# RETAIL SUPPLY CHAIN MANAGEMENT: DEVELOPING A PERFORMANCE MEASUREMENT MODEL USING KEY PERFORMANCE INDICATORS (KPIs)


By

**NEHA GROVER**

Under the Guidance of

**Guide**

**Dr. NEERAJ ANAND**

Senior Associate Professor

College of Management and Economics Studies

**Co-Guide**

**Dr. MANISH PRATEEK**

Professor, College of Engineering Studies


Submitted

IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE

**DEGREE OF DOCTOR OF PHILOSOPHY**

TO

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**

DEHRADUN

JANUARY, 2013

***Dedications***

To my dear Grandparents, Mom and Dad,

*“For your heartfelt show of support, unconditional love and prayers…..I can’t thank all of you enough.”*

# ACKNOWLEDGEMENT

I offer my humble obeisance unto the lotus feet of Krishna!

First, last, and always, I want to acknowledge the source of everything that is in this research thesis, everything that is life and of life itself. The completion of this thesis would not have been possible without valuable advice and generous help from many people.

I pay my sincere gratitude to University of Petroleum and Energy Studies for giving me this opportunity to do research. I am highly indebted to Dr S. J. Chopra, Chancellor and Dr Parag Diwan, Vice Chancellor for their words of wisdom and motivation, to bring the best in me. I am highly thankful to Prof. Utpal Ghosh, PVC for his support and encouragement during my research studies.

I take this opportunity to express my gratefulness to my guide Dr. Neeraj Anand. He has been an inspiration for me to work hard and achieve higher standards in my research work. I thank him for his constant support, expertise, guidance, encouragement and commitment during every stage of this thesis development. I would also like to thank Mrs. Dipika Anand for all her support, love and care.

My co-guide, Dr. Manish Prateek, has always been a pillar of strength and a source of inspiration for me to do my work with perfection. I thank him for his useful feedback and valuable comments throughout my research studies.

A special thanks to Professor Joseph Hair from Kennesaw University, USA. I am grateful to him for reviewing my work and adding value to it. Interacting with him has been a very pleasing and fruitful experience that will benefit me forever. His professionalism is highly admired.

I would like to thank the Dean – CMES Dr Anirben Sengupta, for helping me with industry contacts and also inspiring me to conduct my research in an impeccable manner. I also thank Major General S.P.S Narang, Assistant Dean, Prof. Loveraj Takru, HOD and his team for all their support during my research.

I express my humble gratitude to the industry experts who have been cooperative and supportive in rendering me the valuable advices and inputs. A special thanks to Mr Ashwani Khanna, Vice President, GMR; Mr Pranab Barua, Vice President, Planning and Supply Chain, Madura Fashion Lifestyle; Mr Ajay Saraswat, Business Head, ETA Freightstar; Mr Mukesh Shah, Senior Manager- SCM, TPG Group, for their time, efforts and support.

I would like to thank all the FRC committee members, Dr K. K Pandey, Dr Tarun Dhingra, Dr K. V Mohana Rao, Dr Atul Razdan, Dr M. S Pahwa and Dr D. K Punia for their valuable inputs and suggestions. At UPES, I am also grateful to a number of people including Library, Finance, IT and Admin staff for their assistance and support. I am sincerely indebted to the faculty members and all my fellow doctoral students for their support and constant encouragement. A special thanks to Ms Namita Pragya, Mr Geo Jose Fernandez, Mr Karan Kapoor, Ms Surbhi Arora, Ms Preeti Kashyap, Dr Ratna Banerjee, Dr Alka Dewidi Dr Sheetal Khanka, and Dr Ankur

Mittal, to name a few, they were a great help and encouragement during my research studies.

Special thanks to Sqn Ldr (Retd) Girija Sabitha Banu for her sincere efforts, guidance and support during my research studies. I am highly indebted to her for all her patience, love and care.

My sincere gratitude to my grandparents, mom, dad and other family members, who may never fully understand my research but in their own way, taught me the meaning of life. My brother, Mohit, has been very supportive and understanding throughout my journey so far and I thank him for his love and support. I also thank my cousins Geetanjali, Pooja, and my friend Deeksha for all their cheerful love and enduring support.

At the end, I thank all those who were a part of this journey. I seek forgiveness if I was not able to give much time to my loved ones because of my work.

Neha Grover January 30, 2013

# DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the University or other institute of higher learning, except where due acknowledgment has been made in the text.

Neha Grover January 30, 2013

# THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on **“Retail Supply Chain Management: Developing a Performance Measurement Model using Key Performance Indicators (KPIs)”** by **Neha Grover** in Partial completion of the requirements for the award of the Degree of Doctor of Philosophy is an original work carried out by her under joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University.

<u>Guide</u>

**(Dr. Neeraj Anand)**

<u>Co-Guide</u>

**(Dr. Manish Prateek)**

# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

With increasing competition and advancement in technologies, firms have been experiencing significant changes in the way of doing businesses. The term Supply Chain Management [SCM] was originally introduced by consultants in the early 1980s, and has subsequently gained tremendous attention. Since then, this paradigm has undergone huge developments nationally and internationally. It is important for companies to know what they are doing and where they can reach, and measurement is the first step that leads to control and eventually to improvement.

One of the predominant method for measuring performance is the use of key performance indicators [KPIs] that cascade down from top level business objectives and measures through the organization into a series of functional measures (Storey, Emberson, Godsell, & Harrison, 2006). Once the supply chain performance measures are developed adequately, managers have to identify the key performance indicators (KPIs) that need to be improved. A typical firm already has a certain number of KPIs such a return on investment for assessing its financial performance, but supply chain related KPIs have not been widely adopted and businesses are typically uninformed of them (Chae, 2009). Also, the Traditional BSC and SCOR models generally assume that KPIs are uncoupled (Cai, Liu, Xiao, & Liu, 2009). These approaches could describe business operations well, and serve as a good communication tool, but they are not effective in improving overall performance by accomplishing the critical KPIs (Cai, Liu, Xiao, & Liu, 2009).

It is widely acknowledged that there has been relatively little interest in developing measurement systems and metrics for evaluating supply chain

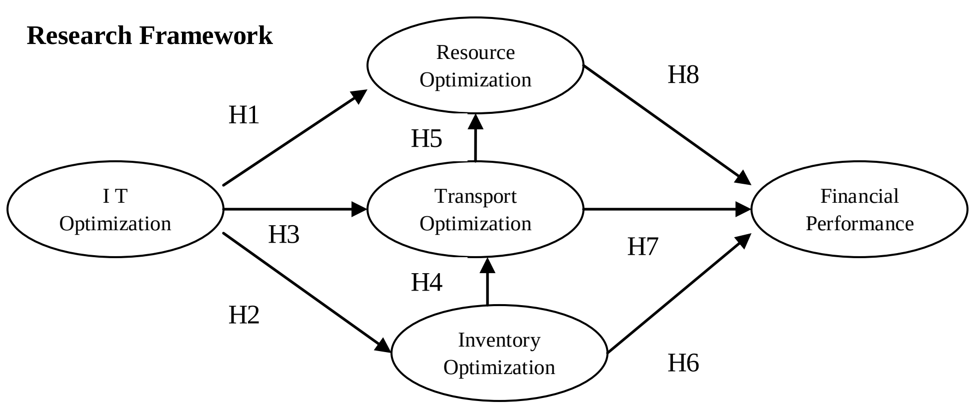
performance (Beamon, 1999; Gunasekaran, Patel, & Tirtiroglu, 2001; Chen & Paulraj, 2004). It was infact found encouraging that some researchers have developed measures to assess the performance of supply chain relationships or the performance of a supply chain as a whole (Ellinger A. E., 2000; Fynes & Voss, 2005). As pointed out by (Douglas, 1996; Ho, Chan, W, Wong, & Chan, 2000; Gumbus, 2005; Lavy, Garcia, & Dixit, 2010) that categorization of KPIs must provide the organizations an opportunity to select the performance indicators in which the companies are most interested.

One of the main problems with supply chain metrics is that they do not capture how the supply chain as a whole has performed (Lambert, Cooper, & Pagh, 1998). There is a need to incorporate broader relationships to collaborate across different levels of supply chain. Some of the concerns that need to be address in this direction include the integration issue of supply chain in varied industries across the countries. Also there is a requirement to conduct more empirical studies on the effect of management practices on combination of these supply chain management practices (Gopal & Thakkar, 2012). To the best of researcher's knowledge no integrated measurement system exists for retail supply chain that combine different aspects of performance (e.g. financial and non-financial, qualitative and quantitative) into one measurement system, in this study researcher aims to develop a model for measuring retail supply chain performance. Therefore, the study seeks to create a comprehensive understanding of the way the performance measurement of contextual factors impacts the financial performance of a retail supply chain. The scope of the study has been narrowed down to four important dimensions of retail supply chain including transport optimization, inventory optimization, resource optimization and information technology optimization. The major objectives of this research study are:

- To identify the Key Performance indicators (KPIs) for Retail Supply Chains.
- To develop a performance measurement model for Retail Supply chains in India.

For this study, contingency approach was adopted, according to contingency theory perspective there is no best way to ensure superior performance. It also advocates that there is not universal set of strategic choices that applies to every business situation (Ginsberg & Venkatraman, 1985). Typical frameworks in the contingency research focus on the relationship between contextual factors and the performance (Schoonhoven, 1981; Ginsberg & Venkatraman, 1985). This view is also supported by RBV, which suggests that the firm extract and create value by optimally utilizing its human and technological resources. This study has combined RBV and contingency theory perspective and a framework was developed with respect to the contextual factors of retail supply chain with the objective of determining which components are most applicable to the supply chain issues confronting retailers in India.

**Research Framework**



**Research Hypotheses**

**H1:** Information technology will have a positive effect on Resource Optimization

**H2**: Information technology will have a positive effect on Inventory Optimization

**H3:** Information technology will have a positive effect on Transport Optimization

**H4:** Inventory Optimization will have a positive effect on Transport Optimization

**H5:** Transport Optimization will have a positive effect on Resource Optimization

**H6:** Transport Optimization mediates the effect of information technology Optimization and inventory Optimization on financial performance

**H7:** Resource Optimization mediates the effect of information technology on financial performance

**H8:** Inventory Optimization mediates the effect of information technology Optimization on financial performance

The target population for the study includes the organized retail in India (both Indian and Private MNCs operating in India). The researcher has adopted Two-Stage Sampling. At first stage the top ten retailers operating in India were identified and at second stage Delhi [NCR] was selected as the geographical region for conducting the survey. The sample frame was constructed primarily to target relatively the senior and middle level managers and sample size in this study is 120. The questionnaire has a total of 56 questions divided into four main sections as per the division into four categories i.e., transport optimization, inventory optimization, information technology optimization and resource optimization. The data was easily fed into the SPSS software for further analysis (factor analysis, IBM SPSS 20 and Structural Equation Modeling, using SMART PLS 2.0.

The model in this study reveals that retail supply chain performance measurement is multidimensional with IT as a great enabler and a strong predictor of inventory and resource optimization. It was also found through this study that respondents have given maximum weightage to inventory optimization, which provides an empirical evidence that inventory is undoubtedly a critical area of focus for retail industry, the extent to which it influence the financial performance of the firm. Infact inventory turnover and productivity of material handling equipments [MHE] has been identified as the most influential indicators for inventory optimization.

The next most important component of the study was resource optimization influencing the financial performance of the firm. Training of employees and value added employee productivity are two most influential indicators. This led to a clear outcome that training of employees is vital for a high value added employee productivity which influences customer experience, finally results in increased sales and profitability of the company. Thus the companies should focus on training their employees for better performance.

As IT is a predictor of inventory and resource optimization, real time sharing of information plays an important role in increasing the accuracy and reliability of information. Retailers use different methods to coordinate with the supply chain partners with real time information in order to optimize their supply chain and assure maximum product availability Accuracy and reliability of information makes it possible that right product is available at right time at the right place, thus increasing the responsiveness to the market demand with better sales forecast. Hence companies are encouraged to invest in IT for data reduction and data maintenance cost.

Furthermore, IT is moderate predictor of transport optimization, it is because of the fact that IT implementation for transport is still in nascent stage of implementation in Indian context. As of now it is seen that besides a few large players the country is dominated by small truck owners and implementation of technology (RFID/TMS/GIS) is a way forward. For transport optimization, the faster turnaround of vehicle and vehicle optimization are the main area of attention. Besides capacity utilization and vehicle routing it is important that there is minimal waiting time for the vehicle at loading and unloading dock. The detention/waiting time of the vehicles affects the vehicle optimization or its complete utilization. As any delay in turnaround time of the vehicle is the cost to the operator. Hence for optimal utility it is significant to efficiently and effectively control the dock operations at DCs/ROs for faster turnaround of vehicles.

Thus, the current research represents one of the first empirical efforts to systematically investigate the relationship between key components of retail supply chain management in the developing economy. Finally it can be concluded that all the relationship variables incorporated in the model are significant for Retail Supply Chain Performance.

The thesis consists of eight chapters. The first chapter, **Introduction to Supply Chain Performance Measurement**, presents the evolution of

Supply Chain and defines SCM with the help of various definitions and theories influencing SCM philosophy followed by objective of SCM, the challenges and opportunities in SCM. Thus, establishes a need for measuring SC performance and discussing the various theories used for measuring SC performance.

The second chapter, **Retail Supply Chain Management**, discusses the concept of retailing and evolution of retail in India. It also throws light on the contribution of retail to GDP of Indian economy and also presents various attitudinal changes in the demographic profile of consumers, which have transformed the retailing face of India. Further this chapter describes the various formats of retail, its organizational structure and a brief profile of foremost retail companies operating in India.

The third chapter, **Literature Review**, presents a review of the available literature on supply chain performance management, and aims to classify the performance indicators into various groups, specifically for measuring retail supply chain performance with the help of a theoretical framework. It highlights the research gaps, while outlining the importance of measuring SCM performance through metrics/KPIs, and also explores different approaches for developing performance measurement tools.

The fourth chapter, **Research Method,** discusses the rationale of the study, problem statement, research questions, and objectives of the study, the research design, conceptual model and hypotheses. Also presents the constructs of the model and measurement of these constructs followed by sampling process, method of data collection, and statistical tools used for analysis, and finally research flow diagram in the end.

The fifth chapter, **Data Analysis,** discusses the sample profile of the respondents and the frequency distribution of the responses. From the frequency analysis, the indicators, respondents displayed the most agreement with, are also discussed. Finally, importance ratings are assigned to the categories based on weights obtained through Principal Component Analysis (PCA).

The sixth chapter, **Key Performance Indicators for Retail Supply Chain,** discusses missing value analysis and imputation, which was conducted for the purpose of preparing data for factor analysis and SEM. Thereafter results obtained from factor analysis for each category of KPIs are presented i.e. for Transport Optimization, Information Technology Optimization, Inventory Optimization and Resource Optimization.

The seventh chapter, **Developing and Testing Model**, gives an overview of classification of models, followed by structural equation modeling (SEM). Covariance based (CB) SEM and PLS SEM was used to identify the underlying structure of the data. Due to restrictions associated with CB SEM, PLS-SEM was found to be a better technique to develop a performance model for measuring retail supply chain performance. In the last section chapter is thus concluded with summary of final results.

The eighth chapter, **Conclusion and Recommendations** presents the conclusion of the study, exhibiting the relative importance of the variables identified in the study. It also discusses the limitations and directions for future research, thereby followed with recommendations based on findings.

## ABBREVIATIONS

| | |
|---|---|
| 3PL: | Third Party Logistics |
| ABC: | Activity Based Costing |
| AHP: | Analytical Hierarchy Process |
| AVE: | Average Variance Explained |
| B&M: | Books & Music |
| BSC: | Balance Score Card |
| BSP: | Buyer Supplier Partnership |
| CART: | Classification and Regression Tree |
| CB-SEM: | Covariance Based Structural Equation Modeling |
| COGS: | Cost of Goods Sold |
| CSF: | Critical Success Factor |
| DBR: | Drum Buffer Rope |
| DC: | Distribution Center |
| DEA: | Data Envelopment Analysis |
| ECR: | Efficient Consumer Response |
| EDI: | Electronic Data Interchange |
| ELA: | European Logistics Association |
| EOC: | Early Order Commitment |
| EPOS: | Electronic Point of Sales |
| ERP: | Enterprise Resource Planning |
| EVA: | Economic Value Added |
| F&G: | Food & Grocery |
| FG: | Finished Goods |
| FMCG: | Fast Moving Consumer Goods |
| GIS: | Geographical Information Systems |
| GPS: | Geographical Positioning System |
| HO: | Head Office |
| IO: | Inventory Optimization |
| IPS: | Integrated Purchasing Strategy |
| IT: | Information Technology |
| ITO: | Information Technology Optimization |
| JIT: | Just in Time |
| JV: | Joint Venture |
| KMO: | Kaiser Meyer Olkin |

| | |
|---|---|
| KPI: | Key Performance Indicator |
| M&S: | Marks & Spencer |
| MADM: | Multi Attribute Decision Model |
| MHE: | Material Handling Equipment |
| MVI: | Missing Value Imputation |
| ORP: | Organized Retail Penetration |
| PCA: | Principal Component Analysis |
| PDS: | Public Distribution System |
| PLS-SEM: | Partial Least Square Structural Modeling |
| POS: | Point of Sales |
| PPP: | Purchasing Power Parity |
| PVA: | Performance Value Analysis |
| R & R: | Roles and Responsibilities |
| RBT: | Resource Based Theory |
| RBV: | Resource Based View |
| RFID: | Radio Frequency Identification |
| RM: | Raw Material |
| RO: | Resource Optimization |
| RO: | Retail Outlet |
| ROA: | Return on Assets |
| ROI: | Return on Investment |
| RRL: | Reliance Retail Limited |
| RV: | Relational View |
| SBM: | Supply Base Management |
| SBO: | Sales Based Ordering |
| SC: | Supply Chain |
| SCC: | Supply Chain Council |
| SCM: | Supply Chain Management |
| SCOR: | Supply Chain Operations Reference Model |
| SCP: | Supply Chain Performance |
| SCS: | Supply Chain Synchronization |
| SFG: | Semi Finished Goods |
| SI: | Supplier Integration |
| SKU: | Stock Keeping Unit |
| SMART: | Specific, Measurable, Attainable, Realistic and Time-sensitive |
| SSA: | Strategic Supplier Alliance |

| | |
|---|---|
| SWOT: | Strength, Weakness, Opportunities and Threats |
| TMS: | Transport Management System |
| TO: | Transport Optimization |
| TOC: | Theory of Constraints |
| TPG: | Texas Pacific Group |
| TQM: | Total Quality Management |
| VCA: | Value Chain Analysis |
| VE: | Variance Explained |
| WMS: | Warehouse Management System |
| ZO: | Zonal Office |

# LIST OF FIGURES

# LIST OF TABLES

# 1 Introduction to Supply Chain Performance Measurement

*"Without a standard there is no logical basis for making a decision or taking action"*

*-Joseph M. Juran.*

*The evolution of supply chain has been a gradual process since 1960s with revolutions in business processes. It is important for companies to know what they are doing and where they can reach, and measurement is the first step that leads to control and eventually to improvement. A growing body of literature has begun in the direction of Supply Chain Performance Measurement. This chapter presents the evolution of Supply Chain and defines SCM with the help of various definitions and theories influencing SCM philosophy, followed by objective of SCM, the challenges and opportunities in SCM. Thus, establishes a need for measuring SC performance and discussing the various theories used for measuring SC performance.*

## 1.1.Evolution of Supply Chain Management

A supply chain is the set of entities that collectively manufactures a product and sells it to an endpoint (Stern, et al., 2001). The term Supply Chain Management [SCM] was originally introduced by consultants in the early 1980s, and has subsequently gained tremendous attention (Chen & Paulraj, 2004; Larson & Halldorsson, 2004; Lambert, Cooper, & Pagh, 1998; Oliver & Webber, 1992). Since then, this paradigm has undergone huge developments nationally and internationally. Initially, power in the Supply Chain [SC] rested with manufacturers, which focused on operations, distribution and inventory (Randall, Gibson, Defee, & Williams, 2011; Langley, 1980; Drucker, 1962). The traditional supply chain and manufacturing processes relied on *experience and intuition of managers*, and were designed with *long supply cycle times, large batch sizes, capacity based on annual volumes, volume-driven technology, and numerous suppliers* for the same parts on the short-term base contracts. In this traditional management approach, the goal of business was to maximize the efficiency of an individual functional unit by achieving competitive edge based on cost reduction. Thus the SCM concept was initially developed along the lines of physical distribution and transport, derived from the work of Forrester, (1961) using the techniques of industrial dynamics, followed by total cost approach to distribution and logistics (Croom, Romano, & Giannakis, 2000 ). A typical supply chain involves various links which includes customers, retailers, wholesalers/distributors, manufactures and component/raw material suppliers as shown in Figure 1.1. The SC encompasses all activities involved in transformation of raw material to final goods/services. It includes not only the manufacturer and suppliers but also various intermediaries such as the transporters, warehouses, retailers and the final customers.

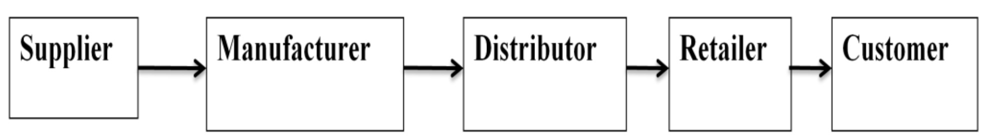



**Figure 1.1: An Illustration of Company's Supply Chain**

The development of the idea of the SC owes much to the emergence from 1950s onwards, from systems theory to the concept of holistic approach (i.e the integrated view of supply chain) (Gunasekarana, Patelb, & McGaughey, 2004; Cavinato, 1992). The term SCM has been used to explain the planning and control of materials and information flows as well as the logistics activities not only within a company but also between companies (Cooper, Lambert, & Pagh, 1997). There is a confusing plethora of overlapping terminologies and meanings within the supply chain management literature, SC theory and practice have evolved hand-in-hand through 20th century, resulting in emergence of modern lean, agile and leagile paradigms (Lamming, 1993; Harrison, Christopher, & Van Hoek, 1999; Christopher & Towill, 2001).

Over a period, there have been major revolutions in the field of SCM, with many labels referring to supply chain practices including: integrated purchasing strategy [IPS] (Burt, 1984), supplier integration [SI] (Dyer, Cho, & Chu, 1998), buyer-supplier partnership [BSP] (Lamming, 1993), supply base management [SBM], strategic supplier alliances [SSA] (Lewis, Naim, & Towill, 1997), supply chain synchronization [SCS] (Tan, Kannan, & Hanfield, 1998), network supply chain (Nassimbeni, 1998), value-added chain (Lee & Billington, 1993), lean chain approach (New & Ramsay, 1995), supply pipeline management (Farmer, 1996),supply network (Nishiguchi, 1994) and value stream (Jones, Hesterly, & Borgatti, 1997).

With reference to these developments, Battaglia, (1994) developed a model depicting the evolution of supply chain from 1960s to date (Figure 1.2). The model is a visual representation of the way in which companies have moved from functional silo approach to more integrated approach. The changes in information technology and the new competitive global environment: created by economic, demographic and political developments evolved supply chain from its core concerns around logistics/operation processes to an integration of various supply chain partners at different levels.

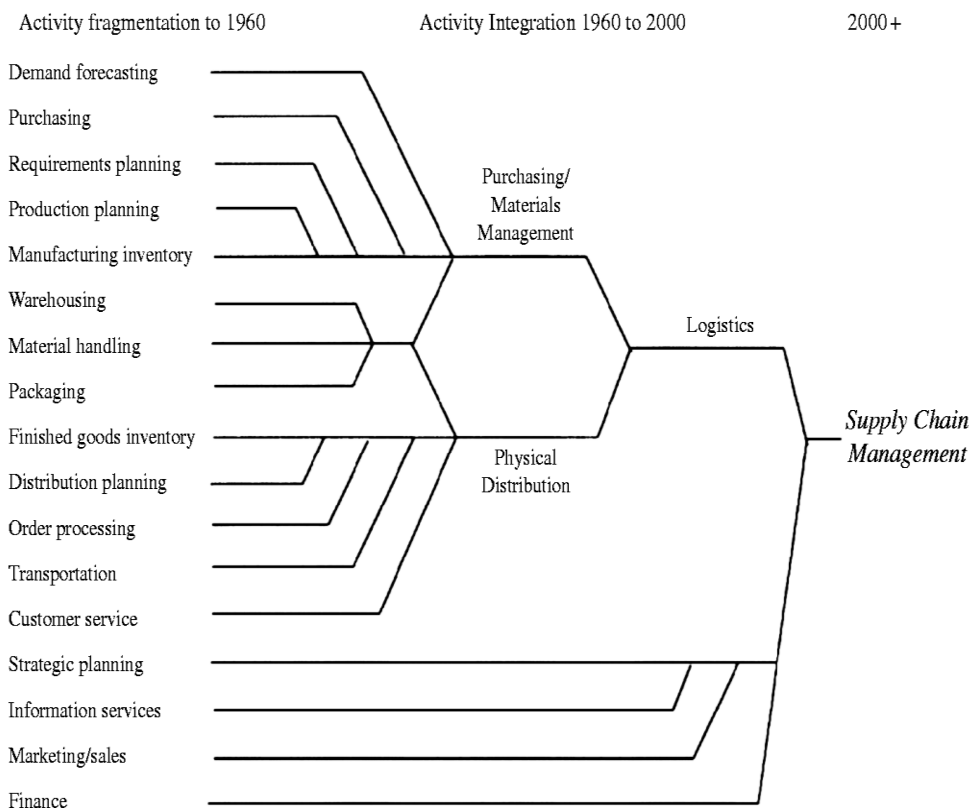



**Figure 1.2: Evolution of Supply Chain**
*Source:* (Battaglia, 1994)

Hence, the concept of supply chain has been considered from different points of view in different bodies of literature, and for this reason no universal definition of supply chain management exists (Croom, Romano, & Giannakis, 2000 ). The literature on SCM also suggests that the field is characterized by idealism and fragmentation which uses overlapping terminologies drawn from multi-disciplinary bases (Storey, Emberson, Godsell, & Harrison, 2006). There are numerous definitions of SCM; few definitions discussed here would give an idea in a nutshell (Table 1.1). Though these definitions have different meanings or emphasis, they share one common theme; they all refer to phenomenon relating to management of operations across organizational boundaries. Furthermore there is a common philosophy (or ideology) that by understanding and managing the supply chain, organizations will gain commercial benefits (New, 1996)

**Table 1.1: Definitions of Supply Chain Management**

| *Authors, year* | *Definition* |
|---|---|
| Oliver & Webber, (1982) | Supply chain management covers the flow of goods from supplier through manufacturing and distribution chains to end user |
| Jones & Rilley, (1987) | Supply chain management techniques deal with the planning and control of total materials flow from suppliers through end-users |
| Stevens (1989) | 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 |
| Ellram, (1991) | An integrative approach to dealing with the planning and control of the materials flow from suppliers to end user |
| Christopher, (1992) | Supply chain management is the management of a network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer |
| International Center for Competitive Excellence, (1994) | Supply chain management is the integration of business processes from end-user through original suppliers that provides products services and information that add value for customers |
| Harland, (1994) | Supply chain management is defined as the management of the flow of goods and services to end consumer to satisfy their requirements |
| Berry, Towill, & Wadsley, (1994) | Supply chain management aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular original equipment manufacturer (OEM) so as to release management resources for developing meaningful, long term relationships. |
| Cooper, Lambert, | An integrating philosophy to manage the total flow of a distribution |

| | |
|---|---|
| & Pagh, (1997) | channel from ultimate customer |
| Lee & NG, (1997) | The management of a network of entities that starts with the suppliers' supplier and end with the customers' customers for the production and delivery of goods and services |
| Lambert, Cooper, & Pagh, (1998) | As the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders |
| Handfield & Nichols, (1999) | The supply chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end-user, as well as associated information flows. Material and information flow both up and down the supply chain. Supply chain management is the integration of these activities through improved supply chain relationships to achieve sustainable competitive advantage |
| Simchi-Levi, Kamisky, & Simchi-Levi, (2000) | Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandize is produced and distributed at the right quantities, to the right locations and at the right time, in order to minimize system-wide costs while satisfying service level requirements |
| Ayers, (2001) | Supply chain management is the design, maintenance, and operation of supply chain processes for satisfaction of end users |
| Arunachalam Raghu, (2003) | Supply chain management is concerned with planning and coordinating the activities of organizations across the supply chain, from raw material procurement to finished goods delivery |
| Koch, (2006) | Supply chain management is the combination of art and science that goes into improving the way company delivers products to customers |

## 1.2.Theories Influencing SCM Philosophy

The main theories that have informed the development of supply chain management philosophy are discussed in this section. The theories have basically emerged from the critical thinking of the researchers in various dimensions.

***Systems Theory:*** Scholars have used 'systems' to explain the behavior of processes, firms, and economies. Basically system theory views the world as collections of resources and processes that exist to meet desired goals. Likewise a system comprises of material, people, information, and financial resources, which may be configured by organizational or technical processes for delivery of goods and services to achieve desired level of performance. Some of the example includes work of (Slack, Chambers, & Johston, 2001; Forrester, 1961), in the field of operations management.

***Transaction Cost Economics****:* The underlying principle of transaction cost economics is determination of whether to produce or buy a specific resource. It helps in determining that when to invest in what asset depending on external and internal factors like asset specificity, uncertainty of relevance or trust of human agents, hierarchical governance, etc. Some example includes work of (Williamson, 1975; Simon, 1960) based on choice of governance structure.

***Game Theory:*** Game theory explores and explains optimization decisions like pricing and investment decisions. Researchers asserted that economic decisions take form of a strategic game involving the anticipation by one player of the other's, for example (Cox, 1999a).

***Inter-organizational Relationships and Industrial Network Theories:*** Inter-organizational research is based on the perspective of inter-organizational relationships, as open systems (Kast & Rosenweig, 1970; Morgan, 1986). Organizations consciously take decisions before entering into contracts. Examples includes work of (Van De Ven & Walker, 1984) based on understanding of relationship between buyers and sellers.

***The Virtual Organizations and E-business Supply Chains:*** Recent developments in the field of IT, telecommunications and web based systems lead to emergence of virtual organizations. The emphasis of research shifted to e-business and development of supply chains through easier, quicker and more comprehensive information and data flows across the supply chain (Croom, Romano, & Giannakis, 2000 ).

As the literature on SCM is drawn from multi-disciplinary bases (Storey, Emberson, Godsell, & Harrison, 2006), much of the theory in supply chain management is based on idealism of optimal routes and quantities for demand fulfillment when considered from a whole-network or chain perspective which basically constitute of common elements, though vary in details. Researchers in the area of SCM have emphasized on the positive effects of SCM on an organization's performance and the integration of business processes internally and externally (Kotzab, Teller, Grant, & Sparks, 2011). The voluminous literature on SCM consists of a mixture of three elements: description, prescription and the identification of alleged trends.

In descriptive approach an effort is made to explore different aspect of SC while contributing to the theory and model building. Prescription approach is more specific in nature and it focus on domains of SC like mass customization and agility (Storey J. , Emberson, Godsell, & Harrison, 2006). Here the explored variables need to be tested and causal effect needs to be discussed. In trends identification the focus is on the impact of SCM on various function such as purchasing, the impacts on suppliers required by retailers to replenish stock based on actual sales, use of tools and techniques (Andersen & Rask, 2003; Wisner & Keah, 2000). Thus, in trends identification the initiatives taken for influential changes are observed which are strategic in nature rather tactical or functional in nature. Table 1.2 suggests the core concepts which constitute the theory SCM (Storey, Emberson, Godsell, & Harrison, 2006). It highlights the dimensions of conventional management approach and SCM approach.

**Table 1.2: Core Concepts of Supply Chain Management**

| Dimensions | Conventional management | Supply chain management |
|---|---|---|
| Unit of analysis, focal point of allegiance | Function, department, or firm as main unit of analysis | Supply pipeline as unit of analysis (materials flow planning; echelons; structures; value chain; network) |
| Use of information and knowledge | Information denial; lack of transparency | Information & knowledge sharing; transparency |
| Beneficiaries | One-sided benefit; win-lose | Mutual benefit; win-win |
| Targets | Optimization; cost reduction; price central | Maximization: Wider set of issues, value creation, quality, service, safety, etc |
| Time horizons | Short-term wins; periodic negotiation | Long term gains; life cycle (total value) costing |
| Relationship episode | Transactional | Longer term, deeper, multi-faceted relations |
| Range of 'partners' | Multiple competitive sourcing | Single or reduced sourcing |
| Scope of task | Fragmental tasks; impermeable rigid boundaries; discrete activities | Interdependency; Co-maker ship; permeable flexible boundaries; overlapping activities |
| Connectivity | Independent logistics | Integrated logistics |
| Reactive Vs. proactive | Reactive buyers | Proactive buyers |
| Process of supplier selection | Competitive tendering | Total screening |
| Scope of attention | Role specific behavior and knowledge | Expansive knowledgeable and behavior |
| Replenishment device | Inventory | Information |

*Source:* (Storey, Emberson, Godsell, & Harrison, 2006)

Consequently it can be understood that SCM has been defined explicitly to explain its dual purpose: firstly, to improve the performance of an individual organization, and secondly, to improve the performance of the whole supply chain (Koh, Demirbag, Bayraktar, & Tatoglu, 2007). In fact, performance evaluation of a supply chain has been identified as one important aspect of SCM domain which needs to be tackled, and the outcome of its operations has to be reported for continuous improvement (Lambert, Cooper, & Pagh, 1998; Croxton, Gracia-Dastugue, Lambert, & Rogers, 2001). Furthermore, Power, (2004) and Braganza, (2002) examined different perspectives on integration, and suggested that integration of several functions at different organizational levels achieve above average financial and performance results.

**Table 1.3: Supply Chain Evolution Phases**

| **Supply Chain evolution phase** | **I** | **II** | **III** | **IV** |
|---|---|---|---|---|
| Supply chain time marker | Early 1980s | Late 1980s | Early 1990s | Late 1990s |
| Supply chain philosophy | Product driven | Market oriented | Market driven | Customer driven |
| Supply chain type | Lean functional silos | Lean supply chain | Leagile supply chain | Customized leagile supply chain |
| Market winner | Quality | Cost | Availability | Lead time |
| Market qualifiers | Cost<br>Availability<br>Lead time | Availability<br>Lead time<br>Quality | Lead time<br>Quality<br>Cost | Quality<br>Cost<br>Availability |
| Performance metrics | Stock turns<br>Production cost | Throughput time<br>Physical cost | Market share<br>Total cost | Customer satisfaction<br>Value added |

Source: (Christopher & Towill, 2000)

Hence, evolution of supply chain has been a gradual process (as shown in Table 1.3). It has evolved from a product driven approach to a customer driven approach, from a lean functional silo approach to a customized leagile supply chain, from quality to lead time, from efficiency to responsiveness and finally the focus of performance shifted from stock turns and production cost to ultimate customer satisfaction and value addition (Christopher & Towill, 2000). That's why, over the years it is seen that companies have started focusing on their core competencies and outsourcing the non-core/ non-value adding activities of supply chain, to achieve a competitive edge in the market by doing a better trade-off between cost and service.

**1.3.Objectives of SCM**

It can be understood that with the changes in business environment, companies have taken steps to form strategic alliances with supply chain partners, with the objective of reducing uncertainty and enhancing control of supply and distribution channels. Such alliances help companies to enhance financial and operational performance of each channel partner through reductions in total supply chain cost and inventories by increase in sharing of real time information (Maloni & Benton, 1997). For this reason, it is important to understand the objective of SCM.

The fundamental objective is to "*add value*".

The objective of every supply chain is to maximize the overall value generated. The value, a supply chain generates is the difference between worth of final product to the customer, and the effort the supply chain lays in fulfilling the customer's request. To put it in a simpler way, the primary purpose for the existence of any supply chain is to satisfy customer needs, in the process of generating profit for itself (Chopra, Meindl, & Kalra, 2007).

Furthermore, according to (Cooper, Ellram, Gardner, & Hanks, 1997a), SCM is designed to face the market challenges, and helps to eliminate non-value-adding activities. The fundamental objective of SCM is to improve the efficiency and effectiveness of all operations in the supply chain (Hsiao, October 2006). It is important to minimize associated investment costs and operating costs, to increases customer responsiveness and flexibility which will enhance performance and competitiveness of the supply chain. It has been recognized that efficient and effective supply chain management can enhance customer value and reduce operating costs. For most commercial supply chains, value will be strongly correlated with supply chain profitability, and an efficient & effective supply chain optimizes performance in meeting agreed customer service requirements and minimizing costs while optimizing the use of all resources (Christopher, 2005).

SCM has also been considered as the most popular operations strategy for improving firm competitiveness in this century (Winser, 2003; Gunasekaran & Kobu, 2007). Therefore, today the companies on realizing the importance and impact of managing SCM have started paying attention to the continuous improvement of SC in order to fulfill the desired objectives of SC, in the process of achieving advantages of an efficient and effective supply chain. Many previous studies conducted in various industries, have revealed tangible benefits generated from efficient and effectively managed SCM (Harrington, 1999; Higginson & Alam, 1997; Alber & Walker, 1997; Palevich, 1997; Giunipero & Brand, 1996; Cooper & Ellram, 1993). These as a gist are set out below.

Some of the benefits of SCM are closer relationship with chain members, cost advantage, cost reduction, customer service level improvement, cycle time reduction, inventory reduction; inventory turns improvement, productivity improvement, profit margin improvement, reliable delivery responsiveness to changes (Alber & W, 1997; Cooper, Ellram, Gardner, & Hanks, 1997a; Guinipero, Larry, & Richard, 1996).

## 1.4.Challenges and Opportunities in SCM

One major problem identified in SCM is the lack of empirical evidence supporting the benefits attributed to SCM (Lambert, Garcia-Dastugue, & Croxton, 2005; Stock, Stefanie, Boyer, & Harmon, 2010). Despite of the need for continuous performance improvement of the SC, the main problem observed is that the SC's partners have not been achieving better results related to profitability and efficiency, because most of the time, their focus is on the individual aspect of the supply chain and not on the entire supply chain. Firms are increasingly realizing that now the competition is not among companies but among the SCs. In such a competitive mien, the goal of SCM to reach a solution with optimized profit for its SC's partners is a big challenge, and often there is a great disparity between potential benefits and the actual practice (Storey, Emberson, Godsell, & Harrison, 2006).

In fact, the design and analysis of the SC as a whole is critical to develop an efficient SCM (Wang, Fergusson, Perry, & Antony, 2008). It is because there are several difficulties regarding SC which need to be solved by an efficient SCM. Some of these difficulties are: long lead times, short responsive time, obsolete inventory, handling number of orders/backorders or absence of control related to priority orders, which implies on schedule conflicts of the resources, among many others (Goldratt, Schragenheim, & Ptak, 2000). A better SC income will only be achieved through a synchronized performance of SC's partners, all of them focused on the entire supply chain. Thus there are also some challenges involved in managing the supply chain efficiently and effectively. In addition, (Jones & Rilley, 1987) also presented the following three main barriers to a supply chain:

- Tradition, organizational, legal, and non-integrated management systems;
- Independent businesses, vendors, and distributors; and
- Information and control systems.

Furthermore, (Higginson & Alam, 1997) identified barriers to successful use of SCM as per the following:

- Lack of strong management commitment and consensus leadership;
- Unclear definitions about SCM;
- Legal issues in sharing data;
- Inefficient information systems, and
- Incompatible systems at channel members.

Also, Johnson, (1998) provided five pitfalls that hinder in effective SCM:

- Wrong choice of metrics for performance measurement,
- Poor operational control and execution,
- Lack of information sharing,
- Poor supply chain design, and
- Poor product design.

Therefore, in the light of discussion so far, SCM is seen to have core sets of concerns or problems, but the variability and uncertainty within supply chain management of its core concerns is one of the problems it faces (Ho, Au, & Newton, 2002). A related challenge is the need to increase the scope of SCM involvement- *'the arc of integration'* (Frohlich & Westbrook, 2001). This can be achieved by bringing in more transparency in information and knowledge, formation and use of appropriate measurements.

Supply chain management can be seen as a part of wider set of trends involving outsourcing, cross-boundary working, new organizational forms characterized by flattened hierarchies, teams, and empowerment and so on, rather than rigid command and control (Ruigrok, Pettigrew, Peck, & Whittington, 1999) which present an opportunity for the development of SCM. The increasing importance of intangibles heightens the need for potential of supply chain management. The complexity in managing a large number of SKUs requires greater set of skills, and globalization has necessitated greater attention to logistics and other components of supply chain management.

### 1.5. Need for Measuring Supply Chain Performance

As supply chains are continuously replacing individual firms by integration for creating value, therefore is important to understand the relationship between supply chain management [SCM] practices and supply chain performance [SCP]. To determine what performance measures should be evaluated for the SC, the question why supply chain performance is needed should be addressed first. Several factors trigger the business firm’s need for the performance measurement, including: Increasing competition which arises from greater customer expectations for cost reductions and value-added products or services (Neely, Bourne, & Kennerley, 1995).

Many companies strive to find specific areas to increase their competitiveness and competency for differentiation. Competition today is no longer between company to company, but rather, supply chain to supply chain. The focus of SCP measurement should go beyond firm focus (Pohlen & Lambert, 2001). Aligning the organizational goals with the supply chain goals is vital to the overall performance success of the supply chain. Moreover, the role of performance measures in the success of Supply Chain cannot be overstated (Gunasekarana, Patelb, & McGaughey, 2004). Performance measurement is an essential element of effective planning and control because it may not only provide necessary feedback information to reveal progress (Chan & Qi, 2003; Fynes & Voss, 2005), but it may also affect strategic, tactical and operational planning and control (Gunasekarana, Patelb, & McGaughey, 2004).

In a SCM context, performance measurement can facilitate integration among the SC members. The authors’ emphasized on the importance of the performance measurement system (Gunasekran, Patel, & Tirtiroglu, 2001) in such a way as to enhance the shared destiny principles of partnership and long term relationships. Thus, performance in a SC is defined as the overall efficiency and effectiveness of SCM. To accomplish this, SCM must integrate a number of key business functions, including purchasing, demand management, distribution planning, transportation, quality management, production planning, and materials management throughout the supply chain. Consequently, the output of the processes enabled by the supply chain must then be measured and compared with a set of standards. Control of processes in a supply chain is crucial in improving overall firm performance (Flynn, Huo, & Zhao, 2010; Li, Ragu-Nathanb, Ragu-Nathanb, & Rao, 2006; Tan, Kannan, & Hanfield, 1998).

Performance management in SC is therefore about setting goals within the SC and between functions that will lead to the desired results with balance and without conflict. Every aspect of SC needs to be considered in measuring the SCP. There are many dimensions to measure, and no single measure defines SCP. Thus, there is a need to obtain balance throughout the SC and the preparedness to change for better results. To measure SCP, there are a set of variables that capture the impact of actual working of supply chains on revenues and costs of the whole system (Ramdas & Spekman, 2000). In some of the studies on performance measurement, the predominant method for measuring performance is the use of KPIs that cascaded down from top level business objectives and measures through the organization into a series of functional measures (Storey, Emberson, Godsell, & Harrison, 2006).

Once the SCP measures are developed adequately, managers have to identify the KPIs that need to be improved. Retailers face many challenges in the ever increasing fierce competition. With the increase in product variety, increasing uncertainty in demand and supply, the need to reduce the time to market, shorter and shorter product life cycles with greater efficiency has raised the benchmark for the retailers to deliver value to the customers. However, as a result of the power that comes with control over consumer contacts, retailers today have the opportunity to organize the work in their supply chains in suitable ways. The positive impact of SCM on operational performance can manifest itself in all dimensions.

Cooperation, process integration, long term relationship, information sharing allow processes improvement and inventories and lead time reduction (Mentzer, et al., 2001; Cooper, Lambert, & Pagh, 1997; Bechtel & Jayaram, 1997; Cooper & Ellram, 1993). The information sharing reduces uncertainty in the whole chain, resulting in better planning and control processes (Lee & NG, 1997). Cooperation and processes integration between members of the same chain result in cost and time reduction and quality and flexibility improvements, as each organization can focus on its core competencies (Jarillo, 1988), and thus, an effective governance mechanism is chosen (Miguel & Brito, 2011; Grover & Malhotra, 2003). Empirically, it has been shown that cooperation and long-term relationship have positive effect on quality and delivery (Shin, Collier, & Wilson, 2000; Dyer & Singh, 1998) as well as in time reduction (Miguel & Brito, 2011; Salvador, Forza, Rungtusanatham, & Choi, 2001). External integration also results in time improvements, as processes design, development and improvements are developed simultaneously (Droge, Jayaram, & Vickery, 2004). Thus, it was concluded that SCM as a multidimensional construct impacts the firm performance as a whole (Mentzer, et al., 2001).

Table 1.4 shows some of the reasons why organizations measure performance (Neely A. D., 1998). A number of performance measurement tools have been identified in which the indicators have been categorized into various groups.

**Table 1.4: Why do Organizations Measure Performance?**

| Why measure? | Check position | Communicate position | Confirm priorities | Compel progress |
|---|---|---|---|---|
| To establish position | ✓ | | | |
| To monitor progress | ✓ | | | |
| Because the organization has to | ✓ | ✓ | | |
| Because the organization wants to communicate performance to shareholders or customers | | ✓ | | |
| Because the organization or others want to be able to benchmark performance | | ✓ | ✓ | |
| Because measures stimulate interest | | ✓ | | ✓ |
| Because measures can be used to communicate priorities | | ✓ | | ✓ |
| Because measures provide a means of motivating people to look for ways of improving performance | | | | ✓ |
| Because measures provide a basis for reward | | | | ✓ |
| Because measures provide a means of management control | ✓ | | | |
| Because measures provide a mean of cost control | ✓ | | | |
| Because measures provide an insight into what is important for the customer | ✓ | | ✓ | |
| Because measures provide an insight into what the business is doing well | ✓ | | ✓ | |
| Because measures provide an insight into what the business is not doing well | ✓ | | ✓ | |
| Because measures provide an insight into what the business needs to focus on | | | ✓ | ✓ |
| Because measures provide an insight into where the business should invest | | | ✓ | |

*Source:* (Neely A. D., 1998)

Many researchers have emphasized the importance of using the right metrics to measure the essential links between strategy, execution, and ultimate value of managing supply chain efficiency effectively

(Gunasekran, Patel, & Tirtiroglu, 2001; Lambert & Pohlen, 2001; Neely, Gregory, & Platts, 2005). Companies should start with a small number of performance indicators, which are necessary to examine the meta-level processes [plan, source, make, and delivery], which can be successfully manage and operate (Chae, 2009). For the proposed performance metrics to work properly, among other things such as systems, master data, and processes (Yang & Chen, 2006), the roles and responsibilities (R&R) of organizational members and units or teams need to be clearly defined and communicated enterprise-wide on a regular basis.

As discussed earlier by (Neely, Bourne, & Kennerley, 1995) the numerous approaches for developing the performance measurement model includes: computer aided manufacturing approaches (Globerson, 1985); performance measurement matrix (Keegan, Eiler, & Jones, 1989); performance measurement questionnaires (Dixon, Nanni, & Vollmann, 1990); balanced scorecard (Kaplan & Norton, 1992); and criteria for measurement system design (Wang, Fergusson, Perry, & Antony, 2008). These studies have also highlighted various limitations of existing measurement systems (John Mills, Wilcox, Neely, & Platts, 2000), including: they lack strategic focus i.e. the measurement system is not aligned correctly with strategic goals, organization culture or reward systems (Skinner, 1974); they encourage short termism (Hayes & Garvin, 1982; Banks & Wheelwright, 1979); they encourage local optimization (Hall, 1983; Fry & Cox, 1989) by forcing managers to minimize the variances from standard (Lynch & Cross, 1991; Johnson & Kaplan, 1987), rather than seek to improve continually; and, they fail to provide adequate information on what competitors are doing through benchmarking.

Continuous analysis of the performance of business functions helps managers to identify the areas of weakness and opportunities for improvements and also to prioritize their importance based on the scope. For example (Tracey & Tan, 2001) empirically tested the impact of SCM capabilities on business performance, so as to determine to what degree customer-oriented SCM influence competitive position and organizational performance. It was found that strategic development of SCM capabilities, such as; efficient inbound and outbound transportation, warehousing, inventory control, production support, packaging, purchasing, order processing, and information dissemination enable a manufacturing firm to identify key performance measures (Borade & Bansod, 2007).

Several other studies have also found a positive relationship between SCM and performance (Carr & Kaynak, 2007; Cousins & Menguc, 2006; Kaufmann & Carter, 2006; Fynes, Voss, & Búrca, 2005; Gimenez & Ventura, 2005; Droge, Jayaram, & Vickery, 2004; Chen, Paulraj, & Lado, 2004; Johnston, McCutcheon, Stuart, & Kerwood, 2004; Winser, 2003). Also few studies prior to these were (Salvador, Forza, Rungtusanatham, & Choi, 2001; Narasimham & Das, 2001; Shin, Collier, & Wilson, 2000) and others were not conclusive. Within the SCM domain there are many aspects that need to be tackled for the purpose of practical application, topics such as; performance evaluation of a supply chain and its members, inter-organizational coordination and management, how the supply chain members share the outcome of the operations (Croxton, Gracia-Dastugue, Lambert, & Rogers, 2001; Lambert, Cooper, & Pagh, 1998); human interaction in a supply chain (Giannakis & Croom, 2004); knowledge (strategic and operational aspects) sharing among supply chain members.

The importance of sharing of knowledge among supply chain members has been discussed by many researchers (Mentzer, et al., 2001; Tyndall, Gopal, Partsch, & Kamauff, 1998; Manrodt, Holcomb, & Thompson, 1997; Cooper, Ellram, Gardner, & Hanks, 1997a). (Spens & Bask, 2002) also emphasized on the importance of linking information of different processes among supply chain members. Hence knowledge transfer and sharing is a very important part of the processes of SC. Furthermore, performance for supply chain firms is measured not only in terms of financial indicators (using profitability measures), but also using non-financial indicators such as customer satisfaction and product quality (Koh, Demirbag, Bayraktar, & Tatoglu, 2007; Li, Ragu-Nathanb, Ragu-Nathanb, & Rao, 2006; Fynes & Voss, 2005). Types of performance measures are identified as necessary components in any supply chain performance measurement system, including resources, output and flexibility (Winser, 2003; Ayers, 2001; Gunasekran, Patel, & Tirtiroglu, 2001; Beamon, 1999). The performance measures are also categorized into qualitative and quantitative measures (Beamon B. M., 1998). The qualitative performance measures are those measures for which there is no single direct numerical measurement, although some aspects of them may be quantified. They include customer satisfaction and responsiveness, flexibility, integration, supplier performance. Some theories developed for measuring SCP are thus discussed in the next section.

## 1.6.Theories for Measuring Supply Chain Performance

SCM is essentially the economic theory of comparative advantage applied at the company level. Adam Smith argued that- (1) The wealth of a nation is the product of its labor and (2) The greatest improvements in the product of labor result from the division of labor.

Through such specialization and trade, wealth is increased (Kaplinsky & Morris, 2000). Authors (Gunasekarana, Patelb, & McGaughey, 2004) have emphasized on the activities undertaken by the various factors involved in supply chain which set the performance indicators as the economic production and distribution of goods. It was advocated by (Chopra, Meindl, & Kalra, 2007) that, '*the processes which occur before manufacturing or production into a deliverable product or service, typically processes dedicated to getting raw materials from suppliers; and the processes which occur after manufacturing or production dedicated to getting goods and services to customers'*. Thus the processes before and after the production along with material and information flow are pinpointed which would help organization to achieve maximum profit. There is no such thing as *'A unified theory of SCM'.* Depending on the concrete situation, one can choose one theory as the dominant explanatory theory, and then complement it with one or several of the other theoretical perspectives.

Theory development in SCM is still an emerging field (Harland, et al., 2006). Moreover there is no consensus about its definitions and constructs resulting in a fragmented literature (Burgess, Singh, & Koroglu, 2006; Chen, Paulraj, & Lado, 2004; Mentzer, et al., 2001) reviewed the most often used theoretical perspectives in the SCM literature, reporting that 20% of the articles had no discernible theory present. One of the relevant theories that support the positive relation between SCM and performance is the resource-based view [RBV] and its extensions. The RBV considers that firms are heterogeneous and achieve competitive advantage due to rare, valuable, inimitable and not substitutable resources and capabilities (Peteraf, 1993; Barney, 1991; Dierickx & Cool, 1989). The original approach of the RBV, focused on the internal resources owned by a firm and was broadened to consider the relationship as a source of competitive advantage. This gave rise to the Relational View [RV] (Dyer & Singh, 1998) integrating transaction cost theory (Williamson O. E., 1996) and its critics (Zajac & Olsen, 1993).

The RV considers relationships as potential sources of superior performance. It identifies four different sources of relational rents: investments in relation specific assets, substantial knowledge exchange, complementary and rare resources, and lower transaction costs. All these sources are influenced by more effective governance mechanisms based on informal safeguards, such as, trust and reputation (Rungtusanatham, Salvador, Forza, & Choi, 2003; Dyer & Singh, 1998). As in the RBV perspective, the relational resources and capabilities should be rare, valuable, and hard to imitate, or to substitute in order to provide sustainable competitive advantage. The positive impact of SCM in performance can be better understood if its constructs are interpreted using the relational view. Information sharing maps directly into knowledge exchange. Long-term relationships can help to reduce transaction costs through the development of trust and reputation (Mentzer, et al., 2001; Cooper, Lambert, & Pagh, 1997). It can also contribute to developing knowledge exchange and assure investments in specific assets. Cooperation and process integration can lead to development of both specific assets and complementary resources.

Likewise in Theory of Constraints [TOC] methodology, a SC is analyzed by means of a holistic view, in other words, it is defined as a group of dependent elements, and therefore, the system's performance is dependent on the efforts of all elements. Every system must have at least one constraint, and this is explained by the fact that if there were nothing to limit the system's performance, it would be infinite (Cox, 1999a). To administer this constraint, the TOC approach includes some issues, such as; the drum-buffer-rope scheduling method, the buffer management, and the five-step focusing process. In the TOC thinking, the activities planning, execution and control should be done through the Constraint Management paradigm by means of a Continuous Improvement Methodology. The idea is to act on the identified constraint that is avoiding the system to reach its main goal, which is the maximization of profits and system profitability.

TOC can help managers to identify and create win-win solutions among the system's entities. Furthermore (Gaither & Frazier, 2001) claim that the approach of the TOC is also known as synchronous manufacture, or Drum-Buffer-Rope [DBR]. The DBR methodology is the basis of the TOC applied to production and with reflex at the minimization of the inventory (Santosa, Marinsb, Alvesc, & Moellmannd, 2012)

The Supply Chain Council [SCC], a non-profitable organization established in 1996, has developed the Supply chain operations reference [SCOR] model. It is intended to be an industrial standard that contains a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality (Huang, Sheoran, & Keskar, 2005). The SCOR performance metrics are structured in two levels, where, Level I is based on *SC's business strategy*; and Level II focuses on: *Delivery reliability - delivery performance, fill rates, perfect order fulfillment; Responsiveness - order fulfillment lead times; Flexibility - supply chain response time, production flexibility; Cost - cost of goods sold, total supply chain management cost, value-added employee productivity, warranty/return processing costs; and Assets - cash-to-cash cycle time, inventory days of supply, asset turns* (Lai, Ngai, & Cheng, 2002).

From a scientific perspective, predictability is a main concern, which occurs not only when researchers identify causal mechanisms that tie action to results, but also when circumstances are described (Christensen & Raynor, 2003). Contingency theory attempts to describe these circumstances, suggesting that no universal set of strategic choices applies to every business situation (Ginsberg & Venkatraman, 1985). Early advocates have indicated that organizations are continuously under pressure for sustaining in the market (Lawrence & Lorsch, 1967). Furthermore, it was pointed out that contingency theory can be used for improving the performance of the firm (Hofer, 1975). Thus, typical frameworks in the contingency research tradition would focus on the relationships between the contextual factors and the performance (Ginsberg & Venkatraman, 1985; Schoonhoven, 1981). Empirical evidence addresses that contingency theory is fairly recent in the SCM literature (Van Donk & Van der Vaart, 2005; Ho, Au, & Newton, 2002). This has further been discussed in chapter 4.

### 1.7. Challenges Involved in Using SC Performance Measurement

One of the most prevalent issues associated with performance measurement is having too many metrics. Some organizations are using hundreds of metrics which are often not aligned to the organization's strategy (Hoffman, 2006). This leads to confusion, often results in *'paralysis by analysis'* and presents difficulties in conducting benchmarking exercises. Thus, there is a requirement for a meaningful and parsimonious set of measures and framework in SCP context. The key challenge for organizations is selecting the most appropriate and effective SCP measures. Also, (Caplice & Sheffi, 1995) recommended that managers should continually review and evaluate their SCP metrics in order to make sense of the growing number of SC metrics, and also to ensure the metrics reflect the ever-evolving SC and business environment. They were not trying to propose new metrics but recognized that metrics needed to evolve with the changing external business environment. They also provided eight criteria on which to judge the quality of metrics: validity, robustness, usefulness, integration, compatibility, economy, level of detail and behavioral soundness.

With organizations facing increased pressure from the government, customers and competition on their environmental and social performance, now is an appropriate time for this review process to take place and for organizations to begin quantifying their impact on the SCP (Shaw & Grant, 2012). It has been argued that management accounting systems do not readily support SCM perspectives It appears that traditional management accounting techniques are nowadays being used together with so-called 'advanced' accounting techniques such as activity-based costing [ABC], target costing, product life cycle costing, just-in-time [JIT] inventory, total quality management [TQM], value chain analysis [VCA], the balanced score-card [BSC] approach to performance measures and others (Abdel-Kader & Luther, 2006a; Islam & Kantor, 2005; Waweru, Hoque, & Uliana, 2004; Luther & Longden, 2001; Anderson & Lanen, 1999; Chenhall & Langfield-Smith, 1998a; Innes & Mitchell, 1995). Traditional management accounting is said to fail to recognize the potential for exploiting linkages with the firm's suppliers and customers. According to (Seal, Cullen, Dunlop, Berry, & Ahmed, 1999), the implications of SCM initiatives for management accounting and for management accountants both support that criticism and show how management accounting is changing in response to the challenges. The contribution of management accounting to SCM may depend on its ability to develop costing and performance measurement technologies that can be understood and respected by non-accountants, who currently predominate in the field of SC (Seal, Cullen, Dunlop, Berry, & Ahmed, 1999) both internal to the firms and in inter-firm relationships (Ramos, 2004; Kulmala, Paranko, & Uusi-Rauva, 2002).

Thus the focus of the study is on SCM performance. For this study a sector specific approach has been adopted focusing on retail supply chain management in Indian context. The next chapter discusses retailing and its details.

# 2 Retail Supply Chain Management

*"I am like any other man. All I do is supply a demand"*

*- Al Capone*

*This chapter discusses the concept of retailing and evolution of retail in India. It also throws light on the contribution of retail to GDP of Indian economy and also presents various attitudinal changes in the demographic profile of consumers, which have transformed the retailing face of India. Further this chapter describes the various formats of retail, its organizational structure and a brief profile of foremost retail companies operating in India.*

## 2.1. Retailing

Retailing is the interface between the producer and the individual consumer, buying for personal consumption. This excludes direct interface between the manufacturer and the institutional buyers, such as the government and other bulk customers. A retailer is one who stocks producers' goods and is involved in the activity of selling it to the individual consumers, at profit margin.

Retailers form an assortment of the different products from different producers to form a suitable product range. They are the direct contact point with the consumers and inform the producers about market needs and help them to promote their products and services (Lang, 2012). Thus, retailing is also referred as the last link that connects the individual consumer with the manufacturing and distribution chain. Retail industry comprises both the organized and the unorganized sectors.

*"Organized retailing refers to trading activities undertaken by licensed retailers, that is, those who are registered for sales tax, income tax, etc. These include the corporate-backed hypermarkets and retail chains, and also the privately owned large retail businesses"* (Parliament of India, Rajya Sabha, 2009)

*"Organized retail in India is popularly referred to as "modern retail" in business-to-business (B2B) exchanges".* Figure 2.1 presents the structure of modern retail, where lesser intermediaries are involved as compared to traditional retail. Unorganized retailing, on the other hand, refers to the traditional formats of low-cost retailing, for example, the local *kirana* shops, owner operated general stores, *paan/beedi* shops, convenience stores, hand cart, pavement vendors, etc (Parliament of India, Rajya Sabha, 2009).

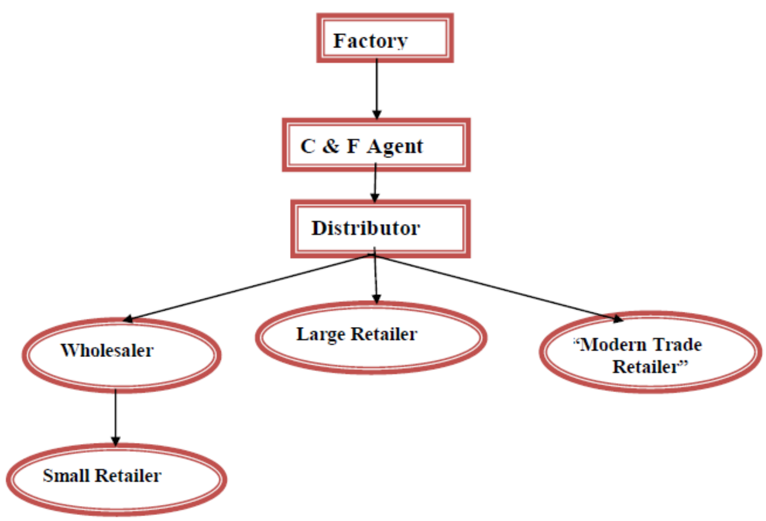



**Figure 2.1: Modern Retail**

## 2.2.Retailing in India

India is one of the fastest growing retail markets in the world. The Indian Retail Industry is ranked among the ten largest retail markets in the world (IJMBS, 2013). The retail sector in India is a key contributor to the country's economy and was responsible for contributing 22 percent to gross domestic product (GDP) in 2011 (Research Gyan, 2013).

