the organization.	McLaren *et al.,* (2004)
		CN3	Reverse logistic operations of the organization tends to reduce the tendency of organization to interact with its supply chain partners just on a transactional basis.	McLaren *et al.,* (2004)
7	IS Capability (CP)	CP1	The process of developing reverse supply chain information systems is flexible to allow infusion of new methodology, tools and techniques.	Ravichandran & Lertwongsatien (2005)
		CP2	The organization has sophisticated information systems to record, track and respond to service requests from the customers.	Ravichandran & Lertwongsatien (2005)
		CP3	Very less manual intervention is required to run the reverse logistics information systems since most of the operational tasks are automated.	Ravichandran & Lertwongsatien (2005)
		CP4	Supply chain partners are able to avoid repeated spending or purchase of reverse logistic information systems.	Yeh *et al.,* (2012)
8	IS for Logistics (LO)	LO1	The information systems used in the reverse supply chain enables faster product return handling upto the vendors.	Beheshti *et al.,* (2007)
		LO2	The information systems used in the reverse logistic supply chain facilitates faster communication of information from and to the customers.	Beheshti *et al.,*(2007)
		LO3	The supply chain information systems consists of a demand forecasting system for making demand forecasts.	Kim & Narasimhan (2002)
		LO4	For making decisions regarding location selections for warehouses and plants in the supply chain, a plant and warehouse location selection systems is being used.	Kim & Narasimhan (2002)
		LO5	The reverse supply chain of the organization uses information systems for effectively managing orders from and towards the customers.	Kim & Narasimhan (2002)
9	IS for Value Creation (VC)	VC1	Information Systems used in the reverse supply chain are being used to establish, sustain and improve customer relationships in the organization.	Tallon *et al.,* (2000)
		VC2	The IS usage in the reverse supply chain has decreased the cost of transactions being carried out.	Zhu *et al.,* (2004)
		VC3	The usage of IS in the reverse logistics has improved the coordination among the members of the supply chain.	Zhu *et al.,* (2004)
		VC4	Information System usage in the reverse supply chain has led to increase in the efficiency of the staff working on the day-to-day operations of the supply chain.	Zhu & Kraemer (2005)
		VC5	The reverse supply chain information systems reduces error while handling the transactions during the product return process as compared to manual handling.	Chang & Shaw (2009)
		VC6	The information systems in reverse supply chain improve the timeliness of information delivery across the supply chain.	Chang & Shaw (2009)
		VC7	Customer requests in regard to product / services specifications and quality, delivery time and customer services gets met quickly and efficiently through use of information system in reverse logistics.	Chang & Shaw (2009)
		VC8	Effective communication of orders, inventory, and invoice information with the supply chain partners can be done through the use of IS in reverse logistics.	Chang & Shaw (2009)
10	IS Partnership Quality (PQ)	PQ1	There is a high degree of trust between the IS / IT department and the organization's supply chain partners.	Ravichandran & Lertwongsatien (2005)
		PQ2	The goals and plans of developing IS are jointly developed by the IS department and the supply chain partners.	Ravichandran & Lertwongsatien (2005)
		PQ3	Critical Information and knowledge that impacts IS / IT projects are shared freely between the IS department and the organization supply chain partners.	Ravichandran & Lertwongsatien (2005)

S No.	Construct	Item Code	Item Description	References
11	Return Frequency (RF)	RF1	The frequency of product returns to the organization due to the product end of life factor is very high.	Genchev *et al.,* (2011)
		RF2	The frequency of product returns to the organization due to defects in the product is very high.	Genchev *et al.,* (2011)
		RF3	The frequency of product returns to the organization due to unsold items is very high.	Genchev *et al.,* (2011)
12	Resource Commitment (RC)	RC1	The organization has committed technological resources while handling returns from the customer.	Daugherty *et al.,* (2005)
		RC2	The organization has allocated appropriate manpower to deal with the product returns from the customer.	Daugherty *et al.,* (2005)
		RC3	The organization is focused to dedicate a good amount of its capital for its reverse logistics operations.	Daugherty *et al.,* (2005)
13	Formalised Processes (FP)	FP1	The vendor of the organization follows strict operating procedures defined by the organization	Genchev *et al.,* (2011)
		FP2	The organization stresses on going through proper channels for getting the job done	Genchev *et al.,* (2011)
		FP3	Specific rules and guidelines are used by the organization for outsourcing the routing to a third party	Genchev *et al.,* (2011)
		FP4	The routing / return-processing procedures are explicitly verbalized and communicated to customers as well as suppliers	Genchev *et al.,* (2011)
14	Government Regulations (GR)	GR1	The organization puts specific emphasis on the monitoring and regulatory compliance of environment-related issues	Shaik & Abdul-Kaider (2012)
		GR2	The organization complies with the regulation of re-using material from product returns	Shaik & Abdul-Kaider (2012)
		GR3	The organization is responsible for the disposal of non-reuse part of returned products as a part of government regulations	Shaik & Abdul-Kaider (2012)
15	Strategic Focus (SF)	SF1	Reverse Logistic operations form a part of the strategic plans of the organization	Skapa & Klapalova (2012)
		SF2	The strategy of the organization gives specific focus on planning and buying of the IS infrastructure for reverse logistics	Skapa & Klapalova (2012)

3.5 <u>Sampling and Data Collection</u>

As discussed in introduction and literature review, reverse logistics is prominent in selected industries including automobile / auto-parts, e-commerce, retail & apparels, food & beverages, electrical & electronic goods, pharmaceuticals and chemical with the frequency of returns varying across these sectors as well. The reason for its prominence only in a few industries is the continued emphasis of practitioners on the forward chain to achieve competitive benefits and the notion of it being assumed primarily as a cost center (Jayant *et al.*, 2011). Hence the developed questionnaire was sent to top and middle level management in these selected industries specifically engaged in supply chain, manufacturing / production, logistics and information systems domain. The data was collected in multiple phases as stated below:

a) Pilot Testing Phase 1 (Sample: 31)
b) Pilot Testing Phase 2 (Sample: 112)
c) Confirmatory Factor Analysis (Sample: 155)
d) Structural Equation Modeling (Sample: 295)

The detailed description of each phase is presented in sections of the subsequent chapter. The sampling method used was a combination of convenience and snowball sampling although an effort was made to send it to organizations across varied geographical locations in India. Convenience sampling is known as availability sampling and is a type of non-probability sampling method which depends on data collection from sample elements who are conveniently available to participate in the study (Dudovskiy, 2017a). It is a method which involves getting participants wherever you can find them and typically wherever is convenient. In convenience sampling, limited criterion is identified prior to the selecting sample elements and is specifically used when the instrument needs to be pilot tested (Dudovskiy, 2017a).

On the other hand, snowball sampling, also known as chain-referral sampling, "is a non-random sampling method used when characteristics to be possessed by samples are rare and difficult to find" (Dudovskiy, 2017b). This sampling method involves sample elements nominating other potential sample elements for data collection purposes. This sampling method is applicable where the sample elements are hidden and it is tough to get a large sample size through other available sampling methods (Dudovskiy, 2017b). In the undertaken research on reverse logistics, where data collection is complex due to organizations not willing to share performance-related information and due to reverse logistics performance in only a few industries, a combination of these two sampling methods were used.

The industry wise sample distribution of the collected sample is illustrated in Table 8.

Table 8 – Industry-wise Sample distribution

S No	Industry	%age
1	Automobile / Auto Component	25.42%
2	e-Commerce, Retail & Logistics	12.88%
3	Electronics & IT Hardware	25.43%
4	Consumable Goods	27.46%
5	Others	8.81%

Annual-turnover data was collected via the demographic section in the questionnaire where respondents in organizations were asked to select a pre-specified turnover range (given in Table 9). The responses indicate that 33.89% of the respondents had an annual turnover of less than 100 crores while 30.51% of the respondents had annual turnover greater than 1000 crores with the remaining 35.60% falling in the middle range of 100 to 1000 crores. This signifies that based on turnover, the sample was uniformly distributed.

Table 9 – Sample Distribution based on Turnover

S No	Annual Turnover (in Crores)	%age
1	Less than 50	22.03%
2	51 to 100	11.86%
3	101 to 250	10.85%
4	251 to 500	11.53%
5	501 to 1000	13.22%
6	1001 to 2500	3.73%
7	2501 to 5000	8.81%
8	Above 5000	17.97%

3.6 Statistical Techniques Used

Before validating the proposed hypotheses using appropriate statistical techniques, reliability and validity of the research instrument was evaluated. The reliability of the instrument was measured by using Cronbach's alpha reliability analysis. Literature defines Cronbach's alpha as "a measure of internal consistency, that is, how closely related a set of items are as a group" ("What does Cronbach's alpha mean? | SPSS FAQ - IDRE Stats", 2017). The higher the value, the more is the internal consistency of the instrument being evaluated. It can be done for individual constructs as well as for the entire instrument. For social science researches, a Cronbach's alpha value greater than 0.70 is considered acceptable, although a value close to or greater than 0.60 is also considered reasonable in certain scenarios (Cronbach, 1951; Nunnally & Bernstein, 1994).

The instrument was also evaluated for its content validity. Content validity of the instrument refers to "the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose" (Haynes *et al.*, 1995). To validate the content of the instrument, the instrument is sent to academia and industry for constructive feedback, which are duly incorporated. Another method to take feedback is by holding interviews with academia and industry and duly incorporating the feedback comments.

To validate the proposed research framework, Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were used. Confirmatory factor analysis is a statistical technique used in studies to investigate the structure of multivariate data and to reason out whether the hypothesized structure is appropriate for multivariate data by generating a set of model-fit indices (Fox, 2010). Although the literature suggests an ongoing debate on the use of confirmatory factor analysis over exploratory factor analysis in organizational research (Hurley *et al.*, 1997), it has also thrown a few indicators with regards to its use in specific situations. In general, literature suggests that confirmatory factor analysis is to be used in situations where researchers have a strong theoretical background underlying their measurement model before analyzing data (Williams, 1995), while exploratory factor analysis is often considered to be more appropriate than confirmatory factor analysis in the early stages of scale development and in situations with little theoretical foundation. With the undertaken research having a good theoretical framework with scales adapted from existing supply chain literature, confirmatory factor analysis was used to investigate the proposed structure through by using model-fit indices.

The literature has suggested a minimal sample size requirement for confirmatory factor analysis and structural equation modeling-based studies. Although there are no hard and fast rules, there are a few heuristics which can be used to identify minimal sample size for such researches (Hazen *et al.*, 2015). Hair *et al.*, (2010) suggested that a 10:1 ratio of sample size to estimated parameters is acceptable. Other literature suggests that a number <200, regardless of sample size to parameter ratio, is unacceptable (Barrett, 2007). But there have been studies in literature which have used sample sizes below 200 (Menachof *et al.*, 2009). But these studies have been far and few and literature suggests that only in specific conditions such as models with no latent variables, very strong correlation between variables or where the population size is quite small to generate a sample greater than 200 (Kenny, 2014).

The most relevant model fit indices reported by studies involving confirmatory factor analysis include ratio of Chi-square and degree of freedom (CMIN/DF), Goodness Fit Index (GFI), Adjusted Goodness Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker Lewis Index (TLI), Root Mean Residual (RMR), Root Mean Standard Error of Approximation (RMSEA) and the HOELTER's criterion. The ratio of Chi-square and degree of freedom is commonly known as relative chi-square or normed chi-square. Hair *et al.,* (2010) suggested that the ratio must be close to one and must not be more than five for the measurement model to be acceptable. A few studies from the literature suggests that the ratio should not be more than three (Qi *et al.,* 2011; Zhu *et al.,* 2013).

The first ever index proposed to represent model-fit was the goodness of fit index (GFI) (Jöreskog, 1969). It represents the variance that can be explained by the measurement model and ranges between zero to one. Literature suggests the value should be close to 1 (Jöreskog, 1969; Hair *et al.,* 2010) with most studies considering a goodness of fit index value of 0.9 and above as acceptable for a good model-fit (Hair *et al.,* 2010; Saldanha *et al.,* 2013). A few researchers have also accepted the goodness of fit index value ranging from 0.8 to 0.9 due to low sample size (Chiou *et al.,* 2011; Zhu *et al.,* 2013).

Adjusted goodness of fit index (AGFI) is a model-fit index which corrects the goodness of fit as it gets affected by number of indicators of each latent variable (Hair *et al.,* 2010). Studies have recommended that the adjusted goodness of fit index value of 0.8 and above is an acceptable indicator of a good model-fit (Hair *et al.,* 2010; Saldanha *et al.,* 2013) while a value between 0.7 and 0.8 is considered moderately acceptable (Chiou *et al.,* 2011; Zhu *et al.,* 2013).

Comparative fit index (CFI), also known as Bentler comparative fit index (Bentler, 1990), compares the measurement model with the null model. Comparative fit index represents the ratio between discrepancy of the measurement/target model and independence/null model (Bentler, 1990). The comparative fit index value ranges from zero to one. Researchers have suggested that comparative fit index value must be close to one and a value above 0.9 is considered acceptable for a good-model fit (Bentler, 1990; Hair *et al.,* 2010).

Normed fit index (NFI) is commonly known as Bentler-Bonett fit index (Bentler & Bonett, 1980). It is defined as the ratio of the difference between chi-square of independence/null model and measurement/target model, and chi-square of independence/null model. Studies recommend that the normed fit index of 0.9 or above is considered acceptable while a value between 0.8 and 0.9 is considered moderately acceptable to establish goodness-of-fit for the measurement model (Chiou *et al.,* 2011; Zhu *et al.,* 2013).

Tucker Lewis Index (TLI) is usually reported in studies and overcomes the disadvantage of normed-fit index by ensuring that there is a penalty of adding parameters (Tucker & Lewis, 1973). Tucker Lewis index depends on the average size of the correlation in the data and if the average correlation between variables is not high than the value of Tucker Lewis index will be low. A value close to 0.90 or above represents a good model-fit.

Root mean residual (RMR) represents the difference between corresponding elements of observed and predicted covariance matrix. A value close to zero is considered as acceptable for a good model fit (Hair *et al.,* 2010). Researchers have suggested that ideally it must be less than 0.05 (Hair *et al.,* 2010; Saldanha *et al.,* 2013).

Root mean standard error of approximation (RMSEA) represents the relationship between chi-square, degree of freedom and sample size (Hair *et al.,* 2010). It is stated as a “badness of fit” index, where a value of zero indicates best fit (Kline, 2011). Studies have suggested that the root mean standard error of approximation values of 0.01, 0.05 and 0.08 represent excellent, good and mediocre fit respectively (MacCallum *et al.,* 1996). However, researchers have suggested that a value between 0.05 and 0.08 is acceptable for a good model-fit (Hazen *et al.,* 2015).

HOELTER’s criterion was proposed by Hoelter (1983) which by focusing on sample size, provides a method for assessing goodness-of-fit. In other words, the Hoelter Index states the sample size at which the chi-square will be significant ($\alpha = 0.05$). Indicating how small one's sample size will be for performing the confirmatory factor analysis.

Confirmatory factor analysis is limited to the extent that it only provides a measurement model fit but gives no indicators about the relationships among latent variables. Moreover, confirmatory factor analysis models direct effects of factors on measured variables that is unable to deal with indirect effects (Nachtigall *et al.,* 2003; Hair *et al.,* 2010; Saldanha *et al.,* 2013). To measure the indirect affects, structural equation modeling is performed on the measurement model provided by confirmatory factor analysis.

Structural equation modelling provides the predictive order of measured variables along with measurement of latent factors which includes the direct as well as the indirect effect measures. Additionally, structural equation modeling is a combination of path analysis, factor analysis as well as regression analysis (Hair *et al.,* 2010; Saldanha *et al.,* 2013) and hence is required to validate the research hypotheses.

The discussion above clearly highlights the objectives of the current research in addition to proposing the research models and a discussion on techniques to be used for validating the proposed framework. The subsequent chapter will emphasize on analyzing the collected data togenerate causal relationships among the latent variables undertaken for analysis by using several statistical techniques including pilot testing, reliability analysis, correlation analysis, confirmatory factor analysis and structural equation modeling.