The demographic shift of the Indian consumer and the rise in purchasing power has led the emergence of organized retail formats which has transformed the face of retailing in India. As a result, Indian retailers are focusing on strategic perspective in retail marketing with the idea of using resources optimally in order to create core competence and gain competitive advantage (IJMBS, 2013). Foreign direct investment [FDI] is an integral part of an open and effective international economic system, which acts as a major catalyst in the development of a country through up-gradation of technology, managerial skills and capabilities in various sectors. The Indian retail industry is marked with huge growth potential. However, in spite of the recent developments in the retail sector and its immense contribution to the economy, it continues to be the least evolved industry in India when compared to rest of the world (IJEMS, 2013)

Thus Retailing in India is still in its formative years and is dominated mostly by the unorganized sector. Henceforth this situation will no longer exist, because the old traditional formats in India are undergoing a major change; formats are becoming bigger and more complex. Malls and mega malls are coming up in almost all places across the country and retailers are being more innovative in delivering value to the customers. This can be attributed to the entry of a large number of domestic and international players in the market (SSIJMAR, 2013)

The logistics sector in India has today become an area of priority. One prime reason for the same stems from the reason that years of high growth in the Indian economy have resulted in a significant rise in the volume of freight traffic moved. This large volume of traffic has provided for growth opportunities in all facets of logistics including transportation, warehousing, freight forwarding, express cargo delivery, container services, shipping services etc. The growth path has also meant that increase demand is being placed on the sector to provide the solutions required for supporting future growth (Deloitte, 2013)

### 2.3.Evolution of Retail in India

Since independence, barter is considered to be the oldest form of retail trade. However, retail in India has evolved to support the unique needs to our country given its size and complexity. *Haats, mandis and melas* have always been a part of Indian landscape. The evolution of Public Distribution System (PDS) of grains in India was its origin in the rationing system introduced by the British during World War II. The system started in 1939in Bombay and subsequently extended to other towns and cities. The system was abolished post war; however, on attaining independence, India was forced to reintroduce it in 1950 in the face of renewed inflationary pressure in the economy (Akhter & Equbal, 2012)

Tracing the evolution of Indian retail would be incomplete without mention of canteen stores department and the post offices in India. The

Khadi and village industries (KVIC) were also set up post independence. Today there are more than 7050 KVIC stores across country. The cooperative movement was again championed by the government which set up Kendriya Bhandras in 1963. In Maharashtra, Bombay Bazaar, which stores under the label Sahakari Bhandar and Apna Bazaars run a large chain of cooperative stores. During the past decades, the Indian market place has transformed dramatically. However, from 1950s to the 80s investments in various industries were a limit due to the low purchasing power in the hands of the consumer and the government policies favoring the small scale sector. It was at this juncture that many steps towards liberalization were taken in the period of 1985-90. Many restrictions on private companies were lifted and in the 1990s the Indian economy slowly progressed from state led to becoming *'Market friendly'.*
The first attempts at organized retailing were noticed in the textile sector. One of the pioneers in this field was Raymonds, which set up stores to retail fabric. Other textile manufacturers, who set up their own retail chains, were Reliance- which set up Vimal and Garden silk mills with Garden Vareli and then later in the league was Madura Garments, Arvind Mills, etc. They set up showrooms for branded menswear. With the success of the branded menswear store, finally, the new age departmental stores arrived in India in early nineties.

Moreover the concept of organized retail had occurred much later in developing economies than the developed economies. Modern day retail came into existence in three successive waves. The first wave took place in the early to mid-1990s in South America, East Asia excluding China, North Central Europe and South Africa. The second wave of organized retail occurred during mid-to-late 1990s in Mexico, Central America, South-east Asia and South Central Europe. The third wave of organized retail boom started in the late 1990s and early 2000 in some parts of Africa, Central and South America, South-east Asia, China, India and Russia and continues to grow at a rapid pace (British Retail Consortium/ICRIER, 2012)

## 2.4.Indian Retail Supply Chain

*'Revolutions begin long before they are officially declared'*

*'At the heart of this revolution lies a radical decision: to shift from treating financial figures as the foundation for performance measurement treating them as one among a broader set of measures'* (Eccles, 1991).

India is estimated to have around 15 million retail outlets, making it the country with the highest retail outlet density in the world. Indian retail sector is highly fragmented in nature, only 4% of Indian retail outlets are larger than 500 sq. feet. Organized retail is just 5% of the total retail market, whereas 95% of the total retail trade in India is in the unorganized sector. Unorganized retail industry in India is the second largest employer after agriculture, employing about 8 % of total work force (Around 40 million persons) (Gopal & Suryanarayana, 2012). Moreover, Indian retail scenario has been distinguished from developed nations on the following three features:

- Fragmented and multi layered retail distribution market,
- Many retailers of various sizes at many locations vying to serve the final consumer,

- Many buyers for the grower and manufacturer, thus, preventing any retailer from establishing a monopoly and dictating price and credit terms to the growers and manufacturers (Guruswamy, Sharma, & Jos, 2007)

India is considered as one of the most desirable retail destinations in the world. India's emerging economy is one of the fastest growing across the globe. Since, the Indian economy was liberalized in the 1990s; the average gross domestic product (GDP) of India has been growing at a rate of 8.6% since 20067-07. The India's retail fundamentals are given in Table 2.1.

**Table 2.1: India's Retail Fundamentals**

| **India's Retail fundamentals** | |
|---|---|
| Market size | US$ 350 billion |
| CAGR | 15-20% |
| Unorganized retail | 12 million mom-and-pop stores |
| Organized retail penetration | 5-8% |
| Retail density | 6% |
| Contribution to GDP | 14% |

Source: (Ernst and Young, 2011)

Retail being India's second largest employer after agriculture is estimated to grow to $ 860 billion by 2018 (Technopak Advisers, 2011). Organized retail can be segmented in two ways - segmentation by verticals and by channels. Verticals are segmented on the basis of the type of merchandise offered; similar merchandise can be clubbed together to form a vertical, for instance food and grocery. Channels are the means through which retailers sell their merchandise; for example, store channels of retailing that comprise different formats like hypermarkets, supermarkets and department stores and non-store formats like online retailing, vending and kiosks (British Retail Consortium/ICRIER, 2012). The key store categories and product categories are given in the Table 2.2, along with the percentage share of revenues for each category.

**Table: 2.2: Revenue Share of Store and Product Category**

| **Store Category** | **Revenue share %** |
|---|---|
| Hypermarket | 3-4 |
| Department Stores | 7-8 |
| **Product Category** | **Revenue Share %** |
| Apparel | 12-18 |
| Footwear | 15-18 |
| Jewellery | 2-2.5 |
| Health and beauty | 10-12 |
| Food | 15-20 |
| Entertainment | 8-10 |

*Source:* (Jones and Lang LaSalle, 2011)

The retail industry is at a key inflection point and the present day economic realities are forcing to rethink on the traditional business models. The industry is somehow struggling to keep pace, because the operating environment has become far more complex and interconnected. In such an open information environment, national and global brands no longer have the control in the market as they used to have. While radio frequency identification [RFID] and related tools are helping the retailers to gain better understanding of consumer buying habits, social networking and other online tools put consumers in touch with one another, which have shifted the power outwardly from producers and retailers into the hands of everyday consumers.

There are multiple drivers for the retail growth, and the recent dynamics suggest that the industry is on the cusp of foundational change. These issues have been brought in front by the changing economic environment and the fast-moving social, technological, and demographic changes. India's retail growth is largely driven by increasing disposable incomes, favorable demographics, changing lifestyles, growth of the middle class segment and high potential for penetration into urban and rural markets.

The country has seen booming capital markets, the emergence of new industries, an ever evolving consumer changing tastes and preferences, entrance of multinational corporations [MNCs]. This significant rise in GDP (as shown in the Figure 2.2), along with the increasing spending power of Indians, is leading to the phenomenon of consumerism. Increasing urban demographics, rapid development of shopping malls, emerging breed of brand-conscious consumers, and various influences from the Western world are changing the face of the Indian retail industry (Halepete, Iyer, & Park, 2008).

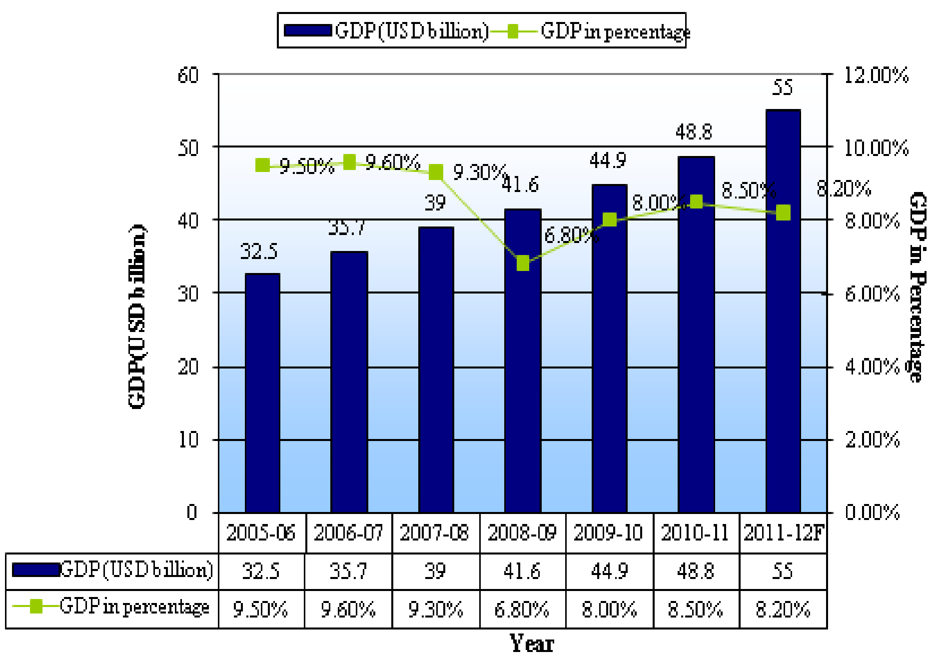



**Figure 2.2: Growth of GDP**

*Source:* (PwC, 2012)

These favorable demographic and psychographic changes relating to India's consumer class, international exposure, availability of quality retail space, wider availability of products and brand communication are some of the factors that are driving retail in India (IMAGES, 2009; PwC, 2012). As shown in Figure 2.3, the increasing purchasing power of consumers across different categories.

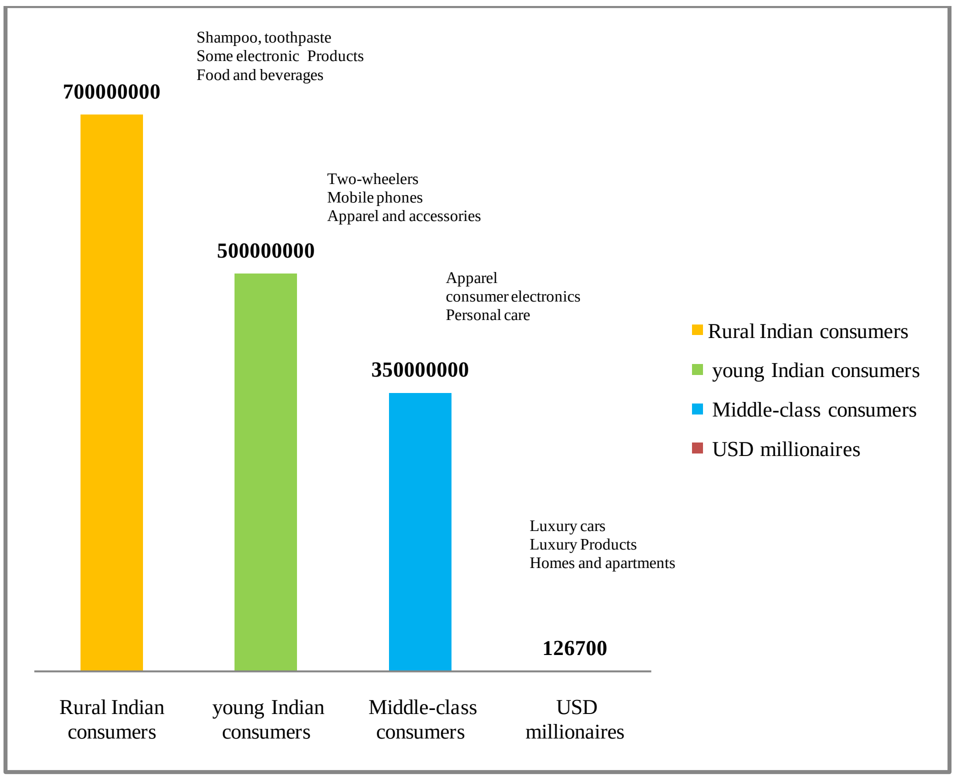



**Figure 2.3: Demographic groups with Purchases across Categories**
*Source:* (PwC, 2012)

Over the last few years, many international retailers have entered the Indian market on the strength of raising affluence levels of the young population along with the heightened awareness of global brands, international shopping experiences and the increased availability of retail real estate space. India's retail sector is worth US$ 350 billion, and has a low Organized Retail Penetration [ORP] of 5 to 8%, and is growing at a CAGR of 15 to 20%. A large market potential is growing for a range of categories with the increasing urbanization, growing incomes, increasing consumer confidence, etc. During the mid to late 2000s, some of India's largest conglomerates took large scale retail initiatives. Also, India's unique demography makes it an attractive market for operating across categories, spanning food and grocery, cash-and-carry, apparel, footwear, accessories, mobile phones, personal care, gems and jewellery, etc. The large and aspirational middle-class of 75 million households or 300 million individuals is the growth engine of Indian economy, which is one of drivers for increase in demand as shown in Figure 2.4.

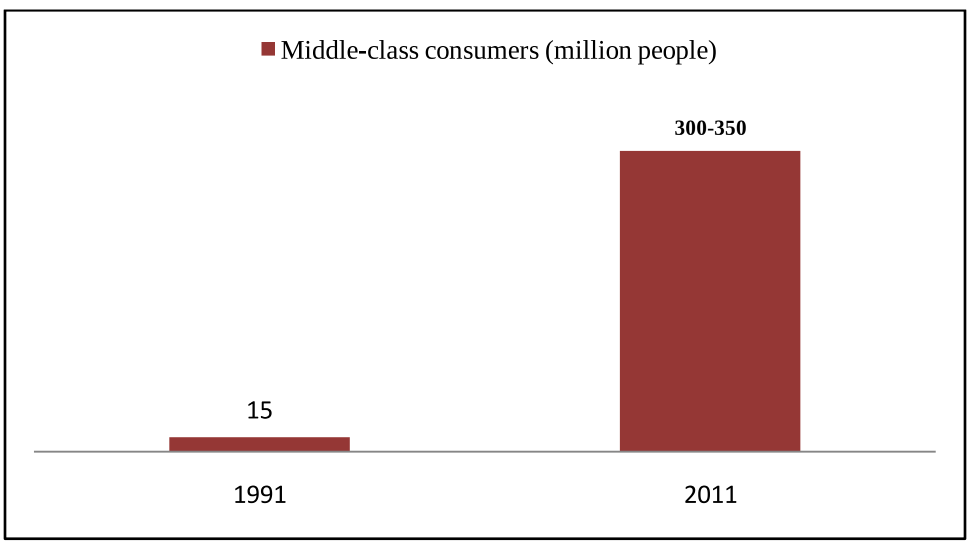



**Figure 2.4: Middle-class Consumers (million people)**

*Source:* (PwC, 2012)

The demand drivers fuelling the growth of retail are as follows:

***Demanding Consumers:*** The tastes and preferences of Indian consumers have changed drastically. Indian consumers have become value conscious and there has been a shift in household demographics demanding access to more, improved and better priced products.

***Increasing Incomes:*** Strong GDP performance, capital market growth and the emergence of new industries have created a large heterogeneous group of consumers who have significantly varying buying power. Consumers are willing to experiment with new forms of retail purchase. The projected growth in GDP, Purchasing Power Parity [PPP] is shown in the Figure 2.5 (PwC, 2012).

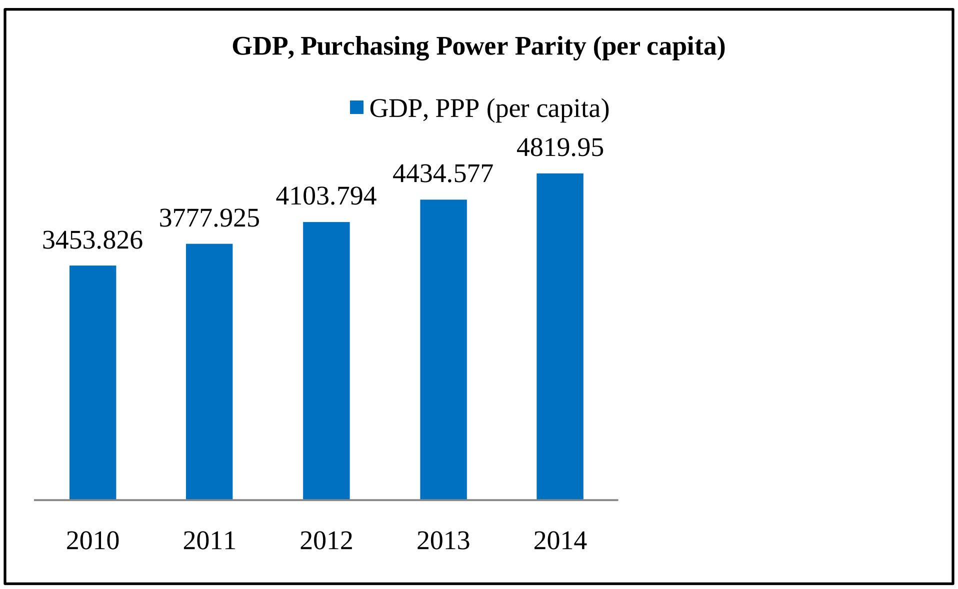



**Figure 2.5: Growth of GDP, Purchasing Power Parity**
*Source:* (PwC, 2012)

***Evolving Consumption Patterns*:** Earlier the Indian consumers used to focus only on saving, but with positive macro-economic fundamentals, changing lifestyles, double-income households, easy availability of credits, etc, have ensured consumers to spend on different categories of products. The young demography has in turn aided to the aspirational demand of lifestyle products with a more disposable income as shown in Figure 2.6.

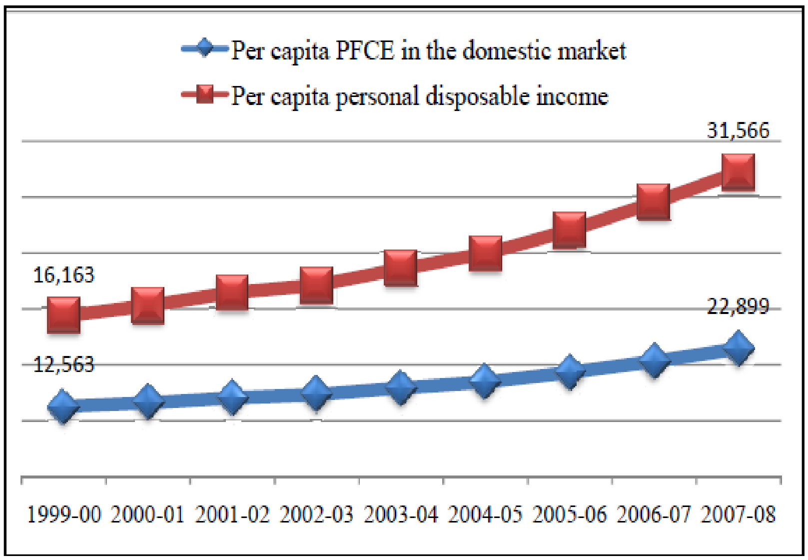



**Figure 2.6: Trends in Per Capita Final Consumption Expenditure (PFCE) and Disposable Income (in Rs)**
*Source:* ( IMaCS Analysis, 2009)

The supply drivers for Growth in Retail are:

***Expansion of Retail:*** The growth of modern trade has evolved over a period of time, and an expansion into Tier II and Tier III cities has made consumers to easily access the retail products and services. Research conducted by Future group classifies Indian customers into three sets and provides a base to the retailers in segmenting the Indian market as given in Table 2.3.

**Table 2.3: Classification of Indian Consumers**

| **India 1** | **India 2** | **India 3** |
|---|---|---|
| **Consuming Class** | **Serving Class** | **Struggling class** |
| • Constitutes only **14%** of the country's population<br><br>• Most of these customers have a substantial disposable income and they form part of usually called as the **upper middle** and the **lower middle class** | • Includes people like drivers, house hold helpers, office peons, liftmen, washer man, etc.<br><br>• These people make life easier and more comfortable for the consuming class or **India 1**<br><br>• Research indicates that for every India 1 at least three India 2's are there, making up approx. 55% of the population but due to low income they have a very little disposable income to spend on buying<br>• Inspirational goods & services. | • It lives hand-to-mouth so, cannot afford to even aspire for good living.<br><br>• Unfortunately, this segment will continue to be on the peripheries of the consumption cycle in India, in years to come. |

*Source:* (Future Group Research, 2001)

***New Entrants:*** The large conglomerates have invested hugely in the country and there has been an entry of world global players. Also, the FDIs coming into picture which has made a difference. With automation and emergence of technology, all the supply partners have spread to the core. Retailers use a mix of formats that include the following:

- Departmental Stores
- Discount Stores
- Warehouse Stores
- Variety Stores
- Mom and Pop Stores

- Specialty Stores
- General Stores
- Convenience Stores
- Hypermarkets
- Supermarkets
- Malls
- Category Killers or Category Specialists
- E-tailing
- Vending Machines

This has led to growth opportunities in the retail sector, and retailers are further exploring and matching their product line to the best of formats.

'*No single format will be suitable for Pan India- finding the relevant format would be a key to successes'*, CEO, a large Indian retailer- (FICCI, 2008)

The various formats adopted by retailers are described as follows:

- ***Departmental Stores****:* are very large stores offering a huge assortment of "soft" and "hard goods; often bear a resemblance to a collection of specialty stores. A retailer of such store carries variety of categories and has broad assortment at average price. They offer considerable customer service.
- ***Discount Stores****:* offers a wide array of products and services, but they compete mainly on price offers extensive assortment of merchandise at affordable and cut-rate prices. Normally retailers sell less fashion-oriented brands.

- ***Warehouse Stores****:* warehouses that offer low-cost, often high-quantity goods piled on pallets or steel shelves, etc
- ***Variety Stores***: offers extremely low-cost goods, with limited selection.
- ***Mom-And-Pop Stores****:* are owned and operated by individuals. The range of products are very selective and few in numbers. These stores are seen in local community often are family-run businesses. The square feet area of the store depends on the store holder.
- ***Specialty Stores:*** gives attention to a particular category and provides high level of service to the customers. A pet store that specializes in selling dog food would be regarded as a specialty store. However, branded stores also come under this format. For example a Reebok or Gap store.
- ***General Stores:*** are rural store that supplies the main needs for the local community.
- ***Convenience Stores:*** are essentially found in residential areas. They provide limited amount of merchandise at more than average prices with a speedy checkout. This store is ideal for emergency and immediate purchases.
- ***Hypermarkets:*** provides variety and huge volumes of exclusive merchandise at low margins. The operating cost is comparatively less than other retail formats. Hypermarkets offer shoppers a one-stop shopping experience. A retail store that combines a department store and a grocery supermarket. Often a very large establishment, hypermarkets offer a large variety of products such as appliances, clothing and groceries.

- ***Supermarkets:*** is a self service store consisting mainly of grocery and limited products on non food items. They may adopt a Hi-Lo or an EDLP strategy for pricing. The supermarkets can be anywhere between 20,000 and 40,000 square feet (3,700 $m^2$).
- ***Malls:*** has a range of retail shops at a single outlet. They endow with products, food and entertainment under a roof.
- ***Category Killers or Category Specialist:*** By supplying wide assortment in a single category for lower prices a retailer can "kill" that category for other retailers. For few categories, such as electronics, the products are displayed at the centre of the store and sales person will be available to address customer queries and give suggestions when required. Other retail format stores are forced to reduce the prices if a category specialist retail store is present in the vicinity.
- ***E-tailers:*** The customer can shop and order through internet and the merchandise are dropped at the customer's doorstep. Here the retailers use drop shipping technique. They accept the payment for the product but the customer receives the product directly from the manufacturer or a wholesaler. This format is ideal for customers who do not want to travel to retail stores and are interested in home shopping. However it is important for the customer to be wary about defective products and non secure credit card transaction. Example: Amazon, Pennyful and Ebay.
- ***Vending Machines:*** This is an automated piece of equipment wherein customers can drop in the money in machine and acquire the products.

## 2.5.Organizational Structure of Retail

The organizational structure of retail organization is given in Figure 2.7. Human Resources [HR] at Retail within itself have teams like Talent Acquisition, Training, and Store Operations etc. The individual store HR, apart from reporting to Store Manager, also report to the HR Store Operations at the Zonal or Head Offices of the organization. Similarly, for Marketing, there are teams like Store Activation, Media Buying and planning and Marketing. The store marketing teams also report to organization's marketing team, apart from store managers. Also specialized teams exist for Logistics, Technology and Finance. The Projects and Properties team is responsible for the scouting and acquisition of new store locations as well as the commissioning and maintenance of stores.

The merchandising team includes the COO at its head which includes, Head-Fashion category, Head-Food category and so on. The size depends on the number of categories that the retail company is present in. Within each category merchandising team, there are three critical functions: Plan, Buy, and Move. The Plan team also works very closely with the store teams and the Move team works closely with the Logistics team of the organization.

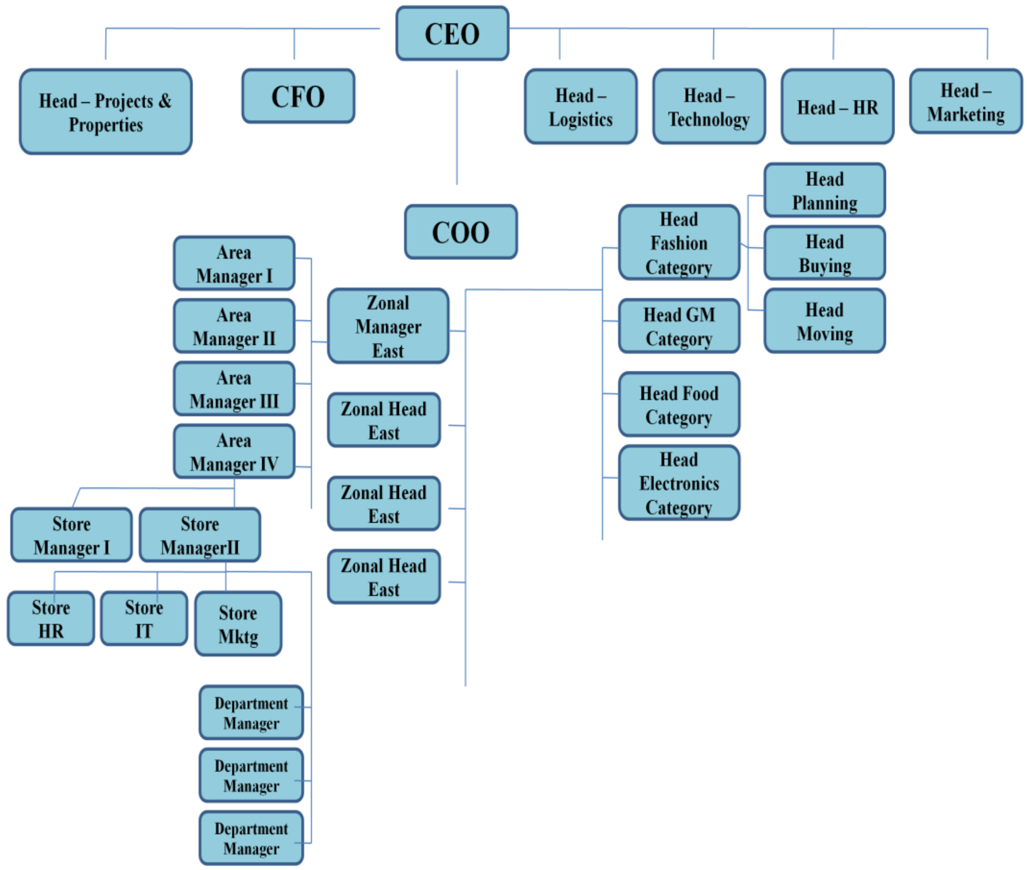



**Figure 2.7: Organizational Structure of Retail**

The Operations includes CEO which includes the Zonal Heads, Area Managers, Department Managers, etc. Depending on the size of the operations, the territory is first divided into zones, then into areas and then into stores. Within stores, there are Department Managers and support functions that both report to the store manager and the support teams at Zonal Offices [ZO] and Head Offices [HO].

## 2.6.Profiles of the Companies

In this section the profiles of top ten retail companies operating in India are presented. These are multi item retailers with multiple stores operating across the nations. These include both Private (Indian) and Private (MNCs) operating in India (Wal-mart and Bharti: Transforming Retail in India, 2009).

### 2.6.1. Aditya Birla Group

The Aditya Birla Group is an Indian multinational company headquartered in Mumbai, Maharashtra, India. The Aditya Birla Group was founded in the 1960s by Aditya Birla. The Group companies of Aditya Birla deals in retail as well as garments sectors. - Mr. Pranab Barua is takes care of the Retail and Apparels. In december 2006 ,Aditya Birla entered in the retail business. On May 2007 Aditya Birla Retail Limited (ABRL) launched their own brand of stores called 'More' which has 487 supermarkets and 14 hyperstores in India. The products offered in retail sector under the brand name MORE are FMCG products, fruits, vegetables, groceries, frozen food, bakery, homecare and pharmacy. The garments sector of Aditya Birla group is defined by its brands-Louis Philippe, Van Heusen, Allen Solly, Peter England, Planet fashion. Madura Fashion & Lifestyle reaches its discerning customers through an extensive network comprising more than 1,000 exclusive and franchise stores, and over 2,000 premium multi-brand trade outlets, both within and outside India. Planet Fashion, the multi-brand, apparel-retailing arm of Madura Fashion & Lifestyle, housing the company's in-house and other brands, is the largest chain of stores of its kind in India (Adiya Birla Retail, 2012).

### 2.6.2. Bharti Walmart Private Limited

Bharti Walmart Private Limited is a joint venture between Bharti Enterprises, one of India's leading business groups with interests in Teleco, agri-business , insurance and retail , and Walmart, the world's leading retailer , renowned for its efficiency and expertise in logistics, supply chain management and sourcing. The first wholesale cash-and-carry facility named "Best Price Modern Wholesale " opened in Amritsar in May 2009 and subsequently in Zirakpur, Jalandar, Kota ,Bhopal, Ludhiana, Raipur, Indore, Vijaywada, Meerut, Agra, Lucknow, Jammu, Guntur, Aurangabad, Bathinda, Amravati, Hyderabad and Rajahmundry. There are in total about 20 retail units all over India. More than 5000 items, across product categories like ,fresh (Fruits, Vegetables, Poultry, Mutton, Fish),dairy (Milk and Milk Products), consumer Packaged Goods (Food and Non Food), general Merchandise, household electronics and appliances are offered under one roof, at low, transparent prices to business members. The focus is to meet the unique needs of every member segment like kirana shop owners, general merchandise resellers, hotels, restaurants, caterers, offices and institutions by offering relevant items at very competitive prices, ensuring consistent availability and convenience (Bharti Walmart, 2012).

### 2.6.3. Carrefour

The euro 81-billion Carrefour retail chain is the largest in France and second-largest in the world after Walmart. The group, has three cash-and-carry outlets in the country, opened a store in New Delhi, its first in India, in December 2010, and followed by one in Jaipur in late 2011 and the third in Meerut in October 2012. Cash-and-carry involves selling to businesses, educational institutions, offices and hotels, but not to individuals in the retail market.

Carrefour has not revealed its plans for expansion in 2013 nor revealed its intention of diversifying into multi-brand retail with or without a local partner. The firm is present in India without a local partner, since there is no FDI cap in cash-and-carry businesses. Carrefour operates cash and carry stores in India under the name "Carrefour Wholesale Cash & Carry". The categories in which Carrefour deals are : staples, processed food, hygiene and beauty , hardware and tools , general merchandise , furniture , fresh food , cleaning , beverages , appliances , apparels (Carrefour, 2012).

### 2.6.4. Future Group

Future Group entered in retail with the launch of first 8000sq.ft store Pantaloons in Kolkata .They serve customers in 93 cities and 60 rural locations across the country. As one of India's retail pioneers with multiple retail formats, they connect a diverse and passionate community of Indian buyers, sellers and businesses. Around 300 million customers walk into the stores each year and choose products and services supplied by over 30,000 small, medium and large entrepreneurs and manufacturers from across India. Their retail business across the value and lifestyle segments focuses on 4 key consumption verticals: food, fashion, general merchandise and home. The various retail businesses in which Future Group deals are Pantaloon, Big bazaar, Food bazaar. Pantaloon has 65 stores across the country. Pantaloons stores have a wide variety of categories like casual wear, ethnic wear, formal wear, party wear and sportswear for Men, Women and Kids. A leading name in Food and Food-related products, Food Bazaar India offers a wide range of food and food-related products of high quality and raw freshness. Customers can find a whole range of food products here including quality fresh vegetables, fruits, butter and cheese products, etc in varied choices and diverse varieties Big bazaar offers fashion and general merchandise, also includes home furnishings, utensils, crockery, cutlery, sports goods and many others (Future Group, 2012).

### 2.6.5. Landmark Group

Founded in 1973 in Bahrain, the Landmark Group has successfully grown into one of the largest and most successful retail organizations in the Middle East and India. The Landmark Group provides a value-driven product range for the entire family through a diverse portfolio of core retail brands. These brands have evolved to become the preferred choice for consumers and are category leaders. In fashion Lifestyle and Max are the retail businesses of Landmark group. Since its inception in 1998, Lifestyle has expanded into a chain of over 100 stores across the Middle East, offering an incredible range of products across all departments. Lifestyle offers a wide range of exclusive products from home decor, furnishing, lighting and bath decor to makeup, perfumes, fashion accessories, bags, spa products and teen gifts.

Max is also one of the largest value fashion retail chain in the Middle East, with 114 stores across, UAE, KSA, Jordan, Kuwait, Bahrain, Qatar, Oman, Turkey, Egypt, Yemen & India. Max offers fashion clothing, footwear, accessories and household products at amazing value, all under one roof. Max retails private label clothing for men, women and children as well as footwear and home accessories (Landmark Group Retail, 2012).

### 2.6.6. Marks & Spencer Reliance India Limited

Marks & Spencer (M&S) is one of the leading retailers of high quality and value clothing for men, women as well as kids, home products and exceptionally good quality food. M&S was founded in 1884 by Michael Marks and Thomas Spencer. M&S is a major British Retailer headquartered in the city of Westminster, London with 703 stores in UK and 390 stores spread across more than 44 countries. In India, “Marks & Spencer Reliance India Pvt Ltd” is a joint venture between Marks & Spencer plc and Reliance Retail (Part of Reliance Group) as a major brand having Marks & Spencer 51% and Reliance Retail remaining 49% of interest. Reliance India Pvt Ltd has the right to operate the stores of Marks & Spencer in India. M&S set up its first store in India in 2001. They use the expansion strategy of own stores which successfully leads to the turnover of Rs.2000 million.

In India, Mark & Spencer Reliance India Pvt Ltd has around 24 numbers of departmental stores in 10 cities with over 1000 number of employees providing services to the customers. Product line of M&S in India includes Apparels (women’s, men’s and children’s clothing), Home wares, and Beauty. M&S has high global plans for India. M&S look forward to expanding their operations by opening new stores in Delhi and Mumbai. The future plans of M&S is to start operations in other metro cities in India such as Kolkata, Bangalore, Hyderabad and Chennai. The focus of M&S is to reach out more and more customers by understanding their needs and providing the best facilities and a great shopping experience to their customers. M&S are on journey to make their business more sustainable (Financial Express, 2013).

### 2.6.7. Reliance Retail Limited

“Reliance Retail Limited” is a private owned Indian company founded on 29$^{th}$ September 1998 as Chembur Patalganaga Pipelines Limited (CPPL) then in March it was rename as Reliance Industrial Infrastructure. Reliance Retail is headquartered/ based in Mumbai and is the second largest retailer in India. Reliance Retail is an auxiliary company of Reliance Industries. Reliance Retail follows the expansion strategy of own retail stores that provides consumers with a wide range of goods such as foods, groceries, apparel , lifestyle and home improvement products, electronic goods, farm implements and input & footwear.

Types of markets or stores that come under reliance retail are: discount stores, grocery, convenience stores, cash and carry & hypermarkets. Basically, Reliance Retail focuses on consumer goods, consumer durables, travel services, energy, entertainment and leisure, and also health & well-being products, educational products & services. Reliance Retail Limited has approximately 1300 stores present all over India with over 1000 number of employees facilitating customers with their services in around 86 cities of India. Reliance Industries has an impressive turnover of Rs. 6251.2 millions from its Reliance Retail Limited.

Key Categories of Products & Divisions of Reliance Retail, Reliance Fresh for vegetables, fruits and groceries, Reliance Digital for Consumer electronics retail stores, Reliance Jewels for Jewellery, Reliance Time Out for Lifestyle stores of books, music, movies, toys, gaming, fragrances and stationary and Reliance Trends for Apparel and clothing. Since its inception in 2006, Reliance Retail Limited (RRL) has grown into an organization that facilitates millions of customers, thousands of farmers and vendors. Based on the core growth strategy of backward integration, RRL has made a rapid growth towards making an entire value chain starting from farmers to end consumers (Reliance Industries Limited, 2012).

### 2.6.8. RPG Group

Shoppers Stop is a Private Indian department stores chain promoted by the K Raheja Corp Group (Chandru L Raheja Group), started in the year 1991 with its first store and headquarters in Andheri, Mumbai. Shoppers Stop Ltd has been awarded "The Hall of Fame" and won "the Emerging Market Retailer of the Year Award", by World Retail Congress at Barcelona, on April10, 2008. They have adopted strategy of having their own retail chain across the country providing various convenience stores and hypermarkets on the back of the vast experience it gathered from feedbacks and keen observance of people's taste keeping in tune with its culture, customs, traditions and income.

Other Retail Outlets of K Raheja like Crossword, Inorbit Mall & Hypercity have set new benchmarks on the basis of information and adaption of worldwide changes, innovations and new techniques in retailing practices. Shoppers Stop has around 220 spencer stores present in 35 cities of India and providing their services to the customers with the help of 60,000 numbers of employees which leads to an impressive turnover of Rs. 6690 million per year. The key categories of products of RPG are Food & Grocery, F&V, and FMCG, Apparels, Lifestyle products and B&M. Shoppers Stop also launched its e-store with delivery across major cities in India in 2008. The focus of the reposition was on the service, ambience up gradation and customer connect. Shoppers Stop offers a truly remarkable shopping experience to the customers with an unparallel assortment of the leading international and national brands (Shoppers Stop, 2012).

### 2.6.9. Tata Group

Trent is the Private Indian Retail part of TATA GROUPS which was established in 1998 and headquartered in Mumbai, India. Trent is a retail company that manages number of retail stores of clothes, footwear & accessories, home furnishings, F&V, staple foods, beverages, health and beauty, B&M. The company's turnover is Rs. 357.6 crores till the year 2006. Trent has their own stores which operate many discount stores, grocery & convenience stores, cash & carry and hypermarkets under which there are around 103 stores in the Metro & Mini-Metro cities.

This big brand of TATA provides employment to over 5000 numbers of employees present in 23 cities of India with the present turnover of Rs. 5200.4 millions. The company has retail stores in 32 major Indian cities under the Westside brand. Trent also operates the hypermarket Star Bazaar in 8 Indian cities. In Aug, 2005 Trent acquired a 76% controlling stake in Landmark, a Chennai-based privately owned books and music retailer and completed 100% acquisition in April 2008. Landmark currently has 16 stores.

Thus the Key Categories of Business of Trent are Westside that offers clothes, footwear and accessories for men, women and children. They are also involved in furnishings, artifacts and an attractive range of home accessories, Star Bazaar which is a kind of Hypermarket chain that offers a huge range of products including staple foods, beverages, health and beauty products, vegetables fruits, dairy and non-vegetarian products, Landmark, a retail chain of books and music having a range of over 1,00,000 titles. It also deals with the stock of movies, toys, gift items and stationary. Landmark is the leader in the category of books and music and Fashion Yatra which bring quality fashion at low prices to value conscious customers in towns across India (TATA, 2012).

### 2.6.10. TPG Group

TPG (Texas Pacific Group) is a leading global private investment firm with $54.5 billion of capital under management. It was founded in 1992. Ram Aggarwal started “Vishal Mega Mart” in Kolkata in 1986, in a 100sq ft shop in Lal Bazaar. It was an Indian Private company which face struggle in the beginning and today Vishal Mega Mart has branches all over India with the turnover of Rs.890 millions till October 2005. On March 14, 2011 TPG, Shriram Group acquires Vishal Retail for Rs 70 crores. Globally, TPG has made significant investments in a wide range if businesses in retail and consumer sectors, including Lilliput Kids Wear Pvt. Ltd in India. Vishal Retail/TPG Group follows the expansion strategy of having own stores throughout India and it facilitates the customers through departmental stores and hypermarkets.

Vishal Mega Mart have around 143 retail stores present in 78 cities of India comforting consumers with their services and providing employment to about 7000 number of employees which helps in raising the turnover of the company to Rs.12410.4 millions till now. Key Categories of Products of Vishal Retail are F&V, Groceries, Staples, Stationary, Footwear, Clothing, Consumer Durables, and General Merchandize. To overcome the losses of Vishal Mega Mart, TPG will invest Rs.2000 millions into TPG wholesale to fund the turnaround of its business and future growth. Today, Vishal Mega Mart is a well known retailing company and is growing at a very good growth rate and facilitating its customers in both big as well as small cities of India (TPG Creative Capital, 2012). Table 2.4 summarizes the profile of these retail companies as follows.

**Table 2.4: Profile of Retail Companies**

| S. No. | Name of the company | Ownership type | Expansion Stratey | Type | Number of Stores | Number of employees | Presence in cities | Turnover (Million Rs) | Key Categories |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Aditya Birla | Private (Indian) | Owns stores | Supermarkets, Hypermarkets | 575 Supermarkets, 12 Hypermarkets | 11000 | 9 | 7098.315 | Food, Grocery, FMCG, General Merchandize, Apparels |
| 2 | Bharti Walmart | Private (MNC) (JV between Bharti Enterprises and Walmart | Owns stores | Wolesale cash and carry , backend SCM operations | 17 wholesale units | 4000 | 17 | 999.98 | F&V, Groceries, staples, Stationery, Footwear, Clothing, consumer durables & General Merchandize |
| 3 | Carrefour | Private (MNC) | Owns stores | Cash and carry stores | 5 Stores | 250 | 2 | 175 | Food and Non-food Products |
| 4 | Future Group | Private (Indian) | Owns stores | Discount Stores, Grocery & Convenience Stores, Cash and carry, hypermarket | 120 Big-Bazaar, 50 Pantaloons | 35000 | 67 | 35000 | Food, Grocery, FMCG, General Merchandize, Apparels |
| 5 | Landmark | MNC | Owns stores | department Store, hypermarket, supermarket | 33 lifestyle stores, 13 SPAR | over 5000 | 10 | 2817.4 | Food and Grocery, F&V, Bakery, Wine, beer & Spirits, Apparels, Home textile, Personal care |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | Marks and Spencer Reliance India Ltd | MNC (JV between Reliance and Marks & Spencer | Owns stores | Department Store | 24 | over 1000 | 10 | ` 2000 | Apparl, Homeware, Beauty |
| 7 | Reliance Retail | Private (Indian) | Owns stores | Discount Stores, Grocery & Convenience Stores, Cash and carry, hypermarket | 1300 | over 1000 | 86 | 6251.2 | Food & Grocery, F&V, Stationery, B&M, Apparels, General Merchandize, Jewels |
| 8 | RPG | Private (Indian) | Owns stores | convinience stores, hypermarket | 220 spencer stores | 60000 | 35 | 6690 | Food & Grocery, F&V, FMCG, Apparels, lifestyle products, B&M |
| 9 | Trent | Private (Indian) | Owns stores | Discount Stores, Grocery & Convenience Stores, Cash and carry, hypermarket | 103 | Over 5000 | 23 | 5200.4 | Clothes, footwear & accessories, home furnishings, F&V, staple foods, beverages, health and beauty, B&M |
| 10 | Vishal Retail/ TPG Group | Private (Indian) | Owns stores | Departmental stores, hypermarkets | 143 | 7000 | 78 | 12410.4 | F&V, Groceries, staples, Stationery, Footwear, Clothing, consumer durables & General Merchandize |

## 2.7.Performance Measurement for Retail Supply Chain

Thus SCM has become the predominant management focus and the source of competitive advantage for many firms. Companies in the retail industry implementing supply chain management aim to react to the increasing uncertainty and complexity of the market environment, to advance their competitive position in the entire value chain. To establish a clear picture of how the retail SC performs, to reflect the supply chain activities, the dimensions of performance should include both financial performance and non-financial performance. It is important to have a comprehensive set of criteria on an operational level, in order to properly evaluate retailers and their degree of modernity in running operations, as supply chain partners form the manufacturer point of view.

Many firms limit their focus to the performance of their own organization and neglect to reduce inefficiencies and eliminate non-value activities in the SC to improve supply chain performance (Holmberg, 2000). Under such circumstances and in order to ensure growth, the retail supply chain must be adaptive and anticipative (Ramesh, Banwet, & Shankar, 2008). Adaptive supply chains, or supply networks, are those that are flexible enough to meet the demand of changing customer markets. An adaptive supply chain requires greater collaboration and visibility between all points within the supply chain and all its extensions. Measurement also enables them to benchmark their current levels of practice against the best-in-class performers. To achieve better supply chain performance (such as complete order fill, accurate and timely information, reliable and short order cycle time), (Cooper, Ellram, Gardner, & Hanks, 1997a) suggested that retailers need to establish closer relationships with supply chain partners.

Hence, performance measurement is not a new concept, the challenge with the managers is that there are a huge number of performance metrics available, and they find it difficult to select a few KPIs which are significant for their supply chain. Therefore an effort has been made in this study to identify the KPIs for retail supply chain and develop a performance model using the identified KPIs. The next chapter discourses the literature review on performance measurement and explores various approaches for categorizing KPIs.

# 3 Literature Review

*"The answers you get from literature depend on the questions you pose"*

*– Margaret Atwood.*

*This chapter presents a review of the available literature on supply chain performance management, and aims to classify the performance indicators into various groups, specifically for measuring retail supply chain performance, with the help of a theoretical framework. It highlights the research gaps, while outlining the importance of measuring SCM performance through metrics/KPIs, and also explores different approaches for developing performance measurement tools.*

## 3.1.Evolution of Performance Measurement

Performance measurement has been defined and redefined over the years. It has its roots in early accounting system in the late Thirteenth century, when traders used it to settle their transactions. As pointed by (Johnson, 1981), even pre-industrial organizations maintained a good account of external transactions and stock without high level techniques, such as, cost accounting. Furthermore (Lebas, 1995) went to the extent of saying that there is no existence of businesses without a performance measurement system, because it is obvious for businesses to collect feedback from employees to manage/improvise the businesses (Sinclair & Zairi, 1995).

The research on accounting systems has been conducted in two major phases, the first phase started in the late 1880s, which lasted for almost a century and the second phase started in late 1980s (Ghalayini & Noble, 1996). The Figure 3.1 below shows the evolutionary phase of performance measurement systems. The first phase started as a result of industrial revolution in Europe and America (Williams, 2002; Taylor, 1911). In this phase the prime focus was on operation cost of the firm (Kurien & Qureshi, 2011).

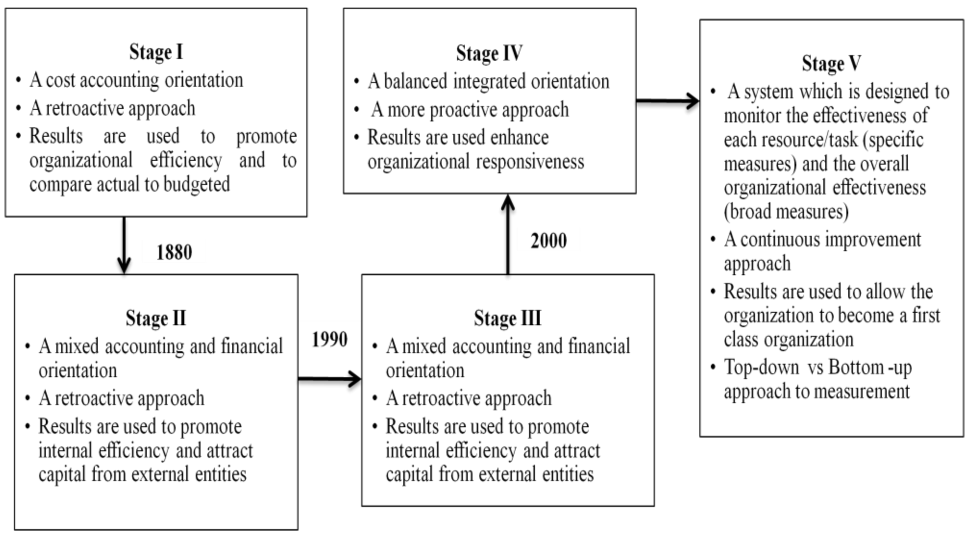



**Figure 3.1: Evolutionary Stages of Performance Measurement Systems.**
Source: (Khan & Shah, 2011)

Some of the techniques used in that era were, cost variance analysis, standard costing and flexible budgets. With the shift from piece-work payments to wage system, the cost accounting performance development started that helped in determination of product cost and in motivating employees for better performance (Johnson, 1981). Earlier internal control systems were created to manage firms with multi-operation production systems (Johnson, 1975; Johnson, 1981) but with the emergence of organizations with more multi-location manufacturing facilities, divisional and departmental budgets were introduced, in order to manage day-to-day operations. Later in 1940s and 1950s, manufacturing concepts emerged [quality control, variety reduction, standardization, etc] with more emphasis on financial indicators such as, sales, production, efficiency, return on investment [ROI] (Bititci, Garengo, Dörfler, & Mendibil, 2009).

Thereafter, financial measures became popular, and were used to develop cost and management control systems (Keegan, Eiler, & Jones, 1989; Johnson & Kaplan, 1987). In late 1980s, after emergence of world economy and globalization of trade, the focus shifted from productivity to quality, time, cost, flexibility and customer satisfaction (Kaplan, 1984; Slack, 1983; Hayes & Abernathy, 1980). This is when the traditional measures were criticized and considered inappropriate for measuring an overall business performance. Infact (Johnson & Kaplan, 1987) were first to suggest a shift from cost accounting based performance measurement approach to a more integrated performance measurement approach.

During the last two decades, performance measurement has gained more attention (Taticchi, Tonelli, & Cagnazzo, 2010). After the industrial revolution, till late twentieth century, financial measures of performance were used. The traditional financial measures laid emphasis on local departmental performance and are internally focused rather than focusing on overall health or performance of the business (Otley, 1999; Neely, Bourne, & Kennerley, 1995; Keegan, Eiler, & Jones, 1989; Johnson & Kaplan, 1987). Changes in global economy made businesses realize that in order to be successful they have to focus on their business strategy, which caused a shift in focus from production or cost oriented approach to a more strategic approach. During this shift, a number of frameworks were developed, which addressed the shortcomings of traditional financial accounting systems. These frameworks provided different perspectives for categorizing performance measures with their own limitations; likewise they do not indicate what to measure with the given objective of the business.

Performance measurement matrix was presented by (Keegan, Eiler, & Jones, 1989) which integrates the different aspects of business performance- financial and non-financial, internal and external as shown in figure 3.2. The drawback of this matrix is that it does not link the different dimensions of business performance.

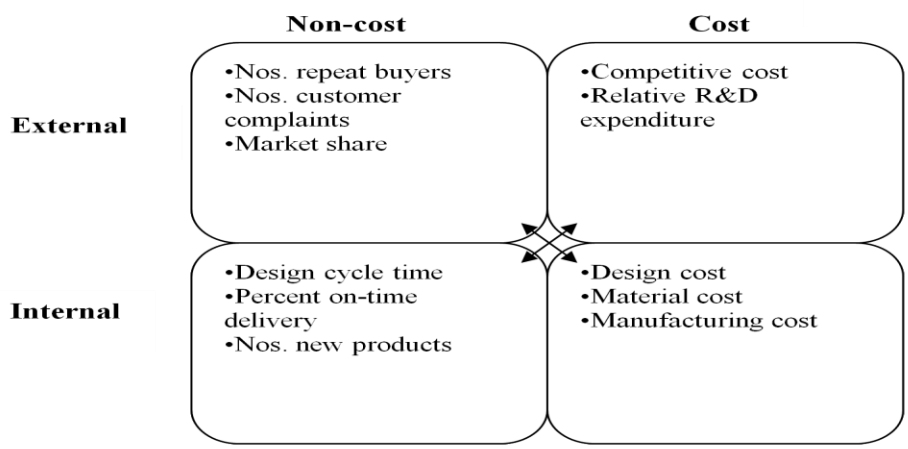



**Figure 3.2: Performance Measurement Matrix**
*Source:* (Keegan, Eiler, & Jones, 1989)

Thereafter, (Fitzgerald, Johnston, Brignall, & Silvestro, 1991) developed matrix for service sector based on two basic types of performance measure in any organization, as results [competitiveness, financial performance] and determinants [quality, flexibility, resource utilization and innovation]. It highlights the fact that results are basically the output of past performance and are the lagging indicators, whereas determinants are the leading indicators as shown in Table 3.1. These performance measurement frameworks adopted a hierarchical approach. Similar approach was adopted by (Azzone, Masella, & Bertele, 1991) based on a strategy of time based competition.

**Table 3.1: Results and Determinants Framework**

| | |
|---|---|
| Results | Financial Performance |
| | Competitiveness |
| Determinants | Quality |
| | Flexibility |
| | Resource utilization |
| | Innovation |

*Source:* (Fitzgerald, Johnston, Brignall, & Silvestro, 1991)

Some of the researchers adopted a business process approach, which was directed towards the flow of materials and information within the organization. Thereafter (Lynch & Cross, 1991) proposed a performance pyramid as shown in Figure 3.3, which falls in the middle of this continuum. It combines the strength of both hierarchical and business process view. The framework proposed by (Lynch & Cross, 1991) is a four level performance pyramid that links the corporate strategy with operational strategy.

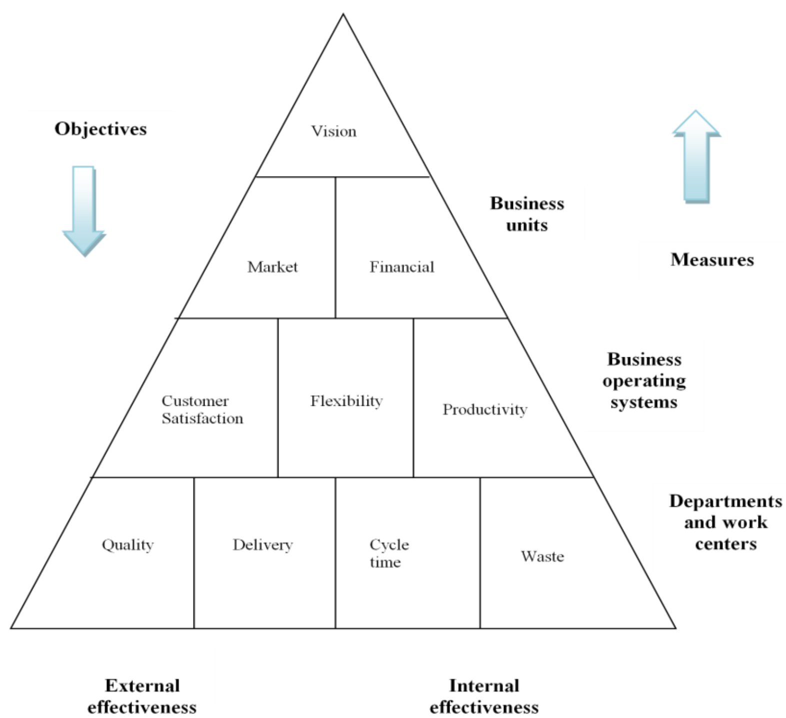



**Figure 3.3: Performance Pyramid**
*Source:* (Lynch & Cross, 1991)

Furthermore, the framework translates the objectives from the top and measures from the bottom, i.e. company's strategy at the top of the pyramid is translated into business unit level objectives. At the second level the business level objectives are categorized into short term financial performance goals and long term market position goals, at the third level these business unit goals are linked to day-to-day operations of the business in term of customer satisfaction, flexibility and productivity and at the lowest level, department and work center operational criteria [quality, delivery, process time and cost] are highlighted.

The terms used in the above frameworks are open-ended, in the sense that they can be interpreted in several ways that it does not guide in selection of a small number of significant indicators, rather they have to make choice from several indicators. After some time (Kaplan & Norton, 1992) introduced balanced scorecard which includes both financial and non-financial measures. It looks at the business from four perspectives, financial, customer, innovation and learning, and internal processes as shown in the Figure 3.4. It emphasizes on translating the organization's strategy into set of objective for each of business perspective.

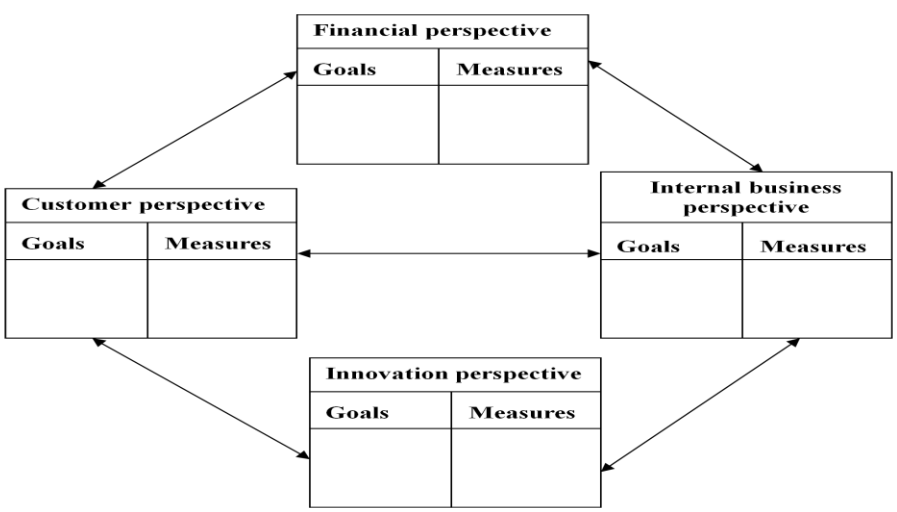



**Figure 3.4: Balanced Scorecard**
*Source:* (Kaplan & Norton, 1992)

The framework given by (Brown, 1996) is based on the Input, process, output and outcome measures as shown in Figure 3.5.

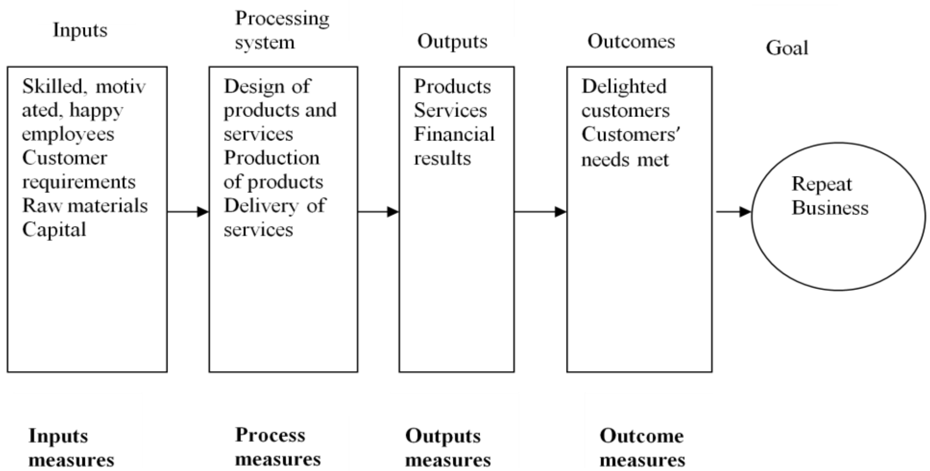



**Figure 3.5: Inputs, Processes, Outputs, Outcomes**
*Source:* (Brown, 1996)

This framework falls at one extreme of a continuum stretching from hierarchical to process focused framework (Neely, Bourne, & Kennerley, 2000). The input process includes not only the raw material but also the motivated and skilled employees. The designed process for production converts the raw material into final products to meet the end customer demand.

Earlier in 1999, the Supply Chain Operations Reference Model [SCOR] was introduced by Supply Chain Council [SCC], ‘an independent, not-for-profit global corporation, and based on a process view of the supply chain using five distinct management processes,

- Plan
- Source
- Make
- Deliver

- Return

The SCOR model integrates the well-known concepts of business process re-engineering, benchmarking, and process measurements into a cross-functional framework. Each of the four processes at the top level is successively divided into sub-processes (as shown in Figure 3.6), first at a configuration level, then at a process element level, finally, at the fourth level and beyond the scope of the SCOR model, activities are defined by companies individually.

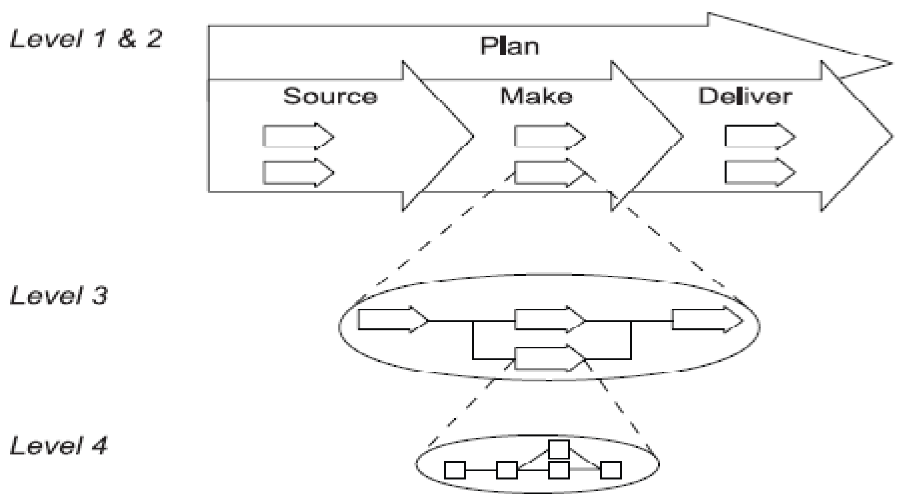



**Figure 3.6: SCOR Model**
*Source:* Supply Chain Council (1999)

Measures are defined for all processes at the three top levels, and firms provide information about how they perform while receiving a benchmark in return against which they can compare their own performance. This model provides not only an opportunity to see how the firm is doing, but also a common frame of reference, and a common language across the supply chain. Later, (Neely, Bourne, & Kennerley, 2000) criticized these frameworks on the ground that they failed to give attention to the actual design and implementation of the performance measurement system. Thus, (Neely, Adams, & Crowe, 2001) rejected the approach of building framework from business strategy, and suggested to take the stakeholders also into consideration while designing the performance measurement system. Therefore, Performance Prism was proposed which adopts a stakeholder's centric approach, which includes employees, suppliers, and intermediaries in the performance measurement as shown in the Figure 3.7. The performance prism selects measures from each of the perspective: stakeholders satisfaction (who are our key stakeholders and what do they want and need?), strategies (what strategies do we have to put in place to satisfy the wants and needs of these key stakeholders?), processes (what critical processes do we need to operate and enhance these processes), capabilities (what capabilities do we need to operate and enhance these processes?) and stakeholder contribution (what contributions do we require from our stakeholders if we are to maintain and develop these capabilities?) (Khan & Shah, 2011).