CHAPTER IV

ANALYSIS & RESULTS

ANALYSIS AND RESULTS

4.1 Pilot Testing

The survey instrument was administered to nearby organizations to pilot test the data for reliability and content validity. A sample of 31 responses was collected on which the reliability and validity tests were performed. For content validity, the respondents from organization were requested to review and comment on the questionnaire items and suggest improvements which were duly incorporated in the questionnaire for further data collection. For evaluating reliability of the instrument, the collected sample was subjected to Cronbach Alpha reliability analysis using alpha method as tabulated in Table 10. Except for supply chain coordination and resource commitment, all other Cronbach alpha values were found to be close to the reasonably acceptable value of 0.60 (Cronbach, 1951; Nunnally & Bernstein, 1994) with the instrument having an overall Cronbach alpha of 0.96. After incorporating the changes suggested by respondents, the questionnaire was sent for further data collection to evaluate reliability improvements. The collected sample of 112 was subjected to a second phase of Cronbach alpha and split-half analysis and all reliability values were found to be above 0.60 (Cronbach, 1951; Nunnally & Bernstein, 1994). The split-half analysis further showcased that the instrument is reliable for smaller sample sizes with all values in both halves being reasonably acceptable.

Table 10 – Reliability Analysis on Pilot Data

S No.	Description	DATASET (31) Cronbach α	DATASET (112) Cronbach α	Cronbach α 1	Cronbach α 2
1	Full Instrument	0.96	0.973	0.97	0.976
2	Economic Performance (EPER)	0.631	0.705	0.676	0.725
3	Strategic Benefits (SBEN)	0.755	0.748	0.777	0.714
4	Customer Relations (CREL)	0.759	0.804	0.758	0.839
5	SC Coordination (SCOO)	0.368	0.623	0.577	0.67
6	SC Agility and Flexibility (SAFL)	0.683	0.754	0.692	0.804
7	Operational Performance (OPER)	0.811	0.864	0.804	0.907
8	IS Capability (ISCP)	0.752	0.744	0.769	0.73
9	IS for Logistical Operations (ISLO)	0.629	0.785	0.713	0.836
10	IS for Value Creation (ISVC)	0.853	0.915	0.903	0.924
11	IS Partnership Quality (ISPQ)	0.822	0.842	0.841	0.843
12	Strategic Focus (SFOC)	0.666	0.672	0.708	0.638
13	Resource Commitment (RCOM)	0.572	0.673	0.675	0.673
14	Formalized Processes (FPRO)	0.697	0.8	0.777	0.819
15	Government Regulations (GREG)	0.838	0.771	0.841	0.709
16	Return Frequency (RFRE)	0.839	0.837	0.853	0.82

4.2 Respondents

The sampling method used was a combination of convenience and snowball sampling although an effort was made to send it to organizations across geographical locations in India. The reason for choosing the sampling was to make use of one's own as well as respondents' references for data collection. To analyze the variation in resource commitment and return frequencies, the developed questionnaire was distributed to organizations across industrial sectors where reverse logistics is prominent. The sample for the survey involved middle and top management executives in the supply chain, logistics and IS domains. A total of 1458 questionnaires were sent out of which 365 were returned by the respondents. Out of the returned responses, 70 were deemed incomplete because of missing values and hence rejected, leading to 295 valid responses for an overall response rate of 20.23% which is considered acceptable as per literature (Gosain *et al.,* 2004-5; Fynes *et al.,* 2005).

4.3 Confirmatory Factor Analysis

To test the conceptual framework, a sample of 155 responses was taken to establish a measurement model using Confirmatory Factor Analysis (CFA) in AMOS 21.0. CFA is generally used to establish a measurement model using an instrument where items have been adapted from existing scales in the literature and a structure of items for a given construct already exists (Suhr, 2006). Since the study instrument included items which were adapted from existing scales in the supply chain literature, this method was used to develop an integrated IS measurement model for enhancing RL performance.

For the purpose of analysis, reverse logistics performance was taken as the mean of all performance constructs i.e. economic performance, operational performance, customer relations, strategic benefits, supply chain agility & flexibility and supply chain coordination. Instrument items were allocated as observed variables while the unobserved variables were named in line with the constructs in the study. Covariance arrows were drawn between unobserved variables and items were loaded onto the observed variables from the data file selected for analysis. The initial measurement model constructed from the data collected is depicted in Figure 9. The model-fit indices generated from the initial measurement model is tabulated in Table 11 which can be observed to be poor as per the acceptable limits set for the mentioned good-fit indices. The initial covariance matrix and standardized residual covariances have been listed in Table 12 and Table 13 respectively.

Table 11 – Goodness of Fit Summary (Initial Model)

S No	Goodness of Fit Parameters	Values	Acceptable	Good / Marginal
1	CMIN/DF	2.157	1 to 3	Good
2	Root Mean Residual (RMR)	0.074	<0.05	Poor
3	Root Mean Standard Error of Approximation (RMSEA)	0.087	<0.06	Poor
4	Comparative Fit Index (CFI)	0.739	>0.90	Poor
5	Tucker Lewis Index (TLI)	0.724	>0.90	Poor
6	Goodness Fit Index (GFI)	0.587	>0.90	Poor
7	Adjusted Goodness Fit Index (AGFI)	0.546	>0.80	Poor
8	Normed Fit Index (NFI)	0.608	>0.90	Poor

Table 12 – Covariance Matrix

			M.I.	Par Change				M.I.	Par Change
e53	<-->	e54	4.620	.075	e39	<-->	e43	4.620	.077
e51	<-->	FOPR	4.715	-.051	e38	<-->	ISCP	7.077	-.110
e51	<-->	ISPQ	9.550	-.080	e38	<-->	RLPER	4.384	.075
e51	<-->	e53	8.663	.097	e38	<-->	e53	10.077	.151
e50	<-->	ISPQ	6.207	.069	e38	<-->	e51	23.001	.230
e50	<-->	e55	5.069	-.076	e38	<-->	e50	6.125	-.127
e50	<-->	e51	11.022	-.117	e38	<-->	e48	5.335	-.093
e49	<-->	ISVC	4.531	-.036	e38	<-->	e44	4.087	-.097
e49	<-->	RLPER	6.078	.062	e38	<-->	e39	5.470	-.092
e49	<-->	e55	10.502	-.106	e37	<-->	STFO	6.421	-.074
e49	<-->	e50	5.810	.088	e37	<-->	ISCP	4.003	.046
e48	<-->	FOPR	9.657	.062	e37	<-->	ISLO	5.057	-.033
e48	<-->	e55	5.316	.061	e33	<-->	ISVC	4.347	.038
e48	<-->	e53	7.234	-.074	e33	<-->	e54	4.230	.078
e47	<-->	ISLO	4.502	.033	e33	<-->	e42	5.335	-.088
e47	<-->	RLPER	5.615	.052	e33	<-->	e35	4.755	.074
e47	<-->	e55	6.619	-.073	e32	<-->	FOPR	5.066	.059
e47	<-->	e50	10.418	.102	e32	<-->	e43	10.738	.162
e47	<-->	e49	8.731	.090	e32	<-->	e36	4.515	-.061
e46	<-->	ISLO	6.205	-.039	e30	<-->	e48	4.567	.050
e45	<-->	ISPQ	6.513	-.071	e30	<-->	e41	4.372	-.062
e45	<-->	e55	5.829	.085	e29	<-->	e53	5.384	-.089
e45	<-->	e49	4.929	-.084	e29	<-->	e51	4.454	-.081
e44	<-->	STFO	4.772	-.076	e29	<-->	e48	11.979	.112
e44	<-->	e45	7.652	.101	e29	<-->	e39	5.736	.076
e42	<-->	ISLO	5.705	.042	e29	<-->	e38	7.496	-.153
e42	<-->	e46	6.549	-.081	e28	<-->	e49	5.351	-.087
e41	<-->	ISPQ	7.713	.076	e28	<-->	e45	4.456	.085
e41	<-->	e55	7.288	-.090	e28	<-->	e42	4.169	.080
e41	<-->	e50	13.480	.136	e27	<-->	ISLO	4.152	.034
e41	<-->	e49	5.824	.086	e27	<-->	e54	6.024	-.083
e41	<-->	e47	16.539	.127	e27	<-->	e41	4.375	.070
e40	<-->	e51	4.315	.058	e27	<-->	e33	11.914	-.118
e40	<-->	e42	16.304	.121	e27	<-->	e31	7.337	.090
e39	<-->	FOPR	4.346	.040	e26	<-->	e55	7.382	.086
e26	<-->	e52	4.430	.065	e16	<-->	e50	12.443	.162
e26	<-->	e50	5.835	-.085	e16	<-->	e26	4.559	-.092
e26	<-->	e28	5.117	.082	e16	<-->	e25	4.878	-.125
e25	<-->	STFO	11.030	.152	e16	<-->	e23	4.225	.130
e25	<-->	e55	8.257	.119	e16	<-->	e19	6.436	.138

			M.I.	Par Change
e25	<-->	e51	7.121	-.116
e25	<-->	e45	9.166	.145
e25	<-->	e38	4.011	-.125
e25	<-->	e37	6.130	-.090
e25	<-->	e34	4.861	.096
e24	<-->	ISPQ	6.649	.094
e24	<-->	e38	4.737	.146
e24	<-->	e32	5.350	.122
e23	<-->	e43	5.634	.152
e23	<-->	e32	11.490	.186
e23	<-->	e26	5.237	-.110
e23	<-->	e24	53.210	.496
e22	<-->	ISLO	4.167	.041
e22	<-->	RLPER	7.439	-.077
e22	<-->	e53	6.693	.098
e22	<-->	e50	5.731	.097
e22	<-->	e44	4.225	.078
e22	<-->	e36	4.991	.065
e22	<-->	e35	4.078	-.074
e22	<-->	e29	6.007	-.109
e22	<-->	e27	4.077	.074
e22	<-->	e26	13.413	-.139
e21	<-->	e55	6.459	-.083
e21	<-->	e53	4.064	.068
e21	<-->	e24	4.157	.098
e20	<-->	STFO	4.273	-.088
e20	<-->	ISLO	6.966	.056
e20	<-->	RLPER	14.657	-.115
e20	<-->	e40	4.137	.070
e20	<-->	e24	14.207	.214
e20	<-->	e23	10.301	.190
e20	<-->	e22	6.428	.118
e19	<-->	FOPR	4.649	-.064
e19	<-->	ISLO	9.129	.067
e19	<-->	e48	5.128	-.080
e19	<-->	e42	4.757	.097
e19	<-->	e38	6.194	.151
e19	<-->	e37	6.066	-.086
e19	<-->	e31	5.066	.099
e19	<-->	e30	5.128	-.080
e19	<-->	e26	5.843	-.101
e19	<-->	e22	10.341	.155
e18	<-->	e38	4.987	.152
e18	<-->	e32	4.093	.108
e18	<-->	e24	19.457	.292
e18	<-->	e23	21.606	.321
e18	<-->	e19	11.128	.199
e17	<-->	e39	4.019	.067
e17	<-->	e36	5.120	-.070
e17	<-->	e21	27.810	.221
e9	<-->	e41	4.530	.092
e9	<-->	e29	4.952	.106
e9	<-->	e28	6.345	-.114
e9	<-->	e26	5.610	-.097
e9	<-->	e21	4.985	-.094
e9	<-->	e10	6.943	.090

			M.I.	Par Change
e15	<-->	e44	7.393	-.108
e15	<-->	e41	16.604	.170
e15	<-->	e21	11.262	-.137
e15	<-->	e17	6.218	-.122
e14	<-->	e42	4.001	-.071
e14	<-->	e25	4.075	-.088
e14	<-->	e24	5.102	-.106
e14	<-->	e23	4.195	-.100
e14	<-->	e18	7.322	-.129
e14	<-->	e15	4.938	-.089
e13	<-->	ISVC	6.576	.052
e13	<-->	RLPER	8.913	-.088
e13	<-->	e52	15.282	.146
e13	<-->	e41	7.544	.115
e13	<-->	e33	9.415	.131
e13	<-->	e24	4.792	-.122
e13	<-->	e22	4.390	.096
e13	<-->	e21	6.800	-.107
e13	<-->	e15	25.001	.239
e12	<-->	ISLO	4.140	.042
e12	<-->	e41	6.094	.101
e12	<-->	e39	4.924	-.071
e12	<-->	e19	8.226	.142
e12	<-->	e17	12.173	-.168
e12	<-->	e16	8.210	.146
e12	<-->	e15	4.939	.104
e11	<-->	e47	5.389	-.069
e11	<-->	e41	4.626	-.075
e11	<-->	e26	21.004	.151
e11	<-->	e23	8.606	-.143
e11	<-->	e22	18.284	-.163
e11	<-->	e19	6.071	-.103
e11	<-->	e18	6.950	-.125
e10	<-->	RLPER	5.160	.047
e10	<-->	e43	6.638	.094
e10	<-->	e32	4.486	-.066
e10	<-->	e26	4.887	.061
e10	<-->	e24	6.880	-.102
e10	<-->	e23	10.060	-.128
e10	<-->	e20	9.162	-.102
e10	<-->	e19	5.634	-.083
e10	<-->	e18	4.872	-.087
e10	<-->	e14	13.359	.102
e10	<-->	e11	16.156	.111
e9	<-->	ISPQ	4.232	.066
e9	<-->	RLPER	8.918	-.091
e9	<-->	e54	5.877	.106
e9	<-->	e53	5.742	-.097
e9	<-->	e46	4.457	.078
e9	<-->	e45	4.019	-.091
e3	<-->	e5	10.745	-.128
e2	<-->	ISLO	9.941	-.051
e2	<-->	e53	4.499	.065
e2	<-->	e51	4.700	.067
e2	<-->	e42	5.482	-.077
e2	<-->	e39	4.015	-.051

			M.I.	Par Change
e8	<-->	e48	4.433	-.078
e8	<-->	e47	6.388	.100
e8	<-->	e44	4.141	.089
e8	<-->	e40	5.758	-.089
e8	<-->	e35	4.225	.086
e8	<-->	e26	6.936	-.115
e8	<-->	e19	18.593	.239
e8	<-->	e16	8.030	.162
e8	<-->	e12	10.708	.170
e8	<-->	e11	17.559	-.185
e7	<-->	e41	6.459	-.125
e7	<-->	e26	7.660	-.129
e7	<-->	e23	5.649	.163
e7	<-->	e16	15.676	.242
e7	<-->	e15	14.769	-.216
e7	<-->	e14	5.355	.110
e7	<-->	e13	5.561	-.133
e7	<-->	e8	4.321	.130
e6	<-->	e38	4.343	-.108
e6	<-->	e21	4.073	-.074
e6	<-->	e20	7.568	-.120
e6	<-->	e9	4.256	-.091
e5	<-->	e47	5.766	.090
e5	<-->	e39	4.323	.071
e5	<-->	e38	4.444	-.128
e5	<-->	e26	11.046	-.138
e5	<-->	e23	16.431	.248
e5	<-->	e19	6.492	.135
e5	<-->	e18	5.261	.137
e5	<-->	e16	10.911	.180
e5	<-->	e12	7.214	.133
e5	<-->	e8	13.853	.207
e5	<-->	e7	6.324	.149
e4	<-->	FOPR	5.116	-.073
e4	<-->	e34	6.284	.115
e4	<-->	e16	5.991	.145
e4	<-->	e14	4.492	-.098
e4	<-->	e12	7.405	.147
e3	<-->	e50	5.340	-.076
e3	<-->	e43	6.845	-.107
e3	<-->	e27	5.077	-.067
e3	<-->	e26	4.615	.066
e3	<-->	e24	9.614	-.135
e3	<-->	e23	14.230	-.171
e3	<-->	e20	6.777	-.098
e3	<-->	e16	6.322	-.101
e3	<-->	e11	7.441	.085
e3	<-->	e10	6.979	.068

			M.I.	Par Change
e2	<-->	e26	4.396	.064
e2	<-->	e20	8.629	-.111
e2	<-->	e19	11.797	-.134
e2	<-->	e16	7.675	-.111
e2	<-->	e14	5.067	.070
e2	<-->	e12	8.917	-.109
e2	<-->	e9	4.684	-.083
e2	<-->	e5	17.875	-.165
e2	<-->	e3	7.232	.077
e1	<-->	ISLO	5.572	-.039
e1	<-->	e53	4.647	.066
e1	<-->	e51	4.073	.063
e1	<-->	e42	4.750	-.072
e1	<-->	e23	4.285	-.094
e1	<-->	e20	8.048	-.107
e1	<-->	e19	12.115	-.136
e1	<-->	e18	4.595	-.095
e1	<-->	e16	5.989	-.099
e1	<-->	e12	13.825	-.136
e1	<-->	e9	6.738	-.100
e1	<-->	e5	14.747	-.150
e1	<-->	e3	7.104	.077
e1	<-->	e2	144.399	.346