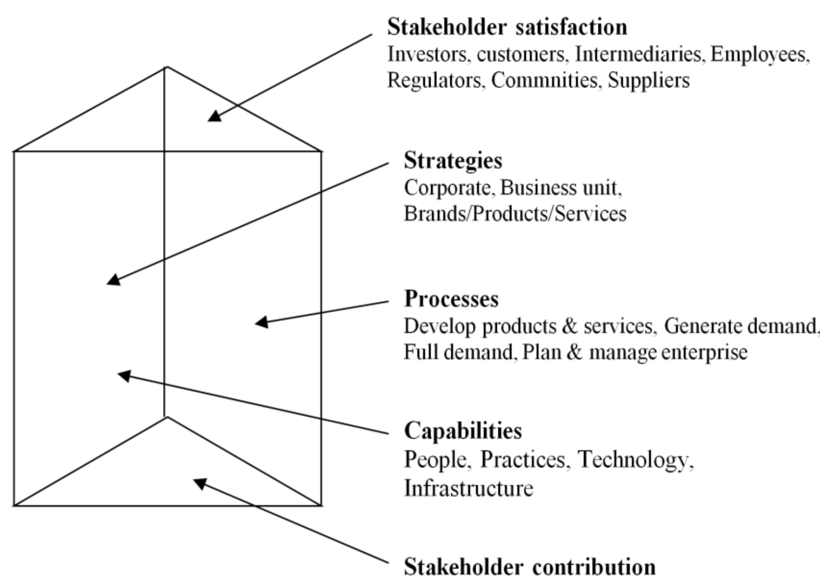



**Figure 3.7: Performance Prism**
*Source:* (Neely, Adams, & Crowe, 2001)

The perspectives of measuring supply chain management have been extended from BSC and SCOR to value and cost accounting. Afterwards (Lambert & Pohlen, 2001) provided framework which takes into account the shareholder's value. According to which the overall performance is determined by the increase in market capitalization for each firm. From the cost accounting point of view, an integrated framework of economic value added [EVA], balance scorecard [BSC] and activity-based costing [ABC] was proposed to measure supply chain performance (Yao & Liu, 2006). Finally, (Akyuz & Erkan, 2010) conducted a critical review in the domains of supply chain, information technology [IT], business process management and performance management, and bring forth the need of performance measurement metrics in present era.

**3.2.Defining Performance Measurement**

Different authors have looked at performance measurement from different perspective and they have given different definitions as discussed below: Neely et al., (1995), (Neely, Bourne, & Kennerley, 1995) defined performance measurement as:

> "*Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action"* or
>
> *"A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of action"* or
>
> *"A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions"*

Otley, (1999) defined as-

> *"An information system that helps managers performing their job and managing the behavior of the organization"*

Gates, (1999) defined it as-

> "*The procedure to implement strategy in an organization by translating business strategy into deliverable result"*

Maisel, (2001) defined it as-

> *"A system that enables an organization to manage its performance and ensures that all the functions and activities are in line with the strategy to achieve the business results and create shareholder's value"*

Bourne & Neely, (2003) defined it as-

> "*A set of multi-dimensional performance measures used for planning and managing the businesses"*

Bititci, Garengo, Dörfler, & Mendibil, (2009) defined it as-

> *"An information system and a reporting process through which the employees are given feedback on the outcome of their actions"*

However, according to Franco-Santos, et al., (2007), there is a lack of agreement on a single definition of performance measurement.

Performance measurement (as promoted in the literature and practiced in leading companies) refers to the use of a multi-dimensional set of performance measures, which include financial and non-financial; internal and external measures with the aim of predicting the future. Performance measurement is applicable with reference to a particular frame with parameters relevant to that context. It has an impact on the environment in which it operates, and then is inclusive of individuals and groups within the organization.

## 3.3.Categorization of Performance Measurement Design Process

From literature, (Bourne & Neely, 2003), two distinct dimensions were identified, the 'hard' issues, which are the underlying procedures and the 'soft' issues, which are the underlying approach including terms of the role of the process leader, change agent or consultant.

### 3.3.1. Hard Issues

There are three distinct procedures, i.e., 'Needs led', 'Audit led' and 'Model led'. The 'Needs led' procedure is one, where emphasis is on the customer, business and stakeholder and it adopts a top down approach, e.g. balance scorecard approach. The 'Audit led' procedure is bottom up approach starting with an audit of existing performance measures, e.g. performance measurement questionnaire. The 'Model led' approach is based on theoretical model of the organization, e.g. ECOGRAI (Bitton, 1990). In this study a Model building approach has been adopted.

### 3.3.2. Soft Issues

There are two approaches, i.e., 'Consultant led' and 'Facilitator led'. The Consultant led is where the majority of work is given to an individual or a group of individuals (usually consultants) who do the entire analysis and present it in form of a report with recommendations and action plan to the management. Whereas, in the Facilitator approach, the entire work is taken by the management team together in facilitated workshops, in which they discover and analyze different phases of the work.

### 3.4. Importance of Measuring Supply Chain Performance

In recent years, organizations have realized the potentials of SCM. However, they lack insight for the development of effective performance measures and metrics, required to achieve a fully integrated SC. Despite of SCM performance importance, putting performance measurement in place has always been a difficult task. Developing a performance measurement tool, also known as KPIs or metrics, involves a rather complicated process, and can be very challenging for ordinary businesses. It is because of lack of incentives and top management support, an organizational culture unfavorable to implement performance measurement system (Aramyan, Lansink, Vorst, & Kooten, 2007; Shepherd & Gunter, 2006; Chan & Qi, 2003; Lapide, 2000). The following points facilitate in understanding the significant role of strategic thinking behind successful implementation of performance measurement, role of KPIs in visibility of entire supply chain performance and the importance of collaborative approach in measuring performance.

- **a.** Authors draw the attention to the role of senior management team in measuring supply chain performance for making strategic decisions as shown in the Table 3.2. It is essential to have the support of the management, as well an organizational culture, to support the development of performance measurement tool consisting of selectively chosen set of appropriate KPIs (Aramyan, Lansink, Vorst, & Kooten, 2007; Shepherd & Gunter, 2006; Chan & Qi, 2003; Lambert & Pohlen, 2001; Lapide, 2000). Furthermore, performance measurement or monitoring plays the role of feedback in the supply chain.

**Table 3.2: Strategic Importance of Performance Measurement**

| Author, year | Research contribution | Inference |
|---|---|---|
| (Davis & Albright, 2004) | Author asserts that performance measurement through the establishment of KPIs helps the senior management team to make important strategic decisions. | Strategic Importance of performance measurement |
| (Kincaid, 1994) | Author mentions that performance measurement is essential – particularly in order to perform comparisons and develop strategies for improvements. | |
| (Lebas, 1995) | Author argues that looking into the past, the present and the future to drive performance improvement decision-making strategies is one prime reason why one should execute performance measurement. | |

As mentioned before that usually companies have very little understanding of how to define KPIs for their supply/demand chain. Some of the characteristics presented by (Beamon, 1999) for performance measurement systems include: inclusiveness (measurement of all pertinent aspects), universality (allow for comparison under various operating conditions), measurability and consistency.

b. Authors highlight the role of KPIs in visibility of entire supply chain performance, as shown in Table 3.3. Logically, performance management in supply chain is about setting objectives for the supply chain functions that will direct to the desired results with agreement. Furthermore (O'Sullivan, Keane, Kelliher, & Hitchcock, 2004; Hitchcock, 2002) state that performance metrics can define the performance objectives in a clear and quantifiable manner.

**Table 3.3: Visibility of Performance in Supply Chain Activities**

| Author, year | Research Contribution | Inference |
|---|---|---|
| Chen and Paulraj, 2004 | Measuring supply chain performance can facilitate a greater understanding of the supply chain, positively influence actors' behavior, and improve its overall performance | Importance of measuring supply chain performance for clear visibility of actors involved in it. |
| Baldwin et al., 2000 | Performance metrics indicate long- and short-term finance and performance-related goals, and are vital for a healthier relationship between the customer and the provider of services | |
| Chae, 2009 | Performance metrics or KPIs offer the overall visibility of supply chain and help to assess the accuracy of supply/ demand plan (e.g. forecast accuracy), and the execution performance (e.g. actual sales versus forecast plan). | |

Performance Measurement tools have been extensively adopted by compaies to support the supply chain strategies, in which performance measures are critical to achieve the desired tasks. As mentioned earlier, performance measures in a supply chain are required *'to streamline the flow of material, information, and cash, simplify the decision-making procedures, and eliminate non-value adding activities'* (Gunasekaran, Patel, & Tirtiroglu, 2001). Therefore, selection of performance measurement system is a crucial step in design and evaluation of a supply chain process. Moreover, such measures and metrics are needed to test and reveal the viability for directing towards realization of goals and improvement of supply chain strategies.

**c.** Authors pointed out the importance of collaborative efforts involved in measuring supply chain performance as shown in Table 3.4. Most of the companies while gathering suggestions and inputs from employees and consultants keep adding measures and fail to realize that a few set of measures can address the supply chain performance.

**Table 3.4: Importance of Collaborative Approach in SC Performance**

| **Author, Year** | **Research contribution** | **Inference** |
|---|---|---|
| Ireland and Crum, 2005 | Top management decides cross-functional activities and involvement of various departments in collaboration at functional/operational and strategic level. Performance at this stage of collaboration is measured through operational efficiency and risk/return ratio. | Collaborative approach involving all the departments performance metrics to relate to the organizational towards performance measurement |
| Stank *et al.*, (2001) and Rowat (2006) | Authors attempted to relate internal and external collaboration with logistical service performance. | |
| Ho et al., 2000 | Author states that performance metrics represent indicators of performance that can be used for a genuine comparison within and between organizations. Performance metrics provide an essential common platform for comparison, based on which improvements can be sought for any individual indicator. | |

It has also been pointed out that while financial performance measurements are important for strategic decisions and external reporting, day-to-day control operational activities, like inventory management and distribution are better handled by non-financial measures. The role of human resource is important for measuring the actual performance and a collaborative approach necessitates it further.

### 3.4.1. Categorization of KPIs

A number of performance measurement tools have been identified in where the indicators have been categorized into various groups. As discussed by (Neely, Bourne, & Kennerley, 1995), numerous approaches were developed for performance measurement model, includes: criteria for measurement system design (Globerson, 1985); performance measurement matrix (Keegan, Eiler, & Jones, 1989); performance measurement questionnaires (Dixon, Nanni, & Vollmann, 1990); balanced scorecard (Kaplan & Norton, 1992); Supply chain operations reference model (SCOR) (Supply Chain council, 1996) and, computer aided manufacturing approaches. Likewise, also highlighted various limitations of existing measurement systems (John Mills, Wilcox, Neely, & Platts, 2000), including: they encourage short termism (Hayes & Garvin, 1982; Banks & Wheelwright, 1979); they lack strategic focus i.e. the measurement system is not aligned correctly with strategic goals, organization culture or reward systems (Skinner, 1974); they encourage local optimization (Hall, 1983; Fry & Cox, 1989) by forcing managers to minimize the variances from standard (Lynch & Cross, 1991; Johnson & Kaplan, 1987), rather than seek to improve continually; and, they fail to provide adequate information on what competitors are doing through benchmarking.

For the proposed performance metrics to work properly, besides the role of systems, master data, and processes (Yang & Chen, 2006), the roles and responsibilities of organizational members and units or teams need to be clearly defined and communicated enterprise-wide on a regular basis. There have been different methods for categorizing KPIs as per the need of the system so that it can be easily monitored.

Various metrics used in SCP assessment have been designed to measure operational performance, to assess enhanced efficiency and to review strategic alignment of the entire supply chain management. Performance measurement or monitoring conducts the job of feedback in better functioning of supply chain activities. Companies usually have modest understanding of how to classify KPIs for their supply chain and lay down the structure of people's roles and responsibilities applicable to performance measurement system.

Developing key performance indicators is not an easy job, listing potential SC related KPIs itself appears to be so vast that it becomes inexhaustible to classify all the performance indicators (Shepherd & Gunter, 2006; Hoffman, 2004; Gunasekaran, Patel, & Tirtiroglu, 2001; Lapide, 2000). Unlike a common insight that 'more is better', in supply chain performance measurement is rather the other way that 'less is better'. Therefore the companies should basically begin assessment with a small number of KPIs In additions, companies can take advantage from those few selected KPIs, and this streamlines the processes accordingly. There are numerous potential approaches to do so. Authors have classified KPIs into different levels depending upon the hierarchy in management of process. Likewise, (Hoffman, 2004), categorized KPIs as top tier, mid-level, and ground level; or performance measurement systems have been analyzed at three levels: the individual metrics; the set of measures, or performance measurement system as an entity; and, the relationship between the measurement system and the internal and external environment in which it operates (Neely, Bourne, & Kennerley, Performance measurement system design: developing and testingaprocess-based approach, 1995).

A set of metrics developed by (Gunasekaran, Patel, & Tirtiroglu, 2001) has been classified into strategic, operational, and tactical levels of supply chain. Further, some of these metrics are also segmented into financial and non-financial measures. Also (Huang, Sheoran, & Keskar, 2005) categorized the KPIs at three levels – strategic (e.g. total cycle time), tactical (e.g. delivery reliability), and operational (e.g. capacity utilization). Individual measures of supply chain performance have typically been categorized into four groups: quality, time, cost, flexibility. Furthermore, the measures have also been classified as quality and quantity, cost and non-cost, strategic/operational/tactical supply chain processes (Shepherd & Gunter, 2006; Gunasekarana, Patelb, & McGaugheyc, A framework for supply chain performance measurement, 2004). The KPIs, which were categorized as cost-related and non-cost-related, were sorted in separate groups of financial and non-financial. All cost-related indicators under a separate category called 'financial' and all non-cost related indicators as 'non-financial'. Also (Chae, 2009) categorized KPIs as primary and secondary. The primary metrics (e.g. forecast accuracy, on time delivery) represent a company's overall supply chain performance. The secondary metrics are potential indicators of why the primary metrics are high or low, and offer a detailed view of supply chain.

In logistics, (Van der Vorst, 2000), makes a distinction between performance indicators on three main levels: first, the supply chain level (e.g. product availability, quality, responsiveness, delivery reliability and total supply chain, second, the organization level (e.g. inventory level, throughput time, responsiveness, delivery reliability and total organizational costs); and third, the process level (e.g. responsiveness, throughput time, process yield and process costs). In manufacturing, (Li &

O'Brien, 1999) proposed a model to improve supply chain efficiency and effectiveness based on four criteria:

- Profit;
- Lead-time performance;
- Delivery promptness; and
- Waste elimination.

Furthermore (Lai, Ngai, & Cheng, 2002) distinguished three dimensions of supply chain performance in transport logistics:

- Service effectiveness for shippers;
- Operational efficiency; and
- Service effectiveness for consignees.

Some of the studies which were conducted in the context of facility management or environmental performance measurement classified the KPIs into groups like energy, environment, etc. Similarly, (Augenbroe & Park, 2005) characterized the indicators as energy, lighting, thermal comfort and maintenance in context to facility management. (Hinks & McNay, 1999), characterized the KPIs as business benefits, equipment, space, environment, change, maintenance/services, consultancy and general. With span of time, besides the usual financial terms, the customer relations and internal business growth were also given importance. (Amaratunga & Baldry, 2003), categorized the KPIs according to four basic principles such as customer relations, FM internal processes, learning and growth, and financial implications. Further analysis of the KPIs revealed that some indicators represent operational performance of a facility or organization; these were then regrouped under either 'Functional' or 'Physical-based' on their scope and intent. Those KPIs found to be unquantifiable or based on subjective opinions were grouped as ‘Survey-based’ KPIs (Lavy, Garcia, & Dixit, 2010; Augenbroe & Park, 2005; Gumbus, 2005; Amaratunga & Baldry, 2003; Ho, Chan, W, Wong, & Chan, 2000; Hinks & McNay, 1999).

With the passage of time, flexibility has gained importance, not only in manufacturing, but also in other aspects of SC, and it has been identified as a key variable influential in measuring SCP. Flexibility is a very general concept that is often viewed as a firm’s ability to match production to market demand in the face of uncertainty and variability. The notion of flexibility is also closely linked to the firm’s ability to provide niche and customized products to the consumer. Therefore, there is a need to look at a wider perspective of SC, which also includes activities like logistics, sourcing, information flexibility, etc. besides the manufacturing activity. (Shepherd & Gunter, 2006; Gunasekarana, Patelb, & McGaugheyc, A framework for supply chain performance measurement, 2004; Beamon B. M., 1999; Bolstorff, 2003), distinguished measures between cost and non-cost measures (time, quality, flexibility and innovativeness). Additionally (Chan & Qi, 2003) categorized measures as cost, quality, resource utilization, flexibility, visibility, trust and innovativeness. Within the agility literature, flexibility and innovativeness are considered to be important strategic drivers of supply chain development in the future (Chen, Paulraj, & Lado, 2004; Gunasekaran, Patel, & Tirtiroglu, 2001; De Toni & Nassimbeni, 2000).

The importance of collaborative efforts have already been mentioned earlier (Ireland & Crum, 2005; Stank, Davis, & Fugate, 2005; Ho, Chan, W, Wong, & Chan, 2000). Furthermore, Hieber, (2002) categorized KPIs as Supply chain collaboration efficiency; coordination efficiency and configuration. The summary of categorization of KPIs is shown in the Table 3.5.

**Table 3.5: Summary of Literature for Categorization of KPIs**

| Author, Year | Categorization of KPIs |
|---|---|
| Hoffman, (2004) | As top tier, mid-level, and ground level |
| Neely, Bourne, & Kennerley, (1995) | At three levels: the individual metrics; the set of measures, or performance measurement system as an entity; and, the relationship between the measurement system and the internal and external environment in which it operates. |
| Huang, Sheoran, & Keskar, (2005); Gunasekran, Patel, & Tirtiroglu, (2001) | In three levels – strategic, tactical and operational |
| Shepherd & Gunter, (2006); Gunasekarana, Patelb, & McGaugheyc, A framework for supply chain performance measurement, (2004) | As quality and quantity, cost and non-cost, strategic/operational/tactical focus, and supply chain processes |
| Chae, (2009) | As primary and secondary indictors |
| Augenbroe & Park, (2005) | Grouped into energy, lighting, thermal comfort and maintenance |
| Hinks & McNay, (1999) | Classified KPIs into business benefits, equipment, space, environment, change, maintenance/services, consultancy and general. |
| Amaratunga & Baldry, (2003) | Classified KPIs into customer relations, FM internal processes, learning and growth, and financial implications. |
| Lavy, Garcia, & Dixit, (2010); Augenbroe & Park, (2005); Gumbus, (2005); Amaratunga & Baldry, (2003); Ho, Chan, W, Wong, & Chan, (2000); Hinks & McNay, (1999). | As cost-related and non-cost-related KPIs |
| Shepherd & Gunter, (2006); Gunasekarana, Patelb, & McGaugheyc, A framework for supply chain performance measurement, (2004); Beamon B. M., (1999); Angerhofer & Angelides, (2006); Bolstorff, (2003) | Grouped KPIs into quality time, cost and flexibility |
| Chen, Paulraj, & Lado, (2004); Gunasekaran, Patel, & Tirtiroglu, (2001); De Toni & Tonchia, (2001) | As cost and non-cost measures (time, quality, flexibility and innovativeness) |

| | |
|---|---|
| Shepherd & Gunter, (2006); Chan & Qi, (2003) | Catergorized KPIs as cost, quality, resource utilization, flexibility, visibility, trust and innovativeness |
| Kulp, Lee, & Ofek, (2004) | As flexibility and innovativeness measures |
| Hieber, (2002) | Grouped into collaboration efficiency; coordination efficiency and configuration. |
| Van der Vorst, (2000) | At three main levels: 1) the supply chain level; 2) the organization level; and 3) the process level |
| Li & O'Brien, (1999) | At four levels: 1) profit; 2) lead-time performance; 3) delivery promptness; and 4) waste elimination. |
| Lai, Ngai, & Cheng, (2002) | At three levels: 1) service effectiveness for shippers; 2) operational efficiency; and 3) service effectiveness for consignees. |
| De Toni & Tonchia, Performance measurement systems, (2001) | As financial and non-financial |
| Gunasekran, Patel, & Tirtiroglu, (2001) | As quantitative and non-quantitative |
| Chopra, Meindl, & Kalra, (2007) | Grouped as facilities, transportation, information, inventory, sourcing, and pricing |
| Chan & Qi, (2003) | Grouped into input measures, output measures, and composite measures |
| Closs & Mollenkopf, (2004) | Grouped into customer service, cost management, quality, productivity, and asset management |
| Agarwal, Shankar, & Tiwari, (2006) | Grouped into market sensitiveness, information driven, and process integration |

### 3.4.2. Approaches for Categorization of KPIs

The important contribution by many researchers is on emphasizing the need for adopting a systemic approach to performance measurement. It has been observed that the performance indicators have been categorized into various categories, and different approaches have been adopted likewise, BSC, SCOR, decision modeling techniques like, analytical hierarchy process [AHP], data envelopment analysis [DEA], etc., (Kaplan & Norton, 1992) introduced balanced scorecard, which includes both financial and non-financial measures.

It looks at the business from four perspectives, i.e., financial, customer, innovation and learning, and internal processes. It emphasizes on translating the organization's strategy into set of objectives for each of business perspective. Performance measurement cannot be executed solely on the basis of one indicator, and suggest that the Balanced Scorecard approach provides holistic metrics of KPIs that include indicators relating to customers, internal processes, financial aspects, and innovation (Amaratunga & Baldry, 2003). The SCOR model has also been a popular measurement tool introduced by Supply Chain Council (SCC) in 1996. It has been extensively used to develop supply chain performance metrics. According to SCOR model, a company's supply chain is represented by five meta-level processes of plan, source, make, delivery and return. In practice, this high-level view of SCM processes can also be used for identifying potential KPIs. SCOR Model advocates a set of supply chain performance indicators as a combination of: reliability measures (e.g. fill rate, perfect order fulfillment), cost measures (e.g. cost of goods sold); responsiveness measures (e.g. order fulfillment lead-time); and asset measures (e.g. inventories) (Shepherd & Gunter, 2006; Huang, Sheoran, & Keskar, 2005; Lockamy III & McCormack, 2004; Neely, Bourne, & Kennerley, Performance measurement system design: developing and testingaprocess-based approach, 1995).

Authors observed that for performance assessment, it is important to identify factors that are crucial to the success of the organization. Furthermore, these factors are referred as critical success factors [CSFs] which indicates the efforts required necessarily to meet organizational goals and it consist of one or more KPIs that facilitate management grasp, evaluate, and govern the progress made by the organization (Cai, Liu, Xiao, & Liu, 2009). Authors also suggested process based division of performance metrics; they differentiated the metrics according to the process in the supply chain they relate to. For example, (Chan & Qi, 2003) identify six core processes (supplier, inbound logistics, manufacturing, outbound logistics, marketing and sales, end customers) and present input, output and composite measures for each which is similar to the proponents of the SCOR model (Huang, Sheoran, & Keskar, 2005; Lockamy III & McCormack, 2004).

Decision modeling techniques were also used widely (Cai, Liu, Xiao, & Liu, 2009; Huang, Sheoran, & Keskar, 2005). Nevertheless, there is some disagreement, whether there is the most appropriate technique for selecting measures. For example, whilst (Chan & Qi, 2003)advocates the use of AHP, its efficacy has recently been disputed by (Chan & Qi, 2003)who favor fuzzy ratios for selecting measures. Data envelopment analysis [DEA] can evaluate the performance measures quantitatively and qualitatively. It is based on the idea of efficient frontier analysis. It is not based on average value but takes the best value form the set of data (Talluri & Sarkis, 2001).

Some of the other approaches discussed are:

Theory of Constraints [TOC], which was introduced as a continuous improvement management philosophy by E.M.Goldratt in 1990 with the aim to initiate and implement breakthrough improvement through focusing on constraints that prevents systems from achieving high level performance (Goldratt, Schragenheim, & Ptak, 2000).

Prioritization of KPIs is also based on SMART criteria [Specific, Measurable, Attainable, Realistic, and Time-sensitive]. The proposed approach results in a systematic decision making approach to assist managers in determining which KPIs are more relevant to organizational goals than others (Shahin & Mahbod, 2007).

A Multi-Attribute Decision Model [MADM], namely Performance Value Analysis [PVA] aim to assess the performance of supply chain by supplementing decision-making process and setting internal benchmarks (Soni & Kodali, 2010).

Strength, weaknesses, opportunities, and threats (SWOT) analysis has been applied on every driver of each supply chain in comparison to others to identify the strong, weak, and improvement aspects of each supply chain drivers (Soni & Kodali, 2010).

Multiple regression analysis is used to analyze data in performance measurement, and benchmarking as well as it provides a good theoretical background to the research by establishing relationship between dependent and independent variables. It, thus, provides meaningful interpretation of the data and results (Moseng, 1995; Blumberg, 1994; Schefcyzk, 1993).

These approaches have their own limitations with respect to a particular context, and they cannot be generalized in all business scenarios. It has been discussed in the later part of the study, and then the identified KPIs are grouped specifically for Retail Supply Chain. The summary of approaches for categorizing KPIs has been summarized in Table 3.6.

**Table 3.6: Summary of Literature of Approaches Developed for Categorization of KPIs**

| Author, Year | Approach |
|---|---|
| Amaratunga & Baldry, (2003); Kaplan & Norton, (1992) | Balanced Scorecard approach |
| Shepherd & Gunter, (2006); Lockamy III & McCormack, (2004); Huang, Sheoran, & Keskar, (2005); Neely, Bourne, & Kennerley, (1995); Bolstorff, (2003) | SCOR approach based on five processes |
| Atkin & Brooks, (2000) | Critical success factors (CSFs) |
| Huang, Sheoran, & Keskar, (2005); Chan & Qi, (2003); Lockamy III & McCormack, (2004) | Process based division of performance metrics |
| Huang, Sheoran, & Keskar, (2005) | Analytical Hierarchy Process AHP |
| Goldratt, Schragenheim, & Ptak, (2000) | Theory of constraints (TOC) |
| Talluri & Sarkis (2001) | Data envelopment analysis (DEA) |
| Shahin & Mahbod, (2007) | SMART approach |
| Soni & Kodali, (2010) | A multi-attribute decision model (MADM), namely performance value analysis (PVA) |
| Soni &Kodali, (2010) | SWOT Analysis |
| Moseng, (1995); Blumberg, (1994); Schefcyzk, (1993). | Regression analysis: |

Some of the reasons identified by (Gunasekran, Patel, & Tirtiroglu, 2001) for the need to study the measures and metrics are lack of balanced approach and lack of a clear distinction between metrics at strategic, tactical and operational levels. Table 3.7 gives a set of metrics which have been developed by (Gunasekaran, Patel, & Tirtiroglu, 2001) and classified into strategic, tactical and operational levels of supply chain. Further, some of the metrics are also segmented into financial and non-financial measures.

**Table 3.7: A framework on Metrics for the Performance Evaluation of a Supply Chain**

| Level | Performance metrics | Financial | Non-financial |
|---|---|---|---|
| **Strategic** | Total supply chain cycle time | | * |
| | Total cash flow time | * | * |
| | Customer query time | * | * |
| | Level of customer perceived value of product | | * |
| | Net profit vs. productivity ratio | * | |
| | Rate of return on investment | * | |
| | Range of product and services | | * |
| | Variations against budget | * | |

| | | | |
|---|---|---|---|
| | Order lead time | | * |
| | Flexibility of service systems to meet particular | | * |
| | Customer needs | | |
| | Buyer-supplier partnership level | * | * |
| | Supplier lead time against industry norm | | * |
| | Level of supplier's defect free deliveries | | * |
| | Delivery lead time | | * |
| | Delivery performance | * | * |
| **Tactical** | Accuracy of forecasting techniques | | * |
| | Product development cycle time | | * |
| | Order entry methods | | * |
| | Effectiveness of delivery invoice methods | | * |
| | Purchase order cycle time | | * |
| | Planned process cycle time | | * |
| | Effectiveness of master production schedule | | * |
| | Supplier assistance in solving technical problems | | * |
| | Supplier ability to respond to quality problems | * | * |
| | Supplier cost saving initiatives | | * |
| | Supplier's booking in procedures | * | * |
| | Delivery reliability | | * |
| | Responsiveness to urgent deliveries | | * |
| | Effectiveness of distribution planning schedule | | * |
| **Operational** | Cost per operation hour | * | |
| | Information carrying cost | * | * |
| | Capacity utilization inventory as:<br>- Incoming stock level<br>- Work-in-progress<br>- Scrap level<br>- Finished goods in transit | * | * |
| | Supplier rejection rate | * | * |
| | Quality of delivery documentation | | * |
| | Efficiency of purchase order cycle time | | * |
| | Frequency of delivery | | * |
| | Driver reliability for performance | | * |
| | Quality of delivered goods | | * |
| | Achievement of defect free deliveries | | * |

*Source:* (Gunasekaran, Patel, & Tirtiroglu, 2001)

## 3.5.Research Gaps

It is widely acknowledged that there has been relatively little interest in developing measurement systems and metrics for evaluating supply chain performance (Chen, Paulraj, & Lado, 2004; Gunasekaran, Patel, & Tirtiroglu, 2001; Beamon, 1999) and others (e.g. (Ellinger A. E., 2000; Fynes, Voss, & Búrca, 2005) found it encouraging that some researchers have developed measures to assess the performance of supply chain relationships, or the performance of a supply chain as a whole  A typical firm already has a certain number of KPIs such as return on Investment for assessing its financial performance, but supply chain related KPIs have not been widely adopted and businesses are typically uninformed of them (Chae, 2009). Traditional BSC and SCOR models generally assume that KPIs are uncoupled (Cai, Liu, Xiao, & Liu, 2009). These approaches could describe business operations well, and serve as a good communication tool, but they are not effective in improving overall performance by accomplishing the critical KPIs (Cai, Liu, Xiao, & Liu, 2009). These approaches could describe business operations well, and serve as a good communication tools, but they are not effective in improving overall performance by accomplishing the critical KPIs (Cai, Liu, Xiao, & Liu, 2009). As pointed out by (Gumbus, 2005; Ho, Chan, W, Wong, & Chan, 2000; Douglas, 1996), that categorization must provide the organizations an opportunity to select the performance indicators in which the companies are most interested.

However, (Lambert & Pohlen, 2001) observe that one of the main problems with SC metrics is that, 'they are, in actuality, about internal logistics performance measures', and do not capture how the supply chain as a whole has performed. For example, although measures such as order fill rate are likely to be influenced by activities throughout the entire SC, they ultimately measure performance at the intra, rather than the inter-organizational level. There is a need to incorporate broader relationships, such as, manufacturers and logistics service providers or distributors to collaborate across different levels of supply chain. Some of the concerns that need to be addressed in this direction include the integration issue of SC in varied industries across the countries. Also, there is a requirement to conduct more empirical studies on the effect of management practices on combination of these SCM practices (Gopal & Thakkar, 2012).

To the best of researcher's knowledge, no integrated measurement system exists in Retail supply chain that combines different aspects of performance (e.g. financial and non-financial, qualitative and quantitative) into one measurement system. Therefore, researcher is aiming to propose a theoretical framework for measuring Retail Supply Chain Performance, which of course can be further empirically tested to develop a performance management model that can be used by the industry professionals. Table 3.8 provides the list of indicators which were identified through literature review. This list was further used to categorize the KPIs specifically for retail industry.

**Table 3.8: List of Metrics for Supply Chain Performance Measurement**

| **Author, Year** | **Performance metrics** | **Context** |
|---|---|---|
| Akkermans, Bogerd, & Vos, (1999) | Business strategies (functional capabilities), processes (operational efficiencies), stake holders view (risk/return ratio) | SCOR model-(plan, source, make, deliver) |
| Kim, (2009); Aviv, (2007); Simatupang & Sridharan, (2004) | Order of dominance and decision Sharing | Collaborative planning and production, decision making |
| Emmet & Crocker, (2006); Dong & Chen, (2005); Lambert & Pohlen, (2001); Beamon, (1999) | Cost, profit, excess inventory, stock-out, resource measure | Collaborative planning and production, decision making |
| Forslund & Jonsson, (2007); Chang, Fu, Lee, Lin, & Hsueh, (2007); McCarthy & Golicic, (2002); Raghunathan, (2001) | Impact of information quality on Forecasting | Information sharing, Forecasting decision making |

| | | |
|---|---|---|
| Forme, Genoulaz, & Campagne, (2007); Angerhofer & Angelides, (2006); Barratt & Oliveira, (2001) | Reliability, reactivity/flexibility | Information sharing, Forecasting decision making |
| Aviv, (2007); Simchi-Levi & Zhao, (2005); Chen, Paulraj, & Lado, (2004); Cachon, (2001) | Inventory and stock position, stock out, lead time, internal service rate, cross-functional capability, logistics efficiency | Replenishment, decision making |
| Chae, (2009) | Cash to cash cycle, Inventory days, planning cycle, supplier fill rate, Automatic PO rate, | Operations strategy |
| Pyke & Cohen, (1994); Pyke & Morris, (1993); Cohen & Moon, (1990); Lee & Feitzinger, (1995) | Cost | Resource metrics |
| Arntzen, Gerald, Terry, & Linda, (1995) | Cost and activity time | Resource metrics |
| Altiok & Raghav, (1995); Christy & Grout, (1994); Davis T. , (1993); K, Takahashi, & Muramatsu, (1988); Newhart, Stott, & Vasko, (1993) | Cost and customer responsiveness | Resource metrics |
| Lee & Billington, (1993) | Customer responsiveness | Output metrics |
| Cai, Liu, Xiao, & Liu, (2009); Angerhofer & Angelides, (2006); Van der Vorst, (2000) | Information accuracy, Information availability, Information timeliness, Information sharing | Information Metrics |
| Cai, Liu, Xiao, & Liu, (2009) | Rates of sales in new products, Supply chain stability, Number of new products launched, Process improvement | Innovativeness metrics |
| Cai, Liu, Xiao, & Liu, (2009) | Manufacturing/production flexibility, New products flexibility, Supply chain responsiveness, Delivery flexibility, Procurement flexibility, Information Systems flexibility, Logistics flexibility | Flexibility |
| Cai, Liu, Xiao, & Liu, (2009) | Sales (or profit), Percent of on-time deliveries, Rate of stockouts (losing sales), Perfect of order-fulfillment, Fill rate (target fill rate achievement, average item fill rate), Customer satisfaction, Order fulfillment lead time, Rates of customer complaints, Planned process cycle time, Cash to | Output metrics |

| | | |
|---|---|---|
| | cash cycle time | |
| Cai, Liu, Xiao, & Liu, (2009); Shepherd & Gunter, (2006); Bolstorff,(2003); Chan & Qi, (2003); Beamon, (1999) | Total supply chain management cost, Information management costs, Distribution costs, Value-added employee productivity, Inventory costs, Warranty costs, Manufacturing costs, Return on investment (or ratio of net profits to total assets) | Resource metrics |
| Voudouris, (1996) | Flexibility | Flexibility metrics |
| Chia, Goh, & Hum, (2009; Christopher, (1994) | Customer Satisfaction | Output metrics |
| Nicoll, (1994) | Information flow | Information metrics |
| Davis T. , (1993) | Supplier performance | Output metrics |
| Johnson & Randolph, (1995) | Risk management | Output metrics |

In the next section the categorization of KPIs is discussed for Retail Supply chain from the identified variables in literature review.

### 3.6. Categorization of KPIs for Performance Measurement in Retail

Industries, such as retail sector, are recognizing the significant role of supply chain management (Hill & Scudder, 2002; Mentzer, Foggin, & Golicic, 2000; Ellram, La Londe, & Weber, 1989), and the need to effectively manage the flow of materials, money and information across the supply chain (Gavirneni, R, & S, 1999; Lee & Billington, 1993). The advances in technology (Sahin & Robinson, 2005) have seen a growing trend for organizations to create external linkages based on the sharing of information (e.g. point of sale data (POS), inventory levels, forecasts, etc.) in order to gain increased visibility of their customers and/or suppliers' operations and activities (Fiala, 2005; Shore & Venkatachalam, 2003; Mabert & Venkataramanan, 1998). The purpose of achieving visibility is primarily for improving their own internal decision making and operating performance (Kulp, Lee, & Ofek, 2004; Rungtusanatham, Salvador, Forza, & Choi, 2003). Visibility in information helps to improve supply chain performance (Kulp, Lee, & Ofek, 2004; Rungtusanatham, Salvador, Forza, & Choi, 2003).

According to (Jones & Towill, 1999), information flow at all levels of supply chain is critical, and specifically, the order entry method determines the way and extent to which customer specification are converted into useful information and channelized across the supply chain partners. In previous studies (Aviv, 2007; Chen, Paulraj, & Lado, 2004; Gavirneni, R, & S, 1999; Lee & Billington, 1993; Bourland, Powell, & Pyke, 1996; Cachon & Fisher, 2001), benefits of information sharing have been found mostly from a modeling/simulation perspective. The important characteristics for information sharing are accurate, trusted, timely, useful and in a readily usable format (Whipple, Frankel, & Daugherty, 2002; Closs, Goldsby, & Clinton, 1997; Gustin, Daugherty, & Stank, 1995). Delivery also heavily relies on the quality of information exchanged. For example, once the activities are scheduled continuous monitoring of information derived and supplied takes place (Gunasekran, Patel, & Tirtiroglu, 2001). According to (Bower & Hout, 1988) and (Christopher M. , 1992), order cycle time is an important measure for reduction in response time of supply chain and also a source of competitive advantage.
Moreover, it also directly influences the customer satisfaction level (Jones & Towill, 1999) by being more responsive to the customer demand and increasing the delivery reliability and consistency of lead time. Due to fluctuations and uncertainty in the supply chain in handling a large amount of SKUs, a reliable and consistent order lead time reduces the redundancies (Schonberger, 1990). The use of technology and its advances

have enforced companies to rearrange the activities of supply chain. The path through which the order travels and spend time in different routes, the non-value adding activities can be identified for elimination.

To necessitate this, it is important to track and trace the products by use of technology (e.g. e-commerce, EDI and internet). The entire planning process of making the final order placement has its impact on cost, quality, speed of delivery and delivery reliability and flexibility (Slack, 1983). As the product range has increased, the value added per employee i.e. productivity of human resource is an important parameter to be considered (Gunasekaran, Patel, & Tirtiroglu, 2001). The starting point for any decision of logistics invariably centers on (Drucker, 1962) description of the economy's Dark Continent, which suggested that distribution was one of the last frontiers of business to be discovered. He noted that distribution was viewed as a low status activity by managers, yet major cost savings could be achieved by managing this function more effectively.

By 1970s and 1980s the supply chain was still viewed as series of disparate functions with materials management dealing with the backend of the supply chain, and physical distribution management focusing upon the flow of product from manufacturers to their customers (retailers and wholesalers). For transport efficiency, the distribution mode, the delivery channel, vehicle scheduling and warehouse location play a significant role, and show tremendous opportunities to improve supply chain performance based on lead-time reduction (Gelders, Mannaert, & Maes, 1994). It is determined by on-time delivery/perfect delivery parameter, which ultimately influences the customer service level (Stewart, 1995).

A large number of different types of performance metrics have been used to characterize the various functions of supply chain; production, distribution and inventory systems. Understanding the meaning of a single metric might be easy, but the meaning of the metrics in combination, and their effect on overall company performance, is hard to intuitively understand. One problem is that metrics based on financial accounting systems, and expressed in financial terms, are not easily compared with operational metrics focused on the physical movement of goods and services.

Through literature review, numerous variables have been identified for supply chain performance measurement. These identified KPIs have been classified into four major categories (KPMG, 2011) which are as follows:

- Transport Optimization,
- Information Technology Optimization
- Inventory Optimization
- Resource Optimization

The importance of these major categories is discussed in the subsequent sections.

### 3.6.1. Transport Optimization

Transport has been identified as a major area of concern in retail sector and its planning needs a trade-off between cost and service. Transport is a key linkage between all activities of supply chain, enabling the physical movement of goods across the multi-echelon of supply chain. Furthermore with the introduction of third party logistics (3PL), this function is being performed in more organized way. It has gained importance with its advancements, like, cold storage, break bulk facilities, which is a value addition to the movement of goods. The inescapable approach of 'Right product at right time and in the right place' across multiple channel touch points have become a challenge for retailers. Moreover the tough cord of fast changing consumer tastes has forced retailers to make their supply chain more effective and efficient.

Logistics is considered as an important activity in the area of operations, marketing and distribution with significant cost implications. According to (Thomas & Griffin, 1996), logistics is: 'the single largest cost component of logistics is transportation cost, often comprising half of the total logistics cost'. Bowersox et al., (2005), (Bowersox, Rodrigues, & Calantone, 2005) identified logistics as: '*One of the largest costs involved in international trade'.*

Some of the researchers have argued that SCM has the potential to lower the total logistics costs, while simultaneously improving customer service and satisfaction (Moberg, Whipple, Cutler, & Speh, 2004). With effective and efficient planning, the distribution cost is one component of total supply chain cost which can be optimized. In a physical distribution channel, the total transportation cost can be treated as trucking cost plus local delivery cost. Furthermore (Rushton, Oxley, & Croucher, 2001) shows that, *'trucking cost is always the highest among all costs of total distribution cost'*. To reduce the delivery cost, this total is given high importance (Gunasekaran, Patel, & Tirtiroglu, 2001).

***Current Scenario of Logistics in India:*** Today India is the 4$^{th}$ largest country in terms of purchasing power parity [PPP] (The World Bank, 2013), and constitutes one of the faster growing markets in the world.

Ports, airports, roads and railways are all seen as vital for the Indian Economy and have been targeted for investment to keep pace with competition and growing demand. The lead time by road is as high as 9-12 weeks and transporters have a long way to go to achieve milestone- 'A journey towards excellence'. An efficient and inexpensive transport system contributes to greater competition in the market place, greater economies of scale in production and reduced prices of goods. A lot of emphasis is laid on the cost/service balance or revenue growth. Logistics networks are seen as a matter of survival and competitive advantage. The linkage between the production facility, distribution centre and retail outlet involves an extensive planning. That is why; we deal with a lot of routing problems, taking into consideration a number of factors, such as, unit production, transportation and inventory holding cost, distance to be covered, modes of transport available, lead time between the two connecting points, service level, etc.

Table 3.9 gives the overview of world-wide logistics conditions and solutions, in which it is seen that India is lacking the necessary infrastructural and government support.

**Table 3.9: World-Wide Logistics Conditions and Solutions**

| Region | Logistics conditions(s) | Logistics solution(s) |
|---|---|---|
| North America | i. Short term focus on shareholder return and return on capital<br>ii. Excellent infrastructure | i.Extensive logistics finance and performance measures<br>ii. Supply chain integration and logistics information systems to reduce capital assets |
| Latin America | i. Limited to no logistics infrastructure and / or logistics service providers | i. Leap frog to World class status<br>ii. Import Logistics service providers and education<br>iii. High security designs |
| Western Europe | i. Transportation heritage<br>ii. Individual rights | i. Transportation heritage makes 3PL providers commonplace<br>ii. Focus on individual rights yields human friendly logistics via excellent |

| | | |
|---|---|---|
| | | logistics ergonomics and green logistics |
| Japan | i. Lack of land and/ or human resources and high logistics transaction requirements | i. Logistics culture of discipline and order<br>ii. Automated storage and handling systems<br>iii. Multi-story logistics facilities |
| India | i. Poor Logistics infrastructure, lack of government support | i. Necessary infrastructure and organizational support |
| China | i. Long delays in property acquisition, varied and complex regulations, difficulty in securing finance | i. Companies have to develop potential strategies for expansion |

*Source:* (Frazelle, 2002b)

In the context of retail logistics, several authors have sought to explain the transformation of logistics practices since 1970s. Also (McKinnon, 1996) identified six trends as follows:

- Retailers increasing their control over secondary distribution/warehouse to shop.
- Restructuring of retailers logistical systems through development of composite distribution and centralization of certain commodities into particular supply chain streams.
- Adoption of quick response techniques to reduce lead time through the implementation of information technology especially electronic data interchange (EDI), EPOS (electronic point of sales) and SBO (sales based ordering).
- Rationalization of primary distribution (factory to warehouse) and attempts to integrate this and secondary distribution into a single network system.
- Introduction of supply chain management and efficient consumer response (ECR).
- Increasing return flow of packaging material and handling equipment for recycle and reuse.

Several authors have discussed the importance of a supply chain focus on the part of transport logistics service providers, as they function to link suppliers, manufacturers, distributors, retailers and customers. They argue that transport logistics service providers must focus on supply chain performance in addition to organizational performance (Lai, Ngai, & Cheng, 2002). The logistics performance construct reflects the organization's performance, as it relates to its ability to deliver goods, and services in the precise quantities and at the precise times required by customers. Authors describe the importance of integrating the Logistics processes of all supply chain partners to better serve the needs of ultimate customers (Stank, Davis, & Fugate, 2005; Lin, 2006). One can observe that Logistics activities are highly integrated in today's retailing sector, and the entire way of doing business has changed due to multiple channels of serving the same customer.

The internal performance measurement mainly focuses on the value chain or logistics supply chain within a single company for its operational functions, like, sourcing, inbound storage/transportation, operations, outbound storage/transportation and consumer distribution (Coyle, Bardi, & Langley, 2003), while the external performance measurement has an emphasis on measuring the performance of the efficient and effective flows of material/products, services, information and financials from the supplier's supplier through various organizations/ companies out to the customer's customer (Coyle, Bardi, & Langley, 2003). Transport is a direct link that connects various activities of supply chain in delivery of goods to the end customers.

Delivery operates in a dynamic ever changing environment, which involves a regular track and trace of flow of goods with accuracy in data.

In any typical delivery distribution mode, the delivery channel, vehicle scheduling and warehouse location play an important role in delivery performance. For perfect delivery, certain parameters have to be taken into consideration, like, temperature control during transportation, safety measures so as to avoid the pilferage/damage in transit. Logistic flexibilities can be accomplished by accommodating changes in warehouse locations; transportation networks and the transportation mode have a positive impact on supply chain performance (Green Jr, Whitten, & Inman, 2008; Bowersox, Closs, Stank, & Keller, 2000). Also, some companies own their fleets for their dedicated routes and flexible logistics operations. An increase in delivery performance is possible by selecting the suitable channel, scheduling and location policies.

On time delivery is also a very important aspect of delivery performance, which helps to determines how perfect the delivery has taken place or not, and it acts as a measure of service level (Gunasekaran, Patel, & Tirtiroglu, 2001). Also (Stewart, 1995) has identified the three important delivery performance measures, i.e., delivery-to-request date, delivery-to-commit date and order fill rate. A reduction in fill rate helps to improve the operational efficiency. The vehicle speed, driver reliability, frequency of delivery and the location of depots have been also identified as significant variables for perfect delivery. The customer satisfaction is ultimately the prime concern; hence, the transport flexibility also plays an important role. The number of faultless notes invoiced, which show the date of delivery, time and condition under which goods were received, show the delivery reliability.

Lai et al., (2002), (Lai, Ngai, & Cheng, 2002) distinguished three dimensions of supply chain performance in transport logistics: service effectiveness for shippers; operational efficiency; and service effectiveness for consignees. Perhaps, the most important research concerning logistics is in the area of designing efficient and cost-effective distribution systems. The single largest cost component in logistics is transportation cost (Thomas & Griffin, 1996). The companies have to do a trade-off between the total cost and service; therefore, delivery measures are of high priority in supply chain. The variables used for Transportation Optimization are given below in the Table 3.10.

**Table 3.10: Variables for Transport Optimization**

| Survey elements | Representation* |
|---|---|
| Percent of on-time deliveries is an important indicator for high service level | TO1 |
| Damages due to inefficient delivery (pilferage/ delay/ damage in transit) of the product as % of total sales should be minimal are critical for operational excellence. | TO2 |
| Proper documentation is important for delivery of goods on time | TO3 |
| Temperature control during transportation for perishable commodities is essential for perfect delivery | TO4 |
| Transport connectivity is important for high growth of business | TO5 |
| Usage of GPS/RFID technology for track & trace is essential | TO6 |
| Vehicle optimization is highly significant for logistics operations | TO7 |
| Faster turnaround time of vehicles at loading and unloading time improves efficiency | TO8 |
| Owned vehicles are convenient and cost effective for transportation | TO9 |
| Outsourced vehicles are more efficient for transporting goods | TO10 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

### 3.6.2. Information Technology Optimization

Today, India is a global village where MNCs have flourished their businesses and ‘Retail’ has been identified as the most promising sector of Pan Asia. IT has made the world flat and has integrated the supply chain partners across the world with the help of real time ‘Information sharing’ which has in turn helped businesses to grow faster and better.

The goal of SCM is to manage the multiple functions of supply chain and information exchange within the supply chain has been cited as a very critical component (Martha, 1997). (Cannon & Perreault Jr., 1999) With the dynamic changes in the industry, the growing pressures of the industry consolidation, emerging new retail formats, new challenges of managing the fast changing trends, stock-outs and markdowns have resulted for technological support by the retailers. As a key industry in the service sector, retailers accounted for approximately 6.1% or $884.9 billion of the U.S. GDP in 2010 (Bureau of Economic Analysis, 2011).Given the access to data and analytical tools, retailers are finding that information technology has been a great support in managing various disruptions in supply chain, primarily because of the availability of right information at the right time across multiple channels to offer consumers multiple touch points and innovative services (Noble, Haytko, & Phillips, 2009; Wallace, Giese, & Johnson, 2004). Principally, the impact of IT was the main concern in the manufacturing supply chain; recently its role in service industry has also started gaining importance. There is a growing need to understand the connection between the information systems [IS] and the design of service delivery systems in information-intensive service domains (Froehle & Roth, 2007; Spohrer, Maglio, Bailey, & Gruhl, 2007).

All the supply chain partners of upstream and downstream intermediaries are linked with real time data that rely on electronic data interchange [EDI] and the open standard of the internet. Besides, the traditional ‘hard’ technologies, like, scanners, barcode readers, and wearable computers, the internet-centric software and analytical tools have added value to the large chunk of data to provide specific solutions for strategizing the desired objective in the market (Rao, 2000).

***Significance of measuring performance of IT:*** Prior research has proposed that when IT and business resources are deployed in a complementary manner, performance gains are likely to happen (Barua, Konana, Whinston, & Yin, 2004; Melville, Kraemer, & Gurbaxani, 2004; Ray, Muhanna, & Barney, 2005; Tanriverdi, 2005; Hulland, Wade, & Antia, 2007). Moreover, IT is becoming the most critical resource in service firms (Froehle & Roth, 2007) and it is used to improve the operational and strategic coordination (Sanders, 2008). With the advent of internet, the way of doing business has changed to e-business, and hence, the multiple partners of supply chain across the globe are integrated with real time information.

Technological developments play an important role in retail operations, in terms of streamlining the flow of goods, services and information. Organizational success first depends upon the performance of the supply chains in which the organization functions as a partner (Rosenzweig, Roth, & Dean, 2003). The implementation of an enterprise resource planning [ERP] can be considered one of the most effective ways towards traceability, since one of its major features is integration between modules, data storing/ retrieving processes and management, and analysis functionalities, combined with the typical functionalities of standalone applications (Hoffman, 2004; Wortmann, 1998; Davenport, 2000). Moreover, ERP has allowed the business partners to share information under one single roof, and therefore performance track becomes more transparent and real for effective decision making (Figure 3.8) (Barratt & Oke, 2007).

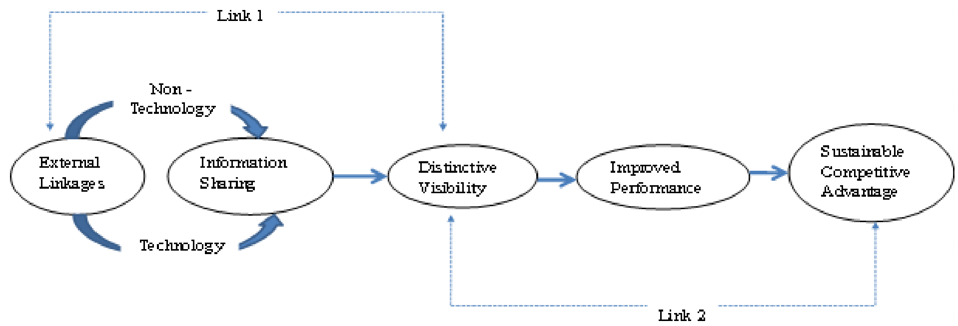



**Figure 3.8: Supply Chain visibility**

The exchange of information and knowledge is so important that supply chain partners should consider the use of an enterprise planning system to promote the exchange of information and knowledge (Towers & Burnes, 2008). Therefore, it is crucial for multichannel retailers to use IT effectively in integrating their activities across the functional areas, so that the consistency and flow of information regarding customers, orders, and inventory can be ensured (Vickery, Jayaram, Droge, & Calantone, 2003). Information accuracy, Information availability, Information timeliness, Information sharing are some of the measures related to information technology (Cai, Liu, Xiao, & Liu, 2009; Angerhofer & Angelides, 2006; Van der Vorst, 2000). Information and knowledge sharing can help spread the risks, costs, and gains for supply chain partners (Ballou, Gilbert, & Mukherjee, 2000). Generally, information sharing in a retail supply chain context has received a lot of attention (Chae, 2009; Gavirneni, R, & S, 1999; Cachon G. , 2001; Sahin & Robinson, 2002), and it has been an important component in improving operational issues (Forrester J. W., 1961; Chen, Drezner, Ryan, & Simchi-Levi, 2000; Lee, Padmanabhan, & Whang, 1997).

***Enabling factors of Information Technology:*** In today's markets, technological and competitive forces are evolving at a very rapid pace. To respond to these forces, radical changes in the organizations have become necessary. To handle these complexities of business, companies have adopted technological advancements in streamlining the flow of various processes of supply chain. Information technology has helped in gaining advantages in terms of cost, speed and flexibility which helps to improve the overall performance of supply chain functions such as warehouse management and network planning. (McCarthy & Golicic, 2002; Forslund & Jonsson, 2007; Rungtusanatham, Salvador, Forza, & Choi, 2003; Chang, Fu, Lee, Lin, & Hsueh, 2007; Chae, 2009) have studied the impact of information quality on Forecasting. Data typically is captured at various interfaces between the supply chain entities, like, customer transactions, shipments to stores, inventory and warehousing activities, interactions pertaining to planning and allocation of stock between retail outlets and corporate head-offices, and the interactions between value chain intermediaries. The data captured at these interfaces is invaluable unless and until it undergoes the proper diagnosis with the help of tools and software for analysis. The analysis of this data has made it possible to make more effective decisions for purchasing, stocking and logistics.

With the help of flexible and adaptable information systems, the reliability and accuracy of data has increased, and it is easily available with the channel partners without any time lag. In addition, Information technologies act as a catalyst for improving the overall performances of the warehouses. Implementation of IT helps to reduce warehouse complexities, which include the number and variety of items to be handled, the nature of product, variety of processes, etc. It helps in tracing items raw material, semi-finished goods and finished goods [RM, SFG and FG] that are stored in a warehouse during material handling operations. Hence, I.T. has made monitoring and managing of inventory surprisingly easier. It provides timely and accurate information about products, which helps to easily track the items, order-picking and sorting of inventory. It is also observed that radio frequency identification [RFID], Warehouse Management Systems [WMS], Electronic Data Interchange [EDI], and Enterprise Resource Planning [ERP], Geographical Information Systems [GIS], etc have become popular tools in automating the logistics operations. Integration and coordination of these information systems are important to supply chain alignment. As Organizational managers are ultimately held accountable for organizational performance (Walters, 2008; Green Jr, Whitten, & In, 2008) it is important to continuously collect feedback and adopt measures to improve the feedback. Information sharing results in benefits for all of the supply chain partners. Here, in this study researchers attempt to identify the KPIs which contribute in improving the overall efficiency of the supply chain operational activities like transport and inventory management. The variables used for Information Technology Optimization are given below in the Table 3.11.

**Table 3.11: Variables for Information Technology Optimization**

| **Survey Elements** | **Representation*** |
|---|---|
| Role of IT in efficient purchasing/inventory management is important | ITO1 |
| EDI helps in faster exchange of data between buyer and seller | ITO2 |
| Quality of the input data *(e.g via POS)* helps in demand forecasting and triggering Re-order point (ROP) | ITO3 |
| Information system should be adaptable and flexible for maximizing benefits. | ITO4 |
| Compliance with latest regulations of information systems is beneficial for overall functioning of organization, hence it is an important indicator for improving SC performance | ITO5 |
| Real time information due to IT usage helps in reducing claims in rupee per month vs monthly turnover | ITO6 |
| IT helps in easy sharing of real time information with channel partners, which increases the accuracy and reliability of the acquired information | ITO7 |
| Investment in IT minimizes the data maintenance and transaction cost | ITO8 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

### 3.6.3. Inventory Optimization

The complexity in managing the uncertainty of supply chain has increased due to the increase in number of product variants with ever shortening life cycles. Moreover every product has its own supply chain as identified by (Fisher, 1997), where he categorized the supply chains as Efficient and Responsive supply chain depending upon the nature of the product. Managing inventory is one of the biggest challenges in retail chains. With the increase in number of product variants, and with decreasing product life cycles, the supply chain responsiveness increases. Customer responsiveness includes lead time, stock-out probability and fill rate. In order to avoid the stock-outs, companies have to keep the stock to meet such uncertainties in demand and supply Therefore, the coordination of logistics and inventory decisions in a supply chain has a significant effect on the supply chain performance.

One of the major reasons for using information technology, like, EDI is that there should be no discrepancy in the physical flow of goods, and with the accuracy in data, inventory levels should be maintained. Retailers, vendors and suppliers tend to share vital information- such as, demand trend reports, forecasts, and inventory levels order status and transportation plans- in real time. This effective communication and data-sharing helps to identify numerous cost-cutting opportunities that can be beneficial to all parties involved in the supply chain. Various types of costs are associated with inventory like investment value with held inventory, cost associated with obsolete inventory, cost associated with work-in-process inventories and the cost with held with finished goods inventories. Some of the initiatives that retailers have started to optimize regarding their entire supply chain include workforce optimization, inventory planning and revamping of technological infrastructure. Optimization models and algorithms, decision support systems and computerized analysis tools are some of the methods adopted by companies for decisions of different functions (e.g., supply process, distribution, inventory management, production planning, facilities location, etc.) for managing the entire supply chain.

In supply chain, the total cost associated with inventory (Stewart, 1995) (Christopher M. , 1992; Slack, 1983; Lee & Billington, 1993; Dobler & Burt, 1996; Levy, 1997) consists of the following:

- Opportunity cost consisting of warehousing, capital and storage;
- Cost associated with inventory as incoming stock level, work in progress;
- Service costs, consisting of cost associated with stock management and insurance;
- Cost held up as finished goods in transit;
- Risk costs, consisting of cost associated with pilferage, deterioration, damage;
- Cost associated with scrap and rework;
- Cost associated with shortage of inventory accounting for lost sales/lost production.

> *"Inventory is where the biggest cost is hidden in most businesses today"*- (Harrington, 1996)

Significant changes have been seen in global retail sector because the challenge for the companies has been to keep abreast of the best practices in the industry. In terms of cost involved managing inventory has been 20% of the total logistics cost (ELA European Logistics Association / A.

T. Kearney Management Consultants, 2004). In a study of an FMCG supply chain, it was found that functional decisions made at each major process are driven by different criteria and this lack of alignment at each link is referred as 'Matrix Ttwist' proposed by (Godsell & Harrison, 1992) ( given in Table: 3.12).

**Table 3.12: Supply Chain Optimization**

| **Supply Chain Process** | **Supply Chain Decision** | **Determined By** |
|---|---|---|
| Source | Which suppliers? | Raw material commodity type |
| Make | Which manufacturing site? | Product family type |
| Deliver | Which Manufacturer warehouse? | Historically a function of order size<br>In process of being divided by export paperwork requirements and customer account (arbitrary spilt) |
| | Which customer regional distribution centre? | Product type and Location of store to serve |
| | Which products to which store? | Demographics of the store's catchments area which drives layout and range decisions |

Inventory levels in different parts of the supply chain have to be monitored and reported, which can help to reduce the total amount of inventory in the supply chain. Optimizing inventory is an important aspect of supply chain, and it has to be continuously traced so that no disruption or bullwhip effect occurs in the supply chain. (Lee, Padmanabhan, & Whang, 1997) identified four main causes of the bullwhip effect: demand signal processing, batch purchasing, price fluctuations, and shortage gaming. Choice of inventory policies, extent of information sharing, and use of early order commitment are often cited as effective means to achieving better supply chain coordination and alleviating the bullwhip effect. Supply chain coordination is imperative to reducing the inventory and counteracting the demand uncertainty throughout the supply chain. Researchers have focused on missing inventory, inventory record inaccuracy and inventory replenishment, it is reasonable to suspect that, given the high level of problems with inventories (Raman, DeHoratius, & Ton, 2001a; Corsten & Gruen, 2003).

For example, it is not obvious as to how the loading or unloading of goods or the productivity in order picking influence the operational result of a distribution center. Other factors, such as, goods handling damages, delivery quality or inventory accuracy greatly influences the performance of the operations as a whole. Furthermore, the use of financial accounting information promotes a functional perspective within an organization, mainly because; resources are allocated from the top down, whereas goods and services flow horizontally through the firm. Traditionally, retailers make their own inventory replenishment decisions based on their demand forecast and their cost structure (i.e., inventory carrying cost and ordering costs). It was (Ferguson & Ketzenberg, 2006) examining the value of reverse flow of information in which the supplier shares its inventory state with the retailer. In addition, (Zhao, Xie, & Wei, 2002) conducted extensive simulation studies on the effect of Early Order commitment (EOC) on supply chain performance under various operational conditions, including demand pattern, forecast errors, cost structure, number of retailers, and capacity cushion. An inventory model for deteriorating items with time-dependent backlogging rate was studies by (Dye 2007).

To achieve the appropriate level of inventory, a focus on correct evaluation, identification, classification and quantification, retrieval and security of goods would provide a clear and accurate view (Chorafas, 1974). The reason for improvement of the warehouse activity is due to the increase in responsiveness and agility of supply chain, which demands higher order accuracy, reduced space requirements, increased volume capacity, control of inventory and increased customer service (Adams, Brown, & Firth, 1996). JIT, MRP and similar methods reflect the need to hold stock or materials for a minimum amount of time. The challenge of holding enough inventories to meet demand, but not incur excess cost, is a perennial supply chain management problem (Forrester J. W., 1961; Lee, Padmanabhan, & Whang, 1997). Warehouses are now redesigned and automated for better efficiency in terms of high throughput and high productivity, to reduce order producing costs. Warehousing activities concern the physical storage and retrieval of materials, and also the processing of information needed about the goods stored. Some of the value adding activities are, production postponement, also conveyor and sortation equipment may be used in a cross-docking facility to direct goods to warehouse areas where such activities as labeling, kitting and hanging may take place, without the goods ever being placed into storage (Marvick & White, 1998) Automation offers flexibility to handle peak throughputs at short notice, particularly in areas where staff availability is a problem, or in operations where the use of additional staffing may result in congestion and productivity issues (Naish & Baker, 2004). The variables used for Inventory Optimization are given below in the Table 3.13.

**Table 3.13: Variables for Inventory Optimization**

| **Survey Element** | **Representation*** |
|---|---|
| Inventory holding cost as % of gross sales shows an impact on overall efficiency | IO1 |
| Accuracy in forecasting sales reduces obsolete inventory | IO2 |
| Stock-outs should be minimum for better profitability | IO3 |
| FIFO is a better method for inventory valuation | IO4 |
| Inventory accuracy *((book inventory – counted inventory)/ book inventory)* gives an insight in your bookkeeping practices and helps to measure stock cover | IO5 |
| Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory | IO6 |
| % of time spent picking orders/back orders impacts the level of operational efficiency | IO7 |
| Inventory replenishment cycle time helps to plan timely orders | IO8 |
| Fill rate is an important indicator in retail operations | IO9 |
| Innovation is a key parameter in Retail Supply Chain *(e.g.* | IO10 |

| | |
|---|---|
| *automation in warehouse helps to speed up the logistics operations)* | |
| Optimum number of warehouses are required for maximizing service level | IO11 |
| productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency | IO12 |
| Warehouse space/ layout/ future scalability/ use of MHE are critical for warehouse optimization | IO13 |
| Certification of the warehouse-ISO certificates/C-TPAT certification/TAPA certification/Accreditation by WRDA India is essential/desirable for compliance with latest regulations | IO14 |
| Electricity consumption (in Kw-hrs) per sqft of warehouse space reflects the energy efficiency, hence optimizes cost | IO15 |
| Depending on the nature of the goods, the storage facility has to be maintained *(e.g cold storage* | IO16 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

### 3.6.4. Resource Optimization

'Resources are generally measured in terms of the minimum requirements (quantity) or a composite efficiency measure' (Beamon, 1999). In fact, resource minimization is one general goal of supply chain analysis, wherein the supply chain is reconfigured to meet the present demand in the market. Companies aim to capitalize maximum on their minimum resources. Efficiency measures the utilization of the resources in the systems that are used to meet the system's objectives. Resource measurement is an important part of the measurement system and resources are directly related to the system's output and flexibility measures.

A supply chain network uses resources of various kinds: manufacturing resources (machines, material handlers, tools, etc.); storage resources (warehouses, automated storage and retrieval systems); logistics resources (trucks, rail transport, air-cargo carriers, etc.); human resources (labor, scientific and technical personnel); and financial (working capital, stocks, etc.). The objective is to utilize these assets or resources efficiently so as to maximize customer service levels, minimize lead times, and optimize inventory levels. In supply chain management, where all the business processes are linked and integrated with all business supply chain members, which makes the structure complex and cumbersome, it is recommended that firms should identify those supply chain members that are critical for successful supply chain performance (Douglas, 1996).

Similarly, the companies have limited resources which have to be optimally used. Resource measures include: inventory levels, personnel requirements, equipment utilization, energy usage and cost. Some of the supply chain resource performance measures include the following cost:

- Total cost: Total cost of resources used
- Distribution cost: Total cost of distribution, including transportation and handling cost
- Manufacturing cost: Total cost of manufacturing, including labor, maintenance and re-work costs
- Inventory: Costs associated with held inventory:
    - Inventory investment: Investment value of held inventory
    - Inventory obsolescence: Costs associated with obsolete inventory; sometimes includes spoilage
    - Work-in-process: Costs associated with work-in-process inventories.
    - Finished goods: Costs associated with held finished goods inventories.
- Return on Investment (ROI): Measures the profitability of an organization. The return on investment is generally given by the ratio of net profit to total assets.

Supply chain assets include, accounts receivable, plant, property and equipment and inventories (Stewart, 1995). It is also important to note here that how the costs associated with each asset, combined with its turnover, affect the 'total cash flow time', which can be measured as the average number of days required to transform the cash invested in assets into the cash collected from a customer. The total cash flow time can be combined with profit with the objective of providing an insight into the rate of return on investment [ROI]. For example, superior customer service leads to improved sales and an increased profit and subsequently a higher ROI. Therefore, ROI is found to be an indicator of financial health of supply chain. Resource based theory [RBT] explains how the rent generating potential of resources and capabilities can lead to sustainable competitive advantage (Wernerfelt, 1984; Barney, 1991; Grant, 1991), and it is also applicable for intangible resources (Conner, 1991; Taylor-Coates and McDermott, 2002). Efficiency describes an input/output relation while effectiveness shows how well supply chain goals have been achieved (see e.g. Bowersox et al., 2010). In this sense, supply chain performance can be seen as a function of the utilization of supply chain resources, or as a function of supply chain results as compared to supply chain targets. The variables used for Resource Optimization are given below in the Table 3.14.

**Table 3.14: Variables for Resource Optimization**

| **Performance Indicator** | **Representation*** |
|---|---|
| The following cost are important for supply chain efficiency | |
| Direct labor cost, Direct material cost and Manufacturing cost | RO1a |
| Cost of goods sold | RO1b |
| Distribution cost and Inventory cost | RO1c |
| Information management cost | RO1d |
| Warranty cost | RO1e |
| Packaging cost | RO1f |
| Facility management/ maintenance cost | RO1g |
| Quality of packaging material used is essential for customer service | RO2 |

| | |
|---|---|
| Customer satisfaction is important for the growth of the business/ maximizing profit | RO3 |
| Value added employee productivity helps to measure supply chain efficiency | RO4 |
| Training employees add to their productivity | RO5 |
| Acquiring a new equipment/software/ labour *as and when* business requirement is essential for the supply chain process improvements | RO6 |
| Cargo carried in terms of volumes for fiscal year indicates the benchmark for next year | RO7 |
| Use of renewable/ solar energy/green terminals are the growing need for business efficiency | RO8 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

In this study, financial performance of the firm is the dependent variable. Therefore in the next section importance of financial performance firm of the firm.

### 3.7.Financial Performance of the Firm

Financial performance is an important indicator for the health of any organization. However, it is challenging to agree on financial measures for performance measurement, as the resources are common, and also because the cost centers are different for trading partners (Papakiriakopoulos & Pramatari, 2010). An early attempt at developing financial measures was made by Du Pont (Walters, 1997). Du Pont is widely acknowledged as being the founder of financial performance measurement (as shown in Figure 3.9), by introducing a pyramid of financial ratios as early as 1903. Thereafter, in the late 1970s and 1980s, numerous authors expressed a general dissatisfaction with traditional backward looking or lag accounting based performance measurement systems (Pitt & Tucker, 2008).

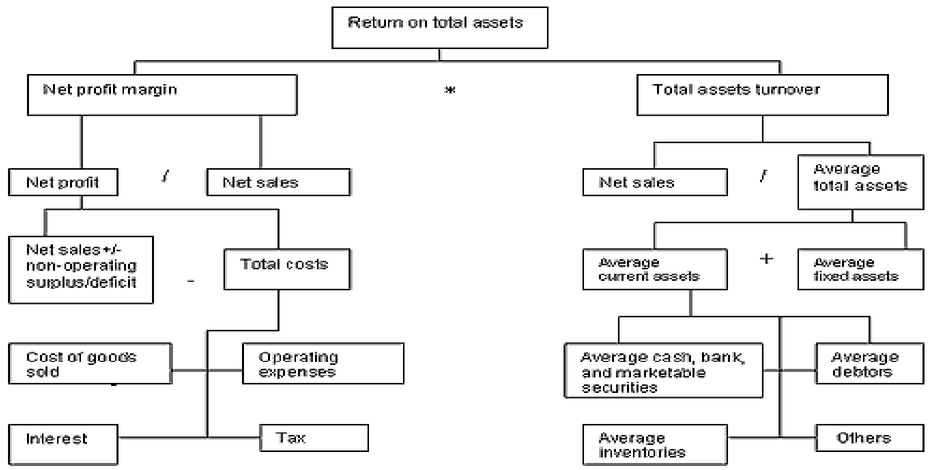



**Figure 3.9: Duo Pont Analysis**

Performance of the firm is mainly measured by financial data, such as the financial ratios. Financial data is useful in providing the measurement of a firm's performance via the market's valuation of the firm's securities. Since the future cash flows of the business entity cannot be estimated with accuracy, measures of financial performance are typically based on accounting data, such as, return on investment [ROI], or, return on assets [ROA]. (Jahera & Lloyd 1992) observed that ROI was a valid performance measure for midsize firms. Moreover, the validity of ROI, as a performance measure, has been challenged (Tobin & Brainard, 1968). A firm's financial leverage can affect its ROI to such an extent that it causes comparisons between firms meaningless (Tan, Kannan, Handfied, & Ghosh, 1999). It is also imperative that firms reporting the highest levels of financial and operational performance emphasize not only on the internal quality initiatives, but also to the management of all elements of their supply chain including customers and suppliers, and the quality of delivered products. Some of the financial indicators identified include: sales, ROA, market share, gross profit (Tan, Kannan, Handfied, & Ghosh, 1999). According to some, financial performance reflects on organization's profitability and return on investment as compared to its competition (Green Jr, Whitten, & Inman, 2008) argue that non-financial performance such as improved quality, innovation and resource planning should actually reduce costs, and thus, have a positive effect on measures of financial performance. The growth of market share and sales growth should impact financial performance through improved revenue numbers (Green Jr, Whitten, & In, 2008). Quality measures help organizations to retain current customers and create greater customer loyalty, which in turn may increase market share and organizational performance (Rust et al., 1994, (Koh, Demirbag, Bayraktar, Tatoglu, & Zaim, 2007).

The supplier-to-customer systems approach taken by P&G, Bridgestone/Firestone (Lampe & Gray, 1998); Pepsi (Bechtel & Jayaram, 1997); Hewlett-Packard (Davis, 1993); and others is based on the 'Seven Rs' of traditional logistics – 'having the Right product, to the Right customer, at the Right place, at the Right time, in the Right condition, in the Right quantity, at the Right cost are essential to market and financial performance' (Tracey, Lim, & Vonderembse, 2005). Anderson et al., (1994) found that marketing performance, as measured by customer satisfaction, positively impacts financial performance, as measured by return on investment.

Any supply chain initiative that results in an improvement of some aspect of supply chain performance must ultimately get translated in to improved business performance. In the final analysis, each firm is primarily interested in improving return on assets (ROA) (Shah, 2009). (LaLonde, 2000), argued that the supply chain management community needed to address an important disconnect between supply chain decisions and financial investment outcomes. Whilst the importance of supply chain management is understood, its influence on organizational financial performance is less explicit (Frohlich & Westbrook, 2001). The financial performance, measured by the retailers, helps the managers to make assumptions about current versus future cash flows. Financial ratios give the retailers an idea about how their assets are being utilized, how the inventory is stocked versus sold. By collecting information on a monthly, quarterly and annual basis, retailers can use the financial data to make decisions, both long term and short term, based on trend analysis for planning the forecast of future sales. The key financial ratios for retailers focus on aspects of income, liquidity and profitability.

From the income point of view, retail managers consider gross margin as an indication of sales remaining after subtracting the cost of purchasing merchandize. It is an indication of converting the existing inventory into future cash. From the liquidity aspect, cash flow is crucial to understand their ability to pay short-term debts. Likewise, quick ratio and inventory turnover ratio provides an insight of business solvency as it uses the most of liquid cash.  Cost of goods sold [COGS] gives an idea as to how fast the inventory is being sold at current sales. Yet any other indicator of high importance is, average collection period, which tells managers as to how quickly they are able to collect the outstanding debts.

The profitability ratios, like ROA allows retail managers to identify how productively and effectively they are using the business assets to grow, and it enables them to make necessary decisions about underperforming assets. The variables used for Financial Performance are given below in the Table 3.15.

**Table 3.15: Variables for Financial Performance**

| Survey Element | Representation* |
|---|---|
| Receivables turnover *(Annual credit sales/Accounts receivables)* | RO9a |
| Average collection period *(Accounts receivables/ (Annual credit sales/365))* | RO9b |
| Inventory turnover (COGS/average inventory) | RO9c |
| Debt Ratio *(Total debt/ Total assets)* | RO9d |
| Debt-to-equity ratio *(Total debt/ total equity)* | RO9e |
| Interest coverage *(EBIT/ Interest charges)* | RO9f |
| Gross profit Margin *((Sales-COGS)/sales))* | RO9g |
| Return on asset (ROA) is a good measure to study the overall impact of the organization's performance | RO10 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

The variables classified in various categories were further validated and tested for identifying KPIs as discussed in chapter 6 and 7.

# 4 Research Method

*"The only source of knowledge is experience"*

*–Albert Einstein*

*Research Method is the framework that gives the blueprint of the study. This chapter discusses the rationale of the study, problem statement, research questions, and objectives of the study, the research design, conceptual model and hypotheses. Also presents the constructs of the model and measurement of these constructs followed by sampling process, method of data collection, and statistical tools used for analysis, and finally research flow diagram in the end.*

## 4.1.Rationale of the Study

Performance measurement is not a new concept. It is often considered in scholarly research. Organizations have always been inquisitive to collect feedback about their performances so they can do better each time. Supply chain performance was initially measured in terms of revenue growth or sales growths, i.e., financial indicators were given more importance. Today, the scenario is different; competition involves not only cost factors but other factors (like service, speed, time, etc.) also contribute to the performance of supply chain. As a result, organizations have to look at both tangible and intangible variables. The challenge with managers is that there are a huge number of performance metrics available, and it difficult to select a few KPIs which are significant for their supply chain.

This study adopted a sector specific approach for classifying the KPIs into different categories. Retail industry at present is becoming organized with the adoption of various formats like supermarkets and hypermarkets. These chains are handling thousands of SKUs (stock keeping units) with a network of partners in a virtually connected environment. Logistics operations like delivery and scheduling of the right product at the right time at the right shelf of the right retail outlet definitely impact consumer purchases, and ultimately sales. Therefore, an effort has been made in this study to identify the KPIs for retail supply chain, and develop a performance model using the identified KPIs.

## 4.2.Problem Statement

Since the development of the balanced scorecard approach to performance measurement, there has been no significant contribution (Sambasivan et. al, 2009). It is challenging for companies to choose KPIs for their supply chains. This thesis completed an exhaustive literature survey to identify the Key performance indicators (KPIs) for retail supply chains, and proposes a performance model, studying the impact of identified KPIs on firm's financial performance in India.

## 4.3.Research Questions

To address the gaps in the existing supply chain relationship literature, some important questions are considered in this research, which are as follows:

- What performance indicators are used for measuring retail supply chain performance?

- What is the relationship of KPIs to the Firm's Financial Performance?

## 4.4. Objectives of the Study

Given these questions, the major objectives of this research are:

- To identify the Key Performance indicators (KPIs) for Retail Supply Chains.
- To develop a performance measurement model for Retail Supply chains in India.

## 4.5. Scope of the Study

The scope of the study is limited to organized retail, and the study was carried out in Delhi [NCR]. The KPIs identified through literature review have been classified into four categories, which are further empirically tested for developing a performance model for retail supply chain.

## 4.6.Research Design

The primary objective of exploratory research is to provide insights into and the comprehension of the problem situation confronting the researcher. Exploratory research is used where a problem needs to be defined more precisely and relevant courses of action are predetermined. In general, exploratory research is characterized by flexibility and versatility with respect to the methods, because formal research protocols and procedures are not employed. The primary data are qualitative in nature, and are analyzed accordingly. Basically the findings of exploratory research are used as inputs for further exploratory or conclusive research.

The basic objective of conclusive research is to test specific hypotheses, and also examine relationships among the identified variables. Conclusive research assists the decision maker in determining, evaluating and selecting the best course of action to be adopted in a given situation.

In this study, the researcher has adopted both types of research designs, i.e., exploratory research followed by conclusive research – a single cross sectional design of descriptive research, where one sample of respondents is drawn from the target population and information is obtained from this sample only once (as shown in figure 3.1). Exploratory research was used during the literature review for development of hypotheses, and in validating and finalizing the variables (KPIs) for the study. The Identified KPIs were further used in the formulation of Research Hypotheses and became a part of the conclusive research.

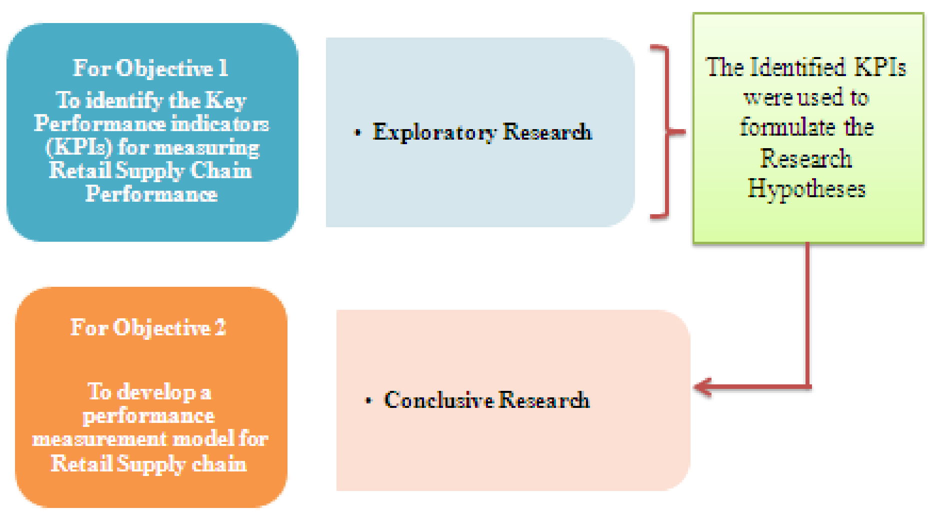



**Figure 4.1: Research Design**

### 4.7. Conceptual Model and Hypotheses

The model building approach focuses on a well-defined research plan, starting with a conceptual model detailing the relationships to be examined

(Hair, Black, Babin, Anderson, &Tatham, 2008). The conceptual model is just a simple representation of the relationships to be studied, where the dependent and independent concepts are defined and supported with the help of literature survey for development of theoretical constructs. Once defined in conceptual terms, the empirical issues of model were addressed and a specific multivariate technique was used to achieve the objective of the research. In this study the data was collected using an instrument (questionnaire), analyzed using statistical procedures to understand the relationship among the variables and the impact of independent, dependent and mediating variables. With an acceptable level of model fit, the nature of multivariate relationships was studied to interpret the output from the sample data.

### 4.7.1. Conceptual Model

Managers began to link functional management areas to lower operating costs. The first linkage was the combination of inventory management and transportation management in the 1960s. This combination was called *physical distribution management*. Significant savings were found by coordinating these functions and using computer-assisted decision making (e.g., vehicle routing and scheduling algorithms, location models, and network analysis). Beginning with the evolution of information technology (IT) in the 1980s, it has become possible to extend the supply management system further to include the final consumer and the firm's suppliers. IT gives the manager the ability to collect, measure, and analyze all the data in the system in a timely, cost-effective, and transparent manner that is available on an equal basis to all its partners in the supply chain. Here, the approach adopted for developing a model has been based on inter-relationship between contextual variables. As the same set of rules does not apply in all situations, certain things are based on circumstances that are again a result of some mediating variables. Contingency theory is based on the same grounds as discussed in the next section.

### 4.7.2. Theoretical Considerations and Research Hypotheses

From a scientific perspective, predictability is a main concern, which occurs not only when researchers identify causal mechanisms that tie action to results, but also when circumstances are described (Christensen & Raynor, 2003). According to contingency theory perspective there is no best way to ensure superior performance. Contingency theory advocates that no universal set of strategic choices applies to every business situation (Ginsberg & Venkatraman, 1985). Organizations tend to adapt activities and processes to the characteristics of the environment. When organizations have resources that match the characteristics of the environment, they perform better, while a mismatch leads to failure and poor performance. Furthermore, it was pointed out that contingency theory can be used for improving the performance of the firm (Hofer, 1975). Thus, typical frameworks in the contingency research tradition would focus on the relationships between the contextual factors and the performance (Schoonhoven, 1981; Ginsberg & Venkatraman, 1985). Empirical evidence addresses that contingency theory is fairly recent in the SCM literature (Ho, Au, & Newton, 2002; Van Donk & Van der Vaart). This study combines Resource based view (RBV) and contingency theory perspectives. The resource based view also suggests that firms extract and create value by optimally utilizing its human and technological resources. Infact resource based view of the firm has been widely used for examining the effects of people, technology and information resources across service delivery systems (Roth & Menor, 2003; Spohrer, Maglio, Bailey, & Gruhl, 2007).

With the increase in product variety, increasing uncertainty in demand and supply, the need to reduce the time to market, shorter and shorter product life cycles are some of the basis for companies to raise the benchmark to compete with better efficiency and value delivery to customers. Industries such as retail sector are recognizing the significant role of supply chain management (Ellram, La Londe, & Weber, 1989; Mentzer, Foggin, & Golicic, 2000; Hill & Scudder, 2002) and the need to effectively manage the flow of materials, money and information across the supply chain (Lee & Billington, 1993; Gavirneni, R, & S, 1999). Retailers face many challenges in the increasingly fierce competition. However, as a result of the power that comes with control over consumer contacts, retailers today have the opportunity to organize the work in their supply chains in suitable ways.

The positive impact of SCM on operational performance can manifest itself in all dimensions. The advances in technology (Sahina & Robinson Jr., 2005) has seen a growing trend for organizations to create external linkages based on the sharing of information (e.g. point of sale data (POS), inventory levels, forecasts, etc.) in order to gain increased visibility of their customers and/or suppliers' operations and activities (Mabert & Venkataramanan, 1998; Shore & Venkatachalam, 2003; Fiala, 2005). The purpose of achieving visibility is primarily for improving their own internal decision making and operating performance (Rungtusanatham, Salvador, Forza, & Choi, 2003; Kulp, Lee, & Ofek, 2004). Visibility in information helps to improve supply chain performance (Rungtusanatham, Salvador, Forza, & Choi, 2003; Kulp, Lee, & Ofek, 2004).

According to (Jones & Towill, 1997), information flow at all levels of the supply chain is critical. And more specifically, the order entry method determines the way and extent to which customer specification are converted into useful information and channelized across the supply chain partners. In previous studies benefits of information sharing has been found mostly from a modeling/simulation perspective (Gavirneni, R, & S, 1999; Chen & Paulraj, 2004).

The important characteristics for information sharing are accurate, trusted, timely, useful and in a readily usable format (Bailey & Pearson, 1983; Gustin, Daugherty, & Stank, 1995; Closs, Goldsby, & Clinton, 1997; Whipple, Frankel, & Daugherty, 2002). Delivery also heavily relies on the quality of information exchanged. For example, once the activities are schedules, continuous monitoring of information derived and supplied takes place (Gunasekran, Patel, & Tirtiroglu, 2001). According to (Bower & Hout, 1988; Christopher, 1992) order cycle time is an important measure for reduction in response time of supply chain and also a source of competitive advantage. Moreover, it also influences directly the customer satisfaction level (Jones & Towill, 1997) by being more responsive to the customer demand and increasing the delivery reliability and consistency of lead time. Due to fluctuations and uncertainty in the supply chain in handling a large amount of SKUs, a reliable and consistent order lead time reduces the redundancies (Schonberger, 1990; Bhagwat & Sharma, 2007). The use of technology and its advances have enforced companies to rearrange the activities of supply chain. The path through which the order travels and spend time in different routes, the non-value adding activities can be identified for elimination.

To necessitate the effective planning it is important to track and trace the products by use of technology (e.g. e-commerce, EDI and internet). The entire planning process of making the final order placement has its impact on cost, quality, speed of delivery and delivery reliability and flexibility (Gunasekarana, Patelb, & McGaughey, 2004). As the product range has increased, the value added per employee i.e. productivity of human resource is an important parameter to be considered (Gunasekaran, Patel, & Tirtiroglu, 2001).

The starting point for any decision of logistics invariably centers on (Drucker, 1962) description of the economy's Dark Continent, which suggested that distribution was one of the last frontiers of business to be discovered. He noted that distribution was viewed as a low status activity by managers yet major cost savings could be achieved by managing this function more effectively. By 1970s and 1980s the supply chain was still viewed as series of disparate functions with materials management dealing with the backend of the supply chain and physical distribution management focusing upon the flow of product from manufacturers to their customers (retailers and wholesalers).

For transport efficiency, the distribution mode, the delivery channel, vehicle scheduling and warehouse location play a significant role and shows tremendous opportunities to improve supply chain performance based on lead-time reduction (Gelders, Mannaert, & Maes, 1994; Bhagwat & Sharma, 2007) and it is determined by on-time delivery/perfect delivery parameter which ultimately influences the customer service level (Stewart, 1995; Sramek, Mentzer, & Stank, 2008). A large number of different types of performance metrics have been used to characterize the various functions of supply chain; production, distribution and inventory systems.

Understanding the meaning of a single metric might be easy, but the meaning of the metrics in combination and their effect on overall company performance is hard to intuitively understand.

One problem is that metrics based on financial accounting systems, and expressed in financial terms, are not easily compared with operational metrics focused on the physical movement of goods and services. Through, literature review numerous variables have been identified for supply chain performance measurement. These identified KPIs have been classified into four major categories i.e., transport optimization, inventory optimization, resource optimization, information technology optimization and resource optimization (KPMG, 2011). This study aims to develop a model for measuring retail supply chain performance and provides a rational framework for conceptualizing the relationship between the contextual factors (information technology, transport, Resource and inventory on financial performance) and structuring the hypotheses as discussed below. The conceptual model based on these inter-relations is shown in Figure 4.2.

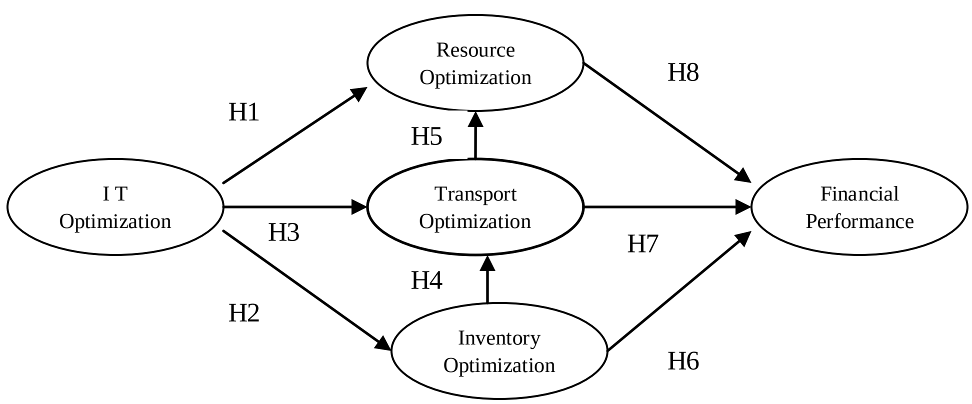



**Figure 4.2: Conceptual Model:** ***Perceived link between Transport Optimization, Inventory Optimization, Information Technology Optimization, Resource Optimization and Financial Performance***

***Research Hypotheses***

**H1:** Information technology will have a positive effect on Resource Optimization

**H2**: Information technology will have a positive effect on Inventory Optimization

**H3:** Information technology will have a positive effect on Transport Optimization

**H4:** Inventory Optimization will have a positive effect on Transport Optimization

**H5:** Transport Optimization will have a positive effect on Resource Optimization

**H6:** Transport Optimization mediates the effect of information technology Optimization and inventory Optimization on financial performance

**H7:** Resource Optimization mediates the effect of information technology on financial performance

**H8:** Inventory Optimization mediates the effect of information technology Optimization on financial performance

## 4.8. Operating Definitions for Theoretical Constructs

The operating definitions for the constructs are given below which have been identified through literature review.

### 4.8.1. Transport Optimization

Transport Optimization here includes the reduced transportation spend, improved service, improved sustainability, increased asset utilization or vehicle optimization, etc. It is simply optimizing daily execution of trucks and routes– the best movement of products while meeting the real world constraints.

### 4.8.2. Information Technology Optimization

Information technology optimization streamlines, simplify information (data/detail) and processes for greater efficiency and effectiveness to create coherence and flow. It helps to organize/prioritize information and makes it more accessible and user friendly. In short, information technology optimization is the production or use of computer systems and networks to collect process and distribute data, information, knowledge and wisdom.

### 4.8.3. Inventory Optimization

Inventory Optimization refers to reduction in inventory levels, enhancement of service levels and supply availability. It also refers to the application of latest techniques and technologies for improving inventory visibility control and management across an extended supply network.

### 4.8.4. Resource Optimization

Resource Optimization is an effective and efficient management of people, processes vehicles, equipments and materials so that utilization is maximized, while business goals are met. Resource optimization minimizes operational costs and deploys assets for maximum effectiveness.

## 4.9.Sampling Design

### 4.9.1. Target Population

The target population for the study includes the organized retail in India [both Indian and Private MNCs operating in India]. The focus is on multi-item retailers.

### 4.9.2. Sampling Frame

The sample frame was constructed primarily to target senior and middle level managers of the top ten retailers of India, which includes, Head-Supply Chain/Operations, Vice Presidents, Business Development-Manager, Chief Merchandizing and Operations manager, SCM managers, logistics managers, store managers, warehouse managers. Such high level managers were targeted in the belief that they are intimately aware of the internal operational workings of their organizations. The retailers included in the study are giant organizations with diversified business models for which a basic criterion of turnover of the company.

### 4.9.3. Sampling Technique

The researcher adopted a Two-Stage Sampling. At first stage the top ten retailers operating in India were identified and at second stage Delhi [NCR] was selected as the geographical region for conducting the survey.

### 4.9.4. Sample Size

According to (Krejcie & Morgan, 1970), the suggested sample size for a population of 10,000 is 370 or 3.7 % of the population. In some of previous studies on apparel manufacturers where a similar data collection method was used, sample sizes ranged from 118 of (Priyadarshi's, 1996) study to 246 of (Lin, Kincade, & Warfield's, 1995) study. Response rates ranges from 32.5% (ZuHone & Morganozky, 1995) to 48% (Kincade, Cassill, & Williamson, 1993). These previous studies reported that intensive follow up contacts with respondents increased the response rates. The final sample size in this study is 120 (as shown in Figure 4.3). As the general norm to conduct factor analysis is to have 5 respondents for each variable (Hair, Black, Babin, Anderson, & Tatham, 2008), it was satisfied in this study. In addition, the sample size necessary to support structural equation modeling as stated by Hair et al., (2006, p. 742), “SEM models containing five or fewer constructs, each with more than three items (observed variables), and with high item communalities (0.6 or higher)can be adequately estimated with samples as small as 100-150”.

The measurement model in this study consists of five constructs, each with three or more observed items, all of which exhibit communalities greater than 0.60. The sample size of 120 is also considered adequate to support the structural equation analysis (Hair, Black, Babin, Anderson, & Tatham, 2008).

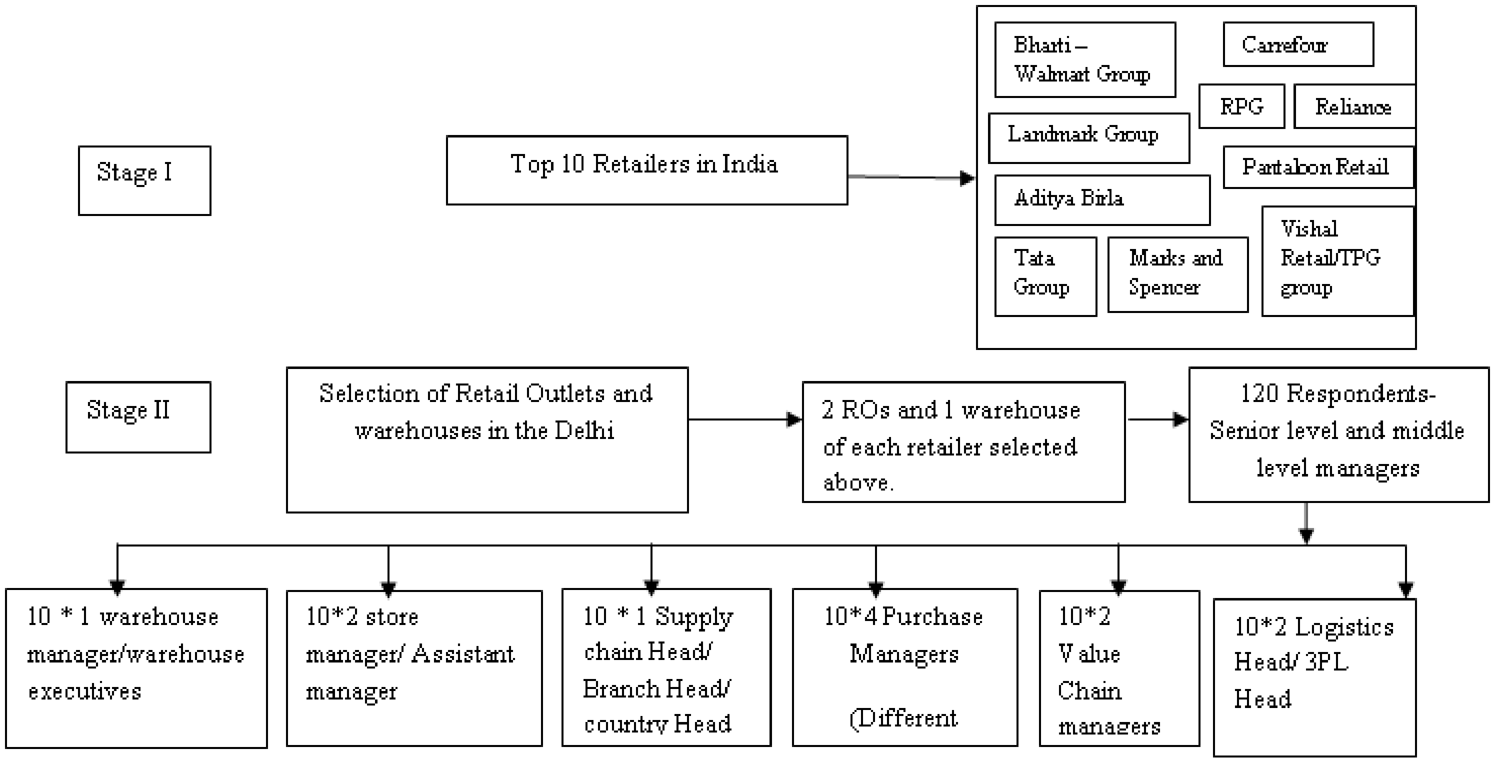



**Figure 4.3: Two-Stage Sampling Approach**

## 4.10. Instrument Design

Questionnaire was used as an instrument to collect data from the respondents. It was designed specifically, keeping in mind the information needed. The questionnaire consisted of structured questions, which were developed on a five point Likert scale. The specific details of the instrument, scale formulation, questionnaire format, data collection, validity and reliability test are given in the subsequent sections.

### 4.10.1. Instrument for Data Collection

The instrument used was a structured – undisguised questionnaire that, prespecify the set of response alternatives and the response format. As many companies do not wish to reveal the information concerning performance, method of investigation therefore included asking the respondents the degree of agreement or disagreement for each indicator on a five point Likert scale [1= “strongly disagree, 5= “strongly agree]. The questionnaire was divided in four parts; 10 questions for Transport Optimization, 8 questions for Information Technology Optimization, 16 questions for inventory optimization and 22 questions for resource optimization out of which 8 questions on financial indicators were included in the construct for financial performance.

***Information sought:*** The list of variables found from literature survey was presented to the respondents in the form of questions (statements). The respondents were asked to select an option (based on a five point Likert scale) for a particular variable to the degree of agreement or disagreement depending upon its significance in retail supply chain.

***Method of administration:*** The responses were collected via personal contact or through email. Specifically, the top management was contacted personally to discuss the questionnaire. A number of responses were also collected via mail (the questionnaire was designed on Google docs). An intense follow up was done in order to get the questionnaires filled online. Some of the responses like from the store managers/warehouse were collected through personal visits to the retail outlets/warehouses.

### 4.10.2. Scale Formulation

In this research, the Likert scale was used; it is an ordinal scale, which contained a set of adjectives ordered from least to most of a particular attribute (Nunnally & Bernstein, 1994). The adjectives used in this study were strongly disagree, disagree, undecided, agree and strongly agree [1 for strongly disagree and 5 for strongly agree].

## 4.11. Instrument Reliability

Reliability is one of the basic criterion by which a particular measurement can be accepted in research. Reliability is the ratio of true variance to the total variance yielded by the measuring instrument. It indicates stability and also the internal consistency of a test. The total variance includes true and error variances

Thus: $V_t = V + V_e$

Where $V_t$ = total variance,

$V$ = true variance, and

$V_e$ = error variance

If there were no errors of measurement, then

$$V_t = V$$

Reliability is related to the variable error of measurement, it refers to the extent to which measurement results are free from variable or experimental error and the responses obtained for the questions are consistent in nature. If the measures obtained from a measuring instrument are true measures of the property measured, then the measuring instrument is said to be reliable. Several types of reliabilities are inter-observer reliability, test-rested reliability, parallel-forms reliability and internal consistency reliability. Out of which internal reliability is one of the most frequent used reliability in research studies as discussed below.

### 4.11.1. Internal Consistency Reliability

Reliability is also associated with internal consistency, whether the same characteristic has been measured by different questions. The different items of the instrument are administered to check whether the results are consistent, i.e. they measure the same construct. There are several ways to test the internal consistency and one way that is used in this study is Cronbach alpha.

Cronbach alpha is a reliability coefficient that reflects how well the items in a set are positively correlated to one another. Cronbach alpha is computed in terms of the average inter-correlations among the items measuring the concept. The closer Cronbach alpha is to 1, the higher the internal consistency reliability (Kerlinger, 1986). The size of alpha is determined by both the number of items in the scale and the mean inter-item correlations. Also, (George & Mallery, 2003) provide the following rules of thumb: "$\alpha > .9$ – Excellent, $\alpha > .8$ – Good, $\alpha > .7$ – Acceptable, $\alpha > .6$ – Questionable, $\alpha > .5$ – Poor, and $\alpha < .5$ – Unacceptable". For the entire set of 56 questions the value of Cronbach alpha was 0.926 (Table 4.1) which was a good measure for that assesses the consistency of entire scale (Hair, Money, Samouel, & Page, 2007).

**Table 4.1: Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .926 | 56 |

In the final data set the communalities for the variables were significant (values above 0.4) and, the Cronbach alpha values for the variables were well above the cut-off of (0.6) (Cronbach, 1951; Nunnally, 1978). The details are given in Appendix II. Also the reliability was tested for each section of the questionnaire, which was divided in to four main parts as shown in the subsequent sections.

### 4.11.2. Transport Optimization

**Table 4.2: Reliability Statistics for TO**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .616 | .650 | 10 |

**Table 4.3: Item Statistics for TO**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| TO1 | 4.70 | .460 | 120 |
| TO2 | 4.33 | .760 | 120 |
| TO3 | 4.48 | .648 | 120 |
| TO4 | 4.48 | .756 | 120 |
| TO5 | 4.47 | .607 | 120 |
| TO6 | 3.93 | .923 | 120 |
| TO7 | 4.44 | .605 | 120 |
| TO8 | 4.31 | .754 | 120 |
| TO9 | 3.70 | .984 | 120 |
| TO10 | 3.81 | .910 | 120 |

**Table 4.4: Inter-Item Correlation Matrix for TO**

| | TO1 | TO2 | TO3 | TO4 | TO5 | TO6 | TO7 | TO8 | TO9 | TO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| TO1 | 1.000 | .288 | .096 | .099 | .415 | .150 | .148 | .099 | -.015 | -.018 |
| TO2 | .288 | 1.000 | .199 | .146 | .170 | .188 | .189 | .054 | .045 | -.016 |
| TO3 | .096 | .199 | 1.000 | .111 | .276 | .181 | .201 | .260 | .005 | .173 |
| TO4 | .099 | .146 | .111 | 1.000 | .337 | .311 | .217 | .301 | -.033 | -.001 |
| TO5 | .415 | .170 | .276 | .337 | 1.000 | .176 | .281 | .289 | -.017 | -.019 |
| TO6 | .150 | .188 | .181 | .311 | .176 | 1.000 | .324 | .308 | .191 | .005 |
| TO7 | .148 | .189 | .201 | .217 | .281 | .324 | 1.000 | .399 | .154 | .048 |
| TO8 | .099 | .054 | .260 | .301 | .289 | .308 | .399 | 1.000 | .114 | .160 |
| TO9 | -.015 | .045 | .005 | -.033 | -.017 | .191 | .154 | .114 | 1.000 | .057 |
| TO10 | -.018 | -.016 | .173 | -.001 | -.019 | .005 | .048 | .160 | .057 | 1.000 |

## 4.11.3. Information Technology Optimization

**Table 4.5: Reliability Statistics for ITO**

| Cronbach Alpha | Cronbach Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .768 | .778 | 8 |

**Table 4.6: Item Statistics for ITO**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| ITO1 | 4.67 | .570 | 120 |
| ITO2 | 4.34 | .739 | 120 |
| ITO3 | 4.61 | .652 | 120 |
| ITO4 | 4.52 | .565 | 120 |
| ITO5 | 4.15 | .785 | 120 |
| ITO6 | 4.27 | .796 | 120 |
| ITO7 | 4.52 | .550 | 120 |
| ITO8 | 4.18 | .830 | 120 |

**Table 4.7: Inter-Item Correlation Matrix for ITO**

| | ITO1 | ITO2 | ITO3 | ITO4 | ITO5 | ITO6 | ITO7 | ITO8 |
|---|---|---|---|---|---|---|---|---|
| ITO1 | 1.000 | .233 | .301 | .304 | .301 | .327 | .313 | .414 |
| ITO2 | .233 | 1.000 | .228 | .218 | .317 | .287 | .203 | .089 |
| ITO3 | .301 | .228 | 1.000 | .235 | .116 | .284 | .265 | .289 |
| ITO4 | .304 | .218 | .235 | 1.000 | .241 | .420 | .459 | .424 |
| ITO5 | .301 | .317 | .116 | .241 | 1.000 | .460 | .247 | .215 |
| ITO6 | .327 | .287 | .284 | .420 | .460 | 1.000 | .546 | .332 |
| ITO7 | .313 | .203 | .265 | .459 | .247 | .546 | 1.000 | .454 |
| ITO8 | .414 | .089 | .289 | .424 | .215 | .332 | .454 | 1.000 |

### 4.11.4. Inventory Optimization

**Table 4.8: Reliability Statistics for IO**

| Cronbach Alpha | Cronbach Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .827 | .830 | 16 |

**Table 4.9: Item Statistics for IO**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| IO1 | 4.39 | .725 | 120 |
| IO2 | 4.43 | .706 | 120 |
| IO3 | 4.28 | .822 | 120 |
| IO4 | 4.15 | .866 | 120 |
| IO5 | 4.39 | .714 | 120 |
| IO6 | 4.23 | .730 | 120 |
| IO7 | 4.03 | .874 | 120 |
| IO8 | 4.38 | .636 | 120 |
| IO9 | 4.27 | .764 | 120 |
| IO10 | 4.43 | .707 | 120 |
| IO11 | 4.24 | .917 | 120 |
| IO12 | 4.07 | .775 | 120 |
| IO13 | 4.33 | .737 | 120 |
| IO14 | 3.99 | .761 | 120 |
| IO15 | 4.11 | .776 | 120 |
| IO16 | 4.48 | .621 | 120 |

Inter-Item Correlation Matrix for Inventory Optimization is given in Appendix III.

### 4.11.5. Resource Optimization

**Table 4.10: Reliability Statistics for RO**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .859 | .863 | 22 |

**Table 4.11: Item Statistics for RO**

| | Mean | Std. Deviation | N |
|---|---|---|---|
| RO1a | 4.18 | .673 | 120 |
| RO1b | 4.26 | .874 | 120 |
| RO1c | 4.63 | .533 | 120 |

| | | | |
|---|---|---|---|
| RO1d | 4.23 | .667 | 120 |
| RO1e | 3.78 | .852 | 120 |
| RO2 | 4.50 | .648 | 120 |
| RO3 | 4.71 | .525 | 120 |
| RO4 | 4.38 | .651 | 120 |
| RO5 | 4.58 | .657 | 120 |
| RO6 | 4.29 | .771 | 120 |
| RO7 | 3.90 | .834 | 120 |
| RO8 | 3.97 | .819 | 120 |
| RO9a | 4.22 | .735 | 120 |
| RO9b | 4.26 | .655 | 120 |
| RO9c | 4.45 | .606 | 120 |
| RO9d | 4.20 | .705 | 120 |
| RO9e | 4.12 | .758 | 120 |
| RO1f | 4.33 | .599 | 120 |
| RO1g | 4.28 | .568 | 120 |
| RO9f | 4.30 | .763 | 120 |
| RO9g | 4.44 | .671 | 120 |
| RO10 | 4.30 | .729 | 120 |

Inter-Item Correlation Matrix for Resource Optimization is given in Appendix IV.

### 4.12. Pilot testing

The questionnaire was pretested with 25 industry professionals, including the business heads, supply chain managers, warehouse managers to name a few. The questionnaire was also discussed with the academic experts in supply chain. A couple of unclear questions were refined, more clarity in sentences was made, re-ordering of some questions was done, some questions with same meaning were deleted, and few relevant things were added. The feedback was indeed a great help in making the questionnaire more concise and specific for the desired objective.

#### 4.12.1. Questionnaire Format

The questionnaire has a total of 56 questions divided into four main sections as per the division into four categories i.e., transport optimization, inventory optimization, information technology optimization and resource optimization, as shown in table 4.12. All the questions are developed on a five point likert scale [“1” as strongly disagree to “5” as strongly agree]. The respondents can respond to the degree of agreement or disagreement. The data was easily fed into the SPSS software for further analysis (factor analysis, IBM SPSS 20 and Structural Equation Modeling using SMART PLS 2.0.

**Table 4.12: Breakup of variables in the questionnaire**

| S. No. | Variable | Number of questions | Questions number |
|---|---|---|---|
| 1. | Transport Optimization | 10 | 1-10 |
| 2. | Information Technology Optimization | 8 | 11-18 |
| 3. | Inventory Optimization | 16 | 19-34 |
| 4. | Resource Optimization (Supply chain cost efficiency measures) | 7 | 35-41 |
| 5. | Resource Optimization | 7 | 42-48 |
| 6. | Resource Optimization (Financial ratio measures) | 8 | 49-56 |

### 4.12.2. Methods for Data Collection

Data was collected from secondary and primary sources both. The secondary data was collected from published refereed articles in top management journals like *Journal of Retailing; Benchmarking: An International Journal; Supply Chain Management: An International Journal, International Journal of Retail & Distribution Management; International Journal of Productivity and Performance Management; Journal of Enterprise Information Management; International Journal of Logistics Management;* Facilities; *Journal of Business and Industrial Marketing; International Journal of Operations and Production Management; Decision Support Systems and so on.*

Data collection from primary sources was predominantly conducted through structured interview method using questionnaire that was developed using the variables identified during literature review. Top and middle level management representing the top ten retailers of India were selected from a data base of Retail association of India (RAI) with details of the core and founder retailers of India. These retailers were surveyed using a traditional initial and follow-up mailing procedure. The sample frame was constructed primarily to target relatively the high-level managers such as Head- Supply Chain/Operations, Vice Presidents, Business Development- Manager, Chief Merchandizing and Operations manager, SCM managers. Such high level managers were targeted in the belief that, while they are intimately aware of the internal operational workings of their organizations. They are also well aware of the performance of the supply chain functions such logistics, inventory management. The validity and reliability of the questionnaire was pre-tested after the pilot survey and it was found compliant with the set criterion. The questionnaire was administered to 400 industry professionals who were the senior and middle level managers in their organizations. The questionnaire was administered by personal visits to the Retail corporate offices in NCR to meet the business heads, supply chain managers; visits were made to the retail outlets to interact with store managers and also the visits were made to the warehouses to meet the warehouse managers. While some of the respondents were contacted via email with regular follow up by phone/mail.

## 4.13. Statistical Tools for Data Analysis

In this research two prime objectives of statistical analysis were to identify the key performance indicators for retail supply chain performance and to develop a model using the identified KPIs. Critical Factors were extracted for each category using a principal component factor analysis, employing

Varimax factor rotation with the help of SPSS 20 software. The factors extracted were further used for confirmatory factor analysis. The conceptual Model and Hypotheses were tested by Structural equation modeling (SEM) using AMOS 20 and Smart PLS 2.0 to estimate the model. The explanation is further given in chapter 7. Besides these softwares, Microsoft Office Excel 2007 was used extensively for making graphs, charts, etc.

### 4.14. Instrument Validity

The instrument constructed has to be checked, whether it is valid or not (Nunnally, 1967). Validity is epitomized by the question "are we measuring what we think we are measuring?" This question refers to contents of an instrument and its ability to predict behavior. Validity means that the measurement must be unbiased and free from systematic errors. A scale or a measuring instrument is said to possess validity to the extent to which differences in measured values reflect true differences in the characteristics or property being measured. Two forms of validity mentioned in research literature are internal validity and external validity.

***Internal Validity:*** It refers the extent to which differences found with a measuring tool reflect true differences among those being tested. The widely accepted classification of validity consists of three major forms: content, criterion-related and construct

#### 4.14.1. Content Validity

Content validity is the extent to which the instrument provides adequate coverage of the topic under study. Content validity has been defined as the representativeness of the content of a measuring instrument. If the instrument contains a representative sample of the universe of the subject matter of interest, then content validity is good. In this thesis the KPIs identified for retail supply chain were classified into four categories: transport optimization, information technology optimization, inventory optimization and resource optimization. The pilot study was conducted at initial stage to seek the inputs from 25 industry professionals on the clarity and completeness of the instrument. The positive validation of the questionnaire proved the validity of the instrument used in the research, although this may not be taken as a conclusive proof of validity from the analysis perspective but only a subjective feedback.

#### 4.14.2. Face Validity

Face validity is a basic and the minimum index of content validity. It indicates that the items that are supposed to measure a concept, on the face of it, do look like they are measuring the concepts and whether the instrument looks complete. This questionnaire was given to the industry experts and it was discussed. Their confirmation to the understanding of the questionnaire helped in establishing the face validity of the instrument.

***External Validity:*** This is referred as criterion-related validity. It reflects the success of measures used for some empirical estimating purpose. One may want to predict some outcome or estimate the existence of some current behavior or condition. These cases involve predictive and concurrent validity.

### 4.14.3. Predictive Validity

The instrument qualifies predictive validity criterion if it is able to predict what it ought to predict. In this study, the items undertaken measure common characteristics and are highly correlated with one another. For instance variables, TO4, TO6, TO7, TO8 (temperature control during transportation, usage of GPS/RFID for track and trace, Vehicle optimization, faster turnaround time of vehicles) that in practice support for transport efficiency and effectiveness and they are highly correlated with each other (Table 4.13, Factor 1), (details of factor analysis tests are given in chapter 6 of this thesis). Similarly items that were to measure 'Perfect delivery rate' or 'IT competencies' or 'Warehouse utilization' or Operational cost' are some of the factors shown in Table 4.13, where the correlation factor is high and it clearly proves the instrument predictive validity test– the ability to predict what it ought to predict.

**Table 4.13: Rotated component matrix showing the correlation (loading) of items (variables) on distinct factors**

| Survey elements (variable) | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Temperature control during transportation for perishable commodities is essential for perfect delivery (TO4) | 0.741 | | | | |
| Usage of GPS/RFID technology for track & trace is essential (TO6) | 0.596 | | | | |
| Vehicle optimization is highly significant for logistics operations (TO7) | 0.583 | | | | |
| Faster turnaround time of vehicles at loading and unloading time improves efficiency (TO8) | 0.701 | | | | |
| Percent of on-time deliveries is an important indicator for high service level (TO1) | | 0.786 | | | |
| Damages due to inefficient delivery (pilferage/ delay/ damage in transit) of the product as % of total sales should be minimal are critical for operational excellence. (TO2) | | 0.729 | | | |
| Transport connectivity is important for high | | 0.514 | | | |

| | | | | | |
|---|---|---|---|---|---|
| growth of business (TO5) | | | | | |
| Role of IT in efficient purchasing/inventory management is important (ITO1) | | | 0.573 | | |
| Quality of the input data *(e.g via POS)* helps in demand forecasting and triggering Re-order point (ROP) (ITO3) | | | 0.508 | | |
| Information system should be adaptable and flexible for maximizing benefits (ITO4) | | | 0.688 | | |
| Real time information due to IT usage helps in reducing claims in rupee per month vs monthly turnover (ITO6) | | | 0.560 | | |
| IT helps in easy sharing of real time information with channel partners, which increases the accuracy and reliability of the acquired information (ITO7) | | | 0.736 | | |
| Investment in IT minimizes the data maintenance and transaction cost (ITO8) | | | 0.805 | | |
| Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory (IO6) | | | | 0.548 | |
| Fill rate is an important indicator in retail operations (IO9) | | | | 0.506 | |
| Innovation is a key parameter in Retail Supply Chain *(e.g. automation in warehouse helps to speed up the logistics operations)* (IO10) | | | | 0.702 | |
| Optimum number of warehouses are required for maximizing service level (IO11) | | | | 0.508 | |
| productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency (IO12) | | | | 0.735 | |
| Warehouse space/ layout/ future scalability/ use of MHE are critical for warehouse optimization (IO13) | | | | 0.727 | |
| Electricity consumption (in Kw-hrs) per sqft of warehouse space reflects the energy efficiency, hence optimizes cost (IO15) | | | | 0.582 | |
| Distribution cost and Inventory cost (RO1c) | | | | | 0.530 |
| Information management cost (RO1d) | | | | | 0.669 |
| Warranty cost (RO1e) | | | | | 0.6699 |
| Packaging cost (RO 1f) | | | | | 0.642 |
| Facility management/ maintenance cost (RO 1g) | | | | | 0.696 |

*Note: Extraction Method- Principal Component Analysis*
*Rotation Method- Varimax with Kaiser Normalisation*
*Rotation converged in 16 iterations*

### 4.14.4. Concurrent Validity

The instrument is supposed to qualify the concurrent criterion, if it is able to distinguish between groups that it should theoretically be able to distinguish between as shown in the correlation matrix for different categories. The items that measure the same construct correlate highly with each other and have no correlation with items that measure different construct. In this study it has been seen that the variables in transport optimization correlate with items in the given category, similarly for Information technology optimization all the items are seen to be highly correlated but do not correlate with items in other category, which concludes concurrent validity criterion. There are similarly other pairs of factors showing the same pattern.

### 4.14.5. Convergent Validity

Convergent validity is established when the scores obtained by two different instruments measuring the same concept are highly correlated. For convergent validity, VE should be 0.5 or greater to suggest adequate convergent validity (Hair, Black, Babin, Anderson, & Ronald, 2008). Almost 68% of the variance is explained by these factors (given in Appendix V) and it can be further considered for developing a model. Here, all factors with Eigen values exceeding one were considered which also confirms the convergent validity (Hair, Black, Babin, Anderson, & Ronald, 2008), as shown in Table 4.14 and the variables can be further considered for developing a model.

**Table 4.14: Eigen values**

| Factor | Eigen value |
|---|---|
| F1 | 2.059 |
| F2 | 1.573 |
| F3 | 1.243 |
| F4 | 1.170 |
| F5 | 2.605 |
| F6 | 1.641 |
| F7 | 3.060 |
| F8 | 2.007 |
| F9 | 1.862 |
| F10 | 1.403 |
| F11 | 2.251 |
| F12 | 1.903 |
| F13 | 1.879 |
| F14 | 1.519 |
| F15 | 1.350 |

**Table 4.15: KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .765 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 2356.204 |
| | Df | 1128 |
| | Sig. | .000 |

The KMO output ensures the sampling adequacy and Bartlett test of Sphericity score was significant at 0.05 levels (as shown in Table 4.15), thereby rejecting the null hypothesis that the variables are independent of each other and in a particular category the variables are correlated, which is a necessary condition to proceed with factor analysis.

### 4.14.6. Discriminant Validity

Discriminant validity is established when, based on theory, two variables are predicted to be uncorrelated, and the scores obtained by measuring them are indeed empirically found to be so. In simple words, one can easily distinguish between constructs that are not similar to each other. For, discriminant validity, no cross loadings of factors should take place for Discriminant validity (Hair J. F., Black, Babin, & Anderson, 2010). It was seen that there was no cross loading of factors in the given rotated component matrix (given in Appendix VI). The instrument therefore has cleared both convergent and discriminant validity which proves that the instrument fulfils construct validity criterion. Also the instrument clears both the reliability (cronbach alpha) and validity (construct validity test). The research process is further explained in the flow chart the research process adopted in this study and details of factor analysis are discussed in chapter 6 of this thesis.

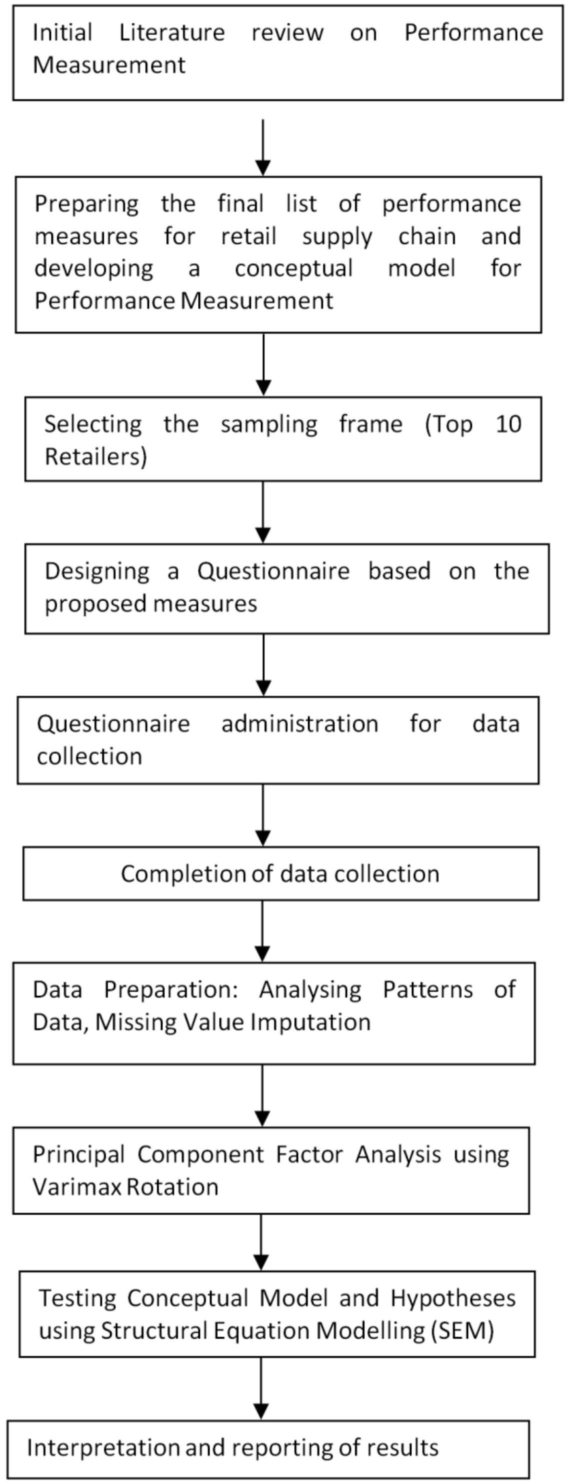



**Figure 4.4: Flow chart of Research Process**

# 5 Data Analysis

*"If I can't picture it, I can't understand it"*

*- Albert Einstein*

*This chapter discusses the sample profile of the respondents and the frequency distribution of the responses. From the frequency analysis, the indicators respondents displayed the most agreement with, are also discussed. Finally, importance ratings are assigned to the categories based on weights obtained through Principal Component Analysis (PCA).*

## 5.1. Sample Profile

The sample profile consists of senior and middle level managers of the top ten retailers in India, including: Heads of Supply Chain/Operations, Vice Presidents, Business Development-Managers, Chief Merchandizing and Operations Managers, SCM Managers, Logistics Managers, Store Managers and Warehouse Managers. Such high level managers were targeted with the belief that they are intimately aware of the internal operational workings of their organizations. It is also believed that they are well aware of the performance of the supply chain functions, such as distribution and warehouse operations, supply allocation, etc.

### 5.1.1. Sample Distribution of Respondents on the Basis of Designation

**Table 5.1: Sample Distribution of Respondents on the Basis of Designation**

| Designation | Total | Percentage |
|---|---|---|
| Heads/VP | 38 | 32 |
| Managers | 57 | 47 |
| Executives | 25 | 21 |
| **Grand Total** | **120** | **100** |

The chart below (Figure 5.1) shows the frequency distribution of the respondents on their job title. As can be noted, managers were the largest group of respondents.

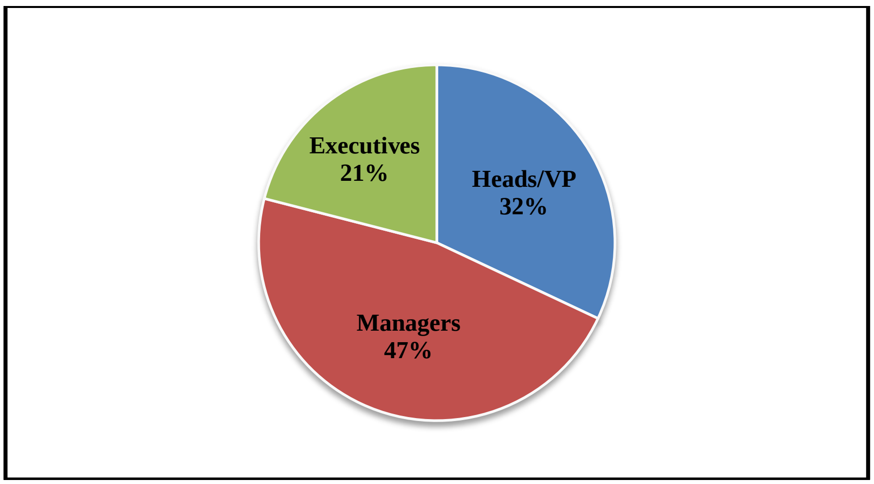



**Figure 5.1: Sample Distribution of Respondents on the Basis of Designation**

### 5.1.2. Sample Distribution of Respondents on the Basis of Age

**Table 5.2: Sample Distribution of Respondents on the Basis of Age**

| Age | Total | Percentage |
|---|---|---|
| 25-35 | 26 | 22 |
| 35-45 | 56 | 46 |
| 45 and above | 38 | 32 |
| **Grand Total** | **120** | **100** |

The chart below (Figure 5.2) shows the frequency distribution of the ages of the respondents. Almost one-half of the respondents were between the ages of 35 and 45.