Table 13 – Initial Standardized Residual Covariances

	VC8	VC7	VC6	VC5	VC4	VC3	VC2	VC1	PQ3	PQ2	PQ1	LO5	LO4	LO3	LO2	LO1
VC8	0															
VC7	0.09	0														
VC6	0.511	0.797	0													
VC5	0.338	0.569	-0.063	0												
VC4	0.301	0.473	1.167	0.318	0											
VC3	-0.956	0.111	0.195	-0.378	-1.565	0										
VC2	-1.295	-0.44	-0.108	-0.403	0.141	1.133	0									
VC1	0.677	-0.216	-0.781	-0.074	-0.459	0.141	-0.288	0								
PQ3	-0.658	0.41	-0.778	-0.8	-1.237	1.528	1.273	-0.311	0							
PQ2	0.09	0.62	-0.71	-0.313	-1.34	0.491	0.248	0.228	0.286	0						
PQ1	1.494	0.764	0.681	0.187	-0.347	0.464	0.006	0.543	-0.48	-0.159	0					
LO5	0.091	-0.334	0.434	0.329	-0.392	0.371	0.218	0.584	-0.294	-0.558	1.493	0				
LO4	0.49	-0.367	-0.665	0.176	-0.006	0.47	0.217	0.237	0.309	0.632	0.449	-0.632	0			
LO3	-0.292	-0.655	-0.329	-0.001	0.055	-0.223	-0.934	-0.185	0.13	-1.241	0.432	-0.182	0.295	0		
LO2	-1.129	0.449	-0.804	0.07	-0.414	1.613	0.926	-0.13	1.75	0.208	0.781	-0.506	-0.249	0.098	0	
LO1	0.016	-0.005	-0.158	0.23	0.75	-0.47	-0.565	0.024	-0.29	-0.823	-0.333	0.037	-0.562	1.518	-0.23	0
CP4	-0.043	0.007	-0.43	-0.053	-0.623	-0.171	0.503	0.287	-0.533	-0.216	0.662	0.699	1.537	-0.741	-0.216	-0.755
CP3	0.965	1.106	2.736	0.588	3.722	-0.845	1.856	0.174	0.066	0.75	1.991	0.515	1.868	1.039	0.964	1.545
CP2	-0.007	-0.806	-0.358	-0.005	-0.637	-1.049	0.08	-0.11	-0.786	-0.135	0.633	0.226	0.636	-1.281	-0.891	-1.409
CP1	0.321	-0.006	0.283	-0.162	-0.033	-0.362	0.329	0.226	-0.292	0.123	1.299	1.013	0.729	0.018	0.393	-0.253
SF2	-0.135	0.823	-0.204	-0.645	0.744	-0.441	1.325	-0.069	0.194	-0.446	0.703	-0.366	0.746	0.261	0.8	-0.226
SF1	-0.407	0.185	-0.842	-0.218	0.096	-0.014	0.517	0.1	-0.32	-0.034	0.648	-0.819	1.204	-0.278	0.061	0.12
GR3	0.998	0.592	-0.715	0.983	-0.196	0.1	-0.423	0.597	-1.067	-0.377	1.103	0.622	-0.034	-0.727	0.066	-0.362
GR2	0.331	-1.365	-1.512	-0.333	-0.921	0.181	-0.638	0.158	-0.846	0.2	1.231	-0.03	1.763	0.694	-0.951	-1.558
GR1	0.569	-0.687	0.022	0.268	-0.337	0.025	-0.174	0.6	0.174	-0.208	1.074	0.589	-0.321	0.603	0.36	-0.296
FP4	0.106	-0.583	-0.366	-0.583	-1.049	0.471	-0.553	1.036	-0.83	-0.132	1.042	0.846	0.747	-0.707	-1.05	-1.059
FP3	1.113	0.446	-0.71	0.204	-1.037	0.908	0.346	2.518	0.472	0.946	0.843	1.174	0.998	0.561	0.053	0.298
FP2	0.386	-0.594	-0.945	-0.183	-1.033	-0.668	-1.731	-0.212	-0.965	-0.195	1.585	0.279	0.253	0.544	-0.728	-1.452
FP1	0.784	-1.11	0	0.561	-0.417	0.244	0.201	0.811	-0.493	-0.127	0.959	0.854	1.202	0.95	0.871	-0.077
EP1	0.386	-0.874	-0.23	-0.004	-0.145	-1.324	0.417	-1.189	-0.292	-0.929	-0.314	-0.052	0.533	-1.293	-0.958	-0.964
EP2	1.841	0.349	0.168	-0.213	-0.831	1.266	0.28	0.501	0.955	0.443	2.558	0.587	0.154	-0.082	0.7	-0.258
EP3	-0.399	-0.357	1.16	-0.055	0.503	0.928	1.104	-0.498	1.974	1.268	0.951	0.812	1.881	0.438	0.507	0.231
EP4	0.304	0.62	0.714	0.334	1.322	0.952	1.677	0.61	1.26	0.543	0.191	0.767	2.524	1.029	0.438	0.199
OP1	0.767	0.524	2.478	0.806	1.327	2.159	1.411	0.536	0.683	-0.34	1.214	2.408	0.46	1.109	0.879	1.25
OP2	-1.416	-0.587	0.876	-0.352	-0.12	0.44	0.1	-0.951	-0.561	-1.124	-0.534	0.782	0.426	0.142	-1.217	-0.138
OP3	1.596	1.158	2.287	1.887	1.576	2.181	1.92	1.033	1.409	1.121	1.825	2.476	2.236	1.664	1.632	2.426
OP4	-0.357	0.732	0.321	0.319	1.358	0.864	1.047	-0.551	1.307	0.245	0.347	1.718	2.071	1.881	1.445	1.021
OP5	0.247	-0.468	0.77	0.188	0.568	-0.158	1.464	0.489	1.273	0.693	1.786	0.467	1.317	0.707	0.615	-0.311
OP6	-0.846	-0.896	-0.414	-0.008	-0.158	-0.849	-0.221	-0.648	-0.47	-0.728	-0.213	0.357	0.375	-0.418	-1.283	-0.068
CR1	-0.19	0.661	1.324	-0.141	0.415	2.389	1.322	-0.324	1.566	-0.277	1.519	0.885	1.611	0.715	-0.148	0.238
CR2	0.692	0.197	1.065	0.588	1.327	0.782	1.085	0.205	0.757	-0.097	0.612	-0.138	-0.218	0.679	2.362	1.36
CR3	-0.861	-0.453	-0.223	-0.594	0.057	0.391	1.073	-0.223	0.999	-0.108	-0.108	0.543	0.28	-1.326	-0.634	-0.47
CR4	1.02	1.495	0.983	3.047	1.541	1.75	1.353	1.664	1.345	0.693	1.054	1.1	0.497	0.764	2.648	1.851
CR5	-0.259	0.561	-0.218	-0.101	0.258	0.546	1.69	0.385	1.002	-0.492	0.734	1.274	0.164	0.598	1.467	0.676
SB1	-0.496	-0.666	-0.292	-0.939	0.245	-0.747	0.325	-0.312	-0.691	-0.584	-0.464	-0.111	1.05	-0.929	-1.48	-0.248
SB2	-0.521	-1.501	-0.788	-1.097	0.214	-1.002	0.735	-0.832	-0.307	-1.072	-0.725	-0.089	1.22	-1.259	-1.242	-1.126
SB3	1.61	1.951	0.158	1.233	1.182	0.533	1.331	1.298	2.199	1.81	0.49	0.936	2.215	0.167	1.822	1.086
AF1	-0.31	0.206	1.081	-0.513	0.86	1.216	1.72	-0.611	1.968	-0.026	1.129	2.047	1.514	0.417	1.352	-0.629
AF2	-1.198	0.055	0.013	-1.41	0.039	0.034	0.035	-0.748	0.025	-1.161	0.116	-0.141	1.036	-0.363	-2.038	-1.561
AF3	-0.485	0.047	0.311	-1.197	-0.378	-0.578	0.912	-0.65	0.338	-0.644	-0.17	0.436	-0.716	-0.235	-0.993	-1.188
AF4	-0.456	0.697	0.151	0.409	0.14	1.41	1.407	-0.253	1.854	0.091	0.289	1.14	1.454	1.288	0.139	1.196
AF5	-0.225	0.025	-0.229	0.308	-0.502	0.441	-0.301	0.101	0.727	0.109	1.28	0.895	0.506	1.125	0.035	0.546
CN1	-0.767	-0.827	0.387	-0.911	0.608	-1.357	-0.433	-0.815	-0.871	-1.355	-0.493	-0.229	-1.095	-0.665	-1.047	-0.815
CN2	-0.116	-0.957	0.695	-1.098	0.885	-0.857	0.173	-0.487	0.099	-0.633	-0.206	0.163	-0.573	-1.651	-1.285	-1.199
CN3	-0.254	-0.889	0.74	-1.343	0.863	-0.696	0.292	-0.518	-0.137	-0.745	-0.087	0.474	-0.728	-1.615	-1.226	-1.15

	CP4	CP3	CP2	CP1	SF2	SF1	GR3	GR2	GR1	FP4	FP3	FP2	FP1	EP1	EP2
VC8															
VC7															
VC6															
VC5															
VC4															
VC3															
VC2															
VC1															
PQ3															
PQ2															
PQ1															
LO5															
LO4															
LO3															
LO2															
LO1															
CP4	0														
CP3	-0.782	0													
CP2	0.23	-0.001	0												
CP1	-0.102	-0.063	0.052	0											
SF2	0.128	2.02	-0.86	0.445	0										
SF1	0.241	1.194	-1.072	0.18	0	0									
GR3	-0.028	-0.009	0.194	0.21	1.151	-0.242	0								
GR2	0.299	-0.139	-0.291	-0.689	-0.555	-0.299	0.227	0							
GR1	0.078	0.473	-0.261	0.256	0.681	-0.466	0.353	-0.457	0						
FP4	0.473	-0.244	-0.598	-0.427	-0.317	-0.156	-0.324	0.549	-0.394	0					
FP3	1.761	-1.264	0.981	0.247	0.507	0.988	0.033	0.691	-0.122	-0.157	0				
FP2	-0.059	-0.407	-0.759	-0.373	0.174	-0.69	-0.347	1.078	-0.324	0.278	-0.406	0			
FP1	0.212	0.894	-0.081	0.133	-0.231	0.553	-1.499	0.327	0.955	-0.029	0.101	-0.035	0		
EP1	-0.23	1.762	0	-0.552	-0.614	-0.26	-0.489	-0.021	-0.5	0.071	0.594	0.644	0.505	0	
EP2	1.285	-0.001	-0.286	0.87	2.015	2.632	1.221	1.649	1.422	1.521	1.887	1.978	1.829	0.775	0
EP3	0.686	2.908	-0.428	0.12	-0.392	0.464	-0.936	1.473	0.286	-0.017	-0.483	0.287	0.312	-0.601	0.916
EP4	1.098	2.204	0.431	0.596	-0.249	0.401	-0.085	2.569	0.301	0.689	0.971	0.121	0.9	-1.106	0.835
OP1	0.999	1.938	0.468	1.528	-0.62	0.446	0.651	0.016	1.814	1.019	-0.366	-0.161	1.687	-1.46	0.618
OP2	-0.093	1.879	-0.674	-0.589	-1.1	-0.326	-1.109	-0.623	0.186	-0.286	-0.769	-0.327	-0.271	-0.154	-0.144
OP3	2.108	2.053	1.778	2.155	0.002	0.457	1.902	2.612	1.993	0.91	1.175	0.656	1.238	-0.051	0.133
OP4	0.583	3.122	-0.743	0.343	0.574	1.271	-0.221	0.561	1.804	-1.269	-0.183	-0.956	-0.008	-1.114	0.196
OP5	1.85	3.443	0.898	1.069	0.533	0.839	-0.163	1.65	1.22	-0.002	0.838	0.079	0.842	-0.9	0.6
OP6	0.205	1.128	-0.248	-0.914	-0.498	0.013	-0.717	0.207	0.332	-0.189	-0.367	-0.207	0.932	0.118	0.614
CR1	-0.265	1.435	0.068	-0.498	0.135	0.161	0.514	0.343	-0.15	0.182	-0.116	-0.856	-0.492	-0.968	-1.497
CR2	-0.286	1.858	-0.292	-0.012	0.467	1.124	1.105	-0.618	0.179	0.783	0.926	0.067	1.168	0.503	0.811
CR3	-0.312	1.101	-0.606	-0.319	-0.252	0.065	-1.055	-0.848	-0.071	-0.334	0.439	-0.547	-0.69	0.175	-1.013
CR4	0.767	0.082	1.112	0.572	0.226	0.657	2.788	0.833	1.442	0.856	1.336	-0.571	1.04	-0.521	0.927
CR5	-0.95	1.309	-0.954	0.006	0.207	1.018	0.566	-0.58	0.686	-0.08	0.424	-1.16	0.223	-0.503	-0.334
SB1	-0.044	1.818	-0.185	-0.553	-0.185	0.025	-1.095	-0.125	0.143	0.236	0.657	-0.222	-0.336	1.319	0.07
SB2	-0.604	1.493	-0.453	-1	-0.423	-0.144	-1.243	-1.824	-0.742	-0.856	0.095	-1.565	-0.055	0.607	-0.565
SB3	1.199	1.618	0.383	0.554	1.212	1.129	0.081	0.113	0.818	0.506	1.869	-1.272	0.812	-1.016	0.02
AF1	0.572	1.421	-0.396	0.284	1.52	0.796	0.434	0.382	1.927	-0.043	0.512	0.136	1.387	-1.189	-0.036
AF2	-0.341	1.526	-0.289	-0.77	-0.526	-0.29	-1.671	-0.376	0.074	-0.855	-0.669	-1.31	-1.166	-1.193	-0.528
AF3	-0.133	0.352	0.007	0.072	0.123	-0.243	-1.628	-0.783	-0.388	-0.752	0.724	-0.734	0.458	0.463	0.229
AF4	1.417	-0.069	0.153	0.818	0.353	0.701	-0.171	0.256	0.867	-0.22	0.152	-0.555	0.65	-1.57	0.494
AF5	-0.724	0.819	-0.165	-0.215	0.023	1.559	0.614	-0.158	-0.101	-1.22	-0.613	-1.217	-1.597	-0.056	0.183
CN1	-0.864	1.998	-0.336	-0.579	-0.394	-0.689	-0.589	-1.308	-0.125	-0.032	0.101	0.136	-0.782	0.629	-0.729
CN2	-0.625	1.611	-0.108	-0.151	-0.802	-0.475	-0.573	-0.42	0.113	0.161	0.154	-0.423	-0.459	0.614	-0.418
CN3	-0.513	1.533	-0.223	-0.07	-0.916	-0.726	-0.619	-0.548	0.169	0.194	0.18	-0.679	-0.357	0.565	-0.558

	EP3	EP4	OP1	OP2	OP3	OP4	OP5	OP6	CR1	CR2	CR3	CR4	CR5	SB1	SB2	SB3
VC8																
VC7																
VC6																
VC5																
VC4																
VC3																
VC2																
VC1																
PQ3																
PQ2																
PQ1																
LO5																
LO4																
LO3																
LO2																
LO1																
CP4																
CP3																
CP2																
CP1																
SF2																
SF1																
GR3																
GR2																
GR1																
FP4																
FP3																
FP2																
FP1																
EP1																
EP2																
EP3	0															
EP4	5.067	0														
OP1	0.588	0.565	0													
OP2	1.058	-0.548	0.734	0												
OP3	2.313	2.054	1.359	0.864	0											
OP4	1.273	1.285	1.879	0.747	0.416	0										
OP5	2.891	3.172	0.573	-0.055	1.124	2.182	0									
OP6	0.89	-0.086	0.35	2.185	-0.267	0.068	0.148	0								
CR1	0.58	1.405	0.714	-0.643	1.038	1.662	-0.298	-1.013	0							
CR2	-0.646	0.229	0.156	-1.622	0.614	0.258	0.296	-1.26	0.944	0						
CR3	-1.094	-1.038	-0.445	0.37	-0.666	-0.182	-1.284	-0.467	0.312	-1.001	0					
CR4	-1.499	0.377	1.261	-1.392	0.181	0.275	-0.704	-0.016	0.582	3.212	-0.914	0				
CR5	-0.458	0.13	0.744	-0.755	0.564	1.757	-0.031	-1.729	1.729	1.275	0.043	1.208	0			
SB1	-0.348	-1.329	-1.594	0.059	-0.193	-1.063	-1.116	0.065	-0.672	-0.011	0.328	-0.169	-0.37	0		
SB2	-1.083	-1.373	-0.39	-0.11	-1.135	-0.978	-0.892	0.089	-0.003	-0.014	1.055	-0.507	-0.134	1.029	0	
SB3	0.361	1.177	0.998	-1.078	0.762	1.051	0.918	-0.429	-0.195	0.461	-0.092	0.904	0.842	-0.361	1.009	0
AF1	0.04	1.071	0.933	0.043	0.498	2.815	0.977	-0.487	1.823	-0.039	-0.097	0.104	1.968	-1.771	-0.478	0.586
AF2	0.087	1.556	-0.299	0.092	-0.342	0.888	0.203	0.09	2.445	-2.258	1.047	-1.521	0.127	-0.107	0.163	0.258
AF3	-0.617	-0.481	-0.257	-0.782	-1.277	-0.828	0.14	0.222	-0.32	-0.48	-0.147	-0.56	0.815	0.436	0.453	-0.977
AF4	1.239	2.872	0.354	-0.335	1.118	1.732	1.534	-0.226	2.213	-0.049	-0.277	0.535	1.684	-0.72	-0.529	1.023
AF5	0.988	0.975	-0.799	-0.16	-0.207	0.97	1.194	0.073	1.641	0.707	-1.051	0.806	1.707	-0.505	-0.353	-0.918
CN1	-1.361	-1.735	-0.441	0.35	-1.039	-0.842	-0.194	-0.029	-1.083	0.596	-0.202	0.266	-0.357	0.745	0.687	-0.668
CN2	-0.589	-0.657	-0.513	0.024	-1.174	-1.507	-0.457	0.13	-1.195	-0.428	0.694	-0.572	-1.194	0.138	-0.252	-0.883
CN3	-0.912	-0.992	-0.418	0.207	-1.181	-1.589	-0.961	0.247	-1.099	-0.435	0.606	-0.713	-1.548	0.051	-0.231	-1.103

	AF1	AF2	AF3	AF4	AF5	CN1	CN2	CN3
VC8								
VC7								
VC6								
VC5								
VC4								
VC3								
VC2								
VC1								
PQ3								
PQ2								
PQ1								
LO5								
LO4								
LO3								
LO2								
LO1								
CP4								
CP3								
CP2								
CP1								
SF2								
SF1								
GR3								
GR2								
GR1								
FP4								
FP3								
FP2								
FP1								
EP1								
EP2								
EP3								
EP4								
OP1								
OP2								
OP3								
OP4								
OP5								
OP6								
CR1								
CR2								
CR3								
CR4								
CR5								
SB1								
SB2								
SB3								
AF1	0							
AF2	1.279	0						
AF3	-0.425	0.895	0					
AF4	2.485	1.613	1.036	0				
AF5	0.115	0.261	0.417	1.377	0			
CN1	-0.35	-0.593	0.378	-1.473	0.132	0		
CN2	-0.841	-0.123	-0.084	-1.903	-0.72	0.75	0	
CN3	-0.507	-0.118	0.154	-1.798	-0.756	0.77	3.49	0

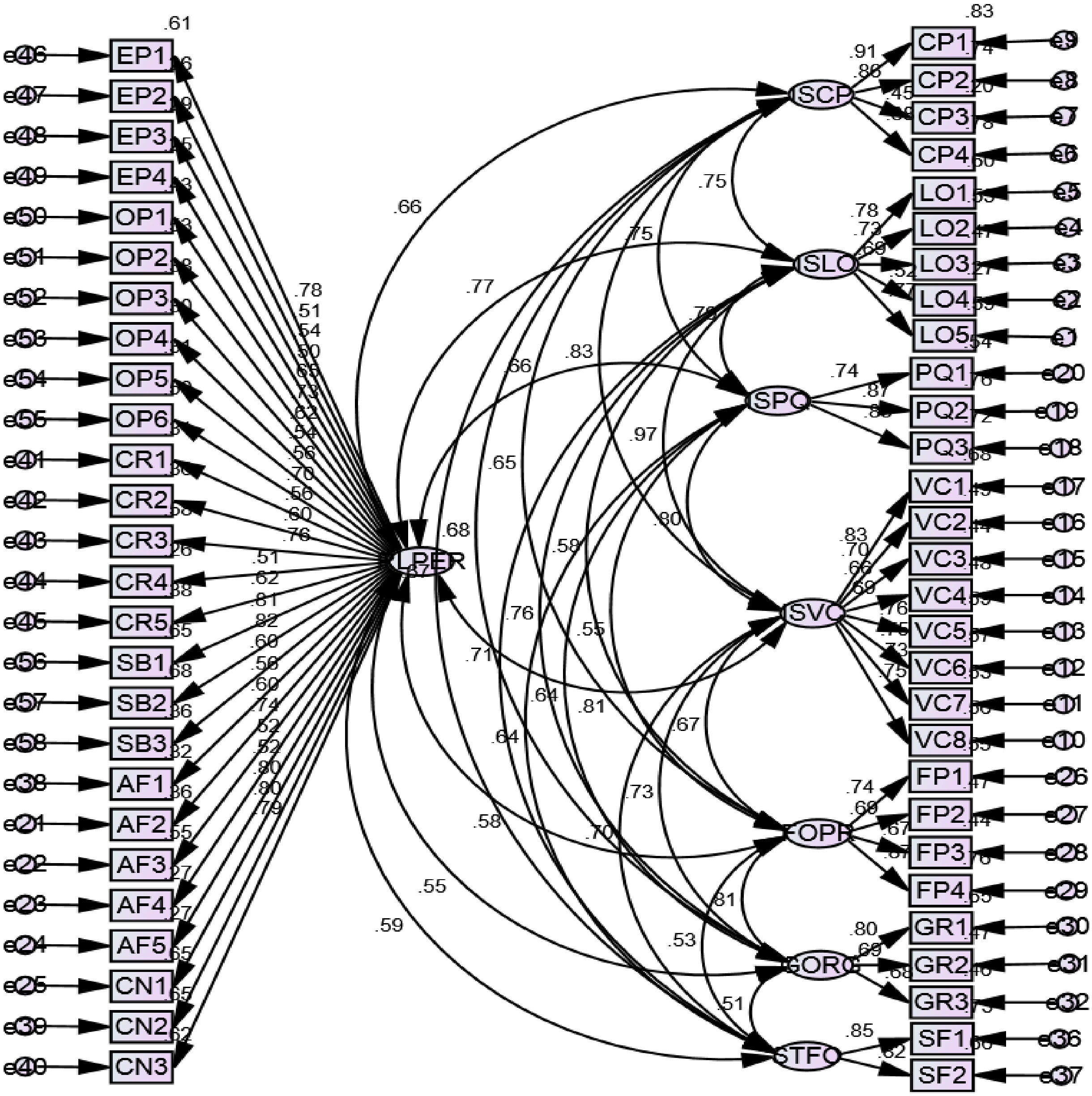

Figure 9 – Initial Measurement Model for RL Performance

The literature suggests structural equation modeling as a combination of exploratory factor analysis and multiple regression (Ullman & Bentler, 2003) while a few other studies consider structural equation modeling and confirmatory factor analysis as an exploratory technique in addition to using it for confirmatory purposes (Schreiber *et al.*, 2006). As observed in Table 11, the goodness-of-fit indices of the intial measurement model were found to be poor. To improve the measurement model, covariances were created between pairs of error terms belonging to the same latent variable and having very high covariance values (values > 10) in the covariance matrix through a sequence of iterations. The pair of error terms between which covariances were created to improve the measurement model is tabulated in Table 14.

Table 14 –Covariances Between Error Terms

Iterations	Error Terms	Between Items	Latent Variable
Iteration 1	e14 →e15	VC4, VC3	ISVC
Iteration 2	e12 → e14	VC6, VC4	ISVC
Iteration 3	e10 → e16	VC8, VC2	ISVC
Iteration 4	e39 → e40	CN2, CN3	RLPER
Iteration 5	e48 → e49	EP3, EP4	RLPER
Iteration 6	e57 → e58	SB2, SB3	RLPER
Iteration 7	e51 → e57	OP2, SB2	RLPER
Iteration 8	e51 → e52	OP2, OP3	RLPER
Iteration 9	e42 → e44	CR2, CR4	RLPER
Iteration 10	e42 → e46	CR2, EP1	RLPER
Iteration 11	e46 → e47	EP1, EP2	RLPER
Iteration 12	e22 → e23	AF3, AF4	RLPER

To further improve the measurement model, a few items where absolute standardized residual covariance values were very high were removed from the model to reach a model fit. In the IS Capability (ISCP) construct, item 3 (CP3) was removed as it was observed to be overlapping with the item 2 with regards to use of sophisticated systems to track, record and respond to service requests. With regards to IS for Logistical Operations (ISLO) construct, item 2 (LO2) and item 4 (LO4) were removed from the analysis as they were found to be overlapping and lacking relevance in the reverse logistics context. While LO2 was found to have been covered by LO1 which deals with faster product handling from customers upto the vendors, LO4 was found to be more relevant to the forward supply chain context.

Items VC3, VC4, VC7 and VC8 were removed from the further analysis based on the standardized residual covariance values. While the item loadings of items VC3 and VC4 were found to be relatively low (0.66 and 0.69 respectively), statements for VC7 and VC8 were found to be too broad and overlapping with other items in the IS for value creation construct (VC6 and VC1 respectively) and hence removed from further analysis.

Item PQ1 was also removed from the measurement model owing to its high standardised residual covariance value. When the item statement was reviewed, it was perceived that the item was very loosely defined with regards to trust between supply chain partners and hence removed from the model. In addition, the item loading for the item was relatively low as compared to other items in the latent variable (0.74 as against 0.87 and 0.85 for PQ2 and PQ3 respectively).

With respect to the formalised processes construct (FOPR), FP3 was found to have high residual covariance and hence removed from the model. On careful observation, it was found that the item loading for the item FP3 was considerably low as compared to other items in the latent variable (0.67 as against 0.74, 0.69 and 0.87 for FP1, FP2 and FP4 respectively). Also, on careful review of the item statements, it was detected to be overlapping with item FP4 which also deals with routing and return-processing procedures.

In the government regulations (GREG) construct, GR2 was found to be having relatively high residual covariance with other items in the matrix and hence removed from the measurement model to establish goodness-of-fit. A careful assessment of the construct item statements led to the argument that the item GR2 was overlapping in context and meaning with GR1 which emphasises on monitoring and regulatory compliance of environment related issues.

As mentioned earlier, the RL performance variable (RLPER) was taken to be the aggregation of 6 performance variables reviewed and conceptualised from the literature. With the aggregated performance construct consisting of 26 items, quite a few of them were found to be having very high residual covariance values. The covariance values for the economic performance items i.e. EP2, EP3 and EP4 were found to be high and hence the items were removed from the measurement model for further analysis. On careful observation, it was found to be overlapping with other item statements within the performance construct. Also, their respective item loadings on the latent variable RLPER were found to be relatively low i.e. 0.51, 0.54 and 0.50 respectively.

With regards to operational construct in reverse logistics performance, OP1, OP3, OP4 and OP5 were found to have high residual covariances across other items in the measurement model. Analysis of the initial path diagram also indicated low factor loadings (0.65, 0.62, 0.54 and 0.56 respectively), thereby leading to deletion of the items for further analysis.

The residual covariances of customer relation performance items CR1, CR2, CR4 and CR5 were found to be abnormally high and hence were removed to establish model fit. The initial path diagram shows low factor loadings for the mentioned 4 customer relation items i.e. 0.56, 0.60, 0.51 and 0.62 respectively. A review of the item statements show overlap between items CR1 and CR2 as well as between items CR4 and CR5 respectively, thus clearly justifying the need to omit these items from the RL performance measurement model.

Amongst the strategic measures of reverse logistics performance, SB3 was found to have large residual covariance values in the matrix. The item statements clearly indicated that SB3 was very loosely defined and meant more of an operational benefit than a strategic outcome and hence could be removed. Even the item loading in the initial measurement model created was found to be low for SB3 (0.60). With regards to agility and flexibility measures, it was found that AF1, AF4 and AF5 were found to be having overlapping statements with item loadings of 0.56, 0.52 and 0.52 respectively which are considered quite low and hence can be omitted from further analysis.

The resultant measurement model is depicted in Figure10. A CMIN/DF of 1.501 (acceptable: 1 to 5), a Comparative Fit Index (CFI) of 0.946 (acceptable>0.9), a Root Mean Residual (RMR) of 0.041 (acceptable<0.05) and a Root Mean Standard Error of Approximation (RMSEA) of 0.057 (acceptable<0.06) were achieved which represents a good model fit (Jackson *et al.,* 2009). The set of model fit values obtained have been summarized in Table 15 while the standardized regression weights between the latent variables and observed variables are listed in Table 16. The final covariance matrix between items, covariances between error terms and standardized residual covariances are tabulated in Table 17, 18 and 19 respectively.

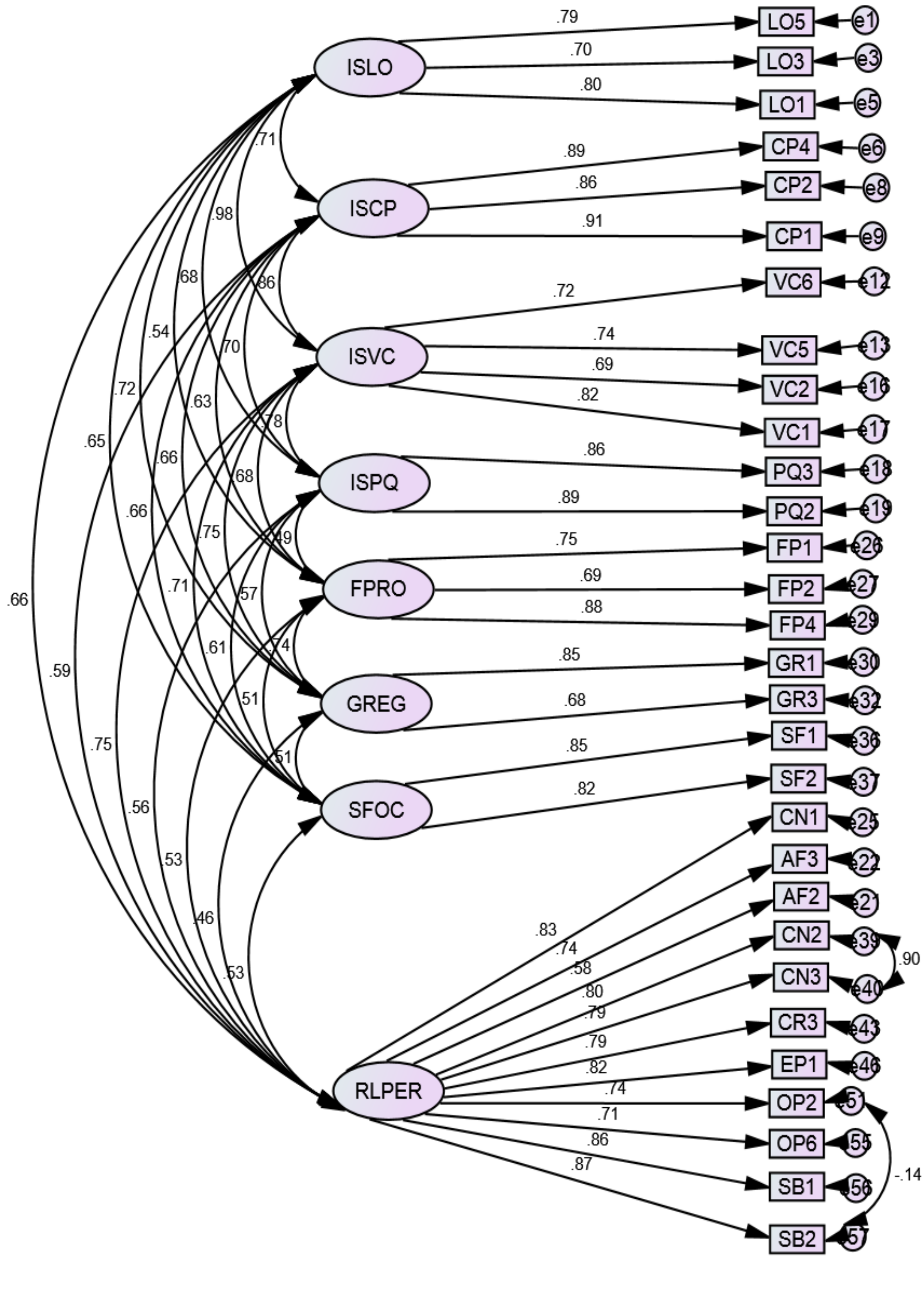

Figure 10 – Measurement Model for Reverse Logistics Performance

Table 15 – Goodness of Fit Summary

S No	Goodness of Fit Parameters	Values	Acceptable	Good / Marginal
1	CMIN/DF	1.501	1 to 3	Good
2	Root Mean Residual (RMR)	0.041	<0.05	Good
3	Root Mean Standard Error of Approximation (RMSEA)	0.057	<0.06	Good
4	Comparative Fit Index (CFI)	0.946	>0.90	Good
5	Tucker Lewis Index (TLI)	0.938	>0.90	Good
6	Goodness Fit Index (GFI)	0.819	>0.90	Marginal
7	Adjusted Goodness Fit Index (AGFI)	0.776	>0.80	Marginal
8	Normed Fit Index (NFI)	0.857	>0.90	Marginal