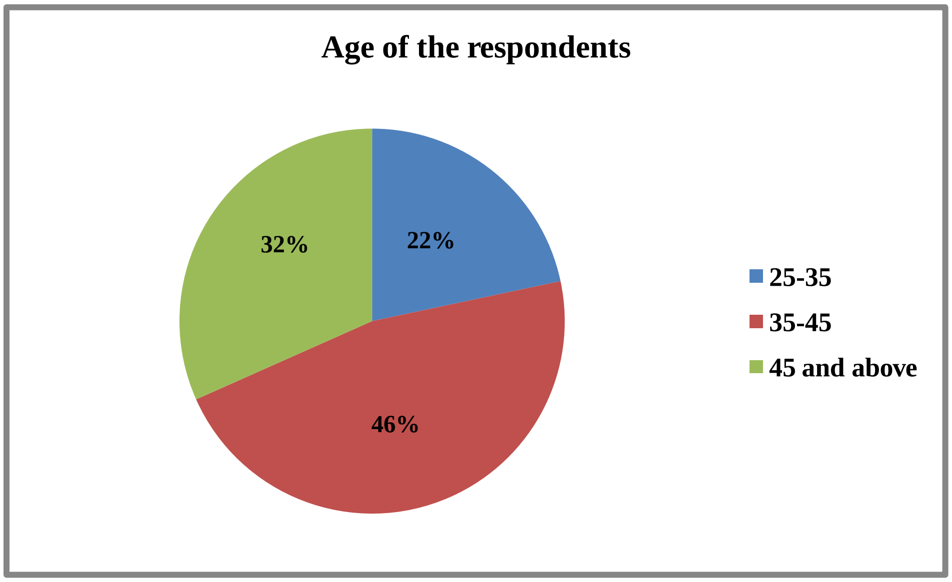



**Figure 5.2: Sample Distribution of Respondents on the Basis of Age**

### 5.1.3. Sample Distribution of Respondents on the Basis of Educational Qualifications

**Table 5.3: Sample Distribution of Respondents on the Basis of Educational Qualifications**

| **Age** | **Total** | **Percentage** |
|---|---|---|
| Graduate | 19 | 16 |
| Post Graduate | 99 | 82 |
| Doctorate | 02 | 02 |
| **Grand Total** | **120** | **100** |

The chart in Figure 5.3 shows the frequency distribution of the Educational Qualification of the respondents. The respondents overwhelmingly indicated they had a post-graduate qualification.

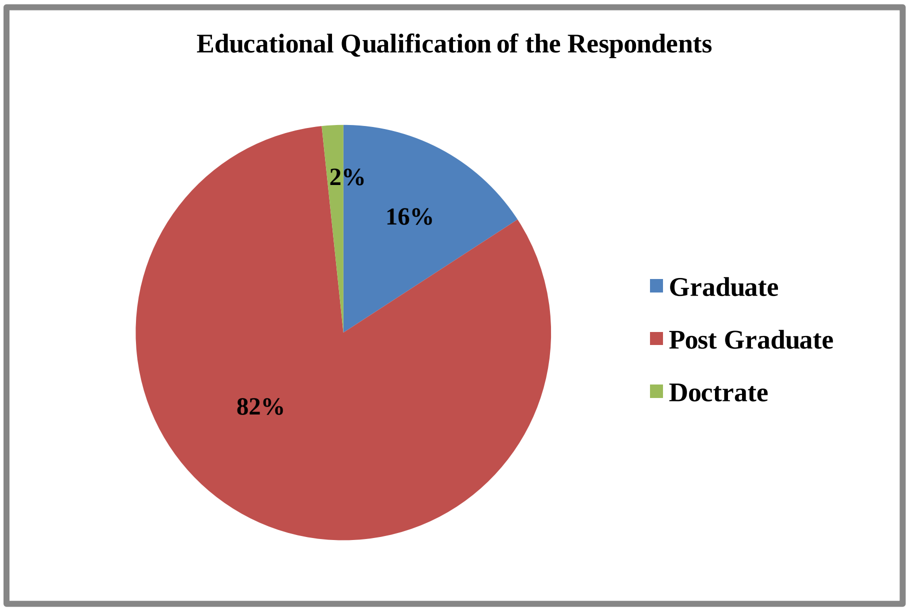



**Figure 5.3: Sample Distribution of Respondents on the Basis of Educational Qualification**

## 5.2. Frequency Distribution

The concepts discussed in Chapter 2 were further surveyed through a structured questionnaire. Responses were collected using a five point likert scale, with 'strongly agree = 5 and strongly disagree = 1'. The final usable sample size was 120. Frequency distributions for the variables in each category are discussed in the subsequent sections of the chapter.

### 5.2.1. Transport Optimization

Transportation is impacted by network optimization, which optimizes daily execution of trucks and routes with the aim of achieving the best movement of products while meeting the real world constraints. Table 5.4 represents the variables taken into consideration for transport optimization for which the frequency chart is shown as in Figure 5.4.

**Table 5.4: Survey Elements for Transport Optimization**

| Survey Elements | Variable |
|---|---|
| Percent of on-time deliveries is an important indicator for high service level | TO1 |
| Damages due to inefficient delivery (pilferage/ delay/ damage in transit) of the product as % of total sales should be minimal are critical for operational excellence. | TO2 |
| Proper documentation is important for delivery of goods on time | TO3 |
| Temperature control during transportation for perishable commodities is essential for perfect delivery | TO4 |
| Transport connectivity is important for high growth of business | TO5 |
| Usage of GPS/RFID technology for track & trace is essential | TO6 |
| Vehicle optimization is highly significant for logistics operations | TO7 |
| Faster turnaround time of vehicles at loading and unloading time improves efficiency | TO8 |
| Owned vehicles are convenient and cost effective for transportation | TO9 |
| Outsourced vehicles are more efficient for transporting goods | TO10 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

The chart shows the extent to which respondents agree that a particular aspect of transport optimization is important. As can be noted, all the variables were rated as very important. That is, the majority of the responses are towards agreement end of the scale (i.e., strongly agree and agree) with very little variance. For example statement TO6, *"Usage of GPS/RFID technology for track and trace is essential"*, 7.5 percent of the respondents disagreed and 0.8 percent strongly disagreed, whereas 18.3%

of the respondents were undecided. This pattern shows two possibilities – either the practice is still nascent in the industry or they have not observed any major contribution from the practice in question.

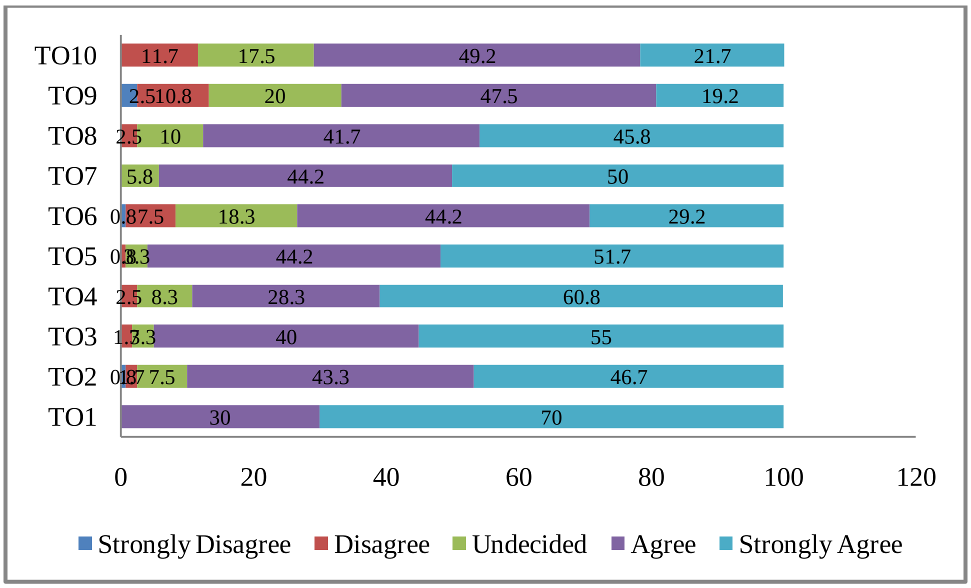



**Figure 5.4: Frequency Chart of Responses for Transport Optimization**

Similarly, for statement TO9, 'O*wned vehicles are convenient and cost effective'*, 10.8% of the respondents disagreed, and 2.5% of the respondents strongly disagreed, whereas 20% of the respondents are undecided. The truck industry in India is highly fragmented with the majority of truck owners having small fleets. Moreover, there is a lack of infrastructure for GPS/RFID implementation in India, and the drivers are not knowledgeably about the use and value of these technologies. Table 5.5 shows the frequency distribution for responses obtained for transport optimization.

**Table 5.5: Frequency Distribution for Transport Optimization**

| | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | *Total* |
|---|---|---|---|---|---|---|
| *TO1* | | | | | | |
| *Frequency* | | | | *36* | *84* | *120* |
| *Percent* | | | | *30* | *70* | *100%* |
| *TO2* | | | | | | |
| *Frequency* | *1* | *2* | *9* | *52* | *56* | *120* |
| *Percent* | *0.8* | *1.7* | *7.5* | *43.3* | *46.7* | *100%* |
| *TO3* | | | | | | |
| *Frequency* | | *2* | *4* | *48* | *66* | *120* |
| *Percent* | | *1.7* | *3.3* | *40* | *55* | *100%* |
| *TO4* | | | | | | |
| *Frequency* | | *3* | *10* | *34* | *73* | *120* |
| *Percent* | | *2.5* | *8.3* | *28.3* | *60.8* | *100%* |
| *TO5* | | | | | | |
| *Frequency* | | *1* | *4* | *53* | *62* | *120* |
| *Percent* | | *0.8* | *3.3* | *44.2* | *51.7* | *100%* |
| *TO6* | | | | | | |
| *Frequency* | *1* | *9* | *22* | *53* | *35* | *120* |
| *Percent* | *0.8* | *7.5* | *18.3* | *44.2* | *29.2* | *100%* |
| *TO7* | | | | | | |
| *Frequency* | | | *7* | *53* | *60* | *120* |
| *Percent* | | | *5.8* | *44.2* | *50* | *100%* |
| *TO8* | | | | | | |
| *Frequency* | | *3* | *12* | *50* | *55* | *120* |
| *Percent* | | *2.5* | *10* | *41.7* | *45.8* | *100%* |
| *TO9* | | | | | | |
| *Frequency* | *3* | *13* | *24* | *57* | *23* | *120* |
| *Percent* | *2.5* | *10.8* | *20* | *47.5* | *19.2* | *100%* |
| *TO10* | | | | | | |
| *Frequency* | | *14* | *21* | *59* | *26* | *120* |
| *Percent* | | *11.7* | *17.5* | *49.2* | *21.7* | *100%* |

The focus of this study is on organized retailers. As a result, most of the responses were favorable. That is primarily because big players prefer to outsource the service from reputed 3PL companies, or they are managing dedicated fleets. Therefore, as can be observed, 44.2 percent of the respondents agree, and 29.2 percent of the respondents strongly agree with that using RFID/GPS technology for track and trace is important.

Furthermore, owning a fleet or outsourcing a fleet is not always easy for the companies. A total of 47.5 percent of the respondents agree and 19.2 percent strongly agree that owning fleets results in convenience and cost effectiveness. In short, respondents believe that owning fleets will help them to be more responsive to the market with shorter lead times. For the other statements the responses ranges between 78-96% towards agreement (agree and strongly agree) end of the scale, as can be seen in Table 5.5.

#### 5.2.1.1.Most Measured Indicators for Transport Optimization

From Figure 5.5, it can be noted that indicator TO1, which measures the percent of on time deliveries, exhibits the highest level of agreement, with 70 percent of the responses strongly agree. It is very clear that physical movement of the goods is the most critical parameter, and today with the cutthroat competition, it is more important to make a tradeoff between cost and service. On time delivery enables the companies to be more responsive to customer demands, and accordingly minimizes chances of stock out. The variable with the second strongest level of agreement is damage free delivery for goods, particularly temperature maintenance based on the nature of the commodity being transported (TO4), with 60.8% strongly agreeing.

Besides achieving a high percentage of on time delivery, it is critical that goods are delivered in the right condition. The variable with the third highest level of agreement is proper documentation required for delivery of goods on time (TO3), with 55 percent responding favorably. It shows how critical the correct documentation is to ensure the timely clearance from a factory gate to toll check, and then to the retailers' DC/RO (Distribution Centre/Retail Outlet).

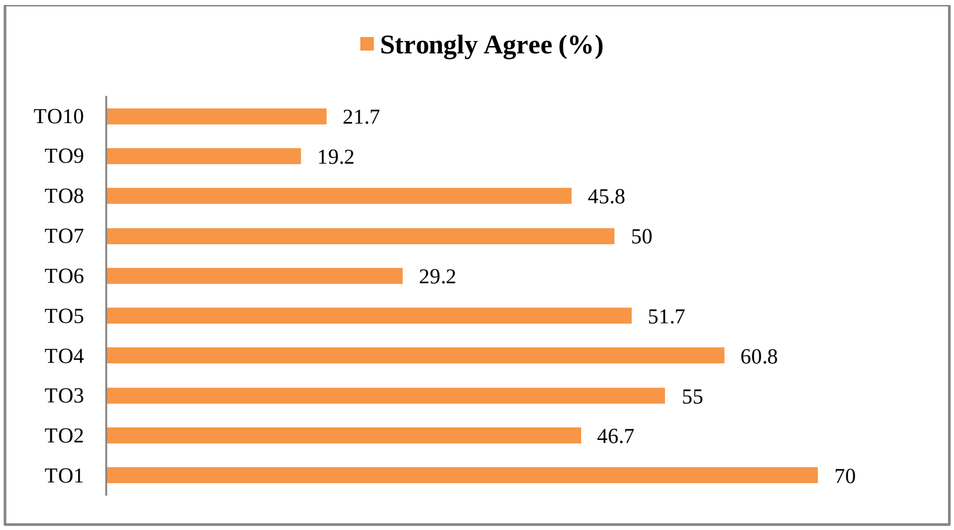



**Figure 5.5: Most Measured Indicators for Transport Optimization**

### 5.2.2. Information Technology Optimization

Information technology optimization helps to streamline/simplify information (data) and processes for greater efficiency and effectiveness to create coherence and flow. In short, information technology optimization is the production or use of computer systems and networks to collect, process, and distribute data, information, knowledge and wisdom. It helps to make the information accessible and user friendly. Table 5.6 represents the variables taken into consideration for information technology optimization. Figure 5.6 shows the responses given by the respondents in the form of a bar chart. It can be observed that in the majority of cases responses are in agreement with the statements representing information technology optimization. There is lesser degree of disagreement for the specified statements which ranges between 0.8-3.3 percent.

**Table 5.6: Survey Elements for Information Technology Optimization**

| Survey elements | Variable |
|---|---|
| Role of IT in efficient purchasing/inventory management is important | ITO1 |
| EDI helps in faster exchange of data between buyer and seller | ITO2 |
| Quality of the input data *(e.g., via POS)* helps in demand forecasting and triggering Re-order point (ROP) | ITO3 |
| Information system should be adaptable and flexible for maximizing benefits. | ITO4 |
| Compliance with latest regulations of information systems is beneficial for overall functioning of organization, hence it is an important indicator for improving SC performance | ITO5 |
| Real time information due to IT usage helps in reducing claims in rupee per month vs. monthly turnover | ITO6 |
| IT helps in easy sharing of real time information with channel partners, which increases the accuracy and reliability of the acquired information | ITO7 |
| Investment in IT minimizes the data maintenance and transaction cost | ITO8 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

For some of the variables, respondents are undecided about the value of using IT. For example statement ITO8, '*Investment in IT minimizes the data maintenance and transaction cost',* 2.5% of the respondents disagreed, and 0.8% of the respondents strongly disagreed, whereas 14.2% of the respondents were undecided.

With the help of IT, data is delivered on time with a lower cost via the Internet, which has facilitated huge transactions in a short period of time at a very low cost of service. Furthermore, 45 percent and 40 percent of the respondents 'Strongly Agree' and 'Agree', respectively, that investment in IT minimizes data maintenance and transaction costs.

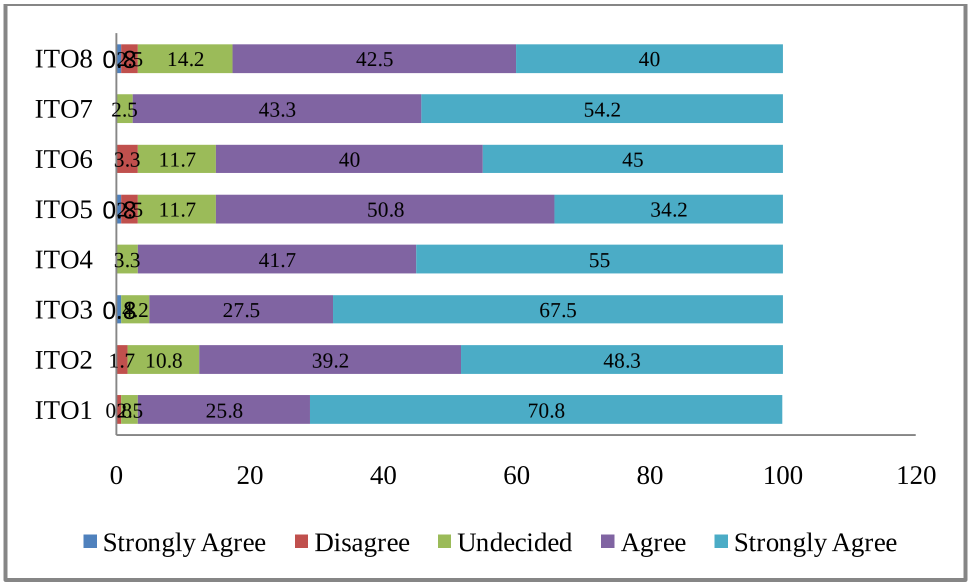



**Figure 5.6: Frequency Chart of Responses for Information Technology Optimization**

Table 5.7 gives the frequency distribution for responses obtained for information technology optimization. The initial investment in acquiring and implementing technology is critical to understand and analyze the benefits of investing in a particular technology. Therefore, the respondents indicate that companies prefer to invest in technologies level/stage wise in order to achieve the benefits and reinvest in the next level of implementation. For example, investing in WMS (warehouse management system), 34.2 percent and 50.8 percent of the respondents strongly agree/agree that compliance with the latest regulations of information systems is beneficial for overall functioning of the organization. It ensures that the data is secured and meets market standards. Real time information helps in reducing claims, with 45 percent and 40 percent of the respondents strongly agree/agree to this statement. In case of any issue with any product, real time information is shared among all the channel partners so as to overcome difficulties as early as possible. Real time information sharing prevents the occurrence of similar problems at other places, and hence claims are reduced and customer problems are resolved earlier.

**Table 5.7: Frequency Distribution for Information Technology Optimization**

| | ***Strongly Disagree*** | ***Disagree*** | ***Undecided*** | ***Agree*** | ***Strongly Agree*** | ***Total*** |
|---|---|---|---|---|---|---|
| ***ITO1*** | | | | | | |
| ***Frequency*** | | ***1*** | ***3*** | ***31*** | ***85*** | ***120*** |
| ***Percent*** | | ***0.8*** | ***2.5*** | ***25.8*** | ***70.8*** | ***100%*** |
| ***ITO2*** | | | | | | |
| ***Frequency*** | | ***2*** | ***13*** | ***47*** | ***58*** | ***120*** |
| ***Percent*** | | ***1.7*** | ***10.8*** | ***39.2*** | ***48.3*** | ***100%*** |
| ***ITO3*** | | | | | | |
| ***Frequency*** | ***1*** | | ***5*** | ***33*** | ***81*** | ***120*** |
| ***Percent*** | ***0.8*** | | ***4.2*** | ***27.5*** | ***67.5*** | ***100%*** |
| ***ITO4*** | | | | | | |
| ***Frequency*** | | | ***4*** | ***50*** | ***66*** | ***120*** |
| ***Percent*** | | | ***3.3*** | ***41.7*** | ***55*** | ***100%*** |
| ***ITO5*** | | | | | | |
| ***Frequency*** | ***1*** | ***3*** | ***14*** | ***61*** | ***41*** | ***120*** |
| ***Percent*** | ***0.8*** | ***2.5*** | ***11.7*** | ***50.8*** | ***34.2*** | ***100%*** |
| ***ITO6*** | | | | | | |
| ***Frequency*** | | ***4*** | ***14*** | ***48*** | ***54*** | ***120*** |
| ***Percent*** | | ***3.3*** | ***11.7*** | ***40*** | ***45*** | ***100%*** |
| ***ITO7*** | | | | | | |
| ***Frequency*** | | | ***3*** | ***52*** | ***65*** | ***120*** |
| ***Percent*** | | | ***2.5*** | ***43.3*** | ***54.2*** | ***100%*** |
| ***ITO8*** | | | | | | |
| ***Frequency*** | ***1*** | ***3*** | ***17*** | ***51*** | ***48*** | ***120*** |
| ***Percent*** | ***0.8*** | ***2.5*** | ***14.2*** | ***42.5*** | ***40*** | ***100%*** |

#### 5.2.2.1. Most Measured Indicators for Information Technology Optimization

The information in Figure 5.7 reveals that indicator ITO1, '*the role of IT in efficient purchasing and inventory management'* is the most important indicator, with 70.8 percent responding favorably. Basically, IT helps to streamline the processes of supply chain from purchases of goods to final delivery. IT helps to track and trace the inventory levels in the system, based on which the stock is replenished. The indicator rated second in terms of agreement is the quality of input data (ITO3; 67.5%), which is critical for effective decision making. It is important to prioritize the information/data that can deliver productive output to the company. The variable rated third highest in agreement is flexibility and adaptability of information systems (ITO4; 55%). It is important that IT systems are user friendly so as to easily train the user, and thereby adapting to its usage quickly.

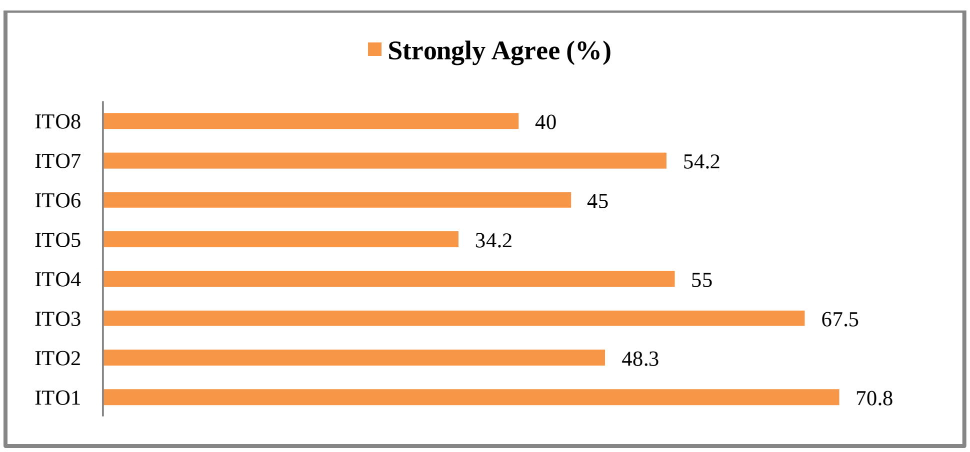



**Figure 5.7: Most Measured Indicators for Information Technology Optimization**

### 5.2.3. Inventory Optimization

Inventory optimization refers to reduction in inventory levels, enhancement of service levels and supply availability to establish the right product mix in distribution channels. It also includes the application of a range of latest technologies for improving inventory visibility, control and management across an extended supply network. The variables taken into consideration for Inventory Optimization are shown in Table 5.8. Similar to previously discussed issues, the responses were primarily in the 'Strongly Agree' and 'Agree' categories, as shown in the Figure 5.8.

For statements like IO11, *'Optimum number of warehouses is required for maximizing service level', 5.8*% of the respondents disagreed, and 1.7% of the respondents strongly disagreed, whereas 5% of the respondents were undecided. It is fundamental for the companies to identify the ideal location of the warehouse so they can facilitate on time, cost efficient delivery. Some warehouse locations serve as hubs and help to cater to a number of retail outlets in a particular region.

It is important to decide the method for inventory valuation. Some of the indicators for which the respondents have neither agreed nor disagreed on this issue by more than 10% are IO4 (18.3 percent), '*FIFO is a better method for inventory valuation'.* But, 41.7 percent strongly agree and 35.8 percent agree with FIFO as a better method for inventory valuation. The percentage of time spent in picking orders/back orders shows the level of operational efficiency. Thus, 31.7 percent strongly agreed and 45.8 percent agreed with this concept, with 16.7 percent undecided. To be efficient detention time/waiting time of the vehicles should be minimized, and it is indeed important to transport operators to save costs and time.

**Table 5.8: Survey Elements for Inventory Optimization**

| **Survey elements** | **Variable** |
|---|---|
| Inventory holding cost as % of gross sales shows an impact on overall efficiency | IO1 |
| Accuracy in forecasting sales reduces obsolete inventory | IO2 |
| Stock-outs should be minimum for better profitability | IO3 |
| FIFO is a better method for inventory valuation | IO4 |
| Inventory accuracy *((book inventory – counted inventory)/ book inventory)* gives an insight in your bookkeeping practices and helps to measure stock cover | IO5 |
| Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory | IO6 |
| % of time spent picking orders/back orders impacts the level of operational efficiency | IO7 |
| Inventory replenishment cycle time helps to plan timely orders | IO8 |
| Fill rate is an important indicator in retail operations | IO9 |
| Innovation is a key parameter in Retail Supply Chain *(e.g. automation in warehouse helps to speed up the logistics operations)* | IO10 |
| Optimum number of warehouses are required for maximizing service level | IO11 |
| productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency | IO12 |
| Warehouse space/layout/future scalability/use of MHE are critical for warehouse optimization | IO13 |
| Certification of the warehouse-ISO certificates/C-TPAT certification/TAPA certification/Accreditation by WRDA India is essential/desirable for compliance with latest regulations | IO14 |
| Electricity consumption (in Kw-hrs) per sq ft of warehouse space reflects the energy efficiency, hence optimizes cost | IO15 |
| Depending on the nature of the goods, the storage facility has to be maintained *(e.g., cold storage* | IO16 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

Certification of warehouses for compliance with the latest regulations is important because it ensures the safety of products and increases the shelf life. Compliance certification not a prominent requirement in India, though it is gaining importance, as indicated by 16.7 percent of the respondents being undecided and 4.2 percent of the respondents disagreeing. But 55 percent and 24.2 percent of the respondents agreed and strongly agreed, respectively.

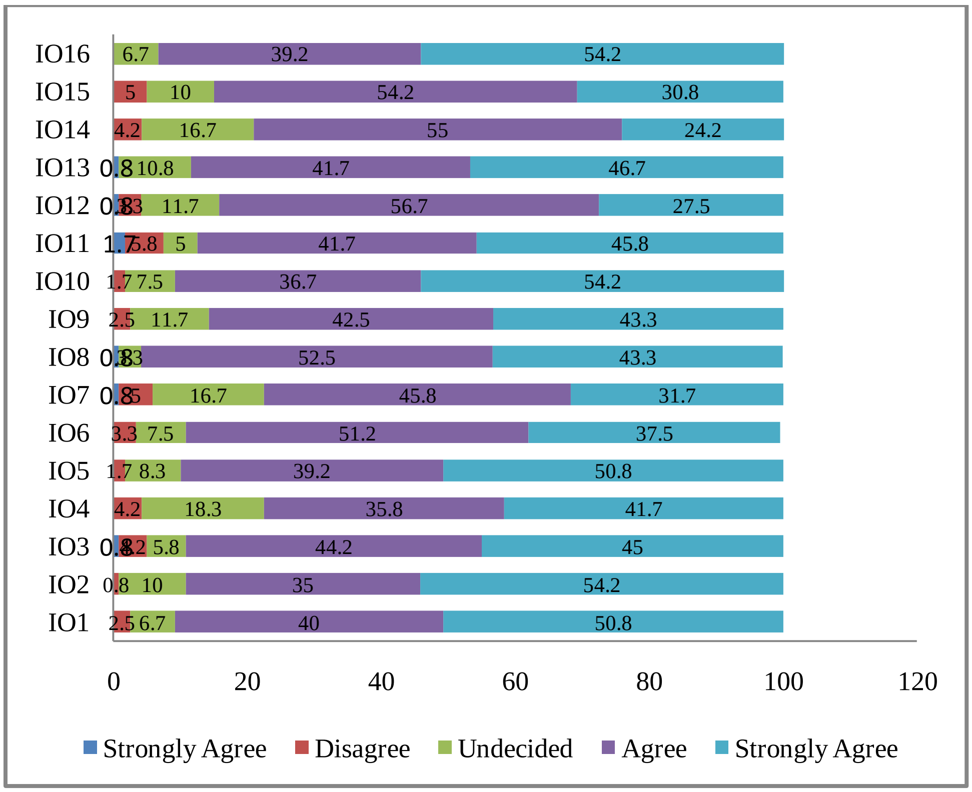



**Figure 5.8: Frequency Chart of Responses for Inventory Optimization**

The Table 5.9 shows the frequency distribution for responses obtained for inventory optimization. Indicators like productivity of MHE (IO12) and electricity consumption per square feet of warehouse are efficiency measures (IO15). Higher productivity of MHE ensures that goods are loaded and unloaded with less effort and time, which improves the overall efficiency. A total of 56.7 percent and 27.5 percent of the respondents agreed and strongly agreed to IO12, with 11.7 percent undecided.

Warehouse management is undoubtedly a cost center, and optimizing the consumption of electricity helps to lower costs and improves efficiency. A total of 55 percent and 24.2 percent of the respondents agreed and strongly agreed with IO15, with 16.7 percent undecided. For most of the statements, however, the degree of agreement lies in the range of 77 to 84%. For example, 77.5% of the respondents agreed to IO4 (35.8 percent agreed and 41.7 percent strongly agreed), and 85.8 % of the respondents agreed to IO9 (42.5 percent agreed and 43.3 percent strongly agreed).

**Table 5.9: Frequency Distribution for Inventory Optimization**

| | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | *Total* |
|---|---|---|---|---|---|---|
| *IO1* | | | | | | |
| *Frequency* | | *3* | *8* | *48* | *61* | *120* |
| *Percent* | | *2.5* | *6.7* | *40* | *50.8* | *100%* |
| *IO2* | | | | | | |
| *Frequency* | | *1* | *12* | *42* | *65* | *120* |
| *Percent* | | *0.8* | *10* | *35* | *54.2* | *100%* |
| *IO3* | | | | | | |
| *Frequency* | *1* | *5* | *7* | *53* | *54* | *120* |
| *Percent* | *0.8* | *4.2* | *5.8* | *44.2* | *45* | *100%* |
| *IO4* | | | | | | |
| *Frequency* | | *5* | *22* | *43* | *50* | *120* |
| *Percent* | | *4.2* | *18.3* | *35.8* | *41.7* | *100%* |
| *IO5* | | | | | | |
| *Frequency* | | *2* | *10* | *47* | *61* | *120* |
| *Percent* | | *1.7* | *8.3* | *39.2* | *50.8* | *100%* |
| *IO6* | | | | | | |
| *Frequency* | | *4* | *9* | *62* | *45* | *120* |
| *Percent* | | *3.3* | *7.5* | *51.2* | *37.5* | *100%* |
| *IO7* | | | | | | |
| *Frequency* | *1* | *6* | *20* | *55* | *38* | *120* |
| *Percent* | *0.8* | *5* | *16.7* | *45.8* | *31.7* | *100%* |
| *IO8* | | | | | | |
| *Frequency* | *1* | | *4* | *63* | *52* | *120* |
| *Percent* | *0.8* | | *3.3* | *52.5* | *43.3* | *100%* |
| *IO9* | | | | | | |
| *Frequency* | | *3* | *14* | *51* | *52* | *120* |
| *Percent* | | *2.5* | *11.7* | *42.5* | *43.3* | *100%* |
| *IO10* | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Frequency*** | | ***2*** | ***9*** | ***44*** | ***65*** | ***120*** |
| ***Percent*** | | ***1.7*** | ***7.5*** | ***36.7*** | ***54.2*** | ***100%*** |
| ***IO11*** | | | | | | |
| ***Frequency*** | ***2*** | ***7*** | ***6*** | ***50*** | ***55*** | ***120*** |
| ***Percent*** | ***1.7*** | ***5.8*** | ***5*** | ***41.7*** | ***45.8*** | ***100%*** |
| ***IO12*** | | | | | | |
| ***Frequency*** | ***1*** | ***4*** | ***14*** | ***68*** | ***33*** | ***120*** |
| ***Percent*** | ***0.8*** | ***3.3*** | ***11.7*** | ***56.7*** | ***27.5*** | ***100%*** |
| ***IO13*** | | | | | | |
| ***Frequency*** | ***1*** | | ***13*** | ***50*** | ***56*** | ***120*** |
| ***Percent*** | ***0.8*** | | ***10.8*** | ***41.7*** | ***46.7*** | ***100%*** |
| ***IO14*** | | | | | | |
| ***Frequency*** | | ***5*** | ***20*** | ***66*** | ***29*** | ***120*** |
| ***Percent*** | | ***4.2*** | ***16.7*** | ***55*** | ***24.2*** | ***100%*** |
| ***IO15*** | | | | | | |
| ***Frequency*** | | ***6*** | ***12*** | ***65*** | ***37*** | ***120*** |
| ***Percent*** | | ***5*** | ***10*** | ***54.2*** | ***30.8*** | ***100%*** |
| ***IO16*** | | | | | | |
| ***Frequency*** | | | ***8*** | ***47*** | ***65*** | ***120*** |
| ***Percent*** | | | ***6.7*** | ***39.2*** | ***54.2*** | ***100%*** |

#### 5.2.3.1. Most measured Indicators for Inventory Optimization

Respondents strongly agreed with three items (IO16, IO10, IO2), as shown in Figure 5.9. The three items were accuracy in forecasting sales, innovation in retail supply chain (e.g., automation in warehouse), and maintenance of storage facilities, depending upon the nature of the product. For these concepts, 54.2 percent strongly agree. It is vital that the storage facility is equipped with the equipment required for storage of goods, depending upon its nature, as well as with the right level of warehouse automation. The aim of this equipment is to easily handle thousands of SKUs and track and trace them in real time.

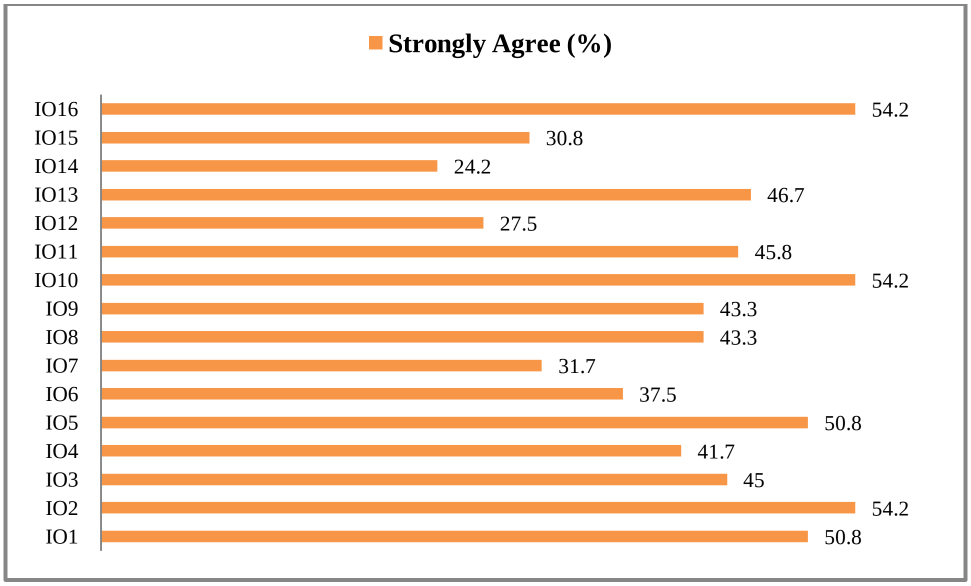



**Figure 5.9: Most Measured Indicators for Inventory Optimization**

### 5.2.4. Resource optimization

Resource optimization is the effective and efficient management of people, processes, vehicles, equipment and materials so that utilization is maximized while business goals are met. Resource optimization aims at minimizing the operational costs, aligning the resources with the corporate goals and increasing the visibility of asset performance management. Table 5.10 shows the variables taken into consideration for Resource Optimization. Invariably the responses have been the same as in other categories, based on the level of agreement to the statements, as shown in Figure 5.10.

**Table 5.10: Survey Elements for Resource Optimization**

| Survey elements | Variable |
|---|---|
| The following cost are important for supply chain efficiency- | |
| Direct labor cost, Direct material cost and Manufacturing overhead | RO1a |
| Cost of goods sold | RO1b |
| Distribution cost and Inventory cost | RO1c |
| Information management cost | RO1d |
| Warranty cost | RO1e |
| Packaging cost | RO1f |
| Facility management/ maintenance cost | RO1g |
| Quality of packaging material used is essential for customer service | RO2 |
| Customer satisfaction is important for the growth of the business/ maximizing profit | RO3 |
| Value added employee productivity helps to measure supply chain efficiency | RO4 |
| Training employees add to their productivity | RO5 |
| Acquiring a new equipment/software/ labour *as and when* business requirement is essential for the supply chain process improvements | RO6 |
| Cargo carried in terms of volumes for fiscal year indicates the benchmark for next year | RO7 |
| Use of renewable/ solar energy/green terminals are the growing need for business efficiency | RO8 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

For example, some of the statements to which the respondents disagreed are COGS and warranty cost for supply chain efficiency. Only 7.5 percent disagreed to COGS and 5.8 percent for warranty cost. However, 46.7 percent and 40 percent of the respondents strongly agree and agree to the importance of COGS, and 21.7 percent and 40.8 percent strongly agree and agree with the importance of warranty cost. COGS is an important component to calculate gross operating profit, but in the opinion of some respondents it might not be of equal importance as compared to other indicators. It may also be true that these costs do not add value to the efficiency of supply chain.

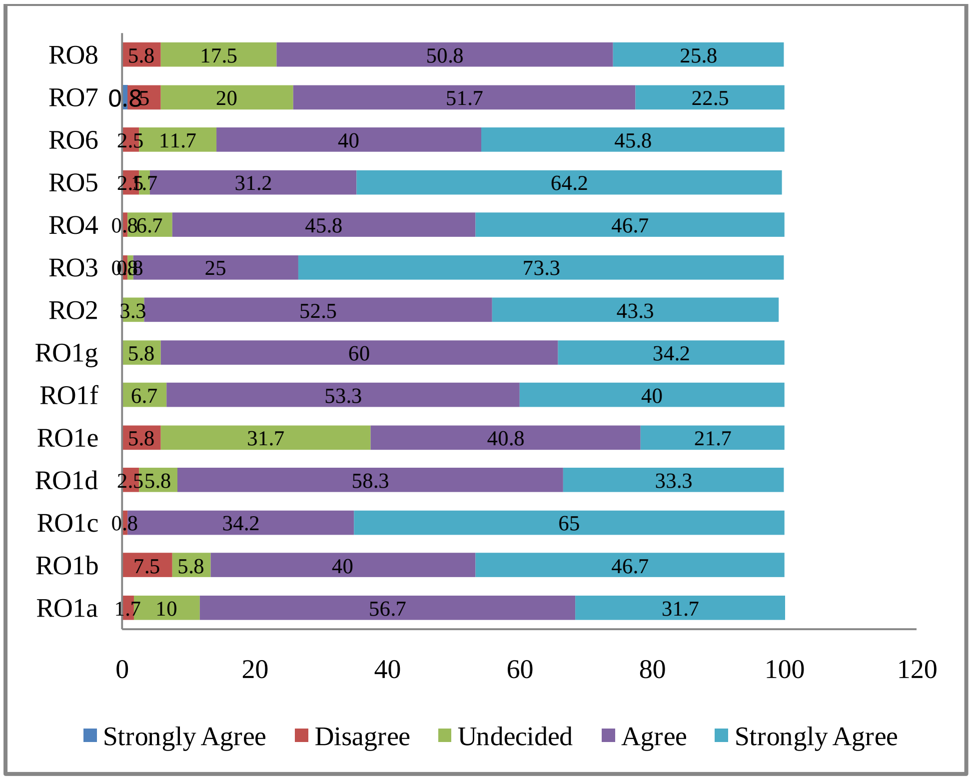



**Figure 5.10: Frequency Chart of Responses for Resource Optimization**

The respondents indicate that companies have not paid attention to the use of renewable sources of energy. But with the growing concern for the environment, and as a part of corporate social responsibility, the companies are opting for greener sources of energy consumption.

Table 5.11 displays the frequency distribution for responses obtained for resource optimization.

**Table 5.11: Frequency Distribution for Resource Optimization**

| | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | *Total* |
|---|---|---|---|---|---|---|
| ***RO1a*** | | | | | | |
| ***Frequency*** | | ***2*** | ***12*** | ***68*** | ***38*** | ***120*** |
| ***Percent*** | | ***1.7*** | ***10*** | ***56.7*** | ***31.7*** | ***100%*** |
| ***RO1b*** | | | | | | |
| ***Frequency*** | | ***9*** | ***7*** | ***48*** | ***56*** | ***120*** |
| ***Percent*** | | ***7.5*** | ***5.8*** | ***40*** | ***46.7*** | ***100%*** |
| ***RO1c*** | | | | | | |
| ***Frequency*** | | ***1*** | | ***41*** | ***78*** | ***120*** |
| ***Percent*** | | ***0.8*** | | ***34.2*** | ***65*** | ***100%*** |
| ***RO1d*** | | | | | | |
| ***Frequency*** | | ***3*** | ***7*** | ***70*** | ***40*** | ***120*** |
| ***Percent*** | | ***2.5*** | ***5.8*** | ***58.3*** | ***33.3*** | ***100%*** |
| ***RO1e*** | | | | | | |
| ***Frequency*** | | ***7*** | ***38*** | ***49*** | ***26*** | ***120*** |
| ***Percent*** | | ***5.8*** | ***31.7*** | ***40.8*** | ***21.7*** | ***100%*** |
| ***RO1f*** | | | | | | |
| ***Frequency*** | | | ***8*** | ***64*** | ***48*** | ***120*** |
| ***Percent*** | | | ***6.7*** | ***53.3*** | ***40*** | ***100%*** |
| ***RO1g*** | | | | | | |
| ***Frequency*** | | | ***7*** | ***72*** | ***41*** | ***120*** |
| ***Percent*** | | | ***5.8*** | ***60*** | ***34.2*** | ***100%*** |
| ***RO2*** | | | | | | |
| ***Frequency*** | | ***2*** | ***4*** | ***46*** | ***68*** | ***120*** |
| ***Percent*** | | | ***3.3*** | ***52.5*** | ***43.3*** | ***100%*** |
| ***RO3*** | | | | | | |
| ***Frequency*** | | ***1*** | ***1*** | ***30*** | ***88*** | ***120*** |
| ***Percent*** | | ***0.8*** | ***0.8*** | ***25*** | ***73.3*** | ***100%*** |
| ***RO4*** | | | | | | |
| ***Frequency*** | | ***1*** | ***8*** | ***55*** | ***56*** | ***120*** |
| ***Percent*** | | ***0.8*** | ***6.7*** | ***45.8*** | ***46.7*** | ***100%*** |
| ***RO5*** | | | | | | |
| ***Frequency*** | | ***3*** | ***2*** | ***38*** | ***77*** | ***120*** |
| ***Percent*** | | ***2.5*** | ***1.7*** | ***31.2*** | ***64.2*** | ***100%*** |
| ***RO6*** | | | | | | |
| ***Frequency*** | | ***3*** | ***14*** | ***48*** | ***55*** | ***120*** |
| ***Percent*** | | ***2.5*** | ***11.7*** | ***40*** | ***45.8*** | ***100%*** |
| ***RO7*** | | | | | | |
| ***Frequency*** | ***1*** | ***6*** | ***24*** | ***62*** | ***27*** | ***120*** |
| ***Percent*** | ***0.8*** | ***5*** | ***20*** | ***51.7*** | ***22.5*** | ***100%*** |
| ***RO8*** | | | | | | |
| ***Frequency*** | | ***7*** | ***21*** | ***61*** | ***31*** | ***120*** |
| ***Percent*** | | ***5.8*** | ***17.5*** | ***50.8*** | ***25.8*** | ***100%*** |

Efficient usage of renewable sources of energy is a new trend. Only 25.8 percent of the respondents strongly agreed with this concept, and 50.8 percent agreed, whereas 17.5 percent of the respondents were undecided and 5.8 percent disagreed. Similarly, few respondents (5 percent) were not in favor of considering the previous year volumes of cargo as a benchmark for the next year, and 20 percent were undecided, 51.7 percent agreed and 22.5 percent strongly agreed. But benchmarking for cargo carried is more meaningful for the managers handling cargo operations and supply scheduling for various locations (e.g. logistics head). Benchmarking is indeed helpful to project future demand, and thus build the capabilities of available resources accordingly. Responses for these statements lie in the range of 74-99%. For example 98.3% of the respondents agreed for RO3 (25 percent agreed and 73.3 percent strongly agreed), and 86.7% of the respondents agreed for RO1b (40 percent agreed and 46.7 percent strongly agreed).

#### 5.2.4.1. Most Measured Indicators for Resource optimization

From Figure 5.11 it can be observed that three indicators for which the respondents have strongly agreed are customer satisfaction (RO4, 73.3 percent), managing distribution and inventory cost (RO1c, 65 percent) and training of employees (RO5, 64.2 percent). Customer satisfaction is undoubtedly the prime consideration because the *'customer is the king'* and companies make endless efforts to retain their customers. Distribution and inventory costs are significant because their impact on the total supply chain cost is clear and they are major cost areas that can be adjusted for maximum benefits. Training of employees is another important aspect that companies invest in with the aim of future growth and development of the business, and also as an integral aspect of customer satisfaction.

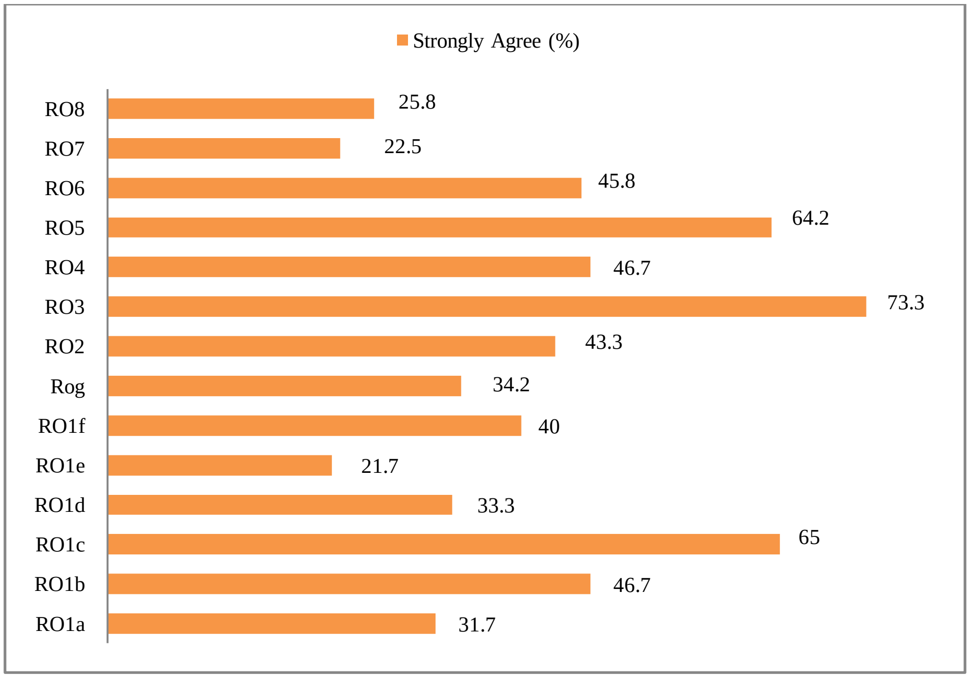



**Figure 5.11: Most Measured Indicators for Resource Optimization**

### 5.2.5. Financial Performance

Financial performance focuses on the organization's profitability and ability to generate returns on investment and sales, as compared to the industry average. The respondents displayed little interest in financial ratios. Instead, they were more attracted toward making more and more profits for the business. Table 5.12 shows the responses obtained for the variables related to financial performance.

**Table 5.12: Survey Elements for Financial Performance**

| Survey Element | Variable |
|---|---|
| The following financial ratios measures the firm's ability to meet its future requirements and also signify the business growth | |
| Receivables turnover *(Annual credit sales/Accounts receivables)* | RO9a |
| Average collection period *(Accounts receivables/ (Annual credit sales/365))* | RO9b |
| Inventory turnover (COGS/average inventory) | RO9c |
| Debt Ratio *(Total debt/ Total assets)* | RO9d |
| Debt-to-equity ratio *(Total debt/ total equity)* | RO9e |
| Interest coverage *(EBIT/ Interest charges)* | RO9f |
| Gross profit Margin *((Sales-COGS)/sales))* | RO9g |
| Return on asset (ROA) is a good measure to study the overall impact of the organization's performance | RO10 |

Representation*: For easy identification of variables, the statements are given a alpha numeric representation

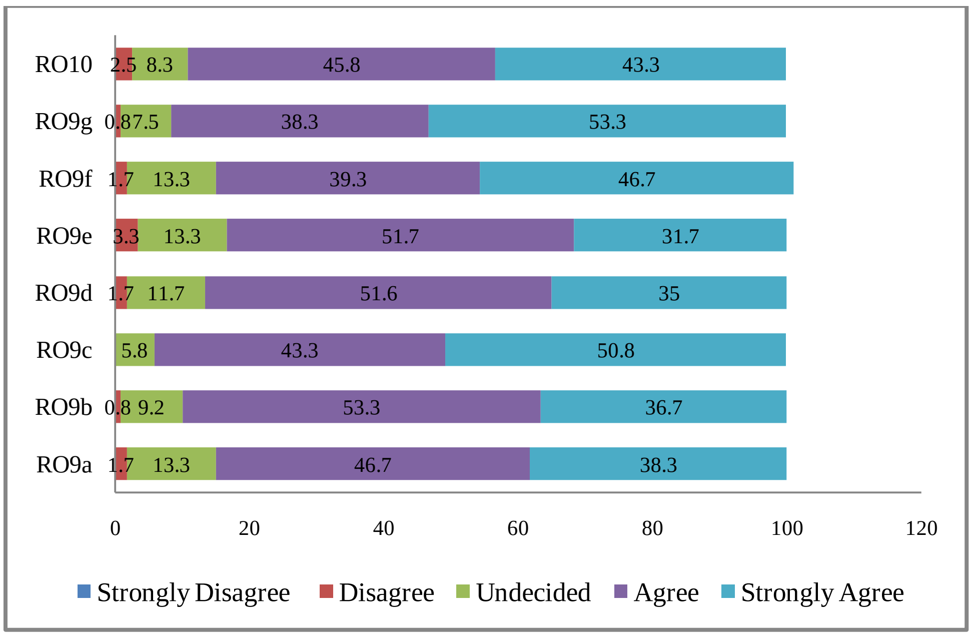



**Figure 5.12: Frequency Chart of Responses for Financial Performance**

**Table 5.13: Frequency Distribution for Financial Performance**

| | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | *Total* |
|---|---|---|---|---|---|---|
| ***RO9a*** | | | | | | |
| ***Frequency*** | | ***2*** | ***16*** | ***56*** | ***46*** | ***120*** |
| ***Percent*** | | ***1.7*** | ***13.3*** | ***46.7*** | ***38.3*** | ***100%*** |
| ***RO9b*** | | | | | | |
| ***Frequency*** | | ***1*** | ***11*** | ***64*** | ***44*** | ***120*** |
| ***Percent*** | | ***0.8*** | ***9.2*** | ***53.3*** | ***36.7*** | ***100%*** |
| ***RO9c*** | | | | | | |
| ***Frequency*** | | | 7 | ***52*** | ***61*** | ***120*** |
| ***Percent*** | | | 5.8 | ***43.3*** | ***50.8*** | ***100%*** |
| ***RO9d*** | | | | | | |
| ***Frequency*** | | ***2*** | ***14*** | ***62*** | ***42*** | ***120*** |
| ***Percent*** | | ***1.7*** | ***11.7*** | ***51.6*** | ***35*** | ***100%*** |
| ***RO9e*** | | | | | | |
| ***Frequency*** | | ***4*** | ***16*** | ***62*** | ***38*** | ***120*** |
| ***Percent*** | | ***3.3*** | ***13.3*** | ***51.7*** | ***31.7*** | ***100%*** |
| ***RO9f*** | | | | | | |
| ***Frequency*** | | 2 | ***16*** | ***46*** | ***56*** | ***120*** |
| ***Percent*** | | 1.7 | ***13.3*** | ***39.3*** | ***46.7*** | ***100%*** |
| ***RO9g*** | | | | | | |
| ***Frequency*** | | 1 | ***9*** | ***46*** | ***64*** | ***120*** |
| ***Percent*** | | 0.8 | ***7.5*** | ***38.3*** | ***53.3*** | ***100%*** |
| ***RO10*** | | | | | | |
| ***Frequency*** | | 3 | ***10*** | ***55*** | ***52*** | ***120*** |
| ***Percent*** | | 2.5 | ***8.3*** | ***45.8*** | ***43.3*** | ***100%*** |

Table 5.13 shows the frequency distribution for responses obtained for Financial Performance. The percentage of disagreement lies in the range of 0.8 - 3.3%, and it is not very large compared to the responses obtained for others variables, wherein there was larger disagreement. Some of the financial indicators for which the respondents were undecided are debt to equity ratio (RO9e, 13.3 percent), interest coverage (RO9f, 13.3 percent) and receivables turnover (RO9a, 13.3 percent). For the same indicators, however, a substantial proportion of the respondents agreed (51.7, 38.3 and 46.7 percent). These indicators are of importance to the company in

terms of managing their assets in right place at right time. To elaborate, firstly, debt to equity ratio signifies the potential of an organization for generating more earnings without outside financing, which is indeed of high importance for expansion plans. Secondly, interest coverage indicates the degree of earnings that will cover the interest payments of the debt undertaken by the company for its business. Thirdly, receivables turnover provides a better picture of business solvency as the company uses the most liquid assets. The responses for these statements range from 83 to 94%. For example, 94% of the respondents agreed to RO9c (43.3 percent agreed and 50.8 percent strongly agreed) and 86.6% of the respondents agreed to RO9d (51.6 percent agreed and 35 percent strongly agreed).

### 5.2.5.1. Most Measured Indicators for Financial Performance

As shown in Figure 5.13, there were three indicators that the respondents strongly agreed to, including gross profit margin (RO9g, 53.3 percent), inventory turnover (RO9c, 50.8 percent) and interest coverage (RO9f, 46.7 percent). These indicators provide insights into how assets are compared to liabilities, or how fast the inventory is being stored versus sold.

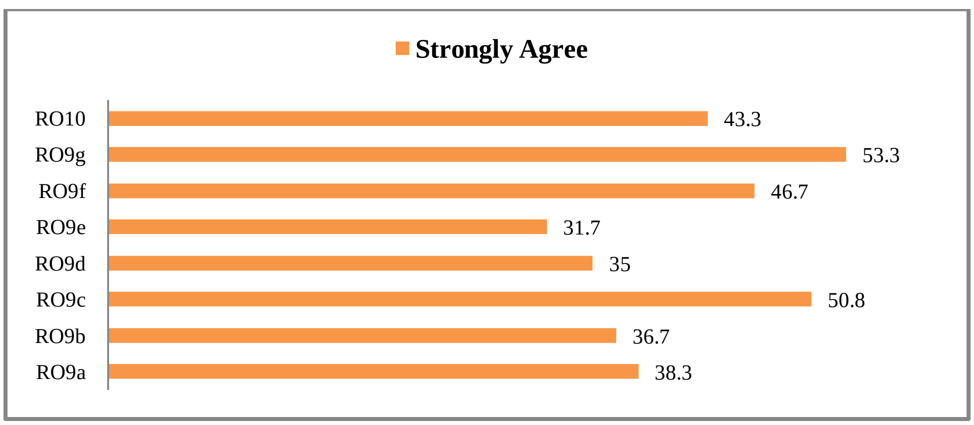



**Figure 5.13: Most Measured Indicators for Financial Performance**

### 5.2.6. Top Three Indicators

The top three indicators rated by respondents in all the categories are summarized in the Table 5.14. The first indicator for each category includes: *percent of on time deliveries* (TOI, 70%), *role of IT in effective purchasing and inventory management* (ITO1, 70.8%), *accuracy in forecasting* (IO2, 54.2%), *customer satisfaction* (RO3, 73.3%), *gross profit margin* (RO9g, 53.3%). The second indicator for each category includes: *temperature control during transportation* (TO4, 60.8%), *quality of input data* (ITO3, 67.5%), *innovation* (54.2%), *distribution and inventory cost* (RO1c, 65%), *inventory turnover* (RO9c, 50.8%). Finally, the third indicator for each category includes: *proper documentation* (TO3, 55%), *adaptability and flexibility of information systems* (ITO4, 55%), *maintenance of storage facility* (IO16, 54.2%), *employee training* (RO5, 64.2%), *interest coverage* (RO9f).

**Table 5.14: Top Three Indicators Rated by the Respondents**

| Category | 1 | 2 | 3 |
|---|---|---|---|
| **Transport Optimization** | Percent of on time deliveries (TO1) | Temperature control during transportation (TO4) | Proper documentation (TO3) |
| **Information Technology Optimization** | Role of IT in effective purchasing and inventory management (ITO1) | Quality of input data (ITO3) | Adaptability and flexibility of information systems (ITO4) |
| **Inventory Optimization** | Accuracy in forecasting (IO2) | Innovation (IO10) | Maintenance of storage facility (IO16) |
| **Resource Optimization** | Customer satisfaction (RO3) | Distribution and inventory cost (RO1c) | Employee training (RO5) |
| **Financial Performance** | Gross profit margin (RO9g) | Inventory turnover (RO9c) | Interest coverage (RO9f) |

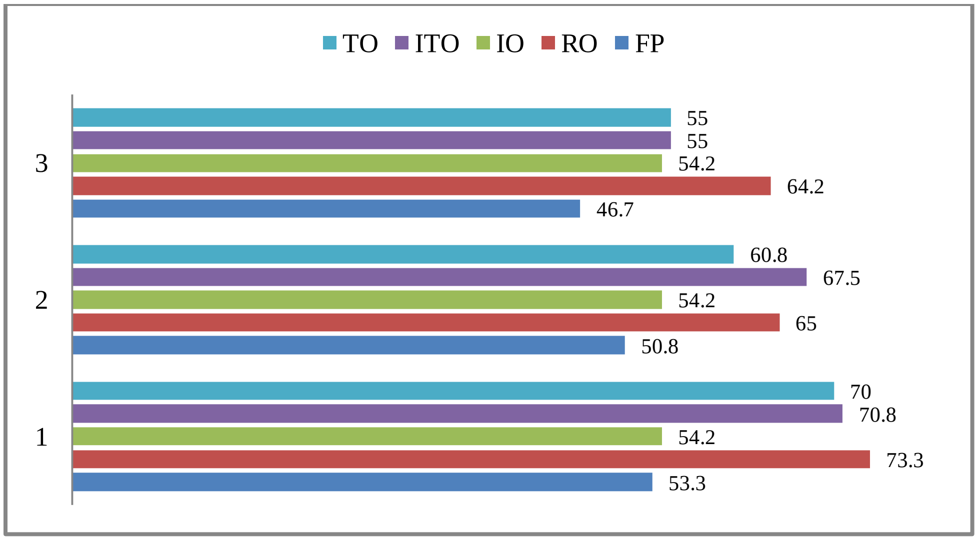



**Figure 5.14: Top Three Indicators Rated by the Respondents**

## 5.3. PCA for Ranking the Categories

It is common to use index numbers to reduce large data sets into a smaller series, in order to make it easier to understand the numbers. Principal component analysis (PCA) is a method for choosing the weights so that y will 'explain' as much of the variance in the group of variables $x_1,\ldots,x_k$ as possible. The weights were chosen using '*Principal Component Analysis'*, a widely used statistical tool.

One way to calculate is to make it a weighted sum of the other k series:

$$y = a_1x_1 + a_2x_2 + \ldots + a_kx_k$$

Where $a_{1,\ldots\ldots,}a_k$ are the weights.

PCA works by examining the variance of each of the k series, and selecting higher weights for those series that vary a lot, so that they influence the weighted sum y relatively more. (The weights $a_{1,\ldots\ldots,}a_k$ are restricted so that the sum of their squared values equals 1; this is necessary for computational reasons.) The graph of y will most strongly reflect the shape of whichever of the k series $x_1,\ldots,x_k$ has the highest variance, and hence the largest weights.

Once the weights are chosen to maximize the explained variance, y is called the *'First Principle Component'* of $x_1,\ldots,x_{k,}$ or PC1. The analysis also produces an estimate of how much of the variance in the x' is explained by the PC1. If the explained variance associated with PC1 is very high, it implies that there is one dominant signal in the k underlying series.

Since y doesn't usually explain everything going on in the underlying data, there is some left-over, unexplained variance associated with each of the k columns. PCA yields a set of k residual vectors, $z_1,\ldots\ldots,z_k$

Thus PCA process can be repeated on the z's, yielding another set of weights and another principal component. In this case it is the PC1 of the z's, it is the "second Principal Component" of the x's, or PC2. PC2 is the summary of the variability left over after the PC1 has explained the dominant variability. The analysis yields an estimate of how much variance in the x's is explained by PC2.

By repeating the process one can similarly compute PC3, PC4, PC5 and so on, at each step obtaining a series that explains progressively less and less of the variance in the x's. Eventually a PC consisting of a column of near-zeroes is obtained, which means there is no variability left to explain.