Table 16 – Standardized Regression Weights

Item	<---	Latent Variable	Estimate
LO3	<---	ISLO	0.701
CP2	<---	ISCP	0.862
FP2	<---	FPRO	0.692
CN2	<---	RLPER	0.805
CN3	<---	RLPER	0.792
CR3	<---	RLPER	0.785
EP1	<---	RLPER	0.820
OP2	<---	RLPER	0.736
CN1	<---	RLPER	0.831
SB2	<---	RLPER	0.865
AF3	<---	RLPER	0.744
AF2	<---	RLPER	0.576
SB1	<---	RLPER	0.858
OP6	<---	RLPER	0.711
CP1	<---	ISCP	0.910
CP4	<---	ISCP	0.890
LO1	<---	ISLO	0.803
LO5	<---	ISLO	0.794
VC6	<---	ISVC	0.720
VC5	<---	ISVC	0.739
VC1	<---	ISVC	0.818
VC2	<---	ISVC	0.686
PQ2	<---	ISPQ	0.889
PQ3	<---	ISPQ	0.862
FP1	<---	FPRO	0.745
FP4	<---	FPRO	0.880
GR1	<---	GREG	0.852
GR3	<---	GREG	0.676
SF2	<---	SFOC	0.816
SF1	<---	SFOC	0.852

Table 17 – Covariance Matrix

			Estimate	S.E.	C.R.	P	Label
ISLO	<-->	ISCP	.470	.078	6.007	***	par_4
ISLO	<-->	ISVC	.546	.080	6.861	***	par_5
ISLO	<-->	ISPQ	.412	.073	5.649	***	par_6
ISLO	<-->	FPRO	.259	.056	4.633	***	par_7
ISLO	<-->	GREG	.457	.079	5.805	***	par_8
ISLO	<-->	SFOC	.404	.074	5.421	***	par_9
ISCP	<-->	ISVC	.555	.081	6.842	***	par_10
ISCP	<-->	ISPQ	.495	.081	6.148	***	par_11
ISCP	<-->	FPRO	.349	.065	5.401	***	par_12
ISCP	<-->	GREG	.480	.083	5.792	***	par_13
ISCP	<-->	SFOC	.476	.082	5.836	***	par_14
ISVC	<-->	ISPQ	.464	.074	6.269	***	par_15
FPRO	<-->	ISVC	.320	.059	5.460	***	par_16
ISVC	<-->	GREG	.466	.077	6.090	***	par_17
ISVC	<-->	SFOC	.432	.074	5.856	***	par_18
FPRO	<-->	ISPQ	.248	.056	4.413	***	par_19
ISPQ	<-->	GREG	.384	.076	5.066	***	par_20
ISPQ	<-->	SFOC	.400	.075	5.318	***	par_21
FPRO	<-->	GREG	.393	.069	5.710	***	par_22
FPRO	<-->	SFOC	.262	.059	4.459	***	par_23
GREG	<-->	SFOC	.346	.077	4.511	***	par_24
ISLO	<-->	RLPER	.322	.066	4.873	***	par_36
FPRO	<-->	RLPER	.216	.050	4.286	***	par_37
GREG	<-->	RLPER	.248	.062	3.992	***	par_38
SFOC	<-->	RLPER	.282	.064	4.409	***	par_39
ISPQ	<-->	RLPER	.291	.063	4.594	***	par_40
ISVC	<-->	RLPER	.359	.069	5.234	***	par_41
ISCP	<-->	RLPER	.333	.069	4.829	***	par_42
e39	<-->	e40	.299	.040	7.515	***	par_26
e51	<-->	e57	-.039	.027	-1.466	.143	par_52

Table 18 – Covariance Matrix between Errors

			M.I.	Par Change
e51	<-->	ISLO	4.357	.053
e51	<-->	e55	26.907	.217
e46	<-->	e56	7.352	.076
e43	<-->	ISPQ	4.838	.068
e43	<-->	e57	5.737	.060
e25	<-->	e43	5.320	-.067
e22	<-->	e51	5.461	-.086
e21	<-->	e46	9.396	-.138
e21	<-->	e43	6.471	.120
e21	<-->	e22	4.958	.116
e37	<-->	GREG	4.902	.073
e36	<-->	GREG	4.280	-.072
e27	<-->	e57	5.665	-.068
e27	<-->	e46	4.769	.075
e26	<-->	e55	4.545	.083
e26	<-->	e25	5.143	-.065
e26	<-->	e22	4.214	.071
e26	<-->	e32	11.209	-.116
e26	<-->	e30	9.124	.101
e18	<-->	e56	5.168	-.061

			M.I.	Par Change
e18	<-->	e43	5.773	.070
e17	<-->	e29	7.517	.067
e16	<-->	e57	4.050	.054
e16	<-->	e37	4.044	.066
e16	<-->	e27	5.852	-.092
e16	<-->	e18	6.242	.077
e13	<-->	e46	5.777	.072
e13	<-->	e32	4.366	.073
e9	<-->	ISLO	4.329	.039
e9	<-->	e55	4.287	-.065
e8	<-->	SFOC	7.203	-.080
e8	<-->	ISLO	4.711	-.045
e6	<-->	e55	4.097	.067
e6	<-->	e29	5.125	.054
e3	<-->	e29	4.477	-.066
e3	<-->	e27	5.485	.092
e3	<-->	e19	4.411	-.067
e3	<-->	e18	6.075	.078
e3	<-->	e5	12.966	.106
e1	<-->	e40	4.802	.027

Table 19 – Standardized Residual Covariances of Measurement Model

	SB2	SB1	OP6	OP2	EP1	CR3	CN3	CN1	AF3	AF2	CN2	SF2	SF1	GR3	GR1
SB2	0														
SB1	0.247	0													
OP6	-0.273	-0.357	0												
OP2	0	-0.377	2.071	0											
EP1	-0.047	0.579	-0.21	-0.49	0										
CR3	0.522	-0.253	-0.682	0.139	-0.3	0									
CN3	-0.591	-0.379	0.16	0.115	0.228	0.387	0								
CN1	0.1	0.089	-0.293	0.072	0.086	-0.604	0.503	0							
AF3	0.094	0.013	0.136	-0.87	0.138	-0.354	0.085	0.12	0						
AF2	0.121	-0.205	0.24	0.244	-1.215	1.113	0.065	-0.558	1.071	0					
CN2	-0.594	-0.277	0.063	-0.047	0.295	0.493	0	0.497	-0.133	0.081	0				
SF2	-0.157	0.034	-0.123	-0.72	-0.348	0.079	-0.491	-0.074	0.534	-0.051	-0.355	0			
SF1	0.14	0.258	0.413	0.082	0.025	0.417	-0.277	-0.354	0.185	0.211	-0.001	0	0		
GR3	-0.799	-0.69	-0.224	-0.605	-0.049	-0.582	-0.059	-0.105	-1.113	-1.146	0.007	1.187	-0.203	0	
GR1	-0.444	0.403	0.732	0.596	-0.201	0.286	0.625	0.227	0.035	0.555	0.589	0.484	-0.661	0	0
FP4	-0.637	0.411	0.16	0.072	0.301	-0.04	0.6	0.252	-0.38	-0.397	0.589	-0.174	-0.002	0.109	-0.244
FP2	-1.386	-0.078	0.078	-0.035	0.837	-0.307	-0.354	0.371	-0.429	-0.944	-0.079	0.294	-0.563	0.01	-0.194
FP1	0.128	-0.198	1.231	0.027	0.696	-0.449	-0.022	-0.552	0.778	-0.784	-0.107	-0.118	0.678	-1.148	1.078
PQ2	-0.563	-0.124	-0.114	-0.501	-0.424	0.477	-0.052	-0.796	0.012	-0.465	0.088	-0.304	0.121	-0.008	-0.06
PQ3	0.234	-0.214	0.16	0.085	0.241	1.619	0.581	-0.286	1.025	0.747	0.85	0.365	-0.139	-0.69	0.35
VC1	-0.609	-0.146	-0.255	-0.552	-0.959	0.101	-0.065	-0.517	-0.224	-0.199	-0.008	-0.103	0.07	0.506	0.16
VC2	0.975	0.506	0.152	0.487	0.661	1.398	0.729	-0.137	1.33	0.54	0.63	1.325	0.523	-0.473	-0.515
VC5	-0.754	-0.653	0.487	0.151	0.355	-0.167	-0.805	-0.501	-0.687	-0.812	-0.53	-0.554	-0.117	1.012	-0.006
VC6	-0.38	0.063	0.125	1.452	0.186	0.267	1.376	0.878	0.901	0.675	1.357	-0.052	-0.682	-0.634	-0.18
CP1	-0.629	-0.236	-0.415	-0.072	-0.175	0.135	0.511	-0.139	0.622	-0.152	0.456	0.532	0.276	0.365	0.109
CP2	-0.117	0.099	0.215	-0.204	0.343	-0.2	0.306	0.063	0.508	0.287	0.447	-0.805	-1.009	0.32	-0.423
CP4	-0.28	0.228	0.67	0.38	0.101	0.09	0.006	-0.48	0.362	0.237	-0.083	0.166	0.287	0.083	-0.11
LO1	-0.734	0.097	0.463	0.405	-0.57	0.002	-0.568	-0.357	-0.64	-0.942	-0.594	0.019	0.383	-0.307	-0.543
LO3	-0.856	-0.574	0.096	0.678	-0.894	-0.866	-1.053	-0.201	0.317	0.242	-1.066	0.534	0.006	-0.634	0.429
LO5	0.302	0.22	0.879	1.324	0.339	1.014	1.07	0.223	0.996	0.486	0.779	-0.135	-0.578	0.669	0.325

	FP4	FP2	FP1	PQ2	PQ3	VC1	VC2	VC5	VC6	CP1	CP2	CP4	LO1	LO3	LO5
SB2															
SB1															
OP6															
OP2															
EP1															
CR3															
CN3															
CN1															
AF3															
AF2															
CN2															
SF2															
SF1															
GR3															
GR1															
FP4	0														
FP2	0.209	0													
FP1	-0.126	-0.11	0												
PQ2	0.32	0.174	0.252	0											
PQ3	-0.371	-0.59	-0.103	0	0										
VC1	0.928	-0.292	0.705	0.291	-0.215	0									
VC2	-0.611	-1.773	0.138	0.339	1.398	-0.142	0								
VC5	-0.553	-0.154	0.576	-0.111	-0.573	0.207	-0.123	0							
VC6	-0.274	-0.866	0.069	-0.445	-0.487	-0.433	0.242	0.426	0						
CP1	-0.249	-0.221	0.278	0.394	0.006	0.075	0.235	-0.146	0.377	0					
CP2	-0.454	-0.636	0.035	0.094	-0.533	-0.282	-0.036	-0.017	-0.297	0.047	0				
CP4	0.605	0.053	0.313	-0.006	-0.295	0.084	0.36	-0.088	-0.39	-0.136	0.161	0			
LO1	-0.965	-1.372	-0.004	-0.288	0.278	-0.147	-0.675	0.227	-0.084	-0.081	-1.277	-0.636	0		
LO3	-0.578	0.655	1.056	-0.711	0.702	-0.272	-0.975	0.059	-0.201	0.232	-1.107	-0.579	1.164	0	
LO5	0.935	0.354	0.92	-0.034	0.256	0.396	0.094	0.312	0.495	1.178	0.354	0.81	-0.413	-0.523	0

The measurement model was validated for reliability, discriminant validity and convergent validity. To achieve this, Composite Reliability (CR), Average Variance Extracted (AVE), Maximum Shared Variance (MSV) and MaxR (H) were estimated for the given constructs. Convergent validity is "the degree to which a measure is correlated with other measures that it is theoretically predicted to correlate with" (Stats.stackexchange.com, 2016). Campbell & Fiske (1959) defined convergent validity as "is the degree of confidence we have that a trait is well measured by its indicators". Fornell-Larcker (1981) used a multi-criterion approach to measure convergent validity of the measurement model. It measures Average Variance Extracted (AVE) and Composite Reliability (CR) to assess convergent validity. Average Variance Extracted measures the level of variance captured by a construct versus the level due to measurement error, values above 0.7 are considered very good while value of 0.5 is considered acceptable. Composite Reliability (CR) is a less biased estimate of reliability than Cronbach's Alpha, the acceptable value of CR is 0.7 and above. All composite reliability values were observed to be above 0.70, thereby proving the measurement model to be reliable. For convergent validity, AVE scores for all constructs were found to be above the acceptable lower limit of 0.5, thereby indicating that all observed variables were converging to their respective latent construct within the measurement model.

Fornell-Larcker (1981) defined discriminant validity as the comparison of the amount of variance captured by the construct and the shared variance with other constructs. According to the criteria, the levels of square root of the AVE for each construct should be greater than the correlation involving the constructs. In other words, the AVE for each construct should be greater than the squared correlation involving the constructs. For discriminant validity, all AVE values were found to be greater than MSV values except for IS for Logistical Operations and IS for Value Creation constructs. The reasoning why these constructs cannot be completely discriminated can be attributed to scenarios where using IS for logistical activities might lead to creating value for the end user. Also, since both these constructs deal with the usability of IS in organizations in specific contexts, there can be a correlation between the two variables.

The reliability and validity summary for the measurement model has been summarized in Table 20.

Table 20 – Reliability and Validity Summary

	CR	AVE	MSV	MaxR (H)	FPRO	ISLO	ISCP	ISVC	ISPQ	RLPER	GREG	SFOC
FPRO	0.818	0.603	0.554	0.848	0.776							
ISLO	0.811	0.589	0.951	0.910	0.542	0.767						
ISCP	0.918	0.788	0.733	0.956	0.630	0.709	0.888					
ISVC	0.830	0.551	0.951	0.964	0.684	0.975	0.856	0.742				
ISPQ	0.868	0.767	0.607	0.971	0.487	0.678	0.703	0.779	0.876			
RLPER	0.944	0.606	0.563	0.981	0.528	0.657	0.587	0.750	0.559	0.779		
GREG	0.741	0.591	0.569	0.982	0.744	0.723	0.657	0.754	0.572	0.459	0.769	
SFOC	0.821	0.696	0.507	0.984	0.507	0.652	0.664	0.712	0.608	0.532	0.506	0.834

4.4 Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) is a methodology which is used to establish a structural model to explain causality between multiple constructs in a multivariate analysis (Nachtigall *et al.*, 2003; Hair *et al.*, 2010). CFA only establishes the direct effects on the measured variables but is unable to deal with indirect effects for which SEM is required (Nachtigall *et al.*, 2003; Hair *et al.*, 2010). SEM ensures a predictive order of the measured variables along with measurement of the latent factors which will also include the indirect effect measure. Hence, to validate the proposed conceptual framework involving a series of mediation and moderation analysis, SEM needs to be used to establish causality of relationship between the constructs.

4.4.1 Mediation Effects

Mediation is an indirect effect that occurs when the causal effect of an independent variable (X) on a dependent variable (Y) is transmitted by a mediator (M). In other words, X affects Y because X affects M, and M, in turn, affects Y (Preacher *et al.*, 2007). Baron & Kenny (1986) have differentiated between complete and partial mediation and mentioned steps for a mediation analysis. Complete mediation is said to be the case in which variable X no longer affects Y after M has been controlled for whereas partial mediation is the case in which the path from X to Y is reduced in absolute size but is still different from zero when the mediator is introduced. In terms of significance, a complete mediation would involve the relationship between X and Y turning insignificant when mediator (M) is introduced while in the case of partial mediation, the relationship is still significant but with reduced β coefficient values.

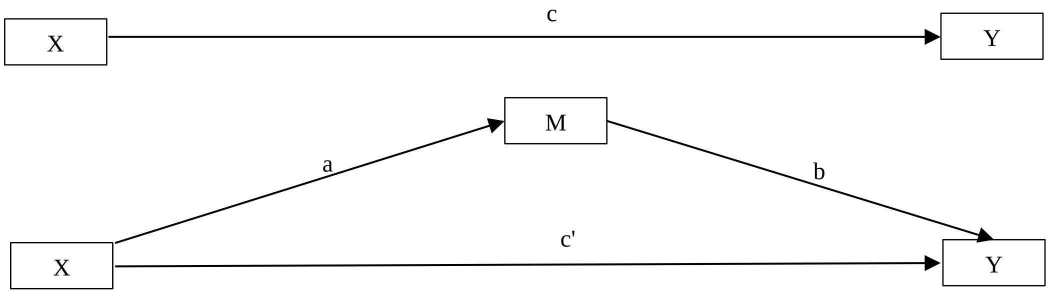

Figure 11 – The Mediation Analysis Concept (Source: Baron & Kenny (1986))

Baron & Kenny (1986) have defined a four-step process for a mediation analysis as described:

Step 1: Show that the causal variable is correlated with the outcome. Use Y as the criterion variable in a regression equation and X as a predictor (path c in the above figure). This step establishes that there is an effect that may be mediated.

Step 2: Show that the causal variable is correlated with the mediator. Use M as the criterion variable in the regression equation and X as a predictor (estimate and test path a). This step essentially involves treating the mediator as if it were an outcome variable.

Step 3: Show that the mediator affects the outcome variable. Use Y as the criterion variable in a regression equation and X and M as predictors (estimate and test path b). It is not sufficient just to correlate the mediator with the outcome because the mediator and the outcome may be correlated because they are both caused by the causal variable X. Thus, the causal variable must be controlled in establishing the effect of the mediator on the outcome.

Step 4: To establish that M completely mediates the X-Y relationship, the effect of X on Y controlling for M (path c') should be zero or insignificant. The effects in both Steps 3 and 4 are estimated in the same equation.

As per Baron & Kenny (1986), if all the four steps are met, then the variable M completely mediates the X-Y relationship, and if only the first three steps are met, then it represents a partial mediation. Preacher & Kelly (2011) advocate that in addition to the above criterion, indirect effects for the combination need to be evaluated and needs to be significant.

After CFA and subsequent validation of the measurement model, an initial structural model was created using the given constructs as shown in Figure 12. The developed structural model was subjected to a series of mediation analysis to validate the hypotheses and subsequently the conceptual framework. The three constructs i.e. formalized processes, government regulations and strategic focus were used as independent variables while the four IS constructs were individually used as mediators with RL performance being the sole dependent variable. The direct effects between each independent variable and the dependent variable were evaluated without taking the mediator into consideration. It was followed by including the mediators individually for each set of independent and dependent variable to find out the direct effects with mediator. The indirect effects were calculated by performing bootstrap with bias-corrected confidence intervals to confirm whether the mediation effects actually exist. The results of the mediation analysis have been tabulated in Table 21.

Table 21 – Mediation Analysis Results

S No	Relationship	Direct without Mediator	Direct with Mediator	Indirect Effect	Mediation
1	FPRO -> ISVC -> RLPER	0.219 (0.000)	-0.023 (0.622)	0.021	Mediation
2	FPRO -> ISLO -> RLPER	0.219 (0.000)	-0.023 (0.618)	0.477	No Mediation
3	FPRO -> ISCP -> RLPER	0.219 (0.000)	-0.023 (0.623)	0.020	Mediation
4	FPRO -> ISPQ -> RLPER	0.219 (0.000)	-0.023 (0.647)	0.037	Mediation
5	GREG -> ISVC -> RLPER	0.150 (0.013)	0.065 (0.097)	0.023	Mediation
6	GREG -> ISLO -> RLPER	0.150 (0.013)	0.065 (0.095)	0.455	No Mediation
7	GREG -> ISCP -> RLPER	0.150 (0.013)	0.065 (0.095)	0.299	No Mediation
8	GREG -> ISPQ -> RLPER	0.150 (0.013)	0.065 (0.096)	0.097	No Mediation
9	SFOC -> ISVC -> RLPER	0.315 (0.000)	0.138 (0.002)	0.006	Mediation
10	SFOC -> ISLO -> RLPER	0.315 (0.000)	0.138 (0.002)	0.405	No Mediation
11	SFOC -> ISCP -> RLPER	0.315 (0.000)	0.138 (0.002)	0.025	Mediation
12	SFOC -> ISPQ -> RLPER	0.315 (0.000)	0.138 (0.002)	0.028	Mediation
13	FPRO -> ISFR* -> RLPER	0.219 (0.000)	0.021 (0.724)	0.005	Mediation
14	GREG -> ISFR* -> RLPER	0.150 (0.013)	0.051 (0.222)	0.010	Mediation
15	SFOC -> ISFR* -> RLPER	0.315 (0.000)	0.123 (0.012)	0.007	Mediation

*** ISFR: ISVC+ISLO+ISCP+ISPQ**

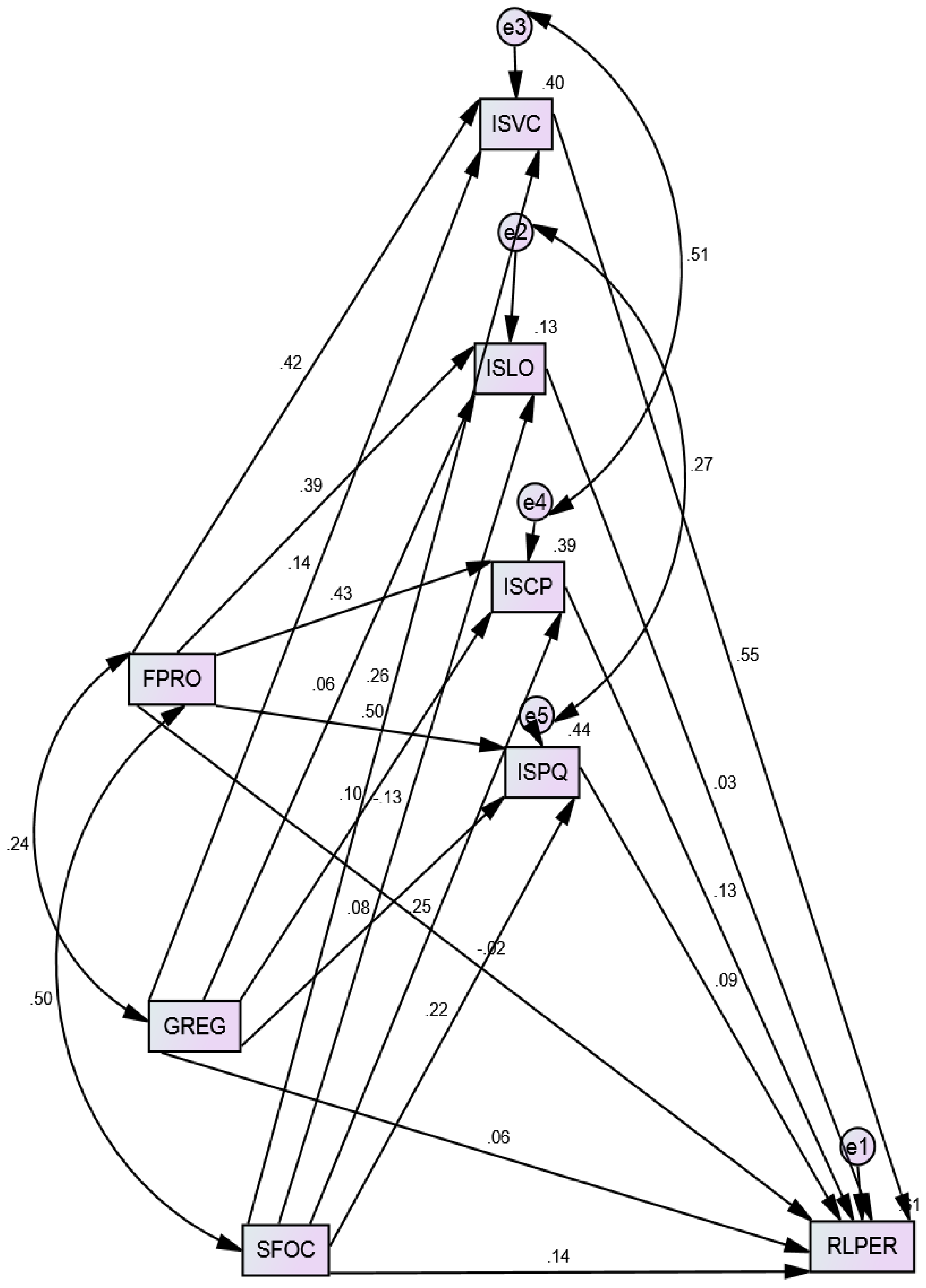

Figure 12 – Structural Model for Reverse Logistics Performance

4.4.2 Moderation Effects

Baron & Kenny (1986) define a moderator as "a qualitative (e.g., sex, race, class) or quantitative (e.g., level of reward) variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable". The moderating effect, as a result of the moderator, can be incremental or detrimental (changing directions). The moderating variables are either individual characteristics or industry level variables. With regards to the survey instrument, the moderating variable needs to be a categorical variable and not a continuous variable. If continuous, it needs to be converted into a categorical variable through use of dummy variable. The moderation effect comes from the interaction effect which is a product of the predictor and moderator variable as illustrated in Figure 13.

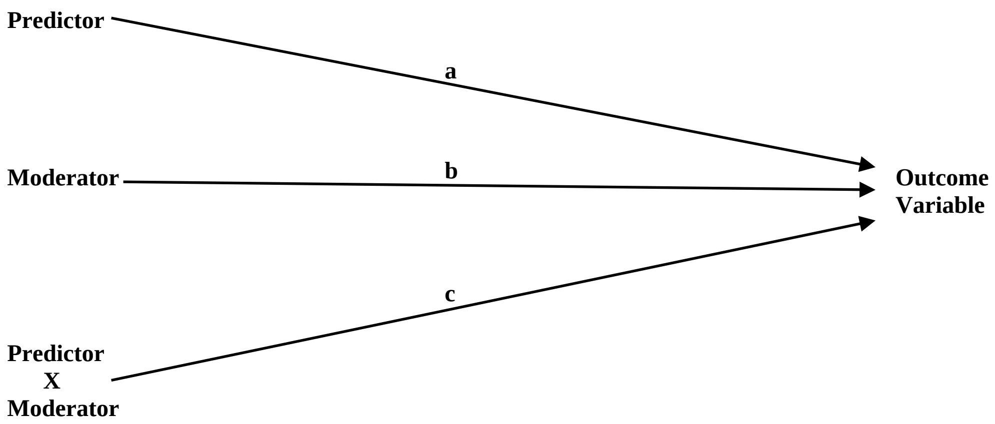

Figure 13 – Moderator Model (Source: Baron & Kenny (1986))

To analyze the moderation effects of return frequency and resource commitment, dummy variables were created to convert these continuous variables to categorical variables. These dummy variables contained binary values (0 and 1) and was done by evaluating median values for the two constructs by computing their respective frequencies in SPSS 21.0. In AMOS, 4 different groups were created to analyze the moderating impact i.e. RetFreqLow, RetFreqHigh, ResComLow and ResComHigh. Each of them was assigned these binary values evaluate the moderation effect on the structural model. The option 'critical ratios for differences' was then selected in the analysis properties to showcase the moderating effect. The table involving regression weights for each set of low and high moderating constructs along with the critical ratios for differences output was used to interpret the impact. The summary of the moderating effects for each set of variables is depicted in Table 22 and Table 23 respectively.

Table 22 – Moderation Effects of Return Frequency

Relationships			RetFreqLow		RetFreqHigh		z-score
			Estimate	P	Estimate	P	
ISCP	<---	GREG	0.154	0.019	0.346	0.000	1.89*
ISCP	<---	SFOC	0.394	0.000	0.069	0.318	-3.617***
ISCP	<---	FPRO	0.208	0.014	0.362	0.000	1.231
ISLO	<---	SFOC	0.348	0.000	0.140	0.042	-2.384**
ISVC	<---	GREG	0.221	0.000	0.204	0.006	-0.183
ISVC	<---	SFOC	0.361	0.000	0.018	0.782	-4.169***
ISLO	<---	GREG	0.228	0.000	0.255	0.000	0.274
ISLO	<---	FPRO	0.018	0.825	0.263	0.004	2.018**
ISVC	<---	FPRO	0.171	0.016	0.410	0.000	2.104**
ISPQ	<---	SFOC	0.358	0.000	0.309	0.000	-0.473
ISPQ	<---	GREG	0.169	0.023	0.258	0.004	0.759
ISPQ	<---	FPRO	0.175	0.066	0.026	0.811	-1.041
RLPER	<---	ISLO	0.139	0.054	0.165	0.048	0.235
RLPER	<---	FPRO	0.024	0.722	0.249	0.009	1.915*
RLPER	<---	GREG	-0.033	0.560	0.126	0.119	1.610
RLPER	<---	SFOC	0.139	0.020	-0.196	0.004	-3.73***
RLPER	<---	ISVC	0.341	0.012	0.330	0.000	0.091
RLPER	<---	ISCP	0.203	0.002	0.447	0.027	2.132**
RLPER	<---	ISPQ	0.153	0.012	0.046	0.523	-1.145

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Table 23 – Moderation Effects of Resource Commitment

Relationships	ResComLow		ResComHigh		z-score
	Estimate	P	Estimate	P	
RLPER <--- ISLO	0.063	0.406	0.337	0.000	2.449**
RLPER <--- FPRO	0.064	0.408	0.162	0.067	0.832
RLPER <--- GREG	-0.056	0.376	0.087	0.233	1.482
RLPER <--- SFOC	0.092	0.129	-0.050	0.537	-1.406
RLPER <--- ISVC	0.436	0.000	0.215	0.027	-1.7*
RLPER <--- ISCP	0.089	0.265	-0.058	0.469	-1.300
RLPER <--- ISPQ	0.083	0.187	0.225	0.001	1.503

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

4.4.3 Direct Relationships

Direct relationships between independent variables and IS framework constructs and between IS framework constructs and RL performance were also measured during analysis and have been tabulated in Table 24. Among the IS constructs, all except IS for Logistical Operations were found to have a significant impact on the RL performance. The possible reasons could be that in the current age of businesses becoming digital and using ecommerce, handling and detecting fraudulent returns has become a bigger challenge than handling logistics and hence might not contribute enough towards enhancing performance. Also, with the current study using reverse logistics performance as a grouping of a number of disparate performance variables, the specific impact of IS for Logistical Operations might not be directly visible and can be included in the future directions of the undertaken study. IS for Value Creation ($\beta=0.551$, $p<0.05$) was found to have the greatest impact on reverse logistics performance followed by IS Capability ($\beta=0.125$, $p<0.05$) and IS Partnership Quality ($\beta=0.093$, $p<0.05$), thereby suggesting the need for organizations to deploy systems on activities which would add value for the end consumers in addition to ensuring collaborative linkages among the supply chain partners.

Table 24 – Direct Relationships

S No	Relationship	Coefficient (p-value)	Significant
1	ISVC -> RLPER	0.551 (0.000)	Significant
2	ISLO -> RLPER	0.028 (0.502)	Not Significant
3	ISCP -> RLPER	0.125 (0.023)	Significant
4	ISPQ -> RLPER	0.093 (0.020)	Significant
5	FPRO -> ISVC	0.418 (0.000)	Significant
6	FPRO -> ISLO	0.388 (0.000)	Significant
7	FPRO -> ISCP	0.433 (0.000)	Significant
8	FPRO -> ISPQ	0.503 (0.000)	Significant
9	GREG -> ISVC	0.141 (0.003)	Significant
10	GREG -> ISLO	0.058 (0.310)	Not Significant
11	GREG -> ISCP	0.101 (0.038)	Significant
12	GREG -> ISPQ	0.079 (0.087)	Not Significant
13	SFOC -> ISVC	0.260 (0.000)	Significant
14	SFOC -> ISLO	-0.126 (0.050)	Not Significant
15	SFOC -> ISCP	0.248 (0.000)	Significant
16	SFOC -> ISPQ	0.223 (0.000)	Significant

To validate the proposed framework, the current chapter focused on the use of different analysis techniques on the reverse logistics performance data collected from industries where reverse logistics is prevalent. The subsequent chapter includes a detailed discussion on the analysis findings, theoretical contributions and managerial implications followed by conclusions, limitations and scope for future studies in the underlying area.