The steps followed in calculating weights using PCA were:

1. First the correlation structure of the data was checked. If the correlation between the indicators is low then it is unlikely that they share common factors.
2. Extraction of factors: The necessary condition for extraction of factors by PCA were fulfilled i.e.:
   - (i) Factors should have Eigen values greater than 1
   - (ii) Factors should individually contribute to the explanation of more than 10%
   - (iii) Cumulatively factors contribute to the explanation of the overall variance by more than 60%
3. Rotation is a standard step that re-evaluates the factors loadings leaving the variance extracted unchanged, but adjusting the analytical solutions obtained ex-ante and ex-post the rotation. Usually, Varimax rotation is used to minimize the number of sub-indicators that have a high loading on the same factor and only a subset of principal components are retained, which account for the largest amount of the variance.
4. The last step involves the development of the weights from the matrix of factor loadings after rotation, given the square of factor loadings represent the proportion of the total unit variance of the indicator which is explained by the factor (Nicoletti, Scarpetta, & Boylaud, 2000).

The outputs for rotated component matrix and the cumulative score for factors are shown in Appendices VII and VIII. The results for the ranks obtained for different categories are as follows (see Table 5.15):

**Table 5.15: Cumulative Score for the Categories by PCA**

| **TO** | Weight | **ITO** | Weight | **IO** | Weight | **RO** | Weight | **FP** | Weight |
|---|---|---|---|---|---|---|---|---|---|
| **TO1** | 0.0195 | **ITO1** | 0.0189 | **IO1** | 0.0141 | **RO1a** | 0.0194 | **RO9a** | 0.0186 |
| **TO2** | 0.0174 | **ITO2** | 0.0189 | **IO2** | 0.0185 | **RO1b** | 0.0178 | **RO9b** | 0.0181 |
| **TO3** | 0.0187 | **ITO3** | 0.0193 | **IO3** | 0.0192 | **RO1c** | 0.0190 | **RO9c** | 0.0190 |
| **TO4** | 0.0185 | **ITO4** | 0.0161 | **IO4** | 0.0187 | **RO1d** | 0.0198 | **RO9d** | 0.0204 |
| **TO5** | 0.0190 | **ITO5** | 0.0161 | **IO5** | 0.0167 | **RO1e** | 0.0186 | **RO9e** | 0.0194 |
| **TO6** | 0.0197 | **ITO6** | 0.0164 | **IO6** | 0.0162 | **RO2** | 0.0178 | **RO1f** | 0.0148 |
| **TO7** | 0.0162 | **ITO7** | 0.0171 | **IO7** | 0.0174 | **RO3** | 0.0171 | **RO1g** | 0.0148 |
| **TO8** | 0.0161 | **ITO8** | 0.0190 | **IO8** | 0.0174 | **RO4** | 0.0173 | **RO9f** | 0.0195 |
| **TO9** | 0.0185 | | | **IO9** | 0.0184 | **RO5** | 0.0189 | **RO9g** | 0.0196 |
| **TO10** | 0.0179 | | | **IO10** | 0.0183 | **RO6** | 0.0175 | **RO10** | 0.0158 |
| | | | | **IO11** | 0.0171 | **RO7** | 0.0187 | | |
| | | | | **IO12** | 0.0193 | **RO8** | 0.0151 | | |
| | | | | **IO13** | 0.0186 | | | | |
| | | | | **IO14** | 0.0163 | | | | |
| | | | | **IO15** | 0.0163 | | | | |
| | | | | **IO16** | 0.0172 | | | | |
| **CS*** | **0.1815** | | **0.1418** | | **0.2797** | | **0.2170** | | **0.1800** |
| **Rank** | **3** | | **5** | | **1** | | **2** | | **4** |

CS* = Cumulative Score

As can be noted from the table, inventory optimization was assigned the maximum weight of 28% for retail supply chains, which shows that inventory management is one of the most critical functions. Resource optimization received the second highest priority with a 22% weight. This demonstrates how vital it is to efficiently and effectively utilize the resources so as to maximize the productivity. These two items were followed by transport optimization and financial performance, with weights of 18% each. Daily operational efficiency is based on the execution of proper plans, and the impact is seen on the financial performance of the firm in terms of growth in sales or profit margins. Information technology optimization with a weight of 14% is the fifth in importance, which is also a vital link between all supply chain functions. Thus technology is an enabler for streamlining the flow of goods, information and funds in the right direction at the right time. In the next chapter the relationship among these variables will be discussed in more detail.

# 6 Key Performance Indicators for Retail Supply Chain

*"Many things difficult to design prove easy to performance"*

- *Samuel Johnson*

*This chapter discusses missing value analysis and imputation, which was conducted for the purpose of preparing data for factor analysis and SEM. Thereafter results obtained from factor analysis for each category of KPIs are presented i.e. for Transport Optimization, Information Technology Optimization, Inventory Optimization and Resource Optimization.*

## 6.1. Missing Value Analysis and Imputation

As with any research study, obtaining good information is a major challenge. Sometimes respondents provide inconsistent information. In this study120 respondents were interviewed, but some could not respond to the items that were asked in the questionnaire due to unavailability of the information or to the confidentiality of the information.

The Missing Value Analysis procedure performed in this study consisted of first studying the patterns of missing information and the pattern of missing data, which helped to address key data inconsistency information such as: Where are the missing values located? How extensive are they? Do pairs of variables tend to have values missing in multiple cases? Are data values extreme? Are values missing randomly? Once this information is available, Missing Value Imputation (MVI) can be performed for the data using the CART (Classification and Regression tree) Algorithm.

### 6.1.1. Patterns of Missing Value

Before executing the missing data imputation using the CART Algorithm, it is important to understand the background of the patterns of this missing information. For this study the missing value pattern analysis available in IBM SPSS Statistics 20.0 has been used to study different statistics of missing information in the data.

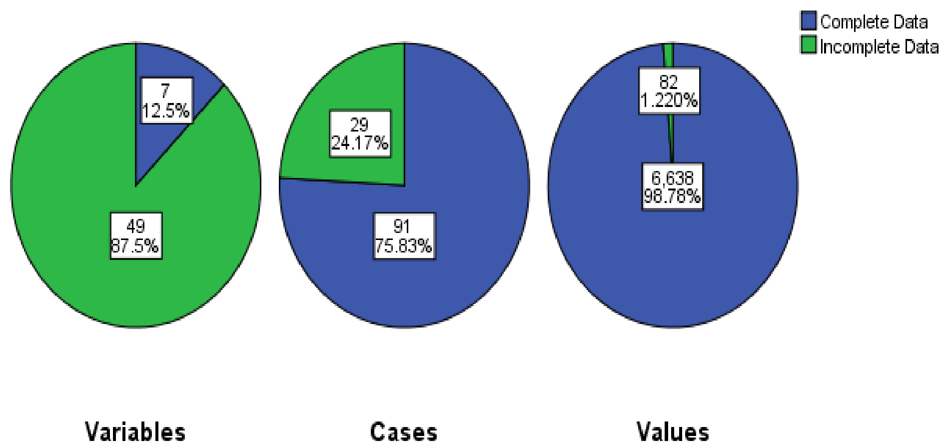



**Figure 6.1: Overall Summary of Missing Values**

Figure 6.1 provides the overall summary of missing values. The description is given as follows:

***Variables Pie Chart:*** The first Pie Chart provides the number of variables that were audited for MVI, The blue pie represents the variables that continued full information and the green represents the variables that had at least one missing Case. The pie chart shows that out of 56 items that were considered in the study only 7 had complete information while the rest of the 49 parameters had at least one missing case.

***Cases Pie Chart:*** The second pie chart provides the number of cases that had at least one missing response for an item. The blue pie represents the cases that contained full information with respect to all items of the questionnaire and the green represents the respondents who have provided partial information. The chart shows that out of 120 respondents who were interviewed in the study 91 Respondents provided no response for at least one of the items in the questionnaire.

There are approximately 24% of the respondents who haven't provided information with respect to at least one item in the questionnaire. In order to include these responses in the analysis, we will be using CART imputation methodology and results are compared in terms of sensitivity, specificity, positive predictive value and negative predictive value.

***Values Pie Chart***: The third pie chart represents the overall missing cells in the data. The blue pie represents the cells that contain the information while the green represents empty cells. The report shows that out of the matrix of 120*56 (Number of Respondents * Number of items in the questionnaire) a total of 82 cells had to be imputed before conducting data analysis.

Each case with missing values has, on average, 2.82 missing values roughly ***(# of Missing Cells/# of Missing Cases)*** out of the 56 items in the questionnaire. This suggests that **listwise deletion** would eliminate much of the information in the dataset.

**Table 6.1: Variable Summary for MVI**

| Variable Summary[a,b] | Missing | | Valid N |
|---|---|---|---|
| | N | Percent | |
| RO8 | 4 | 3.3% | 116 |
| ITO7 | 4 | 3.3% | 116 |
| RO5 | 3 | 2.5% | 117 |
| IO16 | 3 | 2.5% | 117 |
| IO11 | 3 | 2.5% | 117 |
| RO10 | 2 | 1.7% | 118 |
| RO9g | 2 | 1.7% | 118 |
| RO9f | 2 | 1.7% | 118 |
| RO9e | 2 | 1.7% | 118 |
| RO9d | 2 | 1.7% | 118 |
| RO9c | 2 | 1.7% | 118 |
| RO9b | 2 | 1.7% | 118 |
| RO7 | 2 | 1.7% | 118 |
| RO4 | 2 | 1.7% | 118 |
| RO2 | 2 | 1.7% | 118 |
| RO1g | 2 | 1.7% | 118 |
| RO1c | 2 | 1.7% | 118 |
| RO1b | 2 | 1.7% | 118 |
| RO1a | 2 | 1.7% | 118 |
| IO15 | 2 | 1.7% | 118 |
| IO14 | 2 | 1.7% | 118 |
| IO13 | 2 | 1.7% | 118 |
| IO8 | 2 | 1.7% | 118 |
| IO7 | 2 | 1.7% | 118 |
| ITO1 | 2 | 1.7% | 118 |
| TO2 | 2 | 1.7% | 118 |
| RO9a | 1 | 0.8% | 119 |
| RO6 | 1 | 0.8% | 119 |
| RO3 | 1 | 0.8% | 119 |
| RO1f | 1 | 0.8% | 119 |
| RO1e | 1 | 0.8% | 119 |
| RO1d | 1 | 0.8% | 119 |
| IO12 | 1 | 0.8% | 119 |
| IO10 | 1 | 0.8% | 119 |
| IO9 | 1 | 0.8% | 119 |
| IO5 | 1 | 0.8% | 119 |
| IO4 | 1 | 0.8% | 119 |
| IO2 | 1 | 0.8% | 119 |
| IO1 | 1 | 0.8% | 119 |
| ITO8 | 1 | 0.8% | 119 |
| ITO6 | 1 | 0.8% | 119 |
| ITO5 | 1 | 0.8% | 119 |
| ITO4 | 1 | 0.8% | 119 |
| ITO3 | 1 | 0.8% | 119 |
| ITO2 | 1 | 0.8% | 119 |
| TO8 | 1 | 0.8% | 119 |
| TO7 | 1 | 0.8% | 119 |
| TO6 | 1 | 0.8% | 119 |
| TO4 | 1 | 0.8% | 119 |
| a. Maximum number of variables shown: All Missing Variables | | | |
| b. Minimum percentage of missing values for variable to be included: 0.0% | | | |

Table 6.1 indicates the variables that have at least one missing value. It indicates that no items have more than 4 non-responses to the item in a questionnaire. R08 and IT07 had the highest number of missing information (4); other parameters have less than 4 non-responses.

Figure 6.2 shows an important missing value pattern description. The patterns chart displays missing value patterns for the analysis variables. Each pattern corresponds to a group of cases with the same pattern of incomplete and complete data.

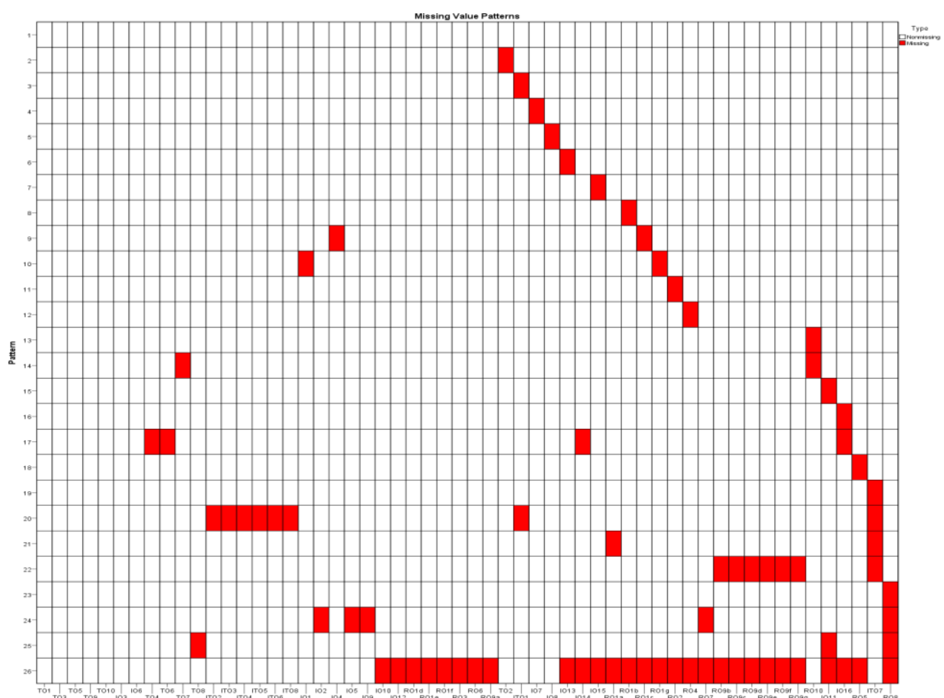



**Figure 6.2: Missing Value Pattern Analysis**

In this study, Pattern 1 represents cases wherein respondents have given complete information. Pattern 2 represents cases that have missing values on TO2, and so on… Finally Pattern 26 represents cases which have missing values on IO10, IO12, RO1d, RO1e, RO1f, RO3, RO6, RO9a, IO13, IO14, IO15, RO1a, RO1b, RO1c, RO1g, RO2, RO4, RO7, RO9b, RO9c, RO9d, RO9e, RO9f, RO9g, RO10, IO11, IO16, RO5, IT07, RO8.

A dataset can potentially have $2^{\text{number of variables}}$ patterns. For 56 analysis variables this is $2^{56}$= 72057594037927936; however, only 26 patterns are available in the 120 cases in the dataset. The chart orders analysis variables and patterns to reveal monotonicity where it exists. Specifically, variables are ordered from left to right in increasing order of missing values. Patterns are then sorted first by the last variable (non-missing values first, then missing values), then by the second to last variable, and so on, working from right to left.

The pattern analysis chart reveals that the monotone imputation method can't be used for imputation methodology since the missing cells in the pattern chart aren't contiguous. That is, there will be no '*islands*' of non-missing cells in the lower right portion of the chart and no *'islands'* of missing cells in the upper left portion of the chart. In the analyzed data there are missing cells in the left portion of the chart and monotone imputation would not be best suited for imputation.

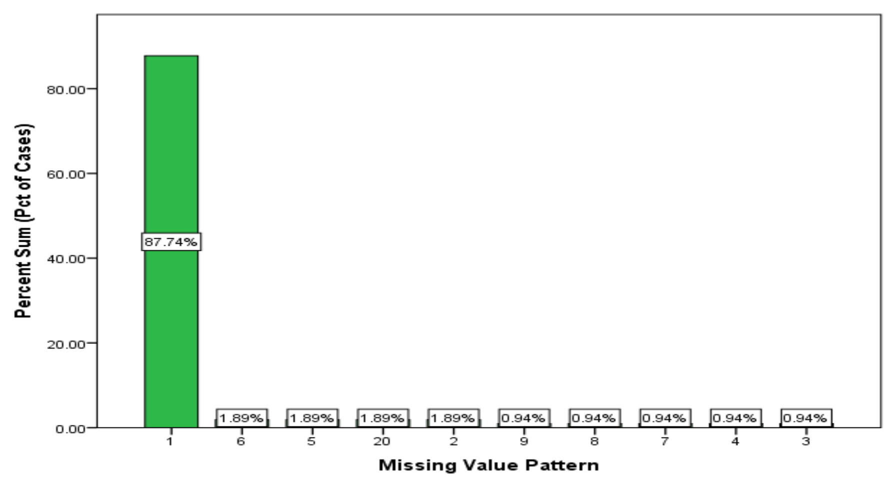



**Figure 6.3: Ten Most Frequent Missing Value Patterns**

Once the missing value pattern analysis graph is obtained, the most frequently occurring patterns of missing information are studied. This information is available in the companion bar chart above (Figure 6.3) which displays the percentage of cases for each pattern. Once the missing value pattern analysis graph is obtained, the most frequently occurring patterns of missing information are studied.

The chart shows that 87.74% of the cases in the dataset have pattern 1, which represents the respondents who provided complete information. Pattern 6 represents cases with a missing value on *IO8*; Pattern 5 represents cases with a missing value on *IO7, and so on.* The analysis of missing patterns has not revealed any particular obstacles to use CART, and the system also has identified that any monotone method of missing imputation will not really be feasible. The initial analysis also reveals that listwise deletion is not a feasible solution as this might result in substantial loss of information during analysis.

## 6.2. Theoretical Background of CART Algorithm for Treating Missing Information in the Data

Missing data are a problem for all statistical analysis. The imputation methods that are discussed in this chapter involve usage of tree-based models with some adjustments. Some of the instances when imputation would be valid in the study involve situations where the percentage of missing data is greater than 5% of the total number of observations. In such situations listwise deletion is not a possible choice as this might lead to loss of information during the analysis.

There are several other methods of treating missing values in addition to CART. An example would be to employ conventional regression in which a predictor with the missing data is regressed on other predictors with which it is likely to be related. The resulting regression equation can then be used to impute what the missing values might be. In this chapter since most of the scales are ordinal it is highly improbable to use such a technique as the data assumptions are not met. There are many other ways of treating a missing observation. One of the better approaches for imputation of Ordinal Data is the CART Algorithm. The summary of models for missing value imputation for all the variables is given in the Appendix IX.

### 6.3. Factor Analysis

Factor analysis is an interdependence technique, whose primary purpose is to define the underlying structure among the variables in the analysis. Factor analysis provides the tools for analyzing the structure of the interrelationships (correlations) among a large number of variables (e.g., test scores, test items, questionnaire responses) by defining sets of variables that are highly interrelated, known as factors (Hair, Black, Babin, Anderson, &Tatham, 2008).These groups of variables (factors) are highly intercorrelated as per the definition and are assumed to represent the dimensions within the data. Factor analytic techniques can achieve their purposes from either an exploratory or confirmatory perspective. Exploratory perspective is useful in searching for structure among set of variables or as a data reduction method. In confirmatory perspective, researcher has preconceived thoughts on the actual structure of the data, based on theoretical support on prior research.

In this study, for the first objective, i.e., to identify Key Performance Indicators (KPIs) for retail supply chain, a Principal Component Factor Analysis was conducted, employing Varimax factor rotation, to reduce the number of variables to a smaller set of factors. For each construct taken in the model certain numbers of indicators were identified and factor analysis was conducted to extract the KPIs for Retail Supply Chain. The factors are further discussed as follows in the subsequent sections of the chapter.

As discussed in the study, the constructs have been divided in to four categories: Transport Optimization, Information Technology Optimization, Inventory Optimization and Resource Optimization. Critical Factors were extracted for each category. The analysis and output for each category are discussed in the subsequent sections.

**6.4. Transport Optimization**

Several authors have discussed the importance of a supply chain, focusing on logistics service providers, as the function of logistics is to link suppliers, manufacturers, distributors, retailers and customers throughout the supply chain. They argue that logistics service providers must focus on supply chain performance in addition to organizational performance (Lai, Ngai, & Cheng, 2002). Also supported by (Larson & Halldorsson, 2004; Placeholder4; Council of Supply Chain Management Professionals, 2007) 'unionist' perspective, that supply chain management incorporates logistics as a key supply chain focused function. The logistics performance construct reflects the organization's performance as it relates to its ability to deliver goods and services in the precise quantities and at the precise times required by customers. Authors also describe the importance of integrating the logistics processes of all supply chain partners to better serve the needs of ultimate customers (Stank, Davis, & Fugate, 2005; Lin, 2006).

### 6.4.1. Factors for Transport Optimization

Table 6.2 shows the four factor solution, which accounts for 60 percent of the variation in the ten variables. All Eigen values (Figure 6.4, Table 6.3) exceeding one was considered. The factor loadings of above 0.5 were considered and a modest amount of correlation was shown among these four factors. The researchers identified four factors: ***'Operational Efficiency (OE',*** referring largely to efficiency parameters for network delivery; optimum; ***Perfect Delivery Rate (DR)',*** related to the percent of perfect deliveries in terms of both cost and service on time; ***'Service Effectiveness (SE)',*** which refers to the service effectiveness of both the shipper and the consignee in terms of proper planning of market or outsourced vehicles accompanied with the associated documents and ***'Logistics Flexibility (LF)',*** in terms of convenience and cost effectiveness achieved through dedicated fleets (owned fleets) by the retailers.

**Table 6.2: Factors Scores and Communalities for Transportation Optimization**

| **Factor** | **Survey elements** | | **Factor Loadings** | **Communalities** |
|---|---|---|---|---|
| F1 (OE) | Temperature control during transportation for perishable commodities is essential for perfect delivery | TO4 | 0.741 | 0.608 |
| | Usage of GPS/RFID technology for track & trace is essential | TO6 | 0.596 | 0.540 |

| | | | | |
|---|---|---|---|---|
| | Vehicle optimization is highly significant for logistics operations | TO7 | 0.583 | 0.486 |
| | Faster turnaround time of vehicles at loading and unloading time improves efficiency | TO8 | 0.701 | 0.618 |
| F2 (DR) | Percent of on-time deliveries is an important indicator for high service level | TO1 | 0.786 | 0.634 |
| | Damages due to inefficient delivery (pilferage/ delay/ damage in transit) of the product as % of total sales should be minimal are critical for operational excellence. | TO2 | 0.729 | 0.580 |
| | Transport connectivity is important for high growth of business | TO5 | 0.514 | 0.605 |
| F3 (SE) | Proper documentation is important for delivery of goods on time | TO3 | 0.633 | 0.539 |
| | Outsourced vehicles are more efficient for transporting goods | TO10 | 0.824 | 0.702 |
| F4 (LF) | Owned vehicles are convenient and cost effective for transportation | TO9 | 0.854 | 0.733 |

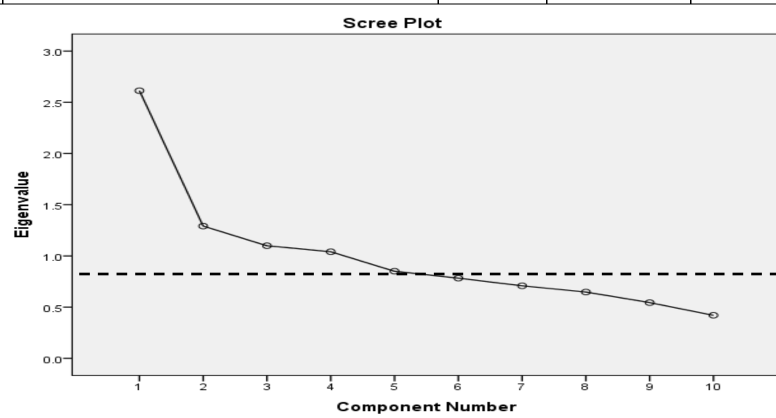



**Figure 6.4: Scree Plot for Transport Optimization**

**Table 6.3: Sum of Eigen Values for Factors of Transport Optimization**

| **Factor** | **F1** | **F2** | **F3** | **F4** | **Total** |
|---|---|---|---|---|---|
| Sum of squares (eigen value) | 2.059 | 1.573 | 1.243 | 1.170 | 6.0453 |
| Percentage of trace | 20.587 | 15.734 | 12.431 | 11.701 | **60.453** |

## 6.5. Information Technology Optimization

Given the access to data and analytical tools, retailers are finding that information technology has been a great support in managing the various disruptions in the supply chain. The availability of the right information at the right time across multiple channels offers consumers multiple touch points with innovative services (Barratt & Oke, 2007; Carr & Kaynak, 2007; Lin, 2006) and is increasingly used to improve the operational and strategic coordination (Sanders, 2008).

### 6.5.1. Factors for Information Technology Optimization

Table 6.4 shows the four factor solution and these four factors account for 53 percent of the variation in the variables. All Eigen values (Figure 6.5, Table 6.5) exceeding one was considered. The factor loadings of above 0.5 were considered and a modest amount of correlation was shown among these two factors. The first indicator is ***IT competencies (IC)*** which reflect those skills and abilities within a specialty area(s) of Information Technology that are required to deliver products and services to support business processes. It is an important indicator especially for the retail industry where huge data resources are available about customers, purchases, stocks, etc. Through easy access of real time data the purchasing and inventory management functions become more effective with reduced replenishment cycle time and minimum transaction cost.

**Table 6.4: Factors Scores and Communalities for Information Technology Optimization**

| Factor | | | Factor Loadings | Communalities |
|---|---|---|---|---|
| F1 (IC) | Role of IT in efficient purchasing/inventory management is important | ITO1 | 0.555 | 0.396 |
| | Information system should be adaptable and flexible for maximizing benefits. | ITO4 | 0.711 | 0.534 |
| | Real time information due to IT usage helps in reducing claims in rupee per month vs monthly turnover | ITO6 | 0.573 | 0.6 |
| | IT helps in easy sharing of real time information with channel partners, which increases the accuracy and reliability of the acquired information | ITO7 | 0.757 | 0.608 |
| | Investment in IT minimizes the data maintenance and transaction cost | ITO8 | 0.811 | 0.66 |
| F2 (RF) | EDI helps in faster exchange of data between buyer and seller | ITO2 | 0.803 | 0.646 |
| | Compliance with latest regulations of information systems is beneficial for overall functioning of organization, hence it is an important indicator for improving SC performance | ITO5 | 0.744 | 0.604 |

*ITO3 was eliminated due to low communality

The second indicator is ***Regulatory information flow (RF)*** which refers to the compliance of information systems and the secure flow of information among the channel partners. It is vital to have right information is available at right time at right place to make quick and effective decisions. At the same time the information obtained via technological resources should be compliant with the latest regulations of Information systems. This builds the technological capability of the organization for enhancement to further level of implementation of technology for various functions (e.g. WMS, ERP, TMS, etc).

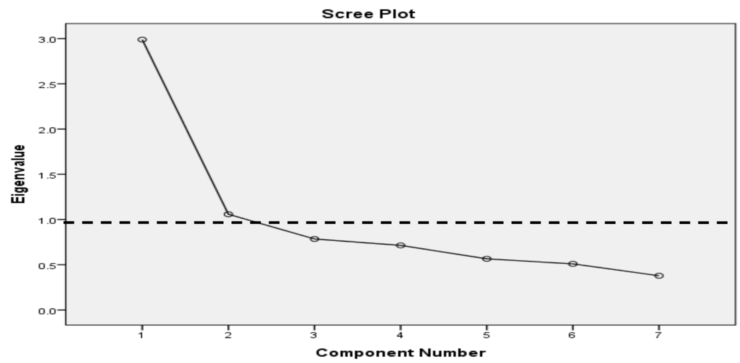



**Figure 6.5: Scree Plot for Information Technology Optimization**

**Table 6.5: Sum of Eigen Values of Factors for Information Technology Optimization**

| **Factor** | **F1** | **F2** | **Total** |
|---|---|---|---|
| Sum of squares (eigen value) | 2.989 | 1.058 | 4.246 |
| Percentage of trace | 34.607 | 23.206 | **57.814** |

## 6.6. Inventory Optimization

In terms of cost involved in managing inventory has been 20% of the total logistics cost (ELA European Logistics Association / A. T. Kearney Management Consultants, 2004; Establish Inc. / Herbert W. Davis & Co., 2005). Optimizing inventory is an important aspect of supply chain and it has to be continuously traced so that no disruption or bullwhip effect occurs in the supply chain (Lee, Padmanabhan, & Whang, 1997). Researchers have focused on missing inventory, inventory record inaccuracy and inventory replenishment, it is reasonable to suspect that, given the high level of problems with inventories (Raman, DeHoratius, & Ton, 2001a; Corsten & Gruen, 2003).

### 6.6.1. Factors for Inventory Optimization

Principal components factor analysis was conducted, employing a Varimax factor rotation, to reduce the factors to a linear combination of a subset of the attributes. Table 6.6 shows the four factor solution and these four factors account for 52 percent of the variation in the 8 variables. All Eigen values (Figure 6.6, Table 6.7) exceeding one was considered. The factor loadings of above 0.5 were considered and a modest amount of correlation was shown among these four factors. The researchers define the four factors as ***"Warehouse Utilization (WU)"*** referring largely to variables contributing to effectiveness and efficiency of inventory and warehouse management systems; ***"Inventory Control (IC)"*** relates to the investment made in holding the inventory, compliance with latest regulations (e.g. certification required for warehouse maintenance) and nature of storage facilities; ***"Forecast Accuracy (FE)"***, which refers to the book keeping practices for measuring the accurate forecast and stock cover value; ***"Stock Position and Valuation (SP)"*** refers to the inventory valuation method which can help in minimizing the stock-outs.

**Table 6.6: Factors Scores and Communalities for Inventory Optimization**

| **Factor** | | | **Factor Loadings** | **Communalities** |
|---|---|---|---|---|
| F1<br><br>(WU) | Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory | IO6 | 0.548 | 0.485 |
| | Fill rate is an important indicator in retail operations | IO9 | 0.506 | 0.474 |
| | Innovation is a key parameter in Retail Supply Chain *(e.g. automation in warehouse helps to speed up the logistics operations)* | IO10 | 0.702 | 0.575 |
| | Optimum number of warehouses are required for maximizing | IO11 | 0.508 | 0.384 |

| | | | | |
|---|---|---|---|---|
| | service level | | | |
| | productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency | IO12 | 0.735 | 0.624 |
| | Warehouse space/ layout/ future scalability/ use of MHE are critical for warehouse optimization | IO13 | 0.727 | 0.588 |
| | Electricity consumption (in Kw-hrs) per sqft of warehouse space reflects the energy efficiency, hence optimizes cost | IO15 | 0.582 | 0.591 |
| F2<br><br>(IC) | Inventory holding cost as % of gross sales shows an impact on overall efficiency | IO1 | 0.522 | 0.309 |
| | Inventory replenishment cycle time helps to plan timely orders | IO8 | 0.575 | 0.501 |
| | Certification of the warehouse-ISO certificates/C-TPAT certification/TAPA certification/Accreditation by WRDA India is essential/desirable for compliance with latest regulations | IO14 | 0..529 | 0.321 |
| | Depending on the nature of the goods, the storage facility has to be maintained *(e.g cold storage* | IO16 | 0.625 | 0.362 |
| F3<br><br>(FE) | Accuracy in forecasting sales reduces obsolete inventory | IO2 | 0.614 | 0.710 |
| | Inventory accuracy *((book inventory – counted inventory)/ book inventory)* gives an insight in your bookkeeping practices and helps to measure stock cover | IO5 | 0.794 | 0.521 |
| | % of time spent picking orders/back orders impacts the level of operational efficiency | IO7 | 0.625 | 0.510 |
| F4<br><br>(SP) | Stock-outs should be minimum for better profitability | IO3 | 0.614 | 0.677 |
| | FIFO is a better method for inventory valuation | IO4 | 0.794 | 0.691 |

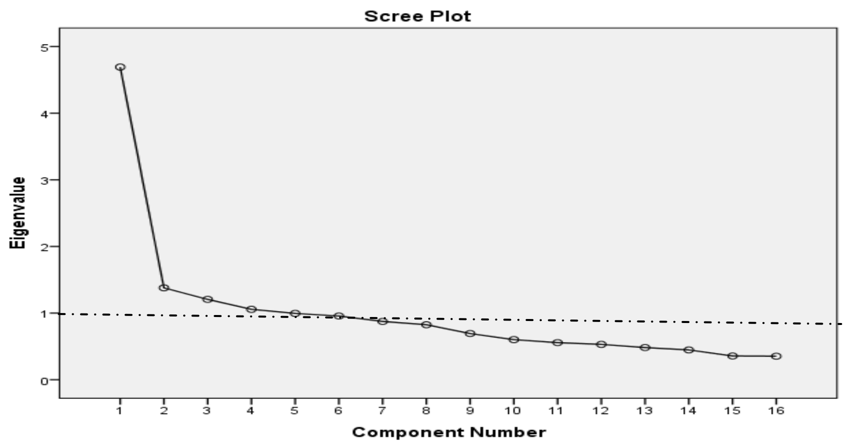



**Figure 6.6: Scree Plot for Inventory Optimization**

**Table 6.7: Sum of Eigen Values for Factors of Inventory Optimization**

| **Factor** | **F1** | **F2** | **F3** | **F4** | **Total** |
|---|---|---|---|---|---|
| Sum of squares (eigen value) | 3.060 | 2.007 | 1.862 | 1.403 | 8.332 |
| Percentage of trace | 19.122 | 12.546 | 11.636 | 8.770 | **52.074** |

## 6.7. Resource Optimization

A supply chain network uses resources of various kinds: manufacturing resources (machines, material handlers, tools, etc.); storage resources (warehouses, automated storage and retrieval systems); logistics resources (trucks, rail transport, air-cargo carriers, etc.); human resources (labor, scientific and technical personnel); and financial (working capital, stocks, etc.). The objective is to utilize these assets or resources efficiently so as to maximize customer service levels, minimize lead times, and optimize inventory levels. In supply chain management where all the business processes are linked and integrated with all business supply chain members, which makes the structure complex and cumbersome, it is recommended to that firms should identify those supply chain members that are critical for successful supply chain performance (Douglas, 1996). Similarly the companies have limited resources which have to be optimally used.

### 6.7.1. Factors for Resource Optimization

Principal components factor analysis was conducted, employing a Varimax factor rotation, to reduce the factors to a linear combination of a subset of the attributes. All Eigen values (Table 6.8) exceeding one was considered. Figure 6.7, Table 6.9 shows the five factor solution and these five factors account for 63.58 percent of the variation in the fourteen variables. The factor loadings of above 0.5 were considered and a modest amount of correlation was shown among these four factors. The researchers define the five factors as; ***"Operational cost (OC)"***, which includes the distribution cost, inventory cost, information management cost, warranty cost, packaging cost and facility management cost; ***"Manufacturing cost (MC)"*** which is component of direct labor, direct material and manufacturing overhead cost; ***"Cost of goods sold (CS)"*** which includes the total cost of material consumed; ***"Resource Value Addition (VA)"*** which here refers to the parameters contributing to the customer satisfaction like quality of packaging material used, acquiring of new equipments, software or labor for improving business efficiency and the employee productivity as a result of training provided for developing the required skills; ***"Benchmarking (BM)",*** which refers to setting the goals for next quarter/fiscal year and setting the course of continuous improvement in business processes like using renewable energy sources.

**Table 6.8: Factors Scores and Communalities for Resource Optimization**

| Factor | | | Factor loading | Communalities |
|---|---|---|---|---|
| F1 (OC) | Distribution cost and Inventory cost | RO1c | 0.530 | 0.731 |
| | Information management cost | RO1d | 0.669 | 0.616 |
| | Warranty cost | RO1e | 0.6699 | 0.523 |
| | Packaging cost | RO1f | 0.642 | 0.707 |
| | Facility management/ maintenance cost | RO1g | 0.696 | 0.582 |
| F2 (MC) | Direct labour cost, Direct material cost and Manufacturing overhead | RO1a | 0.548 | 0.825 |
| F3 (CS) | Cost of goods sold | RO1b | 0.579 | 0.846 |
| F4 (VA) | Quality of packaging material used is essential for customer service | RO2 | 0.690 | 0.490 |
| | Customer satisfaction is important for the growth of the business/ maximizing profit | RO3 | 0.773 | 0.599 |
| | Value added employee productivity helps to measure supply chain efficiency | RO4 | 0.537 | 0.459 |
| | Training employees add to their productivity | RO5 | 0.624 | 0.557 |
| | Acquiring a new equipment/software/ labour *as and when* business requirement is essential for the supply chain process improvements | RO6 | 0.561 | 0.469 |
| F5 (BM) | Cargo carried in terms of volumes for fiscal year indicates the benchmark for next year | RO7 | 0.627 | 0.498 |
| | Use of renewable/ solar energy/green terminals are the growing need for business efficiency | RO8 | 0.836 | 0.712 |

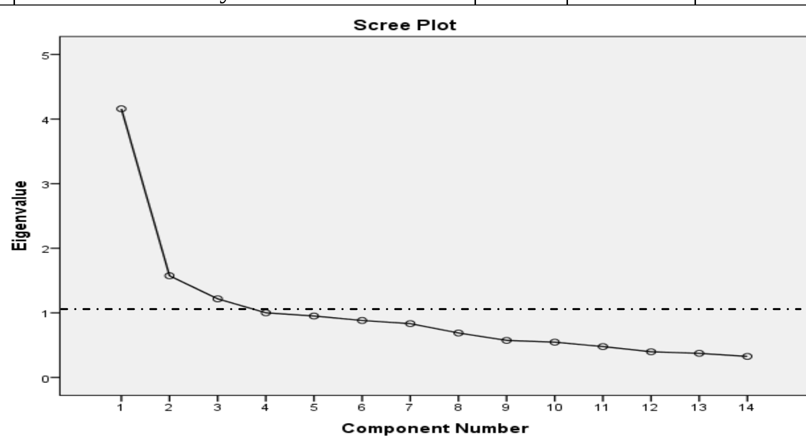



**Figure 6.7: Scree plot for Resource Optimization**

**Table 6.9: Sum of Eigen Values for Factors of Resource Optimization**

| **Factor** | **F1** | **F2** | **F3** | **F4** | **F5** | **Total** |
|---|---|---|---|---|---|---|
| Sum of squares (Eigen value) | 2.251 | 1.903 | 1.879 | 1.519 | 1.350 | 8.902 |
| Percentage of trace | 16.081 | 13.593 | 13.419 | 10.852 | 9..641 | **63.586** |

The indicators are further used for developing a performance model for retail supply chain. In the process of development, a number of items were deleted which were not significant for the context of this study. The details are provided further in chapter 7.

# 7 Developing and Testing Model

*"A model is just a simplified representation of reality and can take many forms"*

*– analyst wisdom*

*This chapter gives an overview of classification of models, followed by structural equation modeling (SEM). Covariance based (CB) SEM and PLS (Partial Least Square) SEM was used to identify the underlying structure of the data. Due to restrictions associated with CB SEM, PLS-SEM was found to be a better technique to develop a performance model for measuring retail supply chain performance. In the last section chapter is thus concluded with summary of final results.*

## 7.1. Classification of Models

The key to model-building lies in abstracting only the relevant variables that affect the criteria of the measures-of-performance of the given system and expressing the relationship in a suitable form. There are many ways to classify models as shown in Figure 7.1; the path of the model used in this study has been highlighted. It is a descriptive model with mathematical degree of abstraction. Here, the relationship between variables is identified by applying statistical tools. The general behavioral characteristics of the variables are dynamic in nature with probabilistic degree of certainty. The model consists of independent and dependent variables with mediating effects of` the variables, as discussed later in the chapter.

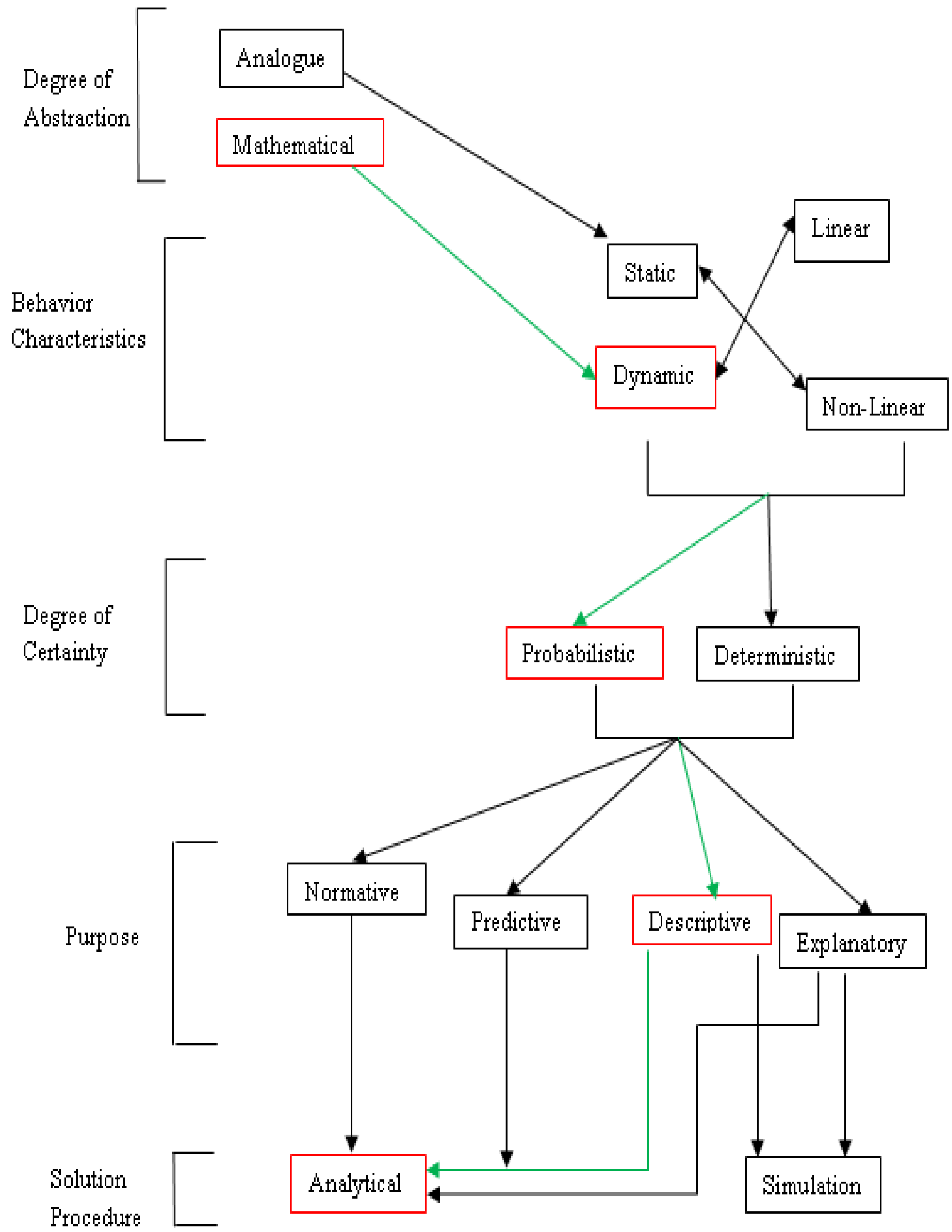



**Figure 7.1: Classification of Models**

*Path of the model*

## 7.2. SEM Analysis

Covariance-based structural modeling (CB-SEM) and variance-based partial least squares (PLS-SEM) are two types of methods for applying SEM (Hair, Sarstedt, Ringle, & Mena, 2011). "Partial least squares (PLS) path modeling was conceived as a composite-based alternative to factor based structural equation modeling (SEM), employing the optimality properties of ordinary least squares regression to approximate results from factor-based SEM, along with more limited distributional assumptions and reduced computational demands" (Rigdon, 2012). Both the methods share the same roots (Joreskog & Wold, 1982), but PLS-SEM has recently been recognized as an alternative approach to structural modeling with some advantages over the CB-SEM approach (Hair, Sarstedt, Ringle, & Mena, 2011).

Among the characteristics of the PLS-SEM method are that it has minimum demands regarding the number of observations and sample sizes (Hu & Bentler, 1995), generally achieves high levels of statistical power (Reinartz, Haenlein, & Henseler, 2009), can handle both reflective and formative measures without restrictions(Chin, 1998), works well with complex models, and is not constrained by identification issues (Hair, Sarstedt, Ringle, & Mena, 2011). Moreover, a distinctive reason for using PLS-SEM is that it is suitable for applications where rigorous assumptions cannot be fully met and is often referred to as a distribution-free "soft modeling approach" (Hair, Sarstedt, Ringle, & Mena, 2011). Finally, PLS-SEM is appropriate when data does not meet the assumption of multivariate normality (Fornell & Bookstein, 1982; Hwang, Malhotra, Kim, Tomiuk, & Hong, 2010; Lohmoller, 1989), a situation that often arises with social science research. For this study CB-SEM was also considered but the convergent validity was not met. Hence it was clear that the model being developed for this study is somewhat different subjected to context and nature of constructs under study. Therefore in the current study PLS-SEM is used for several reasons. One is that the method is a more suitable technique for exploratory research. Second is that it achieves higher levels of statistical power and as a result helps in investigating the relationships between several latent variables. Third, Rigdon(2012) says the $\chi^2$ statistic used in factor based SEM has repeatedly demonstrated that factor models are generally not consistent with the data used to estimate them, that the dominant measurement paradigm is fundamentally flawed, and that researchers should look at a broader range of possible measurement models. Steiger (1990) took a similar position when he argued that the advantages of factor analysis are largely illusory since the probability that data exactly fits the model is essentially zero. Hence, a factor model is just an approximation that may or may not be good (Steiger, 1990). Finally, (Cliff, 1983) noted that "Even in what is called 'confirmatory' factor analysis', it is not the nature of the factors which is confirmed: the only thing which is confirmed is that the observed covariance matrix is not inconsistent with a certain pattern of parameters. It does not tell us what those parameters mean, and experience has shown that our belief that we do know what they mean is often ill founded". In light of these arguments, PLS-SEM was judged to be the most appropriate statistical method for this study. There are certain guidelines for applying PLS-SEM, as discussed in the subsequent sections.

### 7.2.1. Data Characteristics

The data characteristics are determined mainly by the general description and distribution of the sample. Some other considerations like utilizing a hold out sample, relying on the covariance matrix as a starting point, and the type of measurement scales are also important. The description of these measures is given in Table 7.1.

**Table 7.1: Data Characteristics**

| **Criterion** | **Recommendations/ rules of thumb** | **References** |
|---|---|---|
| *Data Characteristics* | | |
| General description of the sample | Use "ten times rule" as rough guidance for minimum sample size | Barclay, Higgins, & Thompson, (1995) |
| Distribution of the sample | Robust when applied to highly skewed data; report skewness and kurtosis | Cassel, Hackl, & Westlund, (1999) |
| Use of holdout sample | 30% of original sample | Hair, Black, Babin, & Anderson, (2010) |
| Provide correlation/ covariance matrix | - | - |
| Measurement scales used | Do not use categorical variables in endogenous constructs ; carefully interpret categorical variables in exogenous constructs | - |

*Adapted from (Hair, Sarstedt, Ringle, & Mena, 2011)*

***General description of sample:*** Sample size has generally not been a major concern for PLS-SEM. However ,the minimum sample size must be evaluated(Marcoulides & Saunders, 2006; Sosik, Kahai, & Piovoso, 2009) even though PLS-SEM achieves high levels of statistical power even with a relatively small sample size (e.g., 100 observations) (Reinartz, Haenlein, & Henseler, 2009).The sample size of the current study is 120, which is consistent with the 'ten times rule of thumb' of using a minimum sample size of ten times the maximum number of paths aiming at any construct in the measurement or structural models(Barclay, Higgins, & Thompson, 1995).

***Distribution of sample*****:** In previous research it has been shown that PLS-SEM is robust even in extreme cases of non-normal data (Cassel, Hackl, & Westlund, 1999; Reinartz, Haenlein, & Henseler, 2009). At the same time, it is also important to recognize that highly skewed data can inflate bootstrap standard errors, thus reducing the statistical power. For this study skewness and kurtosis were examined and are not a concern for the model. The data used in the study was ordinal and it has been widely applied and accepted for PLS-SEM (Fornell & Bookstein, 1982; Reinartz, Haenlein, & Henseler, 2009).

### 7.2.2. Model Characteristics

The model characteristics are determined by the general description of inner and outer models and measurement mode of latent variables. The description of these measures is given in Table 7.2.

**Table 7.2: Model Characteristics**

| **Criterion** | **Recommendations/ rules of thumb** | **References** |
|---|---|---|
| *Model Characteristics* | | |
| Description of inner model | Provide graphical representation illustrating all inner model relations | - |
| Distribution of the outer models | Include a complete list of indicators in the appendix | - |
| Measurement mode of latent variables | Substantiate measurement mode by using CTA-PLS | Diamantopoulos, Riefler, & Roth, (2008); Gudergan, Ringle, Wende, & Will, (2008) |
| Measurement scales used | Do not use categorical variables in endogenous constructs ; carefully interpret categorical variables in exogenous constructs | - |

*Adapted from (Hair, Sarstedt, Ringle, & Mena, 2011)*

There are three types of models (i.e., focused, unfocused and balanced). Focused models have a small number of endogenous latent variables explained by a large number of exogenous latent variables. In contrast, an unfocused model has many endogenous latent variables and mediating effects with a smaller number of exogenous latent variables. Finally, a balanced model is between the focused and unfocused types of models. The model presented in Figure 7.2 is an unfocused model which has a higher number of endogenous latent variables compared to the exogenous variables. Moreover the PLS path model is composed of reflective measures.

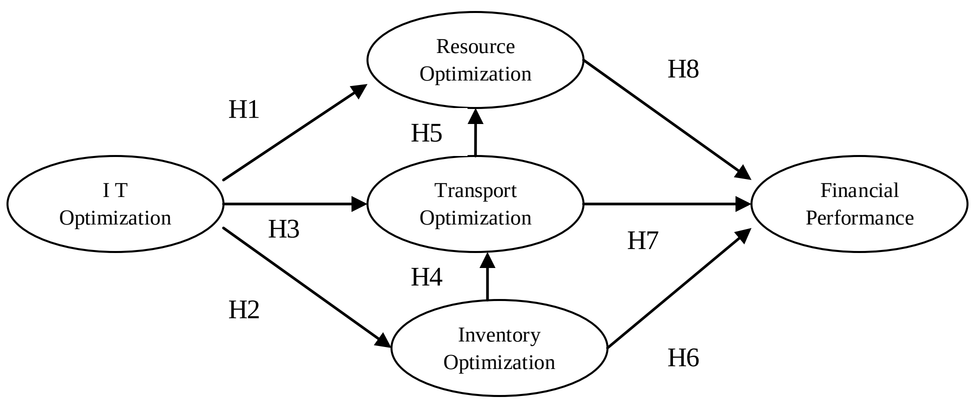



**Figure 7.2: Research Framework**

The number of indicators for reflective constructs is on an average 4, is represented in the Table 7.3.

**Table 7.3: List of Indicators**

| Construct | Indicator |
|---|---|
| **Financial Performance (FP)** | |
| RO9d | Debt Ratio *(Total debt/ Total assets)* |
| RO9e | Debt-to-equity ratio *(Total debt/ total equity)* |
| RO9f | Interest coverage *(EBIT/ Interest charges)* |
| RO9g | Interest coverage *(EBIT/ Interest charges)* |
| **Information Technology Optimization (ITO)** | |
| ITO1 | Role of IT in efficient purchasing/inventory management is important |
| ITO4 | Information system should be adaptable and flexible for maximizing benefits. |
| ITO6 | Real time information due to IT usage helps in reducing claims in rupee per month vs monthly turnover |
| ITO7 | IT helps in easy sharing of real time information with channel partners, which increases the accuracy and reliability of the acquired information |
| ITO8 | Investment in IT minimizes the data maintenance and transaction cost |
| **Resource Optimization (RO)** | |
| RO1g | Facility management/ maintenance cost |
| RO4 | Value added employee productivity helps to measure supply chain efficiency |
| RO5 | Training employees add to their productivity |
| RO6 | Acquiring a new equipment/software/ labour *as and when* business requirement is essential for the supply chain process improvements |
| **Inventory Optimization (RO)** | |
| IO12 | productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency |
| IO13 | Warehouse space/ layout/ future scalability/ use of MHE are critical for warehouse optimization |
| IO15 | Electricity consumption (in Kw-hrs) per sqft of warehouse space reflects the energy efficiency, hence optimizes cost |
| IO6 | Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory |
| IO5 | Inventory accuracy ((book inventory – counted inventory)/book inventory) gives an insight in your book keeping practices and helps to measure stock cover |
| **Transport Optimization (TO)** | |

| | |
|---|---|
| TO6 | Usage of GPS/RFID technology for track & trace is essential |
| TO7 | Vehicle optimization is highly significant for logistics operations |
| TO8 | Faster turnaround time of vehicles at loading and unloading time improves efficiency |

### 7.2.3. Outer Model Evaluation

To evaluate reflectively measured models, the assessment is based on outer loadings, composite reliability, average variance extracted (convergent validity), and discriminant validity. The criteria for these measures are presented in Table 7.4.

**Table 7.4: Outer Model Evaluation**

| **Criterion** | **Recommendations/ rules of thumb** | **References** |
|---|---|---|
| *Outer model evaluation: reflective* | | |
| Indicator reliability | Standardized indicator loadings ≥ 0.70; in exploratory studies, loadings of 0.40 are acceptable | Hulland, (1999) |
| Internal consistency reliability | Do not use Cronbach's alpha; composite reliability ≥ 0.70 (in exploratory research 0.60 is considered acceptable) | Bagozzi & Yi, (1988) |
| Convergent validity | AVE ≥ 0.50 | Bagozzi & Yi, (1988) |
| Discriminant validity Fornell-Larcker criterion | Each construct's AVE should be higher than its squared correlation with any other construct | Fornell & Larcker, (1981) |
| Cross loadings | Each indicator should load highest on the construct it is intended to measure | Chin, (1998); Gregoire & Fisher, (2006) |

*Adapted from (Hair, Sarstedt, Ringle, & Mena, 2011)*

***Indicator Reliability:*** All outer loadings of the reflective constructs of Financial Performance (FP), Information Technology Optimization (ITO), Transport Optimization (TO), Inventory Optimization and Resource Optimization (RO) are well above the minimum threshold of 0.4 for exploratory studies, as shown in Table 7.5.

**Table 7.5: Outer Loadings**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| IO12 | | 0.7221 | | | |
| IO13 | | 0.7209 | | | |
| IO15 | | 0.7086 | | | |
| IO5 | | 0.7216 | | | |
| IO6 | | 0.7275 | | | |
| ITO1 | | | 0.6333 | | |
| ITO4 | | | 0.7166 | | |
| ITO6 | | | 0.7343 | | |
| ITO7 | | | 0.7793 | | |
| ITO8 | | | 0.7382 | | |
| RO1g | | | | 0.6849 | |
| RO4 | | | | 0.73 | |
| RO5 | | | | 0.7627 | |
| RO6 | | | | 0.714 | |
| RO9d | 0.813 | | | | |
| RO9e | 0.8556 | | | | |
| RO9f | 0.8613 | | | | |
| RO9g | 0.8324 | | | | |
| TO6 | | | | | 0.708 |
| TO7 | | | | | 0.7496 |
| TO8 | | | | | 0.7893 |

***Internal Consistency Reliability:*** All the constructs have a high level of internal consistency reliability, as demonstrated by composite reliability in Table 7.6.

***Convergent Validity****:* The average variance explained (AVE) for all the constructs is meeting the minimum threshold of 0.5 (as shown in Table 7.6), thus demonstrating convergent validity.

**Table 7.6: Overview of Quality Criteria**

| | AVE | Composite Reliability | R Square | Cronbach Alpha | Communality | Redundancy | |
|---|---|---|---|---|---|---|---|
| FP | 0.707 | 0.9061 | 0.2815 | 0.8637 | 0.707 | 0.1667 | |
| IO | 0.5186 | 0.8434 | 0.4028 | 0.7718 | 0.5186 | 0.2006 | |
| ITO | 0.5212 | 0.8442 | | 0.7688 | 0.5212 | | |
| RO | 0.5234 | 0.8143 | 0.4089 | 0.6964 | 0.5234 | 0.1889 | |
| TO | 0.5621 | 0.7935 | 0.2693 | 0.6108 | 0.5621 | 0.1157 | |

***Discriminant Validity:*** As per the Fornell-Larcker criterion, each construct's AVE should be higher than the squared correlation with any other construct. The information in Tables 7.7a, b demonstrates discriminant validity for all constructs.

**Table 7.7: Fornell-Larcker Criterion**
**a: Interconstruct Correlations**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| **FP** | 1 | | | | |
| **IO** | 0.5038 | 1 | | | |
| **ITO** | 0.4122 | 0.6347 | 1 | | |
| **RO** | 0.4297 | 0.612 | 0.6106 | 1 | |
| **TO** | 0.2174 | 0.4818 | 0.4548 | 0.4468 | 1 |

**b: Squared Interconstruct Correlations**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| **FP** | 0.707 | | | | |
| **IO** | 0.253814 | 0.5186 | | | |
| **ITO** | 0.169909 | 0.402844 | 0.5212 | | |
| **RO** | 0.184642 | 0.374544 | 0.372832 | 0.5234 | |
| **TO** | 0.047263 | 0.232131 | 0.206843 | 0.19963 | 0.5621 |

***Discriminant Validity: Cross Loading criterion:*** There should be no cross loadings. Each indicator should load highest on the construct it is intended to measure (as shown in Table 7.8) and lower on all other constructs. Thus, both criteria are met for discriminant validity.

**Table 7.8: Cross Loadings Criterion**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| IO12 | 0.2211 | 0.7221 | 0.3738 | 0.3732 | 0.2476 |
| IO13 | 0.3022 | 0.7209 | 0.4742 | 0.3482 | 0.2733 |
| IO15 | 0.4667 | 0.7086 | 0.4399 | 0.4793 | 0.2559 |
| IO5 | 0.3988 | 0.7216 | 0.5418 | 0.5009 | 0.5377 |
| IO6 | 0.3733 | 0.7275 | 0.4104 | 0.4614 | 0.3375 |
| ITO1 | 0.1632 | 0.3659 | 0.6333 | 0.3686 | 0.3734 |
| ITO4 | 0.2966 | 0.385 | 0.7166 | 0.4524 | 0.3276 |
| ITO6 | 0.2653 | 0.49 | 0.7343 | 0.3906 | 0.4007 |
| ITO7 | 0.4097 | 0.5288 | 0.7793 | 0.4332 | 0.3133 |
| ITO8 | 0.3332 | 0.503 | 0.7382 | 0.5493 | 0.2403 |
| RO1g | 0.3693 | 0.4983 | 0.41 | 0.6849 | 0.4469 |
| RO4 | 0.3095 | 0.4438 | 0.4279 | 0.7300 | 0.2985 |
| RO5 | 0.23 | 0.3961 | 0.4296 | 0.7627 | 0.3104 |
| RO6 | 0.3175 | 0.4181 | 0.4935 | 0.714 | 0.2224 |
| RO9d | 0.8130 | 0.2993 | 0.2423 | 0.2627 | 0.1773 |
| RO9e | 0.8556 | 0.4288 | 0.4304 | 0.3399 | 0.1668 |
| RO9f | 0.8613 | 0.4584 | 0.366 | 0.3825 | 0.2421 |
| RO9g | 0.8324 | 0.466 | 0.3219 | 0.4235 | 0.1462 |
| TO6 | 0.1219 | 0.3161 | 0.299 | 0.364 | 0.7080 |
| TO7 | 0.1916 | 0.3324 | 0.2515 | 0.3344 | 0.7496 |
| TO8 | 0.1747 | 0.426 | 0.4541 | 0.3124 | 0.7893 |

### 7.2.4. Inner Model Evaluation

Once the construct measures have been confirmed as reliable and valid, the next step is to assess the structural model results. This involves examining the model's predictive capabilities and the relationships between the constructs. Before the structural model is assessed, it is important to examine the structural model for collinearity. The reason is that the estimation of path coefficients in the structural model is based on OLS regressions of each endogenous latent variable on its corresponding predecessor constructs. Just as in a regular multiple regression, the path coefficients may be biased if the estimation involves significant levels of collinearity among the predictor constructs. The key criteria for assessing the structural model in PLS-SEM are the significance of the path coefficients, the level of the $R^2$ values and the predictive relevance ($Q^2$). The guidelines for these measures are noted in Table 7.9.

**Table 7.9: Inner Model Evaluation**

| **Criterion** | **Recommendations/ rules of thumb** | **References** |
|---|---|---|
| *Inner model evaluation* | | |
| $R^2$ | Acceptable level depends on research context | (Hair, Black, Babin, & Anderson, 2010) |
| Path coefficient estimates | Use bootstrapping to assess significance | (Chin, 1998; Henseler, Ringle, & Sinkovics, 2009) |
| Predictive relevance $Q^2$ | Use blindfolding; $Q^2 > 0$ is indicative of predictive relevance | (Chin, 1998; Henseler, Ringle, & Sinkovics, 2009) |

*Adapted from (Hair, Sarstedt, Ringle, & Mena, 2011)*

***Coefficient of Determination ($R^2$):*** The primary criterion for inner model assessment is the coefficient of determination ($R^2$), which represents the amount of explained variance of each endogenous latent variable as shown in Table 7.10.

**Table 7.10: Coefficient of Determination ($R^2$)**

| | **R Square** |
|---|---|
| FP | 0.2815 |
| IO | 0.4028 |
| ITO | Exogenous |
| RO | 0.4089 |
| TO | 0.2693 |

The final model is thus presented in Figure 7.3. Overall the model predicts 40.9% of variance in Resource Optimization, followed by 40.3% of variance in Inventory Optimization, 28.1% of variance in Financial Performance and 26.9% of variance in Transport Optimization.