CHAPTER V

DISCUSSION & IMPLICATIONS

DISCUSSION & IMPLICATIONS

5.1 Discussion

The analysis carried out has led to some very useful findings for researchers and practitioners. The measurement model developed for measuring and subsequently enhancing RL performance was found to have a good fit with all goodness-of-fit parameters either above or close to the acceptable values. The factor loadings in the measurement model were quite high thereby indicating that the items loaded quite well in the latent variable.

With respect to direct relationships between IS framework constructs and RL performance, it was found that all except IS for logistical operations were found to be significant ($p<0.05$) with IS for value creation ($\beta=0.551$, $p<0.05$) contributing the maximum towards achieving enhanced RL performance as indicated in Table 24, thereby proving hypothesesH_3, H_{3a}, H_{3c} and H_{3d}.This indicates that for RL performance enhancements, organizations should emphasize on investing in IS which creates value for the end consumers including systems which ease the product return and recall processes. IS capability ($\beta=0.125$, $p<0.05$) and IS partnership quality ($\beta=0.093$, $p<0.05$) were also found to be significant thereby showcasing the deploy highly specialized supply chain management (SCM) systems which integrate well across the reverse supply chain in addition to creating collaborative value. Collaborative value can be added by having e-SCM systems in reverse logistics, which not only integrates the reverse chain processes but also ensures real-time information flow which enables customers and firms to track reverse product flow effectively. With the study involving different industrial sectors with varied sample size for each sector in addition to the reverse performance being measured as the aggregate impact of six performance variables (economic, operational, strategic, customer relations, agility & flexibility and coordination), the specific effect of IS for logistical activities in a given industry and performance factor might not be visible, leading to IS for logistics turning insignificant ($p>0.05$).

The analysis of relationships between the independent factors (formalized processes, government regulations and strategic focus) and the IS framework constructs also yielded interesting results. Formalized processes were found to have a significant impact ($p<0.05$) on all IS variables. Thus, H_2, H_{2a}, H_{2b}, H_{2c} and H_{2d} stands validated. This signifies that standardization of RL processes for product return, recycle and reuse makes it easier and simpler for organizations to invest in information systems which results in superior RL performance. Also, formalization of processes was found to have the greatest impact on IS partnership quality (β=0.503, $p<0.05$). This emphasizes that if organizations make efforts to formalize their reverse logistics operations with appropriate documentation of each process, it becomes appropriate for them to implement and use collaborative SCM systems which enhance quality of partnership across the reverse chain in addition to ensuring real-time flow of information and the ability to track product flow effectively.

Standardization of RL processes was found to have the second greatest impact on IS capability (β=0.433, $p<0.05$). Standardization of processes leads to reduced manual intervention leading to a more effective flow of material and information. This signifies that formalization of processes can enable organizations to implement highly capable information systems in the reverse supply chain much more effectively as a result of reduced gap between business process requirements and the information system packages offered by software vendors. With usage of capable systems in reverse logistics leading to greater performance, standardizing the product return processes for recycling, re-use and refurbishing becomes all the more critical.

The relationship between formalized processes and IS for value creation was also found to be significant (β=0.418, $p<0.05$). This clearly justifies that organizations making efforts to standardize their RL operations will be able to implement value-creating systems effectively. With firms looking to implement systems which can detect and control fraudulent returns resulting from ecommerce and with value-creating systems having the greatest impact on RL performance, formalizing the RL operations becomes really significant.

Although the impact of process formalization on IS for logistical operations was significant (β=0.388, $p<0.05$), it was found to be the least among the variables in the IS framework. This clearly is indicative of the fact that the emphasis of organizations to implement systems for handling logistical operations has reduced drastically with enhanced focus on creating value for the customers and creating intra and inter-supply chain collaborative partnerships which could lead to better market positioning and greater competitive advantage. Still the impact is significant, which suggests that process formalization will result in effective deployment of systems to handle logistics in reverse chain, if required.

With respect to government regulations, it was observed that the construct had a significant impact on IS for value creation (β=0.141, $p<0.05$) and IS capability (β=0.101, $p<0.05$) while the relationships with the other two variables were found to be insignificant ($p>0.05$).

With supply chains looking for long term sustainability and with product recycling becoming important and critical as a result of penalties imposed by government, it becomes vital to have information systems which will enable supply chains to sustain themselves environmentally by making the processes of product recycling and refurbishing effective and efficient to handle. Also, with industries implementing ‘go green’ initiatives and corporate social responsibility (CSR), they would need to make sure they invest in best-of-breed and value creating supply chain systems which makes the return processes paperless and also enables them to recycle and refurbish aged products effectively. The effect of the other two factors, IS for logistical operations and IS partnership quality, might not be significant in the context of government regulation implementation in reverse supply chains as the quality of information integration and handling of logistical activities might not contribute towards government regulation implementation. Thus, only hypotheses H_{7a} and H_{7c} hold true.

The results also emphasize that strategic focus on reverse logistics tends to have a positive impact on all IS framework constructs, except IS for logistics ($p>0.05$). Thus, hypotheses H_{9a}, H_{9c} and H_{9d} stands validated. This justifies that logistics alone is not a value adding activity in reverse logistics and organizations thinking of using reverse logistics as a competitive tool need to use sophisticated, value creating and collaborative SCM systems to achieve better performance rather than focusing on only logistic handling systems. For reverse supply chains to be used as a strategic tool, there is a need to have systems which can ensure seamless information integration across the reverse chain in addition to supporting product returns with regards to recycling, refurbishing and re-use. With losses due to fraudulent returns becoming more frequent as a result of organizations selling their products through e-commerce, having intelligent systems which can detect and control fraudulent product returns can result in reverse logistics becoming the required strategic factor.

To carry out subsequent analysis for validating the conceptual framework, a structural model was created by making use of the measurement model. Structural Equation Modeling technique was used to carry out iterations of mediation and moderation analysis to establish relationships between the industry-specific factors, the IS framework and RL performance. The industry-specific factors were individually used as independent variables, the IS framework constructs as mediators and RL performance as the dependent variable. Table 21 indicates that all IS framework constructs except IS for logistical operations completely mediates the impact of formalized processes on RL performance. This proves that there is a direct impact of formalized processes on RL performance in the absence of the mediator but the effect becomes insignificant when the mediator is controlled for. This signifies that firms, with standardized RL processes to handle product recall and returns and using best-in-breed SCM systems to handle those processes effectively, tend to have better RL performance as compared to the firms with non-standardized RL operations. Also, the table clearly emphasizes that there is no aggregate effect of standardized processes in RL and use of information systems to handle logistics. This highlights that organizations with streamlined RL practices and using logistic-handling systems tend to perform the same as the ones not using them.

With respect to government regulations, only IS for value creation mediates the impact of government regulations on RL performance. As in the case of formalized processes, it is a case of complete mediation due to the direct effect becoming insignificant in the presence of the mediator, although it has a significant indirect effect ($p<0.05$). This indicates that firms implementing RL-specific government regulations through use of value creating systems in RL tend to have enhanced RL performance as compared to the ones not doing it. The result also underlines the argument that use of sophisticated and highly capable systems are not critical towards achieving improved RL performance. Rather the emphasis should be solely on systems which create value for customers and at the same time take care of the regulations specific to the given industry.

The results of mediation analysis shown in Table 21 states that all IS constructs except IS for logistics partially mediates the impact of RL strategic focus on RL performance. This proves that there is a direct impact of strategic focus on RL performance ($\beta=0.315$, $p<0.05$) in the absence of the mediator and the effect is still significant (although reduced) when the mediator is controlled for ($\beta=0.138$, $p<0.05$). This signifies that firms, focusing on utilizing RL strategically and using the finest of SCM systems to handle RL activities, will have a superior RL performance as compared to the firms not using the RL strategically. The results again validate the argument that using information systems for logistical activities is no longer sufficient to get enhanced performance even with organizations emphasizing on using RL strategically. Rather, the focus should be on implementing systems in RL which are the best in business, add value for the customers and integrates the reverse chain completely for efficient process handling.

To analyze the moderating effects of return frequency and resource commitment, 2 groups indicating the high and low values of respective moderators were created as depicted in Table 22 and Table 23 respectively. On carrying out the analysis for return frequency as shown in Table 22, it was found that return frequency positively moderates the impact of IS capability on achieving better RL performance i.e. usage of information systems with very high capability tends to better RL performance more in firms where the return frequencies are very high. Thus, hypothesis H_{1e} hold true. The reason can be attributed to the argument that industries such as e-commerce and electronic goods which tend to have high return frequency and use highly capable information systems, are able to utilize their systems better because of which get a better RL performance. On the other hand, industries with low return frequency, even if they implement and use best-in-breed systems, are not able to utilize their systems that well and hence comparatively lesser RL performance. The moderating effect was not observed for other IS constructs including IS for value creation and logistical operations because use of highly capable systems counters the high frequency of returns and as such value creating or logistic-handling systems are not really that critical to be utilised in such a scenario.

With regards to resource commitment as shown in Table 23, the results indicated that resource commitment negatively moderates the impact of IS for value creation on achieving better RL performance i.e. usage of value creating information systems tends to reduce RL performance in firms where the resource commitment to RL is quite high. Thus, hypothesis H_{3f} hold true. The reason can be attributed to the argument that although firms might be committing huge organization resources to RL, those resources might not be getting utilized well by them due to RL still being considered as a cost center (Jayant *et al.,* 2011). The moderating effect was not observed for other IS constructs including IS capability and IS for logistical operations because capability of systems does not determine how much of the allocated resources would be utilized. Similarly, since logistic-handling systems do not really play a role in enhancing RL performances, its impact being moderated by the resources committed doesn't make a difference.

5.2 Theoretical Implications

Regarding theoretical contributions, this study makes an effort to address and establish the role RL can play to achieve competitive benefits in the reverse supply chains. Literature suggests the presence of continued organizational focus on the forward supply chain for attaining profits and competitive benefits, and hence the forward chain became a part of the value chain for organizations (Jayant *et al.,* 2011). This study adds to the literature, the considerable change in emphasis towards the reverse chain through the lens view of IS for attaining larger benefits. Through this study, an IS-integrated framework has been proposed that can be used to analyze the utilization of RL towards achieving competitive benefits. Not only is IS found to be vital, other factors such as government regulations, formalized RL processes and strategic RL focus can go a long way in deciding the degree of benefits achieved through RL. Emphasis has been put to include and explain the influence of return frequency and resource commitment, which seems to hold a lot of significance in the RL context.

The undertaken research presents an integrated framework which not only emphasizes on the role of information systems towards enhancing reverse logistics performance but also looks into the role of other factors such as process formalization, government regulations, strategic focus, frequency of returns and resource commitment to reverse logistics. This is vital because the impact of information system factors on performance cannot be studied in isolation as the impact of other factors can be equally significant.

This study suggests a shift in emphasis from using information systems for infrastructural support (Kim & Narasimhan, 2002) to using them for creating value in the supply chain. Although information systems for creating value is well established in the forward supply chain context (Kim & Narasimhan, 2002), the results clearly establish its relevance in reverse logistics. Creating value has gained emphasis off late and there has been a change in trend from ensuring the delivery of the right product to the customer to ensuring that the entire process creates value for the end consumer (Chang & Shaw, 2009; Hofmann & Locker, 2009; Chen *et al.,* 2015). This study, through an empirical analysis, seconds the emphasis in literature by focusing on the relevance of deploying value creating systems which can handle reverse logistic operations effectively.

The study also contributes the relevance of information systems capability and partnership quality across the reverse supply chain. With the domain of reverse logistics largely unexplored and it beginning to receive research attention recently (Jayant *et al.,* 2011), the usage of highly sophisticated and capable information systems in the reverse chain, which earlier used to be referred to as a cost center, holds a lot of importance. Its significance increases all the more considering the results of the study which clearly emphasizes its impact on enhancing reverse logistics performance. The study also establishes the significant role of quality of IS partnership in the reverse supply chain. The results of the study clearly indicate that ensuring partnership quality in terms of information integration across the reverse supply chain can lead to strategic benefits for the focal firm. Moreover, it has a direct impact on the RL performance and hence plays a pivotal role in the RL context, which adds relevance to the RL literature.

The study surprisingly signifies that IS for logistics is not significant in the RL context. Although, it might hold some significance if tested for specific performance outcomes such as economic and operational performance, it seems insignificant when performance is taken as an aggregate of varied performance outcomes. This is clearly an addition to the literature which underlines the relevance of using systems for logistics and its positive impact on performance (Swafford *et al.,* 2008; Zhang & Whang, 2011). A possible explanation can be on the lines that with reverse logistics still gaining relevance, it becomes vital to add value through best-in-breed information systems than just using systems for handling logistical operations.

The real value addition of the study comes from the analysis of the effect of non-IS variables in the RL literature i.e. process formalization, government regulations, strategic focus, return frequency and resource commitment. Although effect of process formalization on specific performance attributes has been previously evaluated in the RL context (Genchev *et al.,* 2011; Stevens & Johnson, 2016), it effects in the presence of a comprehensive IS framework and aggregated RL performance construct has not been considered. The study results clearly suggest that process formalization is very critical in reverse logistics and tends to positively affect the implementation of different dimensions of IS in reverse logistics in addition to its impact on RL performance variables.

The effect of government regulations implementation in the RL framework is another vital addition to the literature. Although, government regulations as a factor has been explored before (Kumar & Chandra, 2013; Choi *et al.,* 2017), the addition is in terms of the effect of government regulations implementation on factors in the IS framework in addition to its impact on RL performance measures. The results clearly elaborate on its positive effect on implementation of highly capable and value adding information systems in the RL framework and its corresponding effect on the RL performance.

Although a few recent reports have reported the need to use reverse logistics strategically (Cii.in, 2013), very few studies have actually explored it (Singh *et al.,* 2010; Skapa & Klapalova, 2012). The undertaken study adds the relevance of strategic focus on RL in terms of its ability to affect the implement of information systems and its impact on RL performance. With studies reporting saturation of forward supply chain to provide competitive benefits (Jayant *et al.,* 2011), the strategic focus on RL adds a new dimension on how the emphasis and subsequent use of information systems can enhance RL performance for different industries, thereby creating the competitive advantage the companies are looking for.

The study also looks into the moderating impact of return frequency and resource commitment in the context of reverse logistics. Although the direct impact of these factors on performance has been explored in the literature (Genchev *et al.,* 2011; Huang *et al.,* 2012), studies have failed to look into the moderating effect of the mentioned constructs in the RL context. The moderating effect of these variables have been considered since the frequency of returns and commitment of resources to reverse logistics varies across industries and hence becomes very critical to analyze depending on their respective levels across domains. The results clearly justify the need to deploy and use different kinds of information systems in reverse logistics depending on levels of return frequency and resource commitment in reverse logistics. This analysis becomes all the more critical and vital considering the positive relationships between the considered IS variables and RL performance.

5.3 Managerial Implications

The study undertaken has led to some vital implications for the managers and practitioners. Due to its comprehensive framework, the implications have different dimensions which can be utilized by practitioners to gain benefits from reverse logistics. Firstly, the research clearly identifies reverse logistics to be a domain which practitioners can use to gain competitive edge. Gradually, reverse logistics is coming out of its tagline of being a “cost center”. There are costs associated, but at the same time, researchers have developed performance metrics including economic and operational performance which can be utilized to measure its performance, thereby gaining benefits out of it. This study also measures RL performance by making use of six varied dimensions in aggregate i.e. economic performance, operational performance, customer relations, strategic benefits, supply chain agility & flexibility and supply chain coordination. The outcomes of the study in terms of the effects of the independent and the mediating factors reflects the enhancements in performance of the aggregated group as a whole.