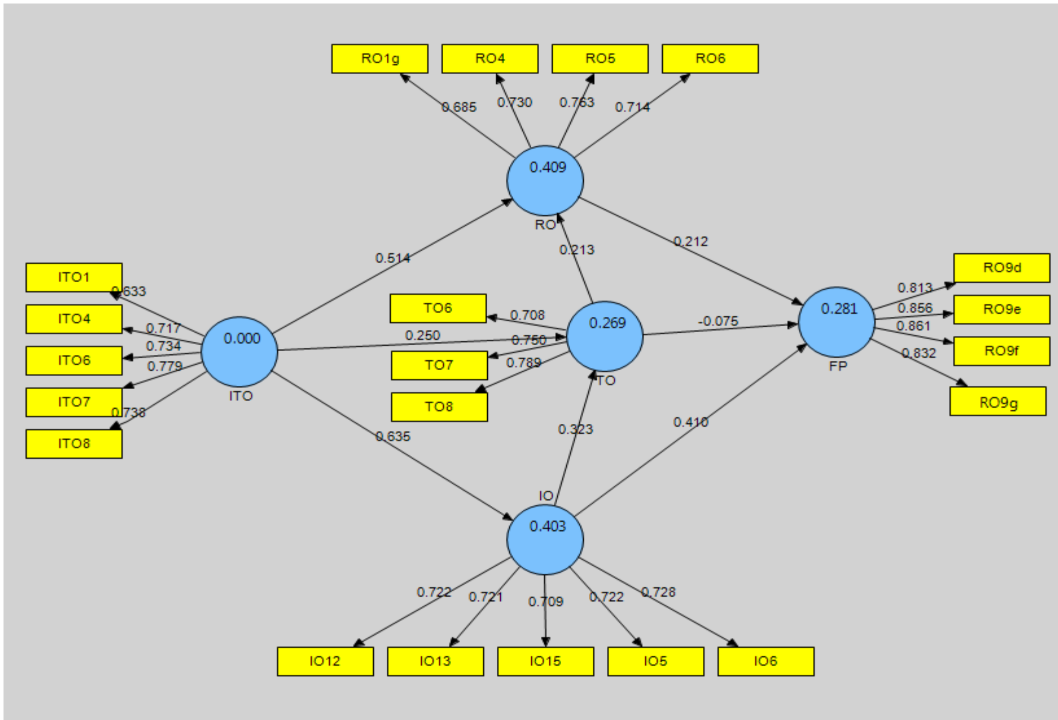



**Figure 7.3: PLS-SEM Model**

***Collinearity Assessment:*** Collinearity is an important concern, since it can inflate bootstrap standard errors. To assess collinearity, each set of predictor constructs is examined separately for each subpart of the structural model. Tolerance levels below 0.20 (VIF above 5.00) in the predictor constructs are indicative of collinearity that is too high (Hair, Sarstedt, Ringle, & Mena, 2011). SPSS was used to assess collinearity for all predictive constructs. The results, shown in Table 7.11 a, b, c, reveal that multicollinearity is not a problem for the structural model.

**Table 7.11: Coefficients**

| **Coefficients[a]** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | -2.485E-06 | .079 | | .000 | 1.000 | | |
| | IO | .345 | .109 | .345 | 3.155 | .002 | .517 | 1.935 |
| | ITO | .095 | .109 | .095 | .871 | .386 | .518 | 1.929 |
| | RO | .160 | .107 | .160 | 1.501 | .136 | .543 | 1.842 |
| a. Dependent Variable: FP | | | | | | | | |

| **Coefficients[b]** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 3.547E-06 | .071 | | .000 | 1.000 | | |
| | TTO | .213 | .080 | .213 | 2.670 | .009 | .793 | 1.261 |
| | ITO | .514 | .080 | .514 | 6.436 | .000 | .793 | 1.261 |
| b. Dependent Variable: RO | | | | | | | | |

| **Coefficients[c]** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 6.884E-06 | .079 | | .000 | 1.000 | | |
| | ITO | .250 | .102 | .250 | 2.440 | .016 | .597 | 1.675 |
| | IO | .323 | .102 | .323 | 3.163 | .002 | .597 | 1.675 |
| c. Dependent Variable: TTO | | | | | | | | |

***Assessing the Significance and Relevance of the Structural Model Relationships****:* After applying the PLS-SEM algorithm, estimates are obtained for the structural model relationships (the path coefficients), which represent the hypothesized relationships between the constructs as shown in Figure 7.3. The significance of path coefficients is assessed through bootstrap analysis.

**Table 7.12: Significance of path coefficients**

| | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | Standard Error (STERR) | T Statistics (\|O/STERR\|) |
|---|---|---|---|---|---|
| IO -> FP | 0.4099 | 0.4161 | 0.0996 | 0.0996 | 4.1157 |
| IO -> TO | 0.3234 | 0.3369 | 0.1353 | 0.1353 | 2.3899 |
| ITO -> IO | 0.6347 | 0.6417 | 0.0684 | 0.0684 | 9.2783 |
| ITO -> RO | 0.5137 | 0.5149 | 0.1008 | 0.1008 | 5.0935 |
| ITO -> TO | 0.2495 | 0.2565 | 0.1283 | 0.1283 | 1.9444 |
| RO -> FP | 0.2124 | 0.2325 | 0.1067 | 0.1067 | 1.99 |
| TO -> FP | -0.075 | -0.1101 | 0.0793 | 0.0793 | 0.9468 |
| TO -> RO | 0.2131 | 0.2268 | 0.1118 | 0.1118 | 1.9064 |

The above results (Table 7.12) show the significance of the path coefficients. The results indicate that all paths are statistically significant using a one-tailed test except TO-FP at $p = 0.05$. Also five of the eight structural paths are significant based on a two-tailed test at $p = 0.05$.

After examining the significance of relationships, it is important to assess the relevance of significant relationships. Path coefficients in the structural model may be significant, but their size may be so small that they do not warrant managerial attention.

Structural model path coefficients can be interpreted relative to one another. If one path coefficient is larger than another, its effect on the endogenous latent variable is greater. More specifically, the individual path coefficients of the path model can be interpreted just as the standardized beta coefficients in an OLS regression. These coefficients represent the estimated change in the endogenous construct for a unit change in the predictor construct as shown in Table 7.13.

**Table 7.13: Bootstrap Report: Path Coefficients**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| FP | | | | | |
| IO | 0.4099 | | | | 0.3234 |
| ITO | | 0.6347 | | 0.5137 | 0.2495 |
| RO | 0.2124 | | | | |
| TO | -0.075 | | | 0.2131 | |

The relative importance of the driver constructs is observed while predicting the dependent construct. Inventory Optimization (IO = 0.4099) is the most important predictor of financial performance of retail supply chains, followed by Resource Optimization (RO = 0.2124).In contrast, Transport Optimization does not have a direct influence on Financial Performance of the firm.

Information Technology is a strong predictor of both Inventory Optimization (ITO-IO = 0.6347) and Resource Optimization (ITO-RO = 0.5137), and only a moderate predictor of Transport Optimization (ITO-TO = 0.2495).Moreover, Transport Optimization mediates the relationship between Information Technology and Resource Optimization (TO-RO = 0.2131), and Inventory Optimization mediates the relationship between Information Technology and Technology Optimization (IO-TO = .3234).

***Understanding Direct and Indirect Effects:*** Researchers are often interested in evaluating not only one construct's **direct effect** on another, but also its **indirect effects** via one or more mediating constructs. The sum of direct and indirect effects is referred to as the **total effect**, shown in Table 7.14.

**Table 7.14: Total Effects**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| FP | | | | | |
| IO | 0.4003 | | | 0.0689 | 0.3234 |
| ITO | 0.3557 | 0.6347 | | 0.6106 | 0.4548 |
| RO | 0.2124 | | | | |
| TO | -0.0298 | | | 0.2131 | |

The findings indicate that inventory optimization (IO = 0.4003) has the strongest total effect on Financial Performance, followed by Information Technology Optimization (ITO = 0.3557) and Resource Optimization (RO = 0.2124).

In addition to examining the size of the path coefficients, researchers can examine the outer loadings of the reflective construct indicators to identify specific elements that need to be addressed. The outer loadings of the construct indicators are shown in Table 7.15.

**Table7.15: Outer Loadings of Reflective construct indicators**

| | FP | IO | ITO | RO | TO |
|---|---|---|---|---|---|
| IO12 | | 0.7221 | | | |
| IO13 | | 0.7209 | | | |
| IO15 | | 0.7086 | | | |
| IO5 | | 0.7216 | | | |
| IO6 | | 0.7275 | | | |
| ITO1 | | | 0.6333 | | |
| ITO4 | | | 0.7166 | | |
| ITO6 | | | 0.7343 | | |
| ITO7 | | | 0.7793 | | |
| ITO8 | | | 0.7382 | | |
| RO1g | | | | 0.6849 | |
| RO4 | | | | 0.73 | |
| RO5 | | | | 0.7627 | |
| RO6 | | | | 0.714 | |
| RO9d | 0.813 | | | | |
| RO9e | 0.8556 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| RO9f | 0.8613 | | | | |
| RO9g | 0.8324 | | | | |
| TO6 | | | | | 0.708 |
| TO7 | | | | | 0.7496 |
| TO8 | | | | | 0.7893 |

Indicators IO6 (0.7275), IO12 (0.7221) and IO5 (0.7216) have the highest outer loadings on the Inventory Optimization construct. These indicators contribute the most, therefore, to the total effect of inventory optimization on financial performance.

For Information technology, ITO7 (0.7793), ITO8 (0.7382) and ITO6 (0.7343) are the three influential indicators with the highest outer loadings. For Resource Optimization, RO5 (0.7627), RO4 (0.73) and RO6 (0.714) are the three dominant indicators with high outer loadings.

Similarly for Transport Optimization, TO8 (0.7893), TO7 (0.7496) and TO6 (0.708) have the highest outer loadings.

***Blindfolding and Predictive Relevance– $Q^2$:*** In addition to evaluating the magnitude of the $R^2$ values as a criterion of predictive accuracy, researchers should also examine the $Q^2$ value – which is an indicator of the model's predictive relevance. The $Q^2$measure applies a sample re-use technique that omits part of the data matrix and uses the model estimates to predict the omitted part. Specifically, when a PLS-SEM model exhibits predictive relevance, it accurately predicts the raw data of the indicators in reflective measurement models of multi-item as well as single-item endogenous constructs (the procedure does not apply to formative endogenous constructs).

For SEM models, $Q^2$ values larger than zero for a specific reflective endogenous latent variable indicate the path model's predictive relevance for a particular construct. $Q^2$ values of zero or below indicates a lack of predictive relevance. As a relative measure of predictive relevance, values of 0.02, 0.15, and 0.35 indicate that an exogenous construct has a small, medium, or large predictive relevance for a certain endogenous construct. Blindfolding is conducted using cross-validated redundancy as a measure of $Q^2$ since it includes the key element of the path model, the structural model, to predict eliminated data points. The $Q^2$ values for endogenous constructs are given in Table 7.16.

**Table 7.16: $Q^2$ for Endogenous Latent Variables**

| | **$Q^2$** |
|---|---|
| FP | 0.1752 |
| IO | 0.1869 |
| RO | 0.218 |
| TO | 0.1552 |

**Table 7.17: Results of $R^2$ and $Q^2$ Assessments**

| **Endogenous Latent Construct** | **$R^2$ Value** | **$Q^2$ Value** |
|---|---|---|
| Firm Performance (FP) | 0.2815 | 0.1752 |
| Resource Optimization (RO) | 0.4089 | 0.2180 |
| Transport Optimization (TO) | 0.2693 | 0.1552 |
| Inventory Optimization (IO) | 0.4028 | 0.1869 |

The Table 7.17 shows that all $Q^2$ values are considerable above zero, thus providing support for the reputation model's predictive relevance for the four endogenous variables.

## 7.3. Findings and Results

**The validation of Retail Supply Chain Performance Measurement Model:**

Findings of this research show that information technology is a strong predictor of both inventory optimization and resource optimization and only a moderator predictor of transport optimization.

Also, transport optimization mediates the relationship between information technology optimization and resource optimization, and inventory optimization mediates the relationship between information technology optimization and transport optimization.

***Validation of Hypotheses:***

H1 is validated: Information technology optimization has a positive effect on resource optimization. The path coefficient for this relationship is 0.614 and it was accepted at $p = .05$.

H2 is validated: Information technology has a positive effect on Inventory Optimization. The path coefficient for this relationship is 0.835 and it was accepted at $p = .05$

H3: Information technology has a positive effect on Transport Optimization. The path coefficient for this relationship is 0.250 and it was accepted at $p = .05$

H4: Inventory Optimization has a positive effect on of Transport Optimization. The path coefficient for this relationship is 0.323 and it was accepted at p = .05

H5: Transport Optimization has a positive effect on of Resource Optimization. The path coefficient for this relationship is 0.213 and it was accepted at p = .05

H6: Inventory Optimization mediates the effect of information technology Optimization on financial performance. The path coefficient for this relationship is 0.410 and it was accepted at p = .05

H7: Transport Optimization does not mediate the effect of information technology Optimization and inventory Optimization on financial performance. The path coefficient for this relationship is not significant at 0.5.

H8: Resource Optimization mediates the effect of information technology on financial performance. The path coefficient for this relationship is 0.212 and it was accepted at p = .05

Based on this quantitative research, a retail supply chain performance model is proposed for organized retail. The main results are summarized as follows:

1) Inventory optimization has the strongest total effect on Financial Performance (IO = 0.4003), followed by Information technology optimization (ITO = 0.3557) and resource optimization (RO = 0.2124).

2) Inventory turnover (IO6 = 0.7275) and productivity of MHE (IO12 = 0.7221) are the most influential indicators for inventory optimization.
3) The accuracy and reliability of information sharing (ITO7 = 0.7793) and reduction in data maintenance and transaction cost with investment in IT (ITO8 = 0.7382) are the most influential indicators for information technology optimization.
4) Training of employees (RO5 = 0.7727) and value added employee productivity (RO4 = 0.73) are the most influential indicators for Resource Optimization.
5) Faster turnaround of vehicles (TO8 = 0.7893) and vehicle optimization (TO7 = 0.7496) are the most influential indicators for Transport Optimization.
6) The values of $Q^2$ were considerably above zero, depicting a predictive relevance of the all the four endogenous variables.
7) The only component that negatively influences financial performance is transport optimization. This result can be understood by the fact that in Indian context the implementation of IT for transportation is still in a nascent stage and hence transport optimization do not mediate the effect of IT on financial performance of the firm.

Thus Figure 7.4 is the pictorial representation of the results obtained in this study. The central theme of any organization is the ultimately making profits, hence Financial Performance of the firm.

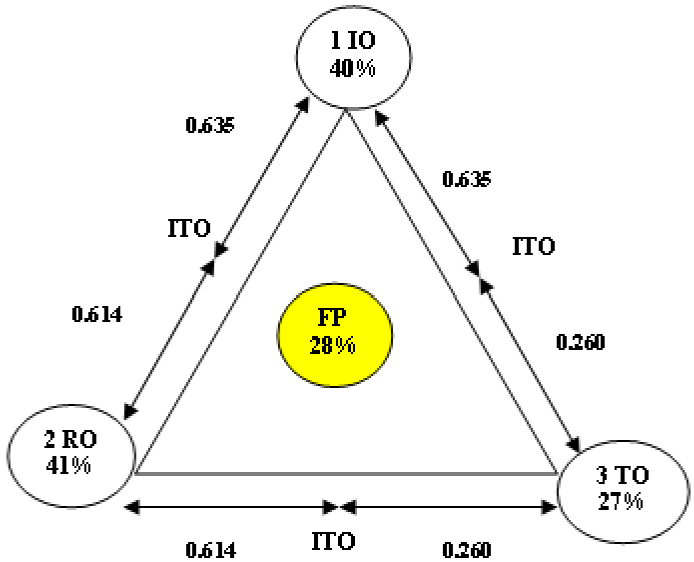



**Figure 7.4: Measurement Triangle**

For a retail supply chain, inventory optimization is the most important; hence inventory optimization obtained first rank, followed by resource optimization and transport optimization as second and third preference and IT is a linkage to communicate information at each nodal point for effective and efficient decision making.

# 8 Conclusion and Recommendations

*"Don't mistake activity with achievement"*

*- John Wooden*

*This chapter presents the conclusion of the study, exhibiting the relative importance of the variables identified in the study. It also discusses the limitations and directions for future research, thereby followed by recommendations based on findings.*

## 8.1. Conclusion

For this study, contingency approach was adopted, according to contingency theory perspective there is no best way to ensure superior performance. It also advocates that there is not universal set of strategic choices that applies to every business situation (Ginsberg & Venkatraman, 1985). Typical frameworks in the contingency research focus on the relationship between contextual factors and the performance (Schoonhoven, 1981; Ginsberg & Venkatraman, 1985). This view is also supported by RBV, which suggests that the firm extract and create value by optimally utilizing its human and technological resources. This study has combined RBV and contingency theory perspective and a framework was developed with respect to the contextual factors of retail supply chain with the objective of determining which components are most applicable to the supply chain issues confronting retailers in India. The basis was exploring different components and their associations with the financial performance of the firm.

Similar kind of frameworks was developed in different context of supply chain (Jara & Cliquet, 2012; Kajalo & Lindblom, 2010; Kim, 2009). A common fallacy was dearth of literature in providing theoretical foundation for conceptualizing and measuring of the concept. The model in this study reveals that retail supply chain performance measurement is multidimensional with IT as a great enabler and a strong predictor of inventory and resource optimization. It was also found through this study that respondents have given maximum weightage to inventory optimization, which provides an empirical evidence that inventory is undoubtedly a critical area of focus for retail industry,  the extent to which it influence the financial performance of the firm. Infact inventory turnover and productivity of material handling equipments [MHE] has been identified as the most influential indicators for inventory optimization.

The next most important component of the study was resource optimization influencing the financial performance of the firm. Training of employees and value added employee productivity are two most influential indicators. This led to a clear outcome that training of employees is vital for a high value added employee productivity which influences customer experience, finally results in increased sales and profitability of the company. Thus the companies should focus on training their employees for better performance.

As IT is a predictor of inventory and resource optimization, real time sharing of information plays an important role in increasing the accuracy and reliability of information. Retailers use different methods to coordinate with the supply chain partners with real time information in order to optimize their supply chain and assure maximum product availability Accuracy and reliability of information makes it possible that right product is available at right time at the right place, thus increasing the responsiveness to the market demand with better sales forecast. Hence companies are encouraged to invest in IT for data reduction and data maintenance cost.

Furthermore, IT is moderate predictor of transport optimization, it is because of the fact that IT implementation for transport is still in nascent stage of implementation in Indian context. As of now it is seen that besides a few large players the country is dominated by small truck owners and implementation of technology (RFID/TMS/GIS) is a way forward. For transport optimization, the faster turnaround of vehicle and vehicle optimization are the main area of attention. Besides capacity utilization and vehicle routing it is important that there is minimal waiting time for the vehicle at loading and unloading dock. The detention/waiting time of the vehicles affects the vehicle optimization or its complete utilization. As any delay in turnaround time of the vehicle is the cost to the operator. Hence for optimal utility it is significant to efficiently and effectively control the dock operations at DCs/ROs for faster turnaround of vehicles.

Thus, the current research represents one of the first empirical efforts to systematically investigate the relationship between key components of retail supply chain management in the developing economy. Finally it can be concluded that all the relationship variables incorporated in the model are significant for Retail Supply Chain Performance.

## 8.2. Limitations and Directions for Future Research

The study has been limited to Delhi [NCR] region of India. With the change in geography certain factors may change such as the size of market, level of IT implementation, its scope and capability, which ultimately affects the business dynamics. This study is limited to organized retail and the results are thus limited to only those large players in the retail market who have multiple stores across the nation and its boundaries.

As the model developed in this study was limited to only five major constructs, the model can further be developed by adding some other latent variables. Moreover, a similar study can also be conducted in other geographic regions or compared with foreign countries. In addition, the study included the top ten retailers operating in India; the KPIs identified in the study can be empirically tested for larger number of retail chains also that are not included in this study. Finally an attempt can be made to develop a similar model for unorganized retail or other industries.

## 8.3. Recommendations

IT is a great enabler, thus investment in IT tools can help companies to reduce the data maintenance & transaction cost with real time information sharing. Companies should identify and develop required technologies which can be used for an effective inventory and transport planning. Companies investing in track/trace systems like GPS/RFID for identification of vehicles can help in minimizing detention time for vehicles. Moreover Companies should look forward for training of employees for enhancing their productivity (such customer service, WMS, Inventory control, logistics planning).

Investment in warehouse should be made keeping in mind its future scalability, the level of automation required enhances the productivity of MHE and increases inventory turns.

**8.4. Final Conclusion**

Thus the study is an empirical evidence of the relationship between key components of retail supply chain management in the emerging economy. Since the variables were extracted from an extensive literature on performance measurement of supply chain in different context. A number of items were eliminated in the process of quantifying their relationship and association in Indian context. Some of the findings were found with similar results of RBV theory and contingency approach. Likewise IT in RBV context is found to be important.

The model proposed here is somewhat different from the previously proposed models in other studies. But the general idea of identifying factors is important, for decision making in a SC context in India is relevant. It is an addition to the existing knowledge on theory development on supply chain performance measurement. The model helps in identifying the critical variables for measuring retail supply chain performance. The managers may prioritize the factors which are important for retail supply chain and can focus on to those factors which are more actionable and result oriented in long term, besides managing the day to day operations.

Because the situation in India is somewhat different from more developed countries, the results are slightly varying for example the usage of RFID/GIS/TMS is more popular in developed nations as compared to its implementation in India.

Inventory is the most critical area of attention for retailers. IT is just an enable to manage SKUs, it is people who needs to be trained to get adapted to the use IT for handling complexities of SC and thus the final impact is seen on financial performance of the SC.

As SCM is complex and involves a network of supply chain partners in the effort of producing and delivering the final product, its entire domain cannot be covered in just one study. Further research can be built on using different methodologies for insights in this area of work.

## References


1. Abdel-Kader, M., & Luther, R. (2006a). IFAC's conception of the evolution of management accounting. *Advances in Management Accounting , 15*, 229-247.
2. Adams, N. D., Brown, T. W., & Firth, R. V. (1996). *Warehouse and Distribution Automation Handbook.* New York: McGraw-Hill.
3. *Adiya Birla Retail*. (2012). Retrieved January 17, 2013, from (http://www.adityabirla.com/our_companies/indian_companies/retail.htm)
4. Agarwal, A., Shankar, R., & Tiwari, M. K. (2006). Modeling the metrics of lean, agile and leagile supply chain: an ANP-based approach. *European Journal of Operational Research , 173* (1), 211-25.
5. Akhter, S., & Equbal, I. (2012). Organized Retailing in India-challenges and opportunities. *International Journal of Multidisciplinary Research , 2* (1), 281-291.
6. Akkermans, H., Bogerd, P., & Vos, B. (1999). Virtuous and vicious cycles on the road towards international supply chain management. *International Journal of Operations&Production Management , 19* (5/6), 565-81.
7. Akyuz, G. A., & Erkan, T. E. (2010). Supply chain performance measurement: A literature review. *International Journal of Production Research , 48* (17), 5137-5155.
8. Alber, K. L., & W, T. W. (1997). Supply Chain Management: A Practitioner's Approach. *The Educational Society for Resource Management*, , 203-210.
9. Altiok, T., & Raghav, R. (1995). Multi-Stage, Pull-Type Production/Inventory Systems. *IIE Transactions , 27*, 190-200.
10. Amaratunga, D., & Baldry, D. (2003). A conceptual framework to measure facilities management performance. *Property Management , 21* (2), 171-89.
11. Andersen, P. H., & Rask, M. (2003). Supply chain management: new organisational practices for changing procurement realities. *Journal of Purchasing and Supply Management , 9* (2), 83-95.
12. Anderson, S. W., & Lanen, W. N. (1999). Economic Transition, Strategy and The Evolution of Management Accounting Practices: The Case of India. *Accounting, Organizations and Society , 24*, 379-412.
13. Angerhofer, B. J., & Angelides, M. C. (2006). A model and a performance measurement system for collaborative supply chains. *Decision Support Systems , 42*, 283–301.

14. Aramyan, L. H., Lansink, A. O., Vorst, J., & Kooten, O. (2007). Performance measurement in agri-food supply chains: a case study. *Supply Chain Management International Journal , 12* (4), 304-315.
15. Arntzen, B. C., Gerald, B. G., Terry, H. P., & Linda, T. L. (1995). Global Supply Chain Management at Digital Equipment Corporation. *INTERFACES , 25*, 69-93.
16. Augenbroe, G., & Park, C. S. (2005). Quantification methods of technical building performance. *Building Research and Information , 33* (2), 159-72.
17. Aviv, Y. (2007). On the benefits of collaborative forecasting partnerships between retailers and manufacturers. *Management Science` , 53* (5), 777-94.
18. Ayers, J. (2001). *Handbook of Supply Chain Management* . Boca Raton Fl: Saint Lucie press.
19. Azzone, G., Masella, C., & Bertele, A. U. (1991). Design of performance measures for time-based companies. *International Journal of Operations & Production Management,* , 77-85.
20. Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural eequation models. *Journal of the Academy of Marketing Science , 16* (1), 74-94.
21. Bailey, J. E., & Pearson, S. W. (1983). "Development of a Tool for Measuring and Analyzing Computer User Satisfaction. *Management Science , 29* (5), 530-545.
22. Ballou, R. H., Gilbert, S. M., & Mukherjee, A. (2000). New managerial challenges from supply chain opportunities. *Industrial Marketing Management , 29* (1), 7-18.
23. Banks, R. L., & Wheelwright, S. C. (1979, May/June). Operations versus strategy ± trading tomorrow for today. *Harvard Business Review* , 112-20.
24. Barclay, D. W., Higgins, C. A., & Thompson, R. (1995). The partial least squares approach to causal modeling: personal computer adoption and use as illustration. *Technology Studies , 2* (2), 285-309.
25. Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management* , 99-120.
26. Barratt, M., & Oke, A. (2007). Antecedents of supply chain visibility in retail supply chains: A resoure-based theory perspective. *Journal of Operations Management , 25*, 1217-1233.
27. Barratt, M., & Oliveira, A. (2001). Exploring the experiences of collaborative planning initiatives. *International Journal of Physical Distribution & Logistics Management , 31* (4), 266-89.

28. Barua, A., Konana, P., Whinston, A. B., & Yin, F. (2004). An empirical investigation of net-enabled business value. *MIS Quarterly , 28* (4), 585-620.
29. Battaglia, A. J. (1994). *Beyond Logistics: Supply Chain Management.* US: Chief Executive.
30. Beamon, B. M. (1999). Measuring supply chain performance. *International Journal of Operations & Production Management , 19* (3), 275-292.
31. Beamon, B. M. (1998). Supply chain design and analysis: models and methods. *International Journal of Production Economics* .
32. Bechtel, C., & Jayaram, J. (1997). Supply chain management: a strategic perspective. *The International Journal of Logistics Management* , 15-34.
33. Berry, D., Towill, D., & Wadsley, N. (1994). Supply Chain Management in the Electronics Products Industry. *International Journal of Physical Distribution and Logistics Management , 24* (10), 20-32.
34. Bhagwat, R., & Sharma, M. K. (2007). Performance measurement of supply chain management: A balanced scorecard approach. *Computers and Industrial Engineering , 53*, 43-62.
35. *Bharti Walmart*. (2012). Retrieved January 18, 2013, from http://www.bharti-walmart.in/AboutUs.aspx
36. Bititci, U., Garengo, P., Dörfler, V., & Mendibil, K. (2009, October). Performance measurement: questions for tomorrow. *SIOM Research PaperSeries* .
37. Bitton, M. (1990). *ECOGRAI : méthode de conception et d'implantation des systèmes de mesure des performances pour organisations industrielles.* Université de Bordeaux I: Thèse de Doctorat en Automatique .
38. Blumberg, D. F. (1994). Strategic benchmarking of service and logistic support operations. *Journal of Business Logistics , 15* (2), 89-119.
39. Bolstorff, P. (2003). Measuring the impact of supply chain performance. *CLO/ Chief Logistics Officers , 12*, 5-11.
40. Borade, A. B., & Bansod, S. V. (2007). Domain of Supply Chain Management – A state of art. *Lournal of Technology Management & Innovation , 2* (4), 109-121.
41. Bourland, K. E., Powell, S. G., & Pyke, D. K. (1996). Exploiting timely demand information to reduce inventories. *European Journal of Operational Research* , 239-253.

42. Bourne, M., & Neely, A. (2003). Implementing performance measurement systems: a literature review. *International journal of Business Perfformance managment , 5* (1), 1-21.
43. Bower, J. L., & Hout, T. M. (1988). Fast cycle capability for competitive power. *Harvard Business Review* , 110-118.
44. Bowersox, D. J., Closs, D. J., Stank, T. P., & Keller, S. B. (2000). How supply chain competency leads to business success. *Supply Chain Management Review , 4* (4), 70-8.
45. Bowersox, D., Rodrigues, A., & Calantone, R. (2005). Estimation of Global and National Logistics Expenditures: 2002 Data Update. *Journal of Business Logistics , 26* (2), 1-16.
46. Braganza, A. (2002). Enterprise integration: creating competitive capabilities. *Integrated Manufacturing Systems , 13* (2), 562 – 572.
47. British Retail Consortium/ICRIER. (2012). *Industry Overview*. Retrieved December 2012, from http://www.dnb.co.in/IndianRetailIndustry/overview.asp
48. Brown, M. (1996). *Keeping Score: Using the Right Metrics to Drive World Class Performance.* New York, NY: Quality Resources.
49. Burgess, K., Singh, P. J., & Koroglu, R. (2006). Supply chain managementa structured literature review and implications for future research. *International Journal of Operations & Production Management , 26*, 703-729.
50. Burt, D. (1984). *Proactive Procurement.* Englewood Cliffs: Prentice Hall.
51. Cachon, G. (2001). Exact evaluation of batch-ordering policies in two-echelon supply chains with periodic review. *Operations Research , 49* (1), 79-98.
52. Cachon, G. P., & Fisher, M. (2001). Supply chain inventory management and the value of shared information. *Management Science , 46*, 1032-1048.
53. Cai, J., Liu, X., Xiao, Z., & Liu, J. (2009, 2009). Improving supply chain performance management: A systematic approach to analyzing iterative KPI accomplishment. *Decision Support Systems* , 612-621.
54. Cannon, J. P., & Perreault Jr., W. D. (1999). Buyer–seller relationships in business markets. *Journal of Marketing Research , 36* (4), 439-460.
55. Caplice, C., & Sheffi, Y. (1995). A Review and Evaluation of Logistics Performance Measurement Systems. *The International Journal of Logistics Management , 6* (1), 61-74.

56. Carr, A. S., & Kaynak, H. (2007). Communication methods, information sharing, supplier development and performance. *International Journal of Operations & Production Management , 27*, 346-370.
57. *Carrefour*. (2012). Retrieved January 16, 2013, from (http://www.carrefour.in/webapp/wcs/stores/servlet/TopCategories?sortBy=DEF&catalogId=10051&storeId=25051&pageSize=10&sortBy=DEF&pageNumber=2)
58. Cassel, C., Hackl, P., & Westlund, A. H. (1999). Robustness of partial least-squares method for estimating latent variable quality structures. *Journal of Applied Statistics , 26* (4), 435-446.
59. Cavinato, J. (1992). Total cost value model for supply chain competitiveness. *Journal of Business Logistics* , *13* (2), 285–291.
60. Chae, B. K. (2009). Developing key performance indicators for supply chain: an industry perspective. *Supply chain Management: An international Journal , 14* (6), 422-428.
61. Chan, F. T., & Qi, H. J. (2003). An innovative performance measurement method for supply chain management. *Supply Chain Management: An International Journal , 8* (3), 209-223.
62. Chang, T., Fu, H., Lee, W., Lin, Y., & Hsueh, H. (2007). A study of an augmented CPFR model for the 3C retail industry. *Supply Chain Management: An International Journal , 12*, 200-9.
63. Chen, F., Drezner, Z., Ryan, J. K., & Simchi-Levi, D. (2000). Quantifying the bullwhip effect in a simple supply chain:the impact of forecasting, lead times, and information. *Management Science , 46* (3), 436-443.
64. Chen, I. J., & Paulraj, A. (2004). Towards a theory of supply chain management:the constructs and measurements. *Journals of Operation Management* , 119-150.
65. Chen, I. J., Paulraj, A., & Lado, A. (2004). Strategic purchasing, supply management and firm performance. *Journal of Operations Management , 22*, 505-523.
66. Chenhall, R. H., & Langfield-Smith, K. (1998a). Adoption and benefits of management accounting practices: an Australian study. *Management Accounting Research , 9* (1), 1-19.
67. Chia, A., Goh, M., & Hum, S. H. (2009). Performance Measurement in supply chain entities: Balance scorecard perspective. *Benchmarking: An International Journal , 16* (5), 605-620.
68. Chin, W. W. (1998). *The partial least squares approach to structural equation modeling. In G.A. Marcoulides (Ed.) Mordern*

*methods for business research* . Mahwah New Jersey: Lawrence Erlbaum Associates.
69. Chopra, S., Meindl, P., & Kalra, D. V. (2007). *Supply Chain Management: Strategy, Planning and Operation* . New Delhi, India: Pearson Education.
70. Christensen, C., & Raynor, M. (2003). Why hard-nosed executives should care about management theory. *Harvard Business Review , 81* (9), 67-74.
71. Christopher, M. (1992). Logistics and supply chain management. *London: Pitman Publishing* .
72. Christopher, M. (1994). *Logistics and Supply Chain Management.* New York, NY: Richard D. Irwin, Inc., Financial Times.
73. Christopher, M. (1992). *Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services* . London: Financial Times/Pitman.
74. Christopher, M. (2005). *Logistics, The Supply Chain and Competitive Strategy* (3rd ed.). FT/ Prentice Hall.
75. Christopher, M., & Towill, D. (2001). An integrated Model for the Design of Agile Supply Chains. *International Journal of Physical Distribution & Logistics Management , 31* (4), 235-246.
76. Christopher, M., & Towill, D. R. (2000). Supply Chain Migration from Lean and Functional to Agile and Customized. *Supply Chain Management: An International Journal , 5* (4), 206-213.
77. Christy, D. P., & Grout, J. R. (1994). Safeguarding Supply Chain Relationships. *International Journal of Production Economics , 36*, 233-242.
78. Churchill, G. A. (1979). A Paradigm for Developing Better Measures of Marketing Constructs. *Journal of Marketing Research* , 64-73.
79. Cliff, N. (1983). Some cautions concerning the application of causal modeling methods. *Multivar. Behav. Res. , 18*, 115-126.
80. Closs, D. J., Goldsby, T. J., & Clinton, S. R. (1997). Information technology influences on world class logistics capability. *International Journal of Physical Distribution & Logistics Management , 27* (1), 4-17.
81. Cohen, M. A., & Moon, S. (1990). Impact of Production Scale Economies, Manufacturing Complexity, and Transportation Costs on Supply Chain Facility Networks. *Journal of Manufacturing and Operations Management , 3*, 269-292.
82. Cooper, M. C., & Ellram, L. M. (1993). Characteristics of Supply Chain Management and the implications for purchasing and logistics

strategy. *The International Journal of Logistics Management , 4* (2), 13-24.
83. Cooper, M. C., Ellram, L. M., Gardner, J. T., & Hanks, A. M. (1997a). Meshing multiple alliances. *Journal of Business Logistics , 18* (1), 67-89.
84. Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply Chain Management: More than a New Name for Logistics. *The International Journal of Logistics Management , 8* (1), 1-14.
85. Corsten, D., & Gruen, T. (2003). Seeking on-shelf availability—an examination of the extent, the causes and the efforts to address retail out-of-stocks. *International Journal of Retail and Distribution Management , 31* (12), 605-716.
86. *Council of Supply Chain Management Professionals.* (2007, December). Retrieved 2012, from www.cscmp.org/Website/AboutCSCMP/Definitions/Definitions.asp.
87. Cousins, P. D., & Menguc, B. (2006). The implications of socialization and integration in supply chain management. *Journal of Operations Management , 24*, 604-620.
88. Cox, A. (1999a). A Research Agenda for Supply Chain and Business Management Thinking. *Supply Chain Management , 4* (4), 209-11.
89. Coyle, J. J., Bardi, E. J., & Langley, C. J. (2003). *The Management of Business Logistics: A Supply Chain Perspective* (7th ed.). Mason, OH: South-Western Thomson Learning.
90. Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrica* , 1-16.
91. Croom, S., Romano, P., & Giannakis, M. (2000 ). Supply chain management: an analytical framework for critical literature review. *European Journal of Purchasing & Supply Management , 6*, 67-83.
92. Croxton, K., Gracia-Dastugue, S., Lambert, D., & Rogers, D. (2001). The Supply Chain Management Process. *International Journal of Logistics Management , 12* (2), 13-36.
93. Davenport, T. H. ( 2000). *Mission critical — realizing the promise of enterprise systems.* Boston (MA): Harvard Business School Press.
94. Davis, S., & Albright, T. (2004). An investigation of the effect of balanced scorecard implementation on financial performance. *Management Accounting Research , 15*, 135-153.
95. Davis, T. (1993). Effective Supply Chain Management. *Sloan Management Review* , 35-46.

96. De Toni, A., & Nassimbeni, G. (2000). Just-in-time purchasing: an empirical study of operational practices, supplier development and performance. *Omega-International Journal of Management Science* , *28* (6), 631-651.

97. De Toni, A., & Tonchia, S. (2001). Performance measurement systems. *International Journal of Operations & Production Management* , *21* (1/2), 46-70.

98. Deloitte. (2013, January 15). *News on India Retail*. Retrieved January 27, 2013, from Logistics Sector: Present Situation And Way Forward: http://www.indiaretailnews.com/

99. Diamantopoulos, A., Riefler, P., & Roth, K. P. (2008). Advancing formative measurement models. *Journal of Business Research* , *61* (12), 1203-1218.

100. Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science* , *35*, 1504-1511.

101. Dixon, J. R., Nanni, A. J., & Vollmann, T. E. (1990). *The New Performance Challenge: Measuring Operations for World-class Competition,*. Irwin, Homewood, IL: Business One .

102. Dobler, D. W., & Burt, D. N. (1996). *Purchasing and Supply Management.* New York, NY: The McGraw-Hill Companies.

103. Dong, M., & Chen, F. F. (2005). Performance modeling and analysis of integrated logistic chains: an analytic framework. *European Journal of Operational Research* , *162*, 83-98.

104. Douglas, J. (1996). Building performance and its relevance to facilities management. *Facilities* , *14* (3/4), 23-32.

105. Droge, C., Jayaram, J., & Vickery, S. K. (2004). The effects of internal versus external integration practices on time-based performance and overall firm performance. *Journal of Operations Management* , *22*, 557-573.

106. Drucker, P. F. (1962, April). The economy's dark continent. *Fortune* , 265-270.

107. Dyer, J. H., & Singh, H. (1998). The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* , *23*, 660-679.

108. Dyer, J. H., Cho, D. S., & Chu, W. (1998). Strategic Supplier Segmentation: The Next Best Practice in Supply Chain Management. *California Management Review* , *40* (2), 57-77.

109. Eccles, R. G. (1991). The Performance Measurement Manifesto. *Harvard Business School* .

110. ELA European Logistics Association / A. T. Kearney Management Consultants. ( 2004). Differentiation for performance excellence in logistics 2004. *Deutscher Verkehrs-Verlag GmbH, Hamburg.*
111. Ellinger A. E., D. P. (2000). The Relationship between Marketing/Logistics Interdepartmental Integration and Performance in U.S. Manufacturing Firms: An Empirical Study. *Journal of Business Logistics , 21* (2), 1-22.
112. Ellram, L. M., La Londe, B. J., & Weber, M. M. (1989). Retail Logistics. *International Journal of Physical Distribution & Materials Management , 19* (12), 29-39.
113. Ellram, L. R. (1991). Supply Chain Management: The Industrial Organization Perspective. *International Journal of Physical Distribution and Logistics Management , 21*, 13-22.
114. Emmet, S., & Crocker, B. (2006). The Relationship – Driven Supply Chain, Gower, Aldershot.
115. Ernst and Young. (2011). Doing Business in India.
116. Establish Inc. / Herbert W. Davis & Co. (2005). Logistic Cost and Service 2005. *Council of Supply Chain Managers Conference 2005.*
117. Farmer, D. (1996). Creating World Class Suppliers. *International Journal of Purchasing and Materials Management , 32* (3), 52.
118. Ferguson, M., & Ketzenberg, M. (2006). Sharing Information to Improve Retail Product Freshness of Perishables. *Production and Operations Management , 15* (1), 57-73.
119. Fiala, P. (2005). Information sharing in supply chains. *Omega , 33* (5), 419-23.
120. FICCI. (2008, October). Footfalls.
121. Financial Express. (2013). Retrieved January 25, 2013, from www.financialexpress.com/news/marks-spencer-to-expand-operations-in-india/69454
122. Fisher, M. L. (1997). What is the Right Supply Chain for your product. *Harvard Business Review* .
123. Fitzgerald, L., Johnston, R., Brignall, T. J., & Silvestro, R. (1991). *Performance Measurement in Service Businesses.* London: Chartered Institute of Management Accountants.
124. Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supplychain integration on performance: A contingency and configuration approach. *Journal of Operations Management , 28* (1), 58-71.

125. Forme, F. G., Genoulaz, V. B., & Campagne, J. P. (2007). A framework to analyse collaborative performance. *Computers in Industry , 58*, 687-97.
126. Fornell, C. G., & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research* , 440-452.
127. Forrester, J. W. (1961). *Industrial Dynamics.* Cambridge, MA: MIT Press.
128. Forslund, H., & Jonsson, P. (2007). The impact of forecast information quality on supply chain performance. *International Journal of Operations & Production Management , 27,* 90.
129. Franco-Santos, M., Kennerley, M., Micheli, P., Martinez, V., Mason, S., Marr, B., et al. (2007). Towards a definition of a business performance measurement system. *Int. J. Oper. Prod. Manage.* , 784-801.
130. Frazelle, E. H. (2002b). *Supply Chain Strategy: The Logistics of Supply Chain Management.* New York: McGraw-Hill.
131. Froehle, C., & Roth, A. (2007). A Resource-Process Framework of New Service Development. *Production and Operations Management , 16* (2), 169-188.
132. Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. *Journal of operations management , 19*, 185-200.
133. Fry, T. D., & Cox, J. F. (1989). Manufacturing performance; local versus global measures. *Production and Inventory Management Journal* , 52-6.
134. Future Group. (2012). *Future group about us*. Retrieved January 21, 2013, from (http://www.futuregroup.in/about-us/about-group.html)
135. Future Group Research. (2001). *"It Happened in India" - Kishore Biyani.*
136. Fynes, B., & Voss, C. a. (2005). The impact of supply chain relationship quality on quality performance. *International Journal of Production Economics , 96* (3), 339-354.
137. Fynes, B., Voss, C., & Búrca, S. (2005). The impact of supply chain relationship dynamics on manufacturing performance. *International Journal of Operations & Production Management , 25,* 6-19.
138. Gaither, N., & Frazier, G. (2001). *Production and Operations Management.* Sao Paulo: Pioneira Thomson Learning.
139. Gavirneni, S., R, K., & S, T. (1999). Value of Information in Capacitated Supply Chains. *Management Science , 45* (1), 16-24.

140. Gelders, L., Mannaert, P., & Maes, J. (1994). Manufacturing strategy performance indicators and improvement programs. *International Journal of Production Research , 32* (4), 797–805.
141. George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference* (11.0 update (4th ed.) ed.). Boston: Allyn & Bacon.
142. Ghalayini, A. M., & Noble, J. S. (1996). The changing basis of performance measurement. *Int. J. Oper. Prod. Manage. , 16* (8), 63-80.
143. Giannakis, M., & Croom, S. R. (2004). Towards the Development of a Supply Chain Management paradigm: A Conceptual Framework. *Journal of Supply chain management , 40* (2), 27-37.
144. Gimenez, C., & Ventura, E. (2005). Logistics-production, logistics-marketing and external integration-Their impact on performance. *International Journal of Operations & Production Management , 25* , 20-38.
145. Ginsberg, A., & Venkatraman, N. (1985). Contingency perspective of organizational strategy: a critical review of the empirical research. *Academy of Management Review , 10* (3), 421-34.
146. Globerson, S. (1985). Issues in developing a performance criteria system for an organisation. *International Journal of Production Research , 23* (4), 639-46.
147. Goldratt, E. M., Schragenheim, E., & Ptak, C. A. (2000). *Necessary But Not Sufficient.* Croton-on-Hudson, NY: North River Press.
148. Gopal, P. R., & Thakkar, J. (2012). A review on supply chain performance measures and metrics: 2000-2011. *International Journal of productivity and performance management , 61* (5), 518-547.
149. Gopal, V. V., & Suryanarayana, A. (2012). Growth Drivers and Challenges for Organised Retailing in India. *2010 International Conference on Business and Economics Research* , 25-28.
150. Green Jr, K. W., Whitten, D., & In, R. A. (2008). The impact of logistics performance on organizational performance in a supply chain context. *Supply Chain Management: An International Journal , 13* (4), 317–327.
151. Gregoire, Y., & Fisher, R. J. (2006). The effects of relationship quality on customer retaliation. *Marketing Letters , 17* (1), 31-46.
152. Grover, V., & Malhotra, M. K. (2003). Transaction cost framework in operations and supply chain management research: theory and measurement. *Journal of Operations Management , 21*, 457-473.

153. Gudergan, S. P., Ringle, C. M., Wende, S., & Will, A. (2008). Confirmatory tetrad analysis in PLS path modeling. *Journal of Business Research , 61* (12), 1238-1249.
154. Guinipero, Larry, C., & Richard, R. B. (1996). Purchasing's Role in Supply Chain Management. *The International Journal of Logistics Management , 7* (1), 29-37.
155. Gumbus, A. (2005). Introducing the balanced scorecard: creating metrics to measure performance . *Journal of Management Education, , 29* (4), 617-30.
156. Gunasekaran, A., & Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and applications. *International Journal of Production Research , 45* (12), 2819-2840.
157. Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations and Production Management , 21* (1/2), 71-87.
158. Gunasekarana, A., Patelb, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics , 84*, 333-347.
159. Gunasekarana, A., Patelb, C., & McGaugheyc, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics , 84*, 333-347.
160. Guruswamy, M., Sharma, K., & Jos, M. M. (2007). FDI in Retail – III Implications of Wal Mart's Backdoor Entry. *Centre for Policy Alternatives* .
161. Gustin, C. M., Daugherty, P. J., & Stank, T. P. (1995). The effects of information availability on logistics integration . *Journal of Business Logistics , 16* (1), 1-21.
162. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th ed.). Englewood Cliffs: Prentice hall.
163. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Ronald, T. L. (2008). *Multivariate Data Analysis* (6 ed.). New Delhi: Pearson Education .
164. Hair, J. F., Money, A. H., Samouel, P., & Page, M. (2007). *Research Methods for Business.* The UK: John Wiley & Son Ltd.
165. Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2011). As assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of Academy of Marketing Science* .

166. Halepete, J., Iyer, K. V., & Park, S. C. (2008). Wal-Mart in India: a success or failure? *International Journal of Retail & Distribution Management* , 701-713.
167. Hall, R. W. (1983). *Zero Inventories*, . Dow Jones-Irwin, : Homewood, IL.
168. Handfield, R. B., & Nichols, E. L. (1999). *Introduction to Supply Chain Management.* Upper Saddle River, NJ: Prentice Hall.
169. Harland, C. M., R.C. Lamming, H. W., Phillips, W. E., Caldwell, N. D., Johnsen, T. E., Knight, L. A., et al. (2006). Supply management: is it a discipline? *International Journal of Operations & Production Management* , *26*, 730-753.
170. Harland, C. (1994). *Perceptions of Requirements and Performance in European Automotive Aftermarket Supply Chains.* PhD thesis, Warwick.
171. Harrington, L. (1996, July 15). Untapped savings abound. *Industry Week* , 53–58.
172. Harrison, A., Christopher, M., & Van Hoek, R. I. (1999). *Creating the Agile Supply Chain.* The UK Institute of Logistics and Transportation.
173. Hayes, R. H., & Abernathy, W. J. (1980). Managing our way to economic decline. *Harv. Bus. Rev.* , *62*, 95-101.
174. Hayes, R. H., & Garvin, D. A. (1982, May/June). Managing as if tomorrow mattered. *Harvard Business Review* , 70-9.
175. Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in international marketing* , *20*, 277–319.
176. Hieber, R. (2002). *Supply Chain Management: A Collaborative Performance Measurement Approach.* Zurich.: Verlag der Fachvereine Hochschulverlag AG an der ETH Zurich.
177. Higginson, J. K., & Alam, A. (1997). Supply Chain Management Techniques in Medium-to-Small Manufacturing Firms. *International Journal of Logistics Management* , *8* (2), 19-32.
178. Hill, C. A., & Scudder, G. D. (2002). The use of electronic data interchange for supply chain coordination in the food industry. *Journal of Operations Management* , *20*, 375-387.
179. Hinks, J., & McNay, P. (1999). The creation of a management-by-variance tool for facilities management performance assessment. *Facilities* , *17* (1/2), 31-53.
180. Hitchcock, R. J. (2002). *High Performance Commercial Building Systems Program, Element 2 –Project 2.1 – Task 2.1.2, Standardized*

*Building Performance Metrics.* Berkeley, CA: Final Report, Building Technology Department, Lawrence Berkeley National Laboratory,.

181. Ho, D. C., Chan, W, E., Wong, N., & Chan, M. (2000). Significant metrics for facilities management benchmarking in the Asia Pacific region. *Facilities , 18* (13/14), 545-55.

182. Ho, D., Au, K., & Newton, E. (2002). Empirical research on supply chain management: a critical review and recommendations. *International Journal of Production Research , 40* (17), 4415-30.

183. Hofer, C. (1975). Towards a contingency theory of business strategy. *Academy of Management Journal , 18* (4), 784-810.

184. Hoffman, D. (2004). *The hierarchy of supply chain metrics: diagnosing your supply chain health.* Boston, Massachusetts: AMR Research.

185. Holmberg, S. (2000). A systems perspective on supply chain measurements. *International Journal of Physical Distribution & Logistics Management , 30* (10), 847-868.

186. Hsiao, J.-M. M. (October 2006). *The Impact of Retailer-Supplier Cooperation and Decision-Making Uncertainty on Supply Chain Performance.* Institute of Transport and Logistics Studies, Faculty of Economics and Business, The University of Sydney.

187. Hu, L. T., & Bentler, P. M. (1995). *Evaluating model fit. In R. H. Hoyle (Ed.).* Thousands Oaks, California: Sage.

188. Huang, S. H., Sheoran, S. K., & Keskar, H. (2005). Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model. *Comput Ind Eng , 48*, 377–394.

189. Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal , 20* (2), 195-204.

190. Hulland, J., Wade, M., & Antia, K. D. (2007). The impact of capabilities and prior investments on online channel commitment and performance. *Journal of Management Information Systems* , 109-42.

191. Hwang, H., Malhotra, N. K., Kim, Y., Tomiuk, M. A., & Hong, S. (2010). A comparitive study on parameter recovery of three approaches to structural equation modeling. *Journal of Marketing Research , 47* (4), 699-712.

192. IJEMS. (2013, January 18). *News on Indian Retail*. Retrieved January 27, 2013, from Foreign Direct Investment in Indian Retail Sector: Issues and Implications: http://www.indiaretailnews.com/

193. IJMBS. (2013, January 24). *India Retail News*. Retrieved January 27, 2013, from Emergence of Retailing Sector in India: Challenges and Opportunities : http://www.indiaretailnews.com/

194. Innes, J., & Mitchell, F. (1995). A survey of activity based costing in the UK's large companies. *Management Accounting Research , 6* (2), 137-153.
195. Ireland, R. K., & Crum, C. (2005). *Supply chain collaboration: How to implement CPFR and other best collaborative practices.* Florida: J. Ross Publishing Inc.
196. Islam, M., & Kantor, J. (2005). The development of quality management accounting practices in China. *Managerial Auditing Journal , 20* (7), 707-724.
197. Jara, M., & Cliquet, G. (2012). Retail brand equity: Conceptualization and measurement. *Journal of Retailing and Consumer Services , 19*, 140-149.
198. Jarillo, J. C. (1988). On strategic networks. *Strategic Management journal , 9*, 31-41.
199. John Mills, M. B., Wilcox, M., Neely, A., & Platts, K. (2000). Designing, implementing and updating performance measurement systems. *International Journal of Operations & Production Management , 20* (7), 754-771.
200. Johnson, H. T. (1975). Management accounting in an early integrated industrial: eI duPont de nemours powder company, 1903-1912. *Bus. Hist. Rev. , 49* (2), 184-204.
201. Johnson, H. T. (1981). Toward a new understanding of nineteenth-century cost accounting. *Account. Rev. , 56* (3), 510-518.
202. Johnson, H. T., & Kaplan, R. S. (1987). Relevance Lost: The Rise and Fall of Management Accounting. *Harvard Business School Press* .
203. Johnson, J. B., & Randolph, S. (1995). Brief: Making Alliances Work--Using a Computer-Based Management System to Integrate the Supply Chain, JPT. *Journal of Petroleum Technology , 47* (6), 512-513.
204. Johnston, D. A., McCutcheon, D. M., Stuart, F. I., & Kerwood, H. (2004). Effects of supplier trust on performance of cooperative supplier relationships. *Journal of Operations Management , 22*, 23-38.
205. Jones and Lang LaSalle. ( 2011). Indian Real Estate: An Outlook on Industry Trends.
206. Jones, C., Hesterly, W., & Borgatti, S. (1997). A General Theory of Network Governance; Exchange Conditions and Social Mechanisms . *Academy of Management Review , 22* (4), 911-945.
207. Jones, R. M., & Towill, D. R. (1997). Information enrichment: designing the supply chain for competitive advantage. *Supply Chain Management: An International Journal` , 2* (4), 137-148.

208. Jones, R. M., & Towill, D. R. (1999). Total cycle time compression and the agile supply chain. *International Journal of Production economics , 62*, 61-73.

209. Jones, T. C., & Rilley, D. W. (1987). using Inventory for Competitive Adnavtage through Supply Chain Management . *International Journal of Physical Distribution and Materials Management , 17*, 94-104.

210. Joreskog, K. G., & Wold, H. (1982). *The ML and PLS techniques for modeling with latent variables: Historical and comparitive aspects. In K.G. Joreskog & H. Wold (Eds.).* Amsterdam: North Holland.

211. K, I., Takahashi, K., & Muramatsu, R. (1988). Integrated Production, Inventory and Distribution Systems. *International Journal of Production Research , 26* (3), 473-482.

212. Kajalo, S., & Lindblom, A. (2010). How retail entrepreneurs perceive the link between surveillance, feeling of securoty, and competitiveness of the retail store? A structural model approach. *Journal of Retailing and Consumer Services , 17*, 300-305.

213. Kaplan, R. S. (1984). Yesterday's accounting undermines production. *Harv. Bus. Rev. , 62* (4), 95-101.

214. Kaplan, R. S., & Norton, D. P. (1992, January-Feburary Issue). The balance Scorecard- Measures That Drive performance. *Harvard Business Review* .

215. Kaplinsky, R., & Morris, M. (2000). A Handbook for Value Chain Research. In IDRC.

216. Kast, F. E., & Rosenweig, J. E. (1970). *Management and Organization.* New York: McGraw Hill.

217. Kaufmann, L., & Carter, C. R. (2006). International supply chain relationships and non financial performance – A comparison of US and German practices. *Journal of Operations Management , 24,* 653-675.

218. Keegan, D. P., Eiler, R. G., & Jones, C. R. (1989, June). Are your performance measures obsolete? *Management Accounting* , 45-50.

219. Kerlinger, F. N. (1986). *Foundations of behavioral research* (3rd ed.). Orlando, F.L: Rinehart and Winston.

220. Khan, K., & Shah, A. (2011). Understanding performance measurement through the literature. *Journal of Business Management , 5* (35), 13410-13418.

221. Kim, W. S. (2009). An investigation on th direct and indirect effect of supply chain integration on firm performance. *International Journal of Production Economics , 119,* 328-346.

222. Kincaid, D. G. (1994). Measuring performance in facility management. *Facilities , 12* (6), 24-7.
223. Koh, L. S., Demirbag, M., Bayraktar, E., Tatoglu, E., & Zaim, S. (2007). The impact of supply chain management practices on performance of SMEs. *Industrial Management & Data Systems , 107* (1), 103-124.
224. Koh, S. C., Demirbag, M., Bayraktar, E., & Tatoglu, E. (2007). The Impact of Supply Chain Management Practices on Performance of SMEs. *Industrial Management and Data Systems Journal , 107* (1), 103-124.
225. Kotzab, H., Teller, C., Grant, D. B., & Sparks, L. (2011). Antecedents for the adoption and execution of supply chain management. *Supply Chain Management: An International Journal , 16* (4), 231-245.
226. KPMG. (2011, July). Issues Monitor: Sharing knowledge on topical issues in Retail Industry. *10*.
227. Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement* , 607-610.
228. Kulmala, H. I., Paranko, J., & Uusi-Rauva, E. (2002). The role of cost management in network relationships. *International Journal of Production Economics , 79*, 33-43.
229. Kulp, S. C., Lee, H. L., & Ofek, E. (2004). Manufacturer Benefits from Information Integration with Retail Customers. *Management Science , 50* (4), 431-44.
230. Kurien, G. P., & Qureshi, M. N. (2011). Study of performance measurement practices in supply chain management. *Int. J. Bus. Manage. Soc. Sci. , 2* (4), 19-34.
231. Lai, K. H., Ngai, E. T., & Cheng, T. E. (2002). Measures for evaluating supply chain performance in transport logistics. *Transp Res Part E , 38*, 439–456.
232. Lambert, D. M., & Pohlen, T. L. (2001). Supply chain metrics. *The International Journal of Logistics Management* , 1-19.
233. Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply Chain Management Implementation Issues and Research Opportunities. *The International Journal of Logistics Management , 11* (1), 1-17.
234. Lambert, D., Garcia-Dastugue, S., & Croxton, K. (2005). An evaluation of process-oriented supply chain management frameworks. *Journal of Business Logistics , 26* (1), 25-51.

235. Lamming, R. C. (1993). *Beyond Partnership: Strategies for Innovation and Lean Supply*. Hemel Hempstead: Prentice Hall.
236. *Landmark Group Retail*. (2012). Retrieved January 18, 2013, from (http://www.landmarkgroup.com/retail/fashion/max/)
237. Lang, G. (2012). *Multi-Channel Retail- Position Paper, Orange Ecole Polytechnique TELECOM Paris Tech*. Paris: BEM Bordeaux Management School.
238. Langley, C. (1980). The evolution of the logistics concept. *Journal of Business Logistics , 7* (2), 1-11.
239. Lapide, L. (2000). What about measuring supply chain performance? *ASCET , 2* (15), 287-297.
240. Larson, P. D., & Halldorsson, A. (2004). Logistics versus supply chain management: an international survey. *International Journal of Logistics: Research and Applications , 7* (1), 17-31.
241. Larson, P. D., & Halldorsson, A. (2004). Logistics Versus Supply Chain Management:An International Survey. *International Journal of Logistics: Research and Applications , 7* (1).
242. Lavy, S., Garcia, J. A., & Dixit, M. K. (2010). Establishment of KPIs for facility performance measurement: review of literature. *Facilities , 28* (9), 440-464.
243. Lawrence, P. R., & Lorsch, W. J. (1967). Differentiation and Integration in Complex Organization . *Administration* , 1-47.
244. Lebas, M. J. (1995). Performance measurement and performance management. *Int. J. Product. Econ. , 41* ((1-3)), 23-35.
245. Lebas, M. J. (1995). Performance measurement and performance management. *International Journal of Production Economics , 41* (1-3), 23-35.
246. Lee, H. L., & Billington, C. (1993). Material Management in Decentralized Supply Chains. *Operations Research , 41* (5), 835-847.
247. Lee, H. L., & Feitzinger, E. (1995). Product Configuration and Postponement for Supply Chain Efficiency. *Institute of Industrial Engineers, Fourth Industrial Engineering Research Conference Proceedings* , 43-48.
248. Lee, H. L., & NG, S. M. (1997). Introduction to the Special Issue on Global Supply Chain Management. *Productions and Operation Management , 6*, 191-2.
249. Lee, H. L., Padmanabhan, V., & Whang, S. (1997). Information distortion in a supply chain: the bullwhip effect. *Management Science , 43*, 546-558.
250. Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The Bullwhip Effect in Supply Chains. *Sloan Management Review* , 93-101.

251. Levy, D. L. (1997, Winter). Lean production in an international supply chain. *Sloan Management Review* , 94–102.
252. Lewis, H. T., Naim, M. M., & Towill, D. R. (1997). An Integrated Approach to Re-Engineering Material and Logistics Control . *International Journal of Physical Distribution and Logistics Management , 27* (3), 197-209.
253. Li, D., & O'Brien, C. (1999). Integrated decision modelling of supply chain efficiency. *International Journal of Production Economics , 59* (1-3), 147-57.
254. Li, S., Ragu-Nathanb, B., Ragu-Nathanb, T. S., & Rao, S. S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega International Journal of Management Science , 34* (2), 107–124.
255. Lin, C. (2006). Influencing factors on the innovation in logistics technologies for logistics service providers in Taiwan. *The Journal of American Academy of Business , 9* (2), 257-63.
256. Lockamy III, A., & McCormack, K. (2004). Linking SCOR planning practices to supply chain performance: An exploratory study. *International Journal of Operations & Production Management , 24* (11/12), 1192–1218.
257. Lohmoller, J. B. (1989). *Latent variable path modeling with partial least squares.* Heidelberg: Physica.
258. Luther, R., & Longden, S. (2001). Management accounting in companies adapting to structural change and volatility in transition economies: A South African study. *Management Accounting Research , 12* (3), 299-320.
259. Lynch, R. L., & Cross, K. F. (1991). *Measure Up - The Essential Guide to Measuring Business Performance.* London: Mandarin.
260. Mabert, V. A., & Venkataramanan, M. A. (1998). Special research focus on supply chain linkages: challenges for design and management in the 21st century. *Decision Sciences , 29* (3), 537–552.
261. Maisel, L. (2001). *Performance measurement practices survey results.* New York: American Institute of Certified Public Accountants.
262. Maloni, M. J., & Benton, W. C. (1997). Supply chain partnerships:Opportunities for operations research. *European Journal of Operational Research , 101*, 419-429.
263. Manrodt, K. B., Holcomb, M. C., & Thompson, R. H. (1997). What is missing in supply chain management? *Supply Chain Management Review , 1* (3), 80-6.

264. Marcoulides, G. A., & Saunders, C. (2006). PLS: a silver bullet? *MIS Quarterly , 30* (2), III-IX.
265. Marvick, D., & White, J. (1998). *Distribution operations: Managing distribution facilities for strategic advantage In Strategic Supply Chain Alignment.* (J. G. Gattorna, Ed.)
266. McCarthy, T. M., & Golicic, S. L. (2002). Implementing collaborative forecasting to improve supply chain performance. *International Journal of Physical Distribution & Logistics Management , 32* (6), 431-54.
267. McKinnon, A. C. (1996). *The development of retail logistics in the UK:A position paper, Technology Foresight: Retail and Distribution Panel.* Edinburgh: Heriot-Watt University.
268. Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Information technology and organizational performance: an integrative model of IT business value. *MIS Quarterly , 28* (2), 283-322.
269. Mentzer, J. T., Dewitt, W., Keeber, J. S., Min, S., Nix, N. W., Smith, C. D., et al. (2001). Defining supply chain management. *Journal of Business Logistics , 22* (2), 1-25.
270. Mentzer, J. T., Foggin, J. H., & Golicic, S. L. (2000, September/October). Collaboration: the enablers, impediments, and benefits. *Supply Chain Management Review .*
271. Miguel, P. L., & Brito, L.-A. L. (2011). Supply chain management measurement and its influence on Operational Performance. *Journal of Operations and supply chain management , 5* (2), 56-70.
272. Moberg, C. R., Whipple, T. W., Cutler, B. D., & Speh, T. W. (2004). Do the Management Components of Supply Chain Management Affect Logistics Performance? *The International Journal of Logistics Management , 15* (2), 15-30.
273. Morgan, G. (1986). *Images of Organization.* London: Sage Publications.
274. Moseng, B. (1995). *Productivity measurement: methods and tools developed in TOPP in Rolstadas, A. (Ed.), Benchmarking Theory and Practice.* London: Chapman & Hall.
275. Narasimham, R., & Das, A. (2001). The impact of purchasing integration and practices on manufacturing performance. *Journal of Operations Management , 19,* 593-609.
276. Nassimbeni, G. (1998). Network Structures and Co-ordination Mechanisms: A Taxanomy. *International Journal of Operations and Production Management , 18* (6), 538-554.

277. Neely, A. D. (1998). *Measuring Business Performance.* London: Economist Books.
278. Neely, A., Adams, C., & Crowe, P. (2001). The performance prism in practice. *Measur. Bus. Excell. , 5* (2), 6-13.
279. Neely, A., Bourne, M., & Kennerley, M. (2000). Performance measurement system design: developing and testing a process-based approach. *International Journal of Operations & Production Management , 20* (10), 1119-1145.
280. Neely, A., Bourne, M., & Kennerley, M. (1995). Performance measurement system design: developing and testingaprocess-based approach. *International Journal of Operations & Production Management , 20* (10), 1119-1145.
281. Neely, A., Gregory, M., & Platts, K. (2005). Performance measurement system design. *International Journal of Operations and Production Management , 25* (12), 1228-1263.
282. New, S. J. (1996). A framework for Analysing Supply Chain Improvement. *International Journal of Operations and Production Management , 16* (4), 19-34.
283. New, S. J., & Ramsay, J. (1995). Supply Chains- Corporate Path to Economic Disaster? *Fourth International IPSERA Conference.* Birmingham.
284. Newhart, D. D., Stott, K. L., & Vasko, F. J. (1993). Consolidating Product Sizes to Minimize Inventory Levels for a Multi-Stage Production and Distribution Systems. *Journal of the Operational Research Society , 44* (7), 637-644.
285. Nicoletti, G., Scarpetta, S., & Boylaud, O. (2000, February 11). Summary indicators of product market regulation with an extension to employment protection legislation. *Unclassified, OECD* .
286. Nicoll, A. D. (1994). Integrating Logistics Strategies. *Annual InternationalConference Proceedings - American Production and Inventory Control Society,*, (pp. 590-94).
287. Nishiguchi, T. (1994). *Strategic Industrial Sourcing: The Japnese Advantage.* Oxford: Oxford University Press.
288. Noble, S. M., Haytko, D. L., & Phillips, J. (2009). What drives college-age Generation Y consumers? *Journal of Business Research , 62* (6), 617-628.
289. Nunnally, J. C. (1967). *Psychometric theory.* New York: McGraw Hill.
290. Nunnally, J. C. (1978). *Psychometric theory.* New York: McGraw Hill.

291. Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric Theory* (3rd ed.). New York: McGraw Hill.
292. O'Sullivan, D. T., Keane, M. M., Kelliher, D., & Hitchcock, R. J. (2004). Improving building operation by tracking performance metrics throughout the building lifecycle (BLC). *Energy and Buildings , 36* (11), 1075-90.
293. Oliver, R. K., & Webber, M. D. (1992). *Supply Chain Management:Logistics Catches up with Strategy. Outlook Cit. Christopher,.* Logistics Catches up with Strategy. Outlook Cit. Christopher, London.
294. Otley, D. T. (1999). Performance management: a framework formanagement control systems research. *Manage. Acc. Res. , 10* (4), 363-382.
295. Papakiriakopoulos, D., & Pramatari, K. (2010). Collaborative performance measurement in supply chain. *Industrial Management & Data Systems , 110* (9), 1297-1318.
296. Parliament of India, Rajya Sabha. (2009). *Ninetienth Report on Foreign and Domestic Investment in Retail Sector.*
297. Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal* , 179-191.
298. Pitt, M., & Tucker, M. (2008). Performance measurement in facilities management:driving innovation? *Property Management , 26* (4), 241-254.
299. Pohlen, T. L., & Lambert, D. M. (2001). Supply Chain Metrics. *International Journal of Logistics Management, , 12* (1), 1-19.
300. Power, D. (2004). The comparative importance of human resource management practices in the context of business to business (B2B) electronic commerce. *Information Technology & People , 17* (4), 380-406.
301. PwC. ( 2012). Prime Minister's Economics Advisory Council, Government of India.
302. Pyke, D. F., & Cohen, M. A. (1994). Multi-product Integrated Production Distribution Systems. *European Journal of Operational Research , 74* (1), 18-49.
303. Pyke, D. F., & Morris, A. C. (1993). Performance Characteristics of Stochastic Integrated Production-Distribution Systems. *European Journal of Operational Research , 68* (1), 23-48.
304. Raghunathan, S. (2001). Information sharing in a supply chain: a note on its value when demand is non stationary. *Management Science , 47* (4), 605-10.

305. Raman, A., DeHoratius, N., & Ton, Z. (2001a). The Achilles heel of supply chain management. *Harvard Business Review* , 136-152.
306. Ramdas, k., & Spekman, R. E. (2000). Chain or Shackles: Understanding What Drives Supply-Chain Performance. *Interfaces* , *30* (4), 3-21.
307. Ramesh, A., Banwet, D. K., & Shankar, R. (2008). Modeling the enablers of supply chain collaboration. *International Journal of Logistics Systems and Management* , 373-83.
308. Ramos, M. M. (2004). Interaction between management accounting and supply chain management. *Supply chain management* , *9* (2), 134-138.
309. Randall, W. S., Gibson, B. J., Defee, C. C., & Williams, B. D. (2011). Retail supply chain management:key priorities and practices. *The International Journal of Logistics Management , 22* (3), 390-402.
310. Rao, B. P. (2000). mproving retail effectiveness through technology: a survey of analytical tools for physical and on-line retailers. *Technology in Society , 22*, 111-122.
311. Ray, G., Muhanna, W. A., & Barney, J. B. (2005). Information technology and the performance of the customer service process: a resource-based analysis. *MIS Quarterly , 29* (4), 625-51.
312. Reinartz, W. J., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance based SEM. *International Journal of Market Research , 26* (4), 332-344.
313. *Reliance Industries Limited*. (2012). Retrieved January 25, 2013, from www.ril.com/html/business/business_retal.html
314. Research, G. (2013, January 25). *Impact Of 51 Percent FDI In Indian Retail*. Retrieved January 27, 2013, from India Retail News: http://www.indiaretailnews.com/
315. Rigdon, E. E. (2012). Rethinking Partial Least Squares Path MOdeling: In Praise of Simple Methods. *Long Range Planning , 45*, 341-358.
316. Rosenzweig, E. D., Roth, A. V., & Dean, J. W. (2003). The influence of an integration strategy on competitive capabilities and business performance: An exploratory study of consumer products manufacturers. *Journal of Operations Management , 21* (4), 437-456.
317. Roth, A. V., & Menor, L. J. (2003). Insights inti Service Operations Management: A research agenda. *Production and Operations Management , 12* (3).
318. Ruigrok, W., Pettigrew, A., Peck, S., & Whittington, R. (1999). Corporate restructuring and new forms of organising: evidence from Europe. *Management International Review , 2*, 41-64.

319. Rungtusanatham, M., Salvador, F., Forza, C., & Choi, T. Y. (2003). Supply-chain linkages and operational performance: A resource-based-view perspective. *International Journal of Operations & Production Management , 23* (9), 1084-99.
320. Rushton, A., Oxley, J., & Croucher, P. (2001). *The handbook of logistics and distribution management* (2nd Edition ed.). London, UK.
321. Sahin, F., & Robinson, E. P. (2002). Flow coordination and information sharing in supply chains: Review, implications, and directions for future research. *Decision Science , 33* (4), 505-535.
322. Sahina, F., & Robinson Jr., E. P. (2005). Information sharing and coordination in make-to-order supply chains. *Journal of Operations Management , 23*, 579-598.
323. Salvador, F., Forza, C., Rungtusanatham, M., & Choi, T. Y. (2001). Supply chain interactions and time-related performances: An operations management perspective. *International Journal of Operations & Production Management , 21*, 461-475.
324. Sanders, N. R. (2008). Pattern of information technology use: the impact on buyer–suppler coordination and performance. *Journal of Operations Management , 26* (3), 349–367.
325. Santosa, R. F., Marinsb, F. A., Alvesc, J. M., & Moellmannd, A. H. (2012). A Real Application of the Theory of Constraints to Supply Chain Management in Brazil. *Brazilian Journal of Operations & Production Management , 7* (2), 81-100.
326. Schefcyzk, M. (1993). Industrial benchmarking: a case study of performance analysis techniques. *International Journal of Production Economics , 32* (1), 1-11.
327. Schonberger, R. J. (1990). Building a chain of customers. *London: The Free Press.*
328. Schoonhoven, C. (1981). Problems with contingency theory: testing assumptions hidden within the language of contingency "theory". *Administrative science quaterly , 26*, 349-377.
329. Seal, W., Cullen, J., Dunlop, A., Berry, T., & Ahmed, M. (1999). Enacting a European supply chain: a case study on the role of management accounting. *Management Accounting Research , 10*, 303-322.
330. Shah, J. (2009). *Supply chain management.* Delhi: Pearson Education.
331. Shaw, S., & Grant, D. B. (2012). Developing environmental supply chain performance measures. *Benchmarking: An International Journal , 17* (3), 320-339.

332. Shepherd, C., & Gunter, H. (2006). Measuring supply chain performance: current research and future directions. *International journal of Productivity and Performance Measurement , 55* (3/4), 242-258.
333. Shin, H., Collier, D. A., & Wilson, D. D. (2000). Supply management orientation and supplier/buyer performance. *Journal of Operations Management , 18,* 317-333.
334. *Shoppers Stop*. (2012). Retrieved January 25, 2013, from www.shoppersstop.com/aboutUs.jsp.vr
335. Shore, B., & Venkatachalam, A. (2003). Evaluating the information sharing capabilities of supply chain partners: A fuzzy logic model. *International Journal of Physical Distribution & Logistics Management , 33* (9), 804-824.
336. Simatupang, T. M., & Sridharan, R. (2004). A benchmarking scheme for supply chain collaboration. *Benchmarking: An international Journal , 11* (1), 9-29.
337. Simchi-Levi, D., & Zhao, Y. (2005). Safety stock positioning in supply chains with stochastic lead times. *Manufacturing & Service Operations Management , 7,* 295-318.
338. Simchi-Levi, D., Kamisky, P., & Simchi-Levi, E. (2000). *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies* . Irwin, New York: Mc-Graw Hill.
339. Simon, H. (1960). *The New Science of Management Decision.* New York: Harper Brotthers.
340. Sinclair, D., & Zairi, M. (1995). Effective process management through performance measurement: Part III - An integrated model of totalquality-based performance measurement. *Bus. Process Manage. J. , 1* (3), 50-65.
341. Skinner, W. (1974, October). The decline, fall and renewal of manufacturing. *Industrial Engineering* , 32-8.
342. Slack, N. (1983). Flexibility as a manufacturing objective. *Int. J. Oper. Prod. Manage. , 3* (3), 4-13.
343. Slack, N., Chambers, S., & Johston, R. (2001). *Operations Management* (3rd ed.). London: FT Pitman.
344. Sosik, J. J., Kahai, S. S., & Piovoso, M. J. (2009). Silver bullet or voodoo statistics? A primer for using partial least squares data analystic technique in group and organization research. *Group & Organization Management , 34* (1), 5-36.
345. Spens, K. M., & Bask, A. H. (2002). Developing a framework for supply chain management. *International Journal of Logistics Management , 13* (1), 73-88.

346. Spohrer, J., Maglio, P. P., Bailey, J., & Gruhl, D. (2007). Steps Toward a Science of Service Systems. *Computer , 40*, 71-77.
347. Sramek, B. D., Mentzer, J. T., & Stank, T. P. (2008). Creating consumer durable retailer customer loyalty through order fulfillment service operations. *Journal of Operation Management , 26*, 781-797.
348. SSIJMAR. (2013, January 17). *News on India Retail*. Retrieved January 27, 2013, from Retail Landscape In India: An Analysis: http://www.indiaretailnews.com/
349. Stank, T. P., Davis, B. R., & Fugate, B. S. (2005). A strategic framework for supply chain oriented logistics. *Journal of Business Logistics , 26* (2), 27-45.
350. Steiger, J. H. (1990). *Some additional thoughts on components, factor and factor indeterminacy. Multivar. Behav.*
351. Stern, L, W., El-Ansary, A., I., Coughlan, A., T., et al. (2001). *Marketing Channels.* (6th ed. ed.). New Jersey., Upper Saddle River: Prentice Hall.
352. Stewart, G. (1995). Supply chain performance benchmarking study reveals keys to supply chain excellence. *Logistics Information Management , 8* (2), 38–44.
353. Stock, J., Stefanie, L., Boyer, S., & Harmon, T. (2010). Research oppotunities in supply chain management. *Journal of the Academy of Marketing Science , 38* (1), 32-41.
354. Storey, J., Emberson, C., Godsell, J., & Harrison, A. (2006). Supply chain management: theory, practice and future challenges. *International Journal of Operations & Production Management , 26* (7), 754-774.
355. Tan, K. C., Kannan, V. R., & Hanfield, R. B. (1998). Supply Chain Management: Supplier Performance and Firm Performance. *International Journal of Purchasing and Materials Management , 34* (3), 2-9.
356. Tan, K.-C., Kannan, V. R., Handfied, R. B., & Ghosh, S. (1999). Supply chain management: an empirical study of its impact on performance. *International Journal of Operations & Production Management , 9* (10), 1034-1052.
357. Tanriverdi, H. (2005). Information technology relatedness, knowledge management capability and performance of multibusiness firms. *MIS Quarterly , 29* (2), 311-34.
358. *TATA*. (2012). Retrieved January 25, 2013, from www.tata.in/company/profile.aspx?sectid=f4fpW5pl8MY=

359. Taticchi, P., Tonelli, F., & Cagnazzo, L. (2010). Performance measurement and management: a literature review and a research agenda. *Meas.Bus. Excell. , 4-18*, 4-18.
360. Taylor, F. W. (1911). *The Principles of Scientific Management.* New York: Harper Brothers.
361. Technopak Advisers. (2011). Organized Agri-Food Retailing in India by NABARD. *NABARD* .
362. The World Bank. (2013). *India Overview.* Retrieved January Saturday, 2013, from http://www.worldbank.org/en/country/india/overview
363. Thomas, D. J., & Griffin, P. M. (1996). Coordinated supply chain management. *European Journal of Operational Research , 94* (1), 1-15.
364. Towers, N., & Burnes, B. (2008). A composite framework of supply chain management and enterprise planning for small and medium-sized manufacturing enterprises. *Supply Chain Management: An International Journal , 13* (5), 349-355.
365. *TPG Creative Capital*. (2012). Retrieved January 25, 2013, from www.tpg.com
366. Tracey, M., & Tan, C. L. (2001). Empirical analysis of supplier selection and involvement, customer satisfaction, and firm performance. *Supply Chain Management: An International Journal , 6* (4), 174-188.
367. Tracey, M., Lim, J.-S., & Vonderembse, M. A. (2005). The impact of supply-chain management capabilities on business performance. *Supply Chain Management: An International Journal , 10* (3), 179-191.
368. Tyndall, G., Gopal, C., Partsch, W., & Kamauff, J. (1998). *Super-Charging Supply Chains: New Ways to Increase Value through Global Operational Excellence.* New York, NY: Wiley.
369. Van De Ven, A., & Walker, G. (1984). The Dynamics of Interorganizational Coordination. *Admistrative Science Quarterky , 29* (4), 598-621.
370. Van der Vorst, J. A. (2000). *Effective food supply chains Generating, modelling and evaluating supply chain scenarios.* Wageningen: PhD thesis, Wageningen University.
371. Van Donk, P., & Van der Vaart, T. (n.d.). A critical discussion on the theoretical and methodological advancements in supply chain integration research in Kotzab, H., Seuring, S., Mu¨ ller, M. and Reiner, G. (Eds). (H. Physica-Verlag, Ed.) *Research Methodologies in Supply Chain Management* , 31-46.

372. Van Donk, P., & Van der Vaart, T. (2005). A critical discussion on the theoretical and methodological advancements in supply chain integration research in Kotzab, H., Seuring, S., Mu¨ ller, M. and Reiner, G. (Eds). (H. Physica-Verlag, Ed.) *Research Methodologies in Supply Chain Management* , 31-46.
373. Vickery, S. K., Jayaram, J., Droge, C., & Calantone, R. (2003). The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct versus indirect relationships. *Journal of Operations Management , 21,* 523-539.
374. Voudouris, V. T. (1996). Mathematical Programming Techniques to Debottleneck the Supply Chain of Fine Chemical Industries. *Computers and Chemical Engineering , 20,* S1269-S1274.
375. Wallace, D. W., Giese, J. L., & Johnson, J. L. (2004). Customer retailer loyalty in the context of multiple channel strategies. *Journal of Retailing , 80* (4), 249-263.
376. Walters, P. G. (2008). Adding value in global B2B supply chains: strategic directions and the role of the internet as a driver of competitive advantage. *Industrial Marketing Management , 37* (1), 59-68.
377. Wang, C., Fergusson, C., Perry, D., & Antony, J. (2008). A conceptual case-based model for knowledge sharing among supply chain members. *Business Process Management Journal , 14* (2), 147-165.
378. Waweru, N. M., Hoque, Z., & Uliana, E. (2004). Management accounting change in South Africa: Case studies from retail services. *Accounting, Auditing & Accountability Journal , 17* (5), 675-704.
379. Whipple, J. M., Frankel, R., & Daugherty, P. J. (2002). Information support for alliances:performance implications. *Journal of Business Logistics , 23* (2), 67-82.
380. Williams, D. (2002). Before Performance Measurement. *Adm. Theory Prax. , 24* (3), 457-486.
381. Williamson, O. E. (1996). *The Mechanisms of Governance.* New York: The Mechanisms of Governance.
382. Williamson, O. (1975). *Markets and Hierarchies: Analysis and Antitrust Implications.* New York: The Free Press.
383. Winser, J. D. (2003). A structural equation model of supply chain management strategies and firm performance. *Journal of Business Logistics , 24* (1), 1-26.
384. Wisner, J. D., & Keah, C. T. (2000). Supply chain management and its impact on purchasing. *Journal of Supply Chain Management , 36* (4), 33-42.

385. Wortmann, J. C. (1998). *Evolution of ERP systems. International conference of the manufacturing value chain.* Troon: Kluwer Academic Publishing,.
386. Yang, C. C., & Chen, B. S. (2006). Supplier selection using combined analytical hierarchy process and grey relational analysis . *Journal of Manufacturing Technology* , 926-941.
387. Zajac, E. J., & Olsen, C. P. (1993). From Transaction Cost to Transactional Value Analysis:Implications for the study of Interorganizational Strategies. *Journal of Management Studies , 30* (1), 131-145.
388. Zhao, X., Xie, J., & Wei, J. C. (2002). The impact of forecast errors on early order commitment in a supply chain. *Decision Sciences , 33* (2), 251-280.

# APPENDIX I

## Questionnaire

***Project Topic:*** Retail Supply Chain Management: developing a performance measurement model using Key Performance Indicators

Dear Sir/Madam,

Greetings for the day.

I am Neha Grover, Doctoral Research Fellow at University of Petroleum and Energy Studies, Dehradun, is pursuing PhD, titled, "Retail Supply Chain Management: Developing a Performance Measurement Model using Key Performance Indicators (KPIs)".

***Objective of the study***: To identify the Key Performance Indicators for measuring the Retail Supply Chain Performance.

***Scope of the study***: The identified KPIs will help in developing a performance measurement model for measuring the retail supply chain performance.

***Nature of the Study***: The entire project is based on primary research having sample size more than 150 which includes industry experts such as Supply Chain Head, Value chain managers, purchase manager, logistics head, store managers, etc.

***Confidentiality***: The data provided would be used for academic purpose only.
For any queries, you may kindly contact Ms. Neha Grover at +91-9927994626 or ngrover@ddn.upes.ac.in

Kindly provide your Personal details as follows:

Your Name: ..........................................................................................

Organization Name: ................................................................................

Location: ................................................................................................

Designation: ...........................................................................................

Email ID: ................................................................................................

Contact Number: ......................................................................................................

The researcher would like to narrow down the scope of study to four Key areas of Retailers' initiatives as follows, For each key area a list of performance indicators have been identified. Kindly ***tick (✓)*** the appropriate cell as follows,

1. ***Transport Optimization***

   As it is a fact that distribution cost is a major cost component of the total supply chain cost. The vehicle routing has to be done such that the total cost of transport is optimized. We have further categorized the performance indictors into various heads as follows:

| S.No. | Performance Indicator | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| 1. | Percent of on-time deliveries is an important indicator for high service level | | | | | |
| 2. | Damages due to inefficient delivery (pilferage/ delay/ damage in transit) of the product as % of total sales should be minimal are critical for operational excellence. | | | | | |
| 3. | Proper documentation is important for delivery of goods on time | | | | | |
| 4. | Temperature control during transportation for perishable commodities is essential for perfect delivery | | | | | |
| 5. | Transport connectivity is important for high growth of business | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6. | Usage of GPS/RFID technology for track & trace is essential | | | | | |
| 7. | Vehicle optimization is highly significant for logistics operations | | | | | |
| 8. | Faster turnaround time of vehicles at loading and unloading time improves efficiency | | | | | |
| 9. | Owned vehicles are convenient and cost effective for transportation | | | | | |
| 10. | Outsourced vehicles are more efficient for transporting goods | | | | | |

### 2. *Information Technology Optimization*

Research has indicated the impact of information systems in increasing the efficiency of supply chains, in aligning supply chain strategy and business strategy and contributing to the overall organizational growth and profitability. The performance indicators for IT have been further categorized as follows:

| S.No. | Performance Indicator | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| 1. | Role of IT in efficient purchasing/inventory management | | | | | |
| 2. | EDI helps in faster exchange of data between buyer and seller | | | | | |
| 3. | Quality of the input data *(e.g via POS)* helps in demand forecasting and | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | triggering Re-order point (ROP) becomes easy | | | | | |
| 4. | Information system should be adaptable and flexible for maximizing benefits. | | | | | |
| 5. | Compliance with latest regulations of information systems is beneficial for overall functioning of organization, hence it is an important indicator for improving SC performance | | | | | |
| 6. | Real time information due to IT usage helps in reducing claims in rupee per month vs monthly turnover | | | | | |
| 7. | IT helps in easy sharing real time information with channel partners, which increases the accuracy and reliability of the acquired information | | | | | |
| 8. | Investment in IT minimizes the data maintenance and transaction cost | | | | | |

### 3. *Inventory Optimization*

The challenge of holding enough inventories in order to meet the demand, but not to incur excess cost, is a perennial supply chain management problem, therefore companies optimize inventory. The identified performance indicators are as follows:

| **S.No.** | **Performance Indicator** | **Strongly Agree** | **Agree** | **Undecided** | **Disagree** | **Strongly Disagree** |
|---|---|---|---|---|---|---|
| 1. | Inventory holding cost as % of gross sales shows an impact on overall efficiency | | | | | |
| 2. | Accuracy in forecasting sales reduces obsolete inventory | | | | | |
| 3. | Stock-outs should be minimum for better profitability | | | | | |
| 4. | FIFO is a better method for inventory valuation | | | | | |
| 5. | Inventory accuracy *((book inventory – counted inventory)/ book inventory)* gives an insight in your bookkeeping practices and helps to measure stock cover | | | | | |
| 6. | Inventory turnover (in rupees per sq. feet) is important to know the average days of inventory | | | | | |
| 7. | % of time spent picking orders/back orders impacts the level of operational efficiency | | | | | |
| 8. | Inventory replenishment cycle time helps to plan timely orders | | | | | |
| 9. | Fill rate is an important indicator in retail operations | | | | | |
| 10. | Innovation is a key parameter in Retail Supply Chain *(e.g. automation in warehouse helps to speed up the logistics operations)* | | | | | |
| 11. | Optimum number of warehouses are required | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | for maximizing service level | | | | | |
| 12. | productivity of MHE (material handling equipment) per square feet of warehouse indicates the level of warehouse efficiency | | | | | |
| 13. | Warehouse space/ layout/ future scalability/ use of MHE are critical for warehouse optimization | | | | | |
| 14. | Certification of the warehouse-ISO certificates/C-TPAT certification/TAPA certification/Accreditation by WRDA India is essential/desirable for compliance with latest regulations | | | | | |
| 15. | Electricity consumption (in Kw-hrs) per sqft of warehouse space reflects the energy efficiency, hence optimizes cost | | | | | |
| 16. | Depending on the nature of the goods, the storage facility has to be maintained *(e.g cold storage)* | | | | | |

### *4. Resource Optimization*

To maximize the return on assets, companies optimize their resources to capitalize their full potential. The identified performance indicators are as follows:

| **S.No.** | **Performance Indicator** | **Strongly Agree** | **Agree** | **Undecided** | **Disagree** | **Strongly Disagree** |
|---|---|---|---|---|---|---|
| 1. | The following cost are important for supply chain efficiency | | | | | |
| (a) | Direct labor cost, Direct material cost and Manufacturing cost | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (b) | Cost of goods sold | | | | | |
| (c) | Distribution cost and Inventory cost | | | | | |
| (d) | Information management cost | | | | | |
| (e) | Warranty cost | | | | | |
| (f) | Packaging cost | | | | | |
| (g) | Facility management/ maintenance cost | | | | | |
| 2. | Quality of packaging material used is essential for customer service | | | | | |
| 3. | Customer satisfaction is important for the growth of the business/ maximizing profit | | | | | |
| 4. | Value added employee productivity helps to measure supply chain efficiency | | | | | |
| 5. | Training employees add to their productivity | | | | | |
| 6. | Acquiring a new equipment/software/ labour *as and when* business requirement is essential for the supply chain process improvements | | | | | |
| 7. | Cargo carried in terms of volumes for fiscal year indicates the benchmark for next year | | | | | |
| 8. | Use of renewable/ solar energy/green terminals are the growing need for business efficiency | | | | | |
| 9. | The following financial ratios measures the firm's ability to meet its future requirements and also signify the business growth | | | | | |
| (a) | Receivables turnover *(Annual credit sales/Accounts* | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *receivables)* | | | | | |
| (b) | Average collection period *(Accounts receivables/ (Annual credit sales/365))* | | | | | |
| (c) | Inventory turnover (COGS/average inventory) | | | | | |
| (d) | Debt Ratio *(Total debt/ Total assets)* | | | | | |
| (e) | Debt-to-equity ratio *(Total debt/ total equity)* | | | | | |
| (f) | Interest coverage *(EBIT/ Interest charges)* | | | | | |
| (g) | Gross profit Margin *((Sales-COGS)/sales))* | | | | | |
| 10. | Return on asset (ROA) is a good measure to study the overall impact of the organization's performance | | | | | |

You may kindly suggest performance indicators which according to you were not mentioned above. Your comments are highly appreciated. Thank you so much for your cooperation. Your inputs are highly appreciated.

............................................................................................................................
......................................................

# APPENDIX II

**Testing Internal Consistency of Each Item of the Instrument**

| Variable | Commonalities | Cronbach Alpha if Item Deleted |
|---|---|---|
| TO1 | .763 | .925 |
| TO2 | .682 | .926 |
| TO3 | .732 | .925 |
| TO4 | .726 | .926 |
| TO5 | .746 | .926 |
| TO6 | .772 | .924 |
| TO7 | .637 | .925 |
| TO8 | .631 | .924 |
| TO9 | .727 | .926 |
| TO10 | .703 | .927 |
| ITO1 | .741 | .925 |
| ITO2 | .740 | .925 |
| ITO3 | .758 | .925 |
| ITO4 | .631 | .924 |
| ITO5 | .632 | .924 |
| ITO6 | .645 | .923 |
| ITO7 | .671 | .924 |
| ITO8 | .745 | .923 |
| IO1 | .553 | .925 |
| IO2 | .724 | .925 |
| IO3 | .751 | .926 |
| IO4 | .733 | .926 |
| IO5 | .655 | .923 |
| IO6 | .634 | .923 |
| IO7 | .684 | .924 |
| IO8 | .684 | .924 |
| IO9 | .722 | .924 |
| IO10 | .720 | .924 |
| IO11 | .671 | .925 |

| | | |
|---|---|---|
| IO12 | .757 | .924 |
| IO13 | .730 | .924 |
| IO14 | .638 | .925 |
| IO15 | .640 | .923 |
| IO16 | .674 | .925 |
| RO1a | .759 | .925 |
| RO1b | .698 | .926 |
| RO1c | .747 | .925 |
| RO1d | .777 | .924 |
| RO1e | .729 | .924 |
| RO2 | .696 | .925 |
| RO3 | .670 | .925 |
| RO4 | .679 | .924 |
| RO5 | .740 | .924 |
| RO6 | .688 | .924 |
| RO7 | .735 | .924 |
| RO8 | .593 | .924 |
| RO9a | .728 | .925 |
| RO9b | .709 | .925 |
| RO9c | .746 | .925 |
| RO9d | .802 | .924 |
| RO9e | .762 | .924 |
| RO1f | .581 | .924 |
| RO1g | .580 | .924 |
| RO9f | .765 | .923 |
| RO9g | .769 | .924 |
| RO10 | .619 | .927 |

# APPENDIX III

**Inter-Item Correlation Matrix for Inventory Optimization**

| | IO1 | IO2 | IO3 | IO4 | IO5 | IO6 | IO7 | IO8 | IO9 | IO10 | IO11 | IO12 | IO13 | IO14 | IO15 | IO16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IO1 | 1.000 | .230 | .108 | .173 | .188 | .239 | .077 | .335 | .128 | .174 | .185 | .192 | .162 | .189 | .178 | .199 |
| IO2 | .230 | 1.000 | .051 | .005 | .351 | .148 | .337 | .316 | .131 | .015 | .113 | .086 | .178 | .116 | .130 | .206 |
| IO3 | .108 | .051 | 1.000 | .259 | .210 | .155 | .236 | .197 | .173 | .091 | .210 | .062 | .051 | .125 | .057 | .063 |
| IO4 | .173 | .005 | .259 | 1.000 | .285 | .263 | .161 | .172 | .091 | .058 | .092 | .223 | .197 | .091 | .363 | .069 |
| IO5 | .188 | .351 | .210 | .285 | 1.000 | .388 | .375 | .340 | .223 | .277 | .291 | .363 | .277 | .238 | .378 | .202 |
| IO6 | .239 | .148 | .155 | .263 | .388 | 1.000 | .254 | .407 | .400 | .307 | .229 | .462 | .479 | .291 | .326 | .254 |
| IO7 | .077 | .337 | .236 | .161 | .375 | .254 | 1.000 | .331 | .229 | .118 | .244 | .407 | .274 | .240 | .331 | .256 |
| IO8 | .335 | .316 | .197 | .172 | .340 | .407 | .331 | 1.000 | .311 | .178 | .261 | .324 | .323 | .267 | .172 | .183 |
| IO9 | .128 | .131 | .173 | .091 | .223 | .400 | .229 | .311 | 1.000 | .360 | .255 | .296 | .318 | .177 | .277 | .351 |
| IO10 | .174 | .015 | .091 | .058 | .277 | .307 | .118 | .178 | .360 | 1.000 | .343 | .407 | .382 | .100 | .266 | .216 |
| IO11 | .185 | .113 | .210 | .092 | .291 | .229 | .244 | .261 | .255 | .343 | 1.000 | .415 | .377 | .232 | .258 | .166 |
| IO12 | .192 | .086 | .062 | .223 | .363 | .462 | .407 | .324 | .296 | .407 | .415 | 1.000 | .520 | .200 | .421 | .213 |
| IO13 | .162 | .178 | .051 | .197 | .277 | .479 | .274 | .323 | .318 | .382 | .377 | .520 | 1.000 | .155 | .421 | .202 |
| IO14 | .189 | .116 | .125 | .091 | .238 | .291 | .240 | .267 | .177 | .100 | .232 | .200 | .155 | 1.000 | .172 | .239 |
| IO15 | .178 | .130 | .057 | .363 | .378 | .326 | .331 | .172 | .277 | .266 | .258 | .421 | .421 | .172 | 1.000 | .259 |
| IO16 | .199 | .206 | .063 | .069 | .202 | .254 | .256 | .183 | .351 | .216 | .166 | .213 | .202 | .239 | .259 | 1.000 |

# APPENDIX IV

## Inter-Item Correlation Matrix for Resource Optimization

| | RO1a | RO1b | RO1c | RO1d | RO1e | RO2 | RO3 | RO4 | RO5 | RO6 | RO7 | RO8 | RO9a | RO9b | RO9c | RO9d | RO9e | RO1f | RO1g | RO9f | RO9g | RO10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RO1a | 1.000 | .433 | .025 | .151 | .216 | .193 | .224 | .164 | .235 | .236 | .272 | .209 | .089 | .216 | -.019 | .188 | .205 | .306 | .346 | .219 | .154 | .110 |
| RO1b | .433 | 1.000 | .295 | .188 | .301 | .096 | .019 | .120 | .003 | .211 | .174 | .165 | .161 | .117 | .048 | .229 | .258 | .123 | .173 | .248 | .105 | .009 |
| RO1c | .025 | .295 | 1.000 | .352 | .286 | .097 | .095 | .215 | .151 | .119 | .144 | .203 | .226 | .153 | .411 | .398 | .315 | .149 | .290 | .293 | .362 | .026 |
| RO1d | .151 | .188 | .352 | 1.000 | .442 | .204 | .117 | .439 | .297 | .182 | .207 | .168 | .123 | .174 | .080 | .136 | .131 | .379 | .318 | .213 | .152 | .067 |
| RO1e | .216 | .301 | .286 | .442 | 1.000 | .183 | -.030 | .242 | .149 | .212 | .218 | .254 | .236 | .146 | .093 | .352 | .287 | .324 | .371 | .269 | .228 | .051 |
| RO2 | .193 | .096 | .097 | .204 | .183 | 1.000 | .407 | .199 | .227 | .261 | .295 | .063 | .229 | .248 | .214 | .129 | .120 | .303 | .160 | .187 | .222 | -.018 |
| RO3 | .224 | .019 | .095 | .117 | -.030 | .407 | 1.000 | .404 | .393 | .274 | .202 | .114 | .100 | .197 | .178 | .000 | .065 | .178 | .223 | .136 | .249 | -.011 |
| RO4 | .164 | .120 | .215 | .439 | .242 | .199 | .404 | 1.000 | .483 | .311 | .226 | .245 | .088 | .101 | .177 | .198 | .215 | .230 | .340 | .342 | .263 | .163 |
| RO5 | .235 | .003 | .151 | .297 | .149 | .227 | .393 | .483 | 1.000 | .479 | .321 | .176 | .140 | .218 | .083 | .112 | .134 | .256 | .303 | .173 | .315 | .128 |
| RO6 | .236 | .211 | .119 | .182 | .212 | .261 | .274 | .311 | .479 | 1.000 | .424 | .109 | .154 | .232 | .040 | .201 | .258 | .206 | .270 | .250 | .334 | -.007 |
| RO7 | .272 | .174 | .144 | .207 | .218 | .295 | .202 | .226 | .321 | .424 | 1.000 | .290 | .173 | .263 | -.076 | .091 | .152 | .269 | .309 | .219 | .125 | -.033 |
| RO8 | .209 | .165 | .203 | .168 | .254 | .063 | .114 | .245 | .176 | .109 | .290 | 1.000 | .096 | .251 | .115 | .230 | .277 | .297 | .291 | .420 | .287 | .031 |
| RO9a | .089 | .161 | .226 | .123 | .236 | .229 | .100 | .088 | .140 | .154 | .173 | .096 | 1.000 | .424 | .175 | .240 | .256 | .197 | .194 | .303 | .315 | .034 |
| RO9b | .216 | .117 | .153 | .174 | .146 | .248 | .197 | .101 | .218 | .232 | .263 | .251 | .424 | 1.000 | .319 | .124 | .159 | .336 | .254 | .247 | .331 | .012 |
| RO9c | -.019 | .048 | .411 | .080 | .093 | .214 | .178 | .177 | .083 | .040 | -.076 | .115 | .175 | .319 | 1.000 | .456 | .360 | .116 | .139 | .360 | .499 | .110 |
| RO9d | .188 | .229 | .398 | .136 | .352 | .129 | .000 | .198 | .112 | .201 | .091 | .230 | .240 | .124 | .456 | 1.000 | .695 | .219 | .235 | .606 | .557 | .242 |
| RO9e | .205 | .258 | .315 | .131 | .287 | .120 | .065 | .215 | .134 | .258 | .152 | .277 | .256 | .159 | .360 | .695 | 1.000 | .302 | .352 | .651 | .559 | .301 |
| RO1f | .306 | .123 | .149 | .379 | .324 | .303 | .178 | .230 | .256 | .206 | .269 | .297 | .197 | .336 | .116 | .219 | .302 | 1.000 | .437 | .276 | .321 | .039 |
| RO1g | .346 | .173 | .290 | .318 | .371 | .160 | .223 | .340 | .303 | .270 | .309 | .291 | .194 | .254 | .139 | .235 | .352 | .437 | 1.000 | .326 | .308 | .097 |
| RO9f | .219 | .248 | .293 | .213 | .269 | .187 | .136 | .342 | .173 | .250 | .219 | .420 | .303 | .247 | .360 | .606 | .651 | .276 | .326 | 1.000 | .609 | .230 |
| RO9g | .154 | .105 | .362 | .152 | .228 | .222 | .249 | .263 | .315 | .334 | .125 | .287 | .315 | .331 | .499 | .557 | .559 | .321 | .308 | .609 | 1.000 | .328 |
| RO10 | .110 | .009 | .026 | .067 | .051 | -.018 | -.011 | .163 | .128 | -.007 | -.033 | .031 | .034 | .012 | .110 | .242 | .301 | .039 | .097 | .230 | .328 | 1.000 |

# APPENDIX V

**Total Variance Explained**

| Total Variance Explained | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Initial Eigen values | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 10.748 | 22.392 | 22.392 | 10.748 | 22.392 | 22.392 | 3.412 | 7.109 | 7.109 |
| 2 | 2.531 | 5.272 | 27.664 | 2.531 | 5.272 | 27.664 | 2.612 | 5.441 | 12.550 |
| 3 | 2.274 | 4.738 | 32.402 | 2.274 | 4.738 | 32.402 | 2.521 | 5.251 | 17.801 |
| 4 | 2.1016 | 4.199 | 36.601 | 2.016 | 4.199 | 36.601 | 2.495 | 5.197 | 22.999 |
| 5 | 1.875 | 3.905 | 40.506 | 1.875 | 3.905 | 40.506 | 2.461 | 5.127 | 28.126 |
| 6 | 1.832 | 3.818 | 44.324 | 1.832 | 3.818 | 44.324 | 2.415 | 5.031 | 33.157 |
| 7 | 1.581 | 3.295 | 47.618 | 1.581 | 3.295 | 47.618 | 2.300 | 4.791 | 37.948 |
| 8 | 1.467 | 3.055 | 50.674 | 1.467 | 3.055 | 50.674 | 2.176 | 4.533 | 42.481 |
| 9 | 1.437 | 2.993 | 53.666 | 1.437 | 2.993 | 53.666 | 2.099 | 4.373 | 46.853 |
| 10 | 1.386 | 2.887 | 56.553 | 1.386 | 2.887 | 56.553 | 1.961 | 4.085 | 50.938 |
| 11 | 1.230 | 2.562 | 59.115 | 1.230 | 2.562 | 59.115 | 1.751 | 3.647 | 54.585 |
| 12 | 1.203 | 2.506 | 61.621 | 1.203 | 2.506 | 61.621 | 1.705 | 3.553 | 58.138 |
| 13 | 1.126 | 2.345 | 63.966 | 1.126 | 2.345 | 63.966 | 1.699 | 3.540 | 61.678 |
| 14 | 1.077 | 2.245 | 66.211 | 1.077 | 2.245 | 66.211 | 1.690 | 3.520 | 65.199 |
| 15 | 1.024 | 2.133 | 68.344 | 1.024 | 2.133 | 68.344 | 1.510 | 3.145 | **68.344** |
| 16 | .955 | 1.990 | 70.334 | | | | | | |
| 17 | .894 | 1.862 | 72.197 | | | | | | |
| 18 | .858 | 1.787 | 73.984 | | | | | | |
| 19 | .827 | 1.724 | 75.708 | | | | | | |
| 20 | .792 | 1.649 | 77.357 | | | | | | |
| 21 | .788 | 1.642 | 78.999 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 22 | .734 | 1.530 | 80.528 | | | | | | |
| 23 | .700 | 1.459 | 81.987 | | | | | | |
| 24 | .667 | 1.389 | 83.376 | | | | | | |
| 25 | .638 | 1.330 | 84.706 | | | | | | |
| 26 | .582 | 1.212 | 85.919 | | | | | | |
| 27 | .543 | 1.132 | 87.050 | | | | | | |
| 28 | .526 | 1.096 | 88.146 | | | | | | |
| 29 | .491 | 1.023 | 89.169 | | | | | | |
| 30 | .483 | 1.007 | 90.176 | | | | | | |
| 31 | .458 | .954 | 91.129 | | | | | | |
| 32 | .436 | .909 | 92.038 | | | | | | |
| 33 | .369 | .769 | 92.806 | | | | | | |
| 34 | .354 | .737 | 93.543 | | | | | | |
| 35 | .338 | .705 | 94.248 | | | | | | |
| 36 | .326 | .678 | 94.926 | | | | | | |
| 37 | .301 | .626 | 95.552 | | | | | | |
| 38 | .282 | .587 | 96.139 | | | | | | |
| 39 | .260 | .542 | 96.682 | | | | | | |
| 40 | .237 | .493 | 97.175 | | | | | | |
| 41 | .222 | .463 | 97.638 | | | | | | |
| 42 | .212 | .441 | 98.078 | | | | | | |
| 43 | .197 | .410 | 98.489 | | | | | | |
| 44 | .185 | .385 | 98.874 | | | | | | |
| 45 | .157 | .327 | 99.201 | | | | | | |
| 46 | .150 | .313 | 99.514 | | | | | | |
| 47 | .129 | .269 | 99.783 | | | | | | |
| 48 | .104 | .217 | 100.000 | | | | | | |

# APPENDIX VI

## Rotated Component Matrix

| | Component | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TO1 | .306 | -.134 | -.095 | .059 | -.079 | .008 | .631 | .234 | -.046 | -.008 | -.043 | -.102 | .328 | .130 | .131 |
| TO2 | -.026 | .091 | .050 | -.083 | .127 | .005 | .131 | .108 | .084 | .045 | .044 | -.031 | .766 | .003 | .056 |
| TO3 | -.212 | -.031 | .169 | .120 | .247 | .110 | .271 | .210 | -.011 | .131 | -.011 | .505 | .111 | .061 | -.078 |
| TO4 | -.059 | .048 | -.009 | -.139 | .056 | .680 | .233 | -.020 | .326 | .071 | -.158 | .071 | .057 | -.144 | .100 |
| TO5 | -.153 | .111 | .149 | .099 | .069 | .165 | .790 | -.010 | .033 | .048 | -.035 | .032 | .073 | -.031 | .052 |
| TO6 | .015 | -.011 | -.063 | .315 | .198 | .569 | .056 | .175 | .180 | .028 | .241 | -.025 | .232 | .298 | -.145 |
| TO7 | .098 | -.164 | .234 | .197 | .522 | .198 | .293 | -.218 | .081 | .320 | -.007 | .052 | .229 | .026 | .178 |
| TO8 | .153 | -.018 | .523 | .083 | .057 | .396 | .298 | -.062 | .230 | .138 | .045 | .262 | -.083 | .076 | -.064 |
| TO9 | .154 | .031 | .147 | .006 | .078 | .035 | -.072 | -.020 | .030 | .205 | .769 | -.006 | .040 | .022 | .080 |
| TO10 | .152 | .031 | -.001 | -.003 | .037 | -.060 | -.053 | .041 | .005 | .036 | .012 | .770 | -.078 | .001 | .113 |
| ITO1 | .259 | .278 | .127 | -.073 | .111 | .075 | .553 | .097 | .212 | .034 | .071 | .171 | -.099 | .167 | -.297 |
| ITO2 | .370 | .033 | .231 | -.012 | .155 | .245 | -.057 | .468 | -.030 | -.220 | -.111 | .030 | .306 | .102 | -.295 |
| ITO3 | .103 | .789 | .107 | -.056 | -.005 | .088 | -.056 | .115 | .085 | .017 | -.177 | -.093 | .099 | .148 | .128 |
| ITO4 | .219 | .258 | -.027 | .214 | .100 | .150 | .172 | .010 | .549 | -.089 | .079 | .144 | .281 | .024 | .036 |
| ITO5 | .118 | .070 | .456 | -.016 | .303 | -.041 | .287 | .088 | -.001 | .266 | -.093 | .135 | .179 | .320 | -.139 |
| ITO6 | .442 | .264 | .304 | .097 | -.020 | .263 | .092 | .027 | .083 | .163 | .011 | .202 | .284 | .140 | .026 |
| ITO7 | .468 | .342 | .107 | .171 | -.083 | .133 | .177 | -.060 | .189 | .068 | .056 | .417 | .154 | .034 | .113 |
| ITO8 | .343 | .482 | -.004 | .111 | .125 | -.020 | .272 | .086 | .266 | .007 | .371 | .109 | -.109 | .094 | .044 |
| IO1 | .155 | .073 | .038 | .030 | -.153 | .103 | .199 | .088 | .317 | .449 | .097 | -.088 | .228 | .136 | .158 |
| IO2 | -.057 | .165 | .676 | .005 | -.139 | .043 | .139 | -.071 | .276 | -.005 | .075 | -.109 | .201 | -.005 | .275 |
| IO3 | .022 | .008 | .102 | .142 | .017 | -.006 | .108 | -.025 | .059 | .063 | -.027 | .012 | .003 | .847 | .006 |
| IO4 | .068 | -.048 | .075 | .701 | -.041 | -.123 | .147 | .037 | .083 | .169 | .181 | -.083 | -.218 | .228 | -.009 |
| IO5 | .207 | .144 | .376 | .487 | .239 | .085 | .123 | -.046 | .282 | -.039 | .146 | .236 | .189 | .135 | .001 |
| IO6 | .276 | .165 | .159 | .556 | .192 | .114 | -.083 | .116 | .319 | .324 | -.139 | .211 | -.169 | .022 | .110 |
| IO7 | .142 | .095 | .741 | .041 | .153 | .093 | -.006 | .125 | -.009 | .122 | .076 | .077 | -.077 | .101 | -.091 |
| IO8 | .102 | -.010 | .287 | .065 | .176 | .159 | -.020 | .108 | .676 | .207 | -.007 | -.028 | -.005 | .133 | -.021 |
| IO9 | .316 | .117 | .186 | .060 | .250 | .319 | -.102 | .235 | .166 | .022 | -.439 | -.060 | -.159 | .207 | .267 |
| IO10 | .761 | .156 | -.144 | .036 | .166 | .079 | .171 | .023 | .094 | -.007 | -.051 | .026 | .104 | .046 | .108 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IO11 | .473 | .185 | .102 | -.132 | .310 | .021 | -.108 | -.177 | .054 | .251 | .221 | -.033 | -.100 | .318 | .162 |
| IO12 | .635 | -.004 | .317 | .193 | .229 | -.044 | -.125 | .090 | .059 | .297 | .098 | -.069 | -.049 | -.092 | -.054 |
| IO13 | .574 | .043 | .246 | .132 | .017 | .070 | -.083 | .148 | .246 | .078 | .193 | .195 | -.175 | -.048 | .227 |
| IO14 | .071 | -.005 | .111 | .079 | .023 | .526 | -.135 | -.025 | .022 | .503 | .111 | .092 | -.016 | .117 | -.153 |
| IO15 | .437 | .126 | .266 | .357 | .186 | .046 | .049 | .332 | -.077 | -.001 | .207 | .122 | -.102 | -.022 | .053 |
| IO16 | .196 | .157 | .265 | .148 | .019 | .626 | .132 | .021 | -.141 | .027 | -.035 | -.163 | -.049 | -.061 | .260 |
| RO1a | .169 | .141 | .004 | .187 | .060 | .054 | .203 | .643 | .298 | .174 | -.156 | -.183 | -.060 | -.138 | -.143 |
| RO1b | -.017 | .105 | .015 | .015 | .008 | -.049 | .071 | .753 | -.037 | .115 | .015 | .188 | .130 | .027 | .208 |
| RO1c | .257 | .078 | .019 | .007 | .166 | .105 | .033 | .143 | .026 | .061 | .072 | .161 | .081 | .047 | .790 |
| RO1d | .129 | -.059 | .012 | .196 | .686 | .251 | -.063 | .192 | -.062 | -.010 | -.017 | .166 | .025 | .214 | .181 |
| RO1e | .004 | .076 | .156 | .155 | .150 | .220 | -.171 | .445 | .113 | .046 | .305 | .128 | .080 | .443 | .176 |
| RO2 | -.011 | .277 | .043 | .695 | .063 | .144 | -.045 | -.006 | .010 | .051 | -.204 | .077 | .268 | -.077 | .014 |
| RO3 | .159 | .522 | .045 | .202 | .274 | -.011 | -.091 | -.117 | .355 | .192 | -.313 | -.080 | .251 | -.140 | -.074 |
| RO4 | .245 | .192 | .088 | .011 | .675 | -.018 | .086 | .034 | .212 | .139 | .002 | .076 | .154 | -.024 | .035 |
| RO5 | .047 | .440 | .162 | .156 | .583 | .035 | .158 | -.037 | .228 | -.001 | .241 | -.070 | .039 | -.118 | -.033 |
| RO6 | .134 | .665 | .125 | .192 | .189 | .035 | .131 | .154 | -.052 | .079 | .190 | .182 | .024 | -.122 | -.045 |
| RO7 | .072 | .385 | -.041 | .284 | .127 | .042 | .164 | .074 | -.068 | .623 | .168 | .149 | -.011 | .006 | -.024 |
| RO8 | .069 | -.083 | .268 | .071 | .128 | .090 | -.010 | .228 | .162 | .498 | .090 | .062 | .008 | .035 | .109 |
| RO1f | .200 | -.015 | -.039 | .568 | .227 | .199 | .052 | .188 | .149 | .111 | -.013 | .077 | -.154 | .144 | .022 |
| RO1g | .192 | .119 | -.013 | .267 | .261 | .468 | .110 | .254 | .285 | .188 | .166 | -.069 | -.046 | .100 | .119 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 16 iterations.

# APPENDIX VII

## Rotated Component Matrix

**Rotated Component Matrix[a]**

| | Component | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| TO1 | .223 | .186 | -.178 | .047 | .548 | .036 | -.075 | -.116 | .111 | -.006 | .161 | .465 | -.119 | -.108 | .089 | .053 | -.183 |
| TO2 | .011 | -.079 | .132 | -.096 | .055 | .011 | .130 | .109 | .058 | .022 | .108 | .763 | .052 | .076 | .019 | .088 | -.043 |
| TO3 | -.053 | -.124 | -.098 | .049 | .215 | .081 | .221 | .129 | .640 | .072 | .117 | .110 | .038 | .086 | .041 | .154 | .329 |
| TO4 | -.028 | -.032 | .047 | -.054 | .191 | .753 | .059 | .043 | -.023 | .092 | .018 | .113 | .223 | -.117 | -.128 | -.052 | .077 |
| TO5 | -.001 | -.159 | .031 | .140 | .713 | .258 | .105 | .219 | .132 | -.082 | .039 | .120 | -.043 | .010 | -.064 | -.140 | -.024 |
| TO6 | -.031 | -.035 | .013 | .348 | .077 | .474 | .180 | -.100 | -.035 | .157 | .123 | .193 | .206 | .272 | .336 | .259 | -.041 |
| TO7 | .077 | .104 | -.143 | .242 | .248 | .211 | .425 | .252 | -.080 | .258 | -.115 | .244 | .039 | -.017 | .007 | -.200 | .054 |
| TO8 | -.037 | .193 | -.016 | .113 | .345 | .379 | .057 | .388 | .135 | .234 | -.041 | -.083 | .126 | .044 | .108 | .062 | .220 |
| TO9 | .104 | .232 | -.033 | .022 | -.038 | -.014 | .071 | .134 | -.162 | .197 | .040 | .041 | .011 | .749 | .031 | -.074 | .013 |
| TO10 | .186 | .116 | -.001 | -.008 | .021 | -.046 | .080 | -.039 | .004 | .063 | .095 | -.074 | -.010 | .001 | -.015 | -.009 | .791 |
| ITO1 | .006 | .157 | .249 | -.037 | .701 | .040 | .078 | .074 | -.032 | .070 | .026 | -.081 | .217 | .078 | .163 | .169 | .165 |
| ITO2 | -.005 | .226 | .092 | .005 | .063 | .117 | .112 | .103 | -.049 | .008 | .289 | .192 | .037 | -.089 | .095 | .706 | -.004 |
| ITO3 | .167 | .085 | .794 | -.058 | .019 | .093 | .001 | .113 | -.035 | -.044 | .154 | .041 | .065 | -.118 | .137 | .000 | -.055 |
| ITO4 | .171 | .191 | .224 | .233 | .188 | .182 | .038 | .002 | .054 | -.082 | -.033 | .358 | .471 | .090 | .014 | .053 | .136 |
| ITO5 | .001 | .124 | .051 | .047 | .352 | -.102 | .380 | .441 | .139 | .163 | .077 | .117 | .016 | -.065 | .229 | .121 | .032 |
| ITO6 | .034 | .435 | .270 | .189 | .189 | .228 | .055 | .339 | -.090 | .078 | .127 | .216 | -.017 | .011 | .147 | .065 | .193 |
| ITO7 | .237 | .447 | .281 | .175 | .244 | .146 | -.089 | .105 | .116 | -.001 | -.036 | .188 | .075 | .087 | .027 | .012 | .377 |
| ITO8 | .188 | .402 | .371 | .067 | .326 | .008 | .036 | -.031 | .243 | -.128 | .027 | -.023 | .224 | .401 | .088 | -.020 | .040 |
| IO1 | -.018 | .239 | .101 | .052 | .185 | .129 | -.105 | .118 | .102 | .275 | .207 | .275 | .229 | .067 | .159 | -.325 | -.124 |
| IO2 | .172 | .030 | .120 | -.008 | .075 | .122 | -.073 | .749 | -.019 | -.034 | .016 | .181 | .166 | .056 | -.008 | -.132 | -.099 |
| IO3 | .134 | .017 | -.026 | .127 | .123 | -.063 | .041 | .076 | .090 | .080 | -.047 | .046 | .049 | -.041 | .816 | .034 | -.004 |
| IO4 | .072 | .131 | -.111 | .712 | .145 | -.141 | -.017 | .084 | .038 | .049 | .054 | -.191 | .085 | .169 | .190 | -.116 | -.119 |
| IO5 | .236 | .174 | .128 | .343 | .147 | .056 | .215 | .315 | .061 | .061 | -.122 | .187 | .260 | .163 | .142 | .190 | .240 |
| IO6 | .159 | .364 | .174 | .315 | -.030 | .099 | .175 | .091 | .229 | .261 | .080 | -.140 | .331 | -.102 | .012 | -.032 | .171 |
| IO7 | .116 | .188 | .090 | .016 | .045 | .020 | .131 | .618 | .129 | .276 | .015 | -.128 | -.015 | .092 | .081 | .314 | .044 |
| IO8 | -.018 | .191 | .051 | .066 | .018 | .187 | .138 | .291 | .070 | .212 | .086 | .017 | .649 | .001 | .151 | -.011 | -.019 |
| IO9 | .189 | .373 | .142 | .055 | -.094 | .345 | .257 | .102 | .074 | .058 | .194 | -.115 | .130 | -.436 | .171 | .125 | -.081 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IO10 | .238 | .644 | .180 | .003 | .245 | .074 | .133 | -.242 | -.072 | .007 | -.048 | .189 | .065 | -.082 | .062 | .119 | .037 |
| IO11 | .126 | .522 | .207 | -.112 | -.024 | .015 | .322 | .076 | -.105 | .158 | -.090 | -.071 | -.018 | .186 | .326 | -.164 | -.005 |
| IO12 | .004 | .704 | .048 | .153 | -.042 | -.118 | .189 | .181 | .095 | .282 | -.018 | -.038 | .094 | .088 | -.069 | .178 | -.093 |
| IO13 | .136 | .720 | -.028 | .117 | -.042 | .101 | .027 | .182 | .068 | -.015 | .137 | -.102 | .218 | .154 | -.053 | .017 | .159 |
| IO14 | .088 | .046 | .061 | .074 | -.071 | .382 | .003 | .046 | .118 | .622 | -.078 | -.049 | .011 | .124 | .188 | .049 | .061 |
| IO15 | .361 | .391 | .078 | .332 | .105 | -.011 | .167 | .150 | .032 | .069 | .237 | -.106 | -.082 | .163 | -.052 | .255 | .067 |
| IO16 | .329 | .191 | .095 | .086 | .059 | .608 | .052 | .186 | .124 | .059 | -.050 | -.054 | -.136 | -.001 | -.045 | .093 | -.222 |
| RO1a | .118 | .121 | .155 | .212 | .280 | .031 | .001 | -.060 | .019 | .188 | .500 | -.041 | .353 | -.147 | -.196 | .230 | -.232 |
| RO1b | .143 | .019 | .065 | .033 | .073 | -.042 | .049 | .005 | .095 | .050 | .783 | .113 | -.012 | .000 | -.037 | .084 | .128 |
| RO1c | .315 | .426 | .004 | -.045 | -.113 | .260 | .241 | .052 | .133 | -.130 | .313 | .203 | -.098 | .047 | .025 | -.345 | .134 |
| RO1d | .024 | .181 | -.032 | .194 | -.072 | .221 | .719 | -.051 | .128 | -.020 | .228 | -.022 | -.028 | .019 | .186 | .131 | .094 |
| RO1e | .166 | .087 | .039 | .141 | -.163 | .172 | .180 | .148 | .148 | .031 | .492 | .012 | .116 | .306 | .423 | .103 | .043 |
| RO2 | .063 | -.039 | .322 | .687 | -.083 | .125 | .081 | .074 | .125 | -.026 | .011 | .184 | .013 | -.139 | -.048 | .028 | .088 |
| RO3 | -.020 | .152 | .529 | .233 | -.047 | .013 | .210 | .072 | .018 | .114 | -.143 | .238 | .314 | -.230 | -.135 | -.005 | -.018 |
| RO4 | .181 | .183 | .260 | .016 | .147 | -.024 | .655 | .053 | -.035 | .128 | .027 | .141 | .210 | .009 | -.043 | .024 | .078 |
| RO5 | .119 | .082 | .416 | .111 | .150 | .047 | .473 | .090 | .194 | .021 | -.166 | .081 | .236 | .321 | -.150 | .114 | -.111 |
| RO6 | .142 | .152 | .601 | .174 | .178 | .014 | .115 | .060 | .211 | .053 | .076 | .025 | -.070 | .284 | -.159 | .153 | .127 |
| RO7 | -.052 | .143 | .381 | .353 | .237 | -.016 | .167 | -.031 | .116 | .431 | .178 | -.024 | -.087 | .217 | -.029 | -.247 | .095 |
| RO8 | .263 | .101 | -.078 | .049 | .022 | .004 | .123 | .161 | .070 | .633 | .147 | .068 | .164 | .063 | -.014 | .016 | .027 |
| RO9a | .207 | .013 | .165 | .031 | .045 | .005 | -.029 | .094 | .747 | .023 | .116 | -.049 | .055 | -.079 | .167 | -.179 | -.028 |
| RO9b | .152 | .228 | .028 | .271 | -.017 | .071 | .006 | -.080 | .654 | .197 | -.009 | .167 | .021 | -.150 | -.073 | .032 | -.156 |
| RO9c | .540 | .146 | .014 | -.003 | -.163 | .292 | .054 | .074 | .173 | -.063 | -.142 | .386 | -.002 | -.285 | .075 | -.134 | .064 |
| RO9d | .809 | .012 | .045 | .066 | -.016 | .182 | .014 | .170 | -.003 | .045 | .226 | .078 | -.101 | .063 | .031 | -.059 | .016 |
| RO9e | .775 | .147 | .065 | .106 | .160 | .001 | -.010 | .103 | .069 | .046 | .144 | -.073 | -.007 | .131 | .108 | .017 | .160 |
| RO1f | .200 | .188 | -.009 | .554 | .074 | .156 | .181 | -.123 | .138 | .182 | .105 | -.115 | .128 | -.015 | .121 | .109 | .027 |
| RO1g | .202 | .228 | .100 | .232 | .127 | .338 | .210 | -.074 | .133 | .191 | .194 | -.008 | .291 | .195 | .109 | .050 | -.120 |
| RO9f | .723 | .096 | .128 | .094 | .093 | -.060 | .081 | .080 | .043 | .333 | .122 | .101 | .062 | -.056 | .165 | .035 | .096 |
| RO9g | .744 | .195 | .145 | .079 | -.082 | .078 | .074 | -.060 | .242 | .136 | -.112 | .053 | .156 | .035 | -.025 | .068 | .070 |
| RO10 | .519 | -.008 | -.019 | -.035 | .024 | -.209 | .222 | -.115 | -.087 | -.224 | -.047 | -.228 | .337 | .037 | -.052 | -.036 | -.104 |
| EV* | 4.122 | 3.810 | 2.588 | 2.554 | 2.495 | 2.449 | 2.388 | 2.234 | 2.075 | 2.026 | 1.983 | 1.967 | 1.894 | 1.873 | 1.691 | 1.542 | 1.533 |
| EV/TV<br>** | 0.105<br>094 | 0.097<br>132 | 0.065<br>986 | 0.065<br>115 | 0.063<br>599 | 0.062<br>432 | 0.060<br>883 | 0.056<br>966 | 0.052<br>906 | 0.051<br>642 | 0.050<br>548 | 0.050<br>153 | 0.048<br>291 | 0.0477<br>44 | 0.04309<br>8 | 0.0393<br>2 | 0.0390<br>91 |

EV* = Eigen value                EV/TV** = Eigen value/total sum of Eigen values

# APPENDIX VIII

### Cumulative Score for Factors

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0121 | 0.0090 | 0.0122 | 0.0009 | 0.1204 | 0.0005 | 0.0023 | 0.0060 | 0.0059 | 0.0000 | 0.0131 | 0.1098 | 0.0075 | 0.0062 | 0.0047 | 0.0018 | 0.0218 |
| 0.0000 | 0.0017 | 0.0067 | 0.0036 | 0.0012 | 0.0000 | 0.0071 | 0.0053 | 0.0016 | 0.0002 | 