The current study has presented an integrated framework to enhance RL performance across industries where reverse logistics operations are prominent. It has used information system factors and non-information system factors and made efforts to derive relationships which could enable practitioners to use them for achieving the desired performance outcomes. The study has focused on the specific role of information systems on bettering the performance which could be useful for the practitioners in terms of implementing them in their respective supply chains. The research clearly emphasizes the importance of setting up value creating information systems in the reverse supply chains. With the use of e-commerce on a high, these systems need to focus on detecting and controlling the fraudulent returns which have increased manifold off late and have the potential to result in huge losses for the firms. At the same time, results indicate that these value-creating systems need to ensure that they manage the product return and recycling processes effectively to comply with the 'Go Green', corporate social responsibility and product recycling regulations, thereby creating the edge companies are looking forward to. As a part of their sustainability initiatives, the government has implemented penalties for products which are not recycled, thus having systems which can enable firms to comply with such regulations becomes really critical and vital.

The study also throws light on integrating the reverse supply chain with highly capable systems. The results indicate that deploying highly capable systems becomes really important if the company wishes to utilize reverse logistics as a strategic tool. Companies requiring to comply with the government regulations with regards to sustainability and product recycling also need to have highly capable systems handling the key processes in the reverse supply chain. With these domains turning really critical for the reverse chain, use of these systems at key locations in the reverse chain becomes really significant.

Another key outcome of the study is the key role played by information integration in the reverse supply chain. The results of the study clearly indicate that partnership quality of information systems across the reverse chain needs to be high for it to reap performance benefits. Not only is seamless information integration required to comply with government regulations to achieve environmental sustainability, but also in case the firms wish to use reverse logistics as their strategic tool to achieve collaborative supply chain benefits through integration with their suppliers and customers. Hence, to enhance reverse logistics performance, ensuring seamless integration across the supply chain partners will lead to multifold benefits for the reverse supply chain.

The results from the IS-integrated framework presented in the study gives a lot of emphasis to formalization of reverse logistics processes. Although process formalization has been talked about in literature (Genchev *et al.,* 2011; Stevens & Johnson, 2016), a comprehensive approach with respect to its impact on IS variables and performance outcomes has been measured in the undertaken study. The results clearly identify formalization of reverse logistics processes as a key factor as far as RL performance enhancement is concerned. It has been found that process formalization helps achieve the desired performance outcomes with the factor impacting the implementation of all IS variables in reverse logistics. With the processes well established and documented, deploying seamlessly-integrated, highly-capable and value-creating information systems becomes easy. Process standardization has the greatest impact on quality of IS partnerships across the reverse chain. It also impacts deployment of value creating systems in reverse logistics by reducing the gap between business process requirements and the package requirements. It can easily enable focal firms to deploy and use high-end e-SCM and ERP applications, thereby reaping performance benefits, leading to competitive edge for the supply chain.

The study results also emphasize the role of strategic focus on reverse logistics. By focusing on reverse logistics strategically, the companies can reap collaborative supply chain benefits in terms of improved economic, operational and other performance indicators. With industry reports suggesting the need to have strategic focus (cii.in, 2013), it becomes really critical for practitioners to use RL operations strategically. The information system factors in the IS framework have been observed to mediate the impact of strategic focus. This signifies the need for managers to implement the right kind of information systems in reverse logistics if they wish to optimally utilize the strategic emphasis on reverse logistics. Although the impact of implementing government regulations in reverse logistics has been found to be limited, it has been evaluated to be a key ingredient towards enhancing performance. Implementing government regulations in terms of environmental sustainability and product recycling can have a drastic impact on the reverse logistics performance considering a continued emphasis on sustainability by organizations. If organizations can implement systems capable of handling and managing recycling processes effectively, it will go a long way towards achieving the desired sustainability objectives and performance outcomes.

A very important outcome of the study carried out is the relevance of return frequency and resource commitment in reverse logistics. Although the direct impact has been measured earlier in literature (Swafford *et al.,* 2008; Genchev *et al.,* 2011), its moderating impact, considering its variance across industries, has been evaluated. The results clearly indicate that frequency of returns and resource commitment have a moderating impact on the performance. In case of return frequency, it was found that frequency of returns positively moderates the impact of IS capability on achieving better RL performance i.e. usage of information systems with very high capability tends to better RL performance more in firms where the return frequencies are very high. This can be critical for organizations while making a decision to implement systems in reverse logistics. Industries with high frequency of returns can look to implement best-in-breed information systems to achieve better reverse logistics performance outcomes. On the other hand, organizations with relatively lower return frequency can use relatively lower end systems and still achieve the similar performance benefits.

For resource commitment, it was observed that the variable negatively moderates the impact of IS for value creation and subsequent RL performance. This indicates that organizations with greater resource commitment to reverse logistics tend to perform lower as compared to organizations with lesser commitment of resources. This is an important result considering organizations to be looking to enhance resource commitment to reverse logistics. A possible line of argument can be the low utilization of the committed resources which might be leading to lower performance outcomes. Thus, organizations need to find ways to increase this resource utilization so that a higher resource commitment can result in enhanced performance. Some of the ways by which this can be achieved is by organizing appropriate training for employees engaged in reverse logistic operations and carrying out regular audits to ensure that the resources committed to reverse logistics are being utilized optimally.

CHAPTER VI

CONCLUSION & FUTURE SCOPE

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The main objective of the study was to establish a framework which enables organizations use reverse logistics effectively to gain competitive benefits. A conceptual model was framed by including factors from supply chain literature which tend to impact supply chain performance with specific emphasis on reverse logistics. With the study focusing on information system specific effects on performance, the factors were categorized into IS factors and non-IS / industrial factors. Data was collected through a survey instrument by distributing it to organizations where reverse logistics is prominent. Post data collection, a measurement model was developed by using confirmatory factor analysis. Structural equation modeling (SEM) was used to generate a structural model in order to carry out mediation and moderation analysis for validating the proposed conceptual framework.

6.1 Conclusion

The result of the analysis has yielded some really useful implications for the researchers and practitioners. It has been found that different facets of information systems play a big role in enhancing the RL performance in organizations. Use of highly-sophisticated and value adding SCM systems tend to impact the performance more as compared to systems only handling the logistics. The organizations need to identify the operations in RL which adds value for the customers and orient their technology investments accordingly. Also, it has been witnessed that use of information systems in RL on top of formalized RL operations leads to better RL performances. The organizations need to focus on using RL as a strategic tool to gain competitive benefits by allocating sufficient organizational resources to it and utilizing them well. Firms need to implement strategies with regards to environmental sustainability and product recycling regulations which will lead to enhanced capability and better RL performance. Return frequency and resource commitment are critical in the reverse logistics context as they have a moderating effect on the achievement of performance outcomes. While higher resource commitment seems to have a detrimental effect on performance, firms need to ensure that they utilize the resources well to make sure performance objectives are met. Moreover, industries with higher return frequencies need to make use of highly capable SCM systems to increase the performance outcomes manifold.

6.2 Limitations & Future Scope

The results of the study open up scope for future researchers to work in this area. The validated IS integrated model can be tested in industry specific contexts to generate some findings for organizations to work upon and use them to attain competitive benefits in terms of increased sustainability and better profit margins. Researchers can use the model to carry out case study analysis for individual firms to verify if the results actually hold good or there are dimensions which can make the model more comprehensive. With the current work done in the Indian context, the generated model can be verified by researchers through cross-geographical studies which can not only substantiate the real value of the developed model but will also help in identifying geography-specific factors which might affect RL performance across supply chains. Also, RL performance has been taken to be an aggregation of six different performance outcomes which is a limitation as it fails to report the specific effects of IS and non-IS factors on individual performance outcomes. Future studies can look into taking these performance outcomes i.e. economic performance, operational performance, strategic benefits, customer relations, supply chain agility & flexibility and coordination individually to get pin-pointed theoretical and managerial implications with regards to the impact on each these factors.

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APPENDIX-I

Academic Research Questionnaire

This is an academic research in the area of reverse logistics and information systems and the information collected through this questionnaire would be used strictly for academic purposes. Please use your judgement to the best of your ability and mark the most appropriate responses to the questions asked in the questionnaire. You are free to keep some of the details anonymous in case the company policies do not allow you to reveal those details.
Please take out 10-15 minutes of your valuable time to fill up this questionnaire as it would enable us to conduct this study effectively. Thank you.

A. Details about the Organization

This section relates to the generic profile of the organization as a whole for research purposes.

1. Name of Respondent

2. Official Email Address

3. Name of the Organization

4. Department

5. Designation

6. Annual turnover of the Organization (in Crores)
a) Less than 50
b) 51 to 100
c) 101 to 250
d) 251 to 500
e) 501 to 1000
f) 1001 to 2500
g) 2501 to 5000
h) Above 5000

7. Type of Organization
a) Automobile / Auto Component
b) Beverages / Food Processing
c) Chemical
d) Domestic / Industrial Gases
e) IT Hardware
f) Electronics & Electrical Goods
g) Pharmaceutical
h) Retail
i) Apparels
j) e-Commerce
k) Other:

8. Number of Employees in the Organization
a) Less than 50
b) 51 to 100
c) 101 to 250
d) 251 to 500
e) 501 to 1000

f) 1001 to 2500
g) 2501 to 5000
h) Above 5000

B. Details about the Organization's Operations and Use of ITResources

This section deals with your feedback on the operational activities as well as the use of IT resources in the organization. Please read each of the questions carefully and mark the most appropriate option as per the following scale.

(1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree)

9. Reverse Logistics operations in the company effectively handles the recovery of assets for the products returned by the customer.

10. Carrying out the reverse logistic operations in an organized manner gives the organization an edge over its competitors.

11. The reverse logistics system in the organization has led to timely rework and repair of the returns.

12. Long term association with the supply chain partners is enhanced due to the reverse logistic operations of the organization.

13. The organization is able to offer customized products quickly by studying the customer’s product return patterns.

14. Reworking and re-using the returned products provides the organization flexibility in terms of product range and product volume.

15. The customer satisfaction levels have increased as a result of efficient reverse logistic operations in the organization.

16. Reverse Logistics operations in the company has an impact on containing the cost of operations in the company.

17. The organization is able to launch new products quickly due to an organized reverse- logistics operations.

18. The quality of re-work and repair of the returned products has shown improvement due to an efficient returned merchandise handling strategy.

19. The reliability of the product being delivered is increased through the use of a systematic product return process.

20. The productivity levels of the organization have been benefitted by the reverse logistic operations.

21. The customers value the organization more if quick action is taken on the returned products and the customers are kept informed about its status.

22. The capacity utilization improves by the use of well defined reverse supply chain processes

23. Having a well-organized product return system helps the organization in forming strategic partnerships with its supply chain partners.

24. Improved coordination with distributors and wholesalers is enabled by efficient reverse supply chain practices of the organization.

25. The cycle time of the returned products has reduced as a result of handling the returned merchandise in the organization.

26. Reverse logistic system has an impact on improving the organization’s forecasting accuracy.

27. The organization is incurring lower compliance costs with environmental regulations due to the returns handling method.

28. The organization gains flexibility in the manufacture of its products as a result of having a well-defined reverse-supply chain strategy.

29. Organization also gets strategic benefits like reduced delivery lead time and customer query time by having a systematic reverse logistics process.

30. The organization’s reverse logistic operations are able to handle the reconciliation of charge-backs effectively.

31. The organized product return process of the organization tends to enhance the effectiveness of interaction between the organization and its suppliers.

32. The organization’s reverse logistic operations have a positive impact on the internal efficiency of the processes within the organization.

33. The investment in inventory has reduced due to the reverse logistics operations in the organization.

34. The reverse supply chain enables the organization to efficiently track products.

35. In order to make decisions regarding location selection of warehouses and plants in the supply chain, a plant and warehouse location selection systems or something similar is being used.

36. The usage of IS in the reverse logistics has improved the coordination among the members of the supply chain.

37. The information systems used in the reverse logistic supply chain facilitates faster communication of information from and to the customers.

38. Critical Information and knowledge that impacts IS / IT projects are shared freely between the IS department and the organization supply chain partners.

39. The IS usage in the reverse supply chain has decreased the cost of transactions being carried out.

40. The reverse supply chain of the organization uses information systems for effectively managing orders from and towards the customers.

41. There is a high degree of trust between the IS / IT department and the organization's supply chain partners.

42. The process of developing reverse supply chain information systems is flexible to allow infusion of new methodology, tools and techniques.

43. The organization has sophisticated information systems to record, track and respond to service requests from the customers.

44. The goals and plans of developing information systems are jointly developed by the ISdepartment and the supply chain partners.

45. Customer requests in regard to product / services specifications and quality, delivery time and customer services gets met quickly and efficiently through use of information system in reverse logistics.

46. The information systems in reverse supply chain improves the timeliness of information delivery across the supply chain.

47. The supply chain information systems consists of a demand forecasting system for making demand forecasts.

48. Very less manual intervention is required to run the reverse logistics information systems since most of the operational tasks are automated.

49. Information System usage in the reverse supply chain has led to increase in the efficiency of the staff working on the day-to-day operations of the supply chain.

50. The information systems used in the reverse supply chain enables faster product return handling upto the vendors.

51. Supply chain partners are able to avoid repeated spending or purchase of reverse logistic information systems.

52. The reverse supply chain information systems reduces error while handling the transactions during the product return process as compared to manual handling.

53. Information Systems used in the reverse supply chain are being used to establish, sustain and improve customer relationships in the organization.

54. Effective communication of orders, inventory, and invoice information with the supply chain partners can be done through the use of information systems in reverse logistics.

55. The organization puts specific emphasis on the monitoring and regulatory compliance of environment-related issues.

56. The organization complies with the regulation of re-using material from product returns.

57. The organization is responsible for the disposal of non-reuse part of returned products as a part of government regulations.

58. The organization has committed technological resources while handling returns from the customer.

59. The frequency of product returns to the organization due to defects in the product is very high.

60. The frequency of product returns to the organization due to unsold items is very high.

61. The organization stresses on going through proper channels for getting the job done.

62. The organization has allocated appropriate manpower to deal with the product returns from thecustomer.

63. The routing / return-processing procedures are explicitly verbalized and communicated to customers as well as suppliers.

64. The strategy of the organization gives specific focus on planning and buying of the ISinfrastructure for reverse logistics.

65. The frequency of product returns to the organization due to the product end of life factor is very high.

66. Reverse Logistic operations form a part of the strategic plans of the organization.

67. The vendor of the organization follows strict operating procedures defined by the organization.

68. The organization is focused to dedicate a good amount of its capital for its reverse logistics operations.

69. Specific rules and guidelines are used by the organization for outsourcing the routing to a third party.

APPENDIX - II

Publications, Conferences and Book Chapters

A. Publications

- Mahindroo, A., Samalia, H. V., & Verma, P. (2018). Information systems road map to enhance economic and operational reverse logistics performance. *International Journal of Logistics Systems and Management*, *29*(2), 215-240. ('C' category in ABDC list)

- Mahindroo, A., Samalia, H. V., & Verma, P. (2018). Moderated influence of return frequency and resource commitment on information systems and reverse logistics strategic performance. *International Journal of Productivity and Performance Management*, 67(3), 550-570. ('B' category in ABDC list)

B. Conferences

- Mahindroo, A., Samalia, H. V. & Verma, P. (2017). Achieving Agility And Flexibility Through Formalised Processes And Value Creating Systems In Reverse Logistics: A Mediation Analysis. *24th European Operations Management Association Conference (EurOMA 2017),* Heriot Watt University, Edinburgh, Scotland (3-5th July 2017).

- Mahindroo, A., Goyal, G., Samalia, H. V. & Verma, P. (2016). A Review of Information Technology Usage in Supply Chains and its Applicability in the Indian Context. *I International Conference on Indian Management Thought, Practice and Transformation*, L. M. Thapar School of Management, TU Derabassi, India (14 November, 2016), pp. 225-249

- Mahindroo A, Verma P., & Samalia H. V. (2014). An Information Technology Based Conceptual Framework for Supply Chain Performance Improvements, *II International Conference on Applied Research in Business, Management, Economics and Finance (ARC-2014),* Pattaya, Thailand (August 02-03, 2014); pp. 130-137.

- Mahindroo A, Samalia H. V., & Goyal G. (2012). Performance Measures of Supply Chain and Logistics Management: A Review of Literature. *Changing Perspectives and Paradigms in Business and Behavioral Sciences (CPPBBS-2012),* Thapar University, Patiala (April 27-28, 2012).

C. Edited Book Chapters

- Indian Management, Edition: 2017, Chapter: Information Technology in Indian Context, Publisher: Bloomsbury Publishing India Pvt Ltd, Editors: Karminder Ghuman, Anita Sharma, Arunesh Garg, pp.225-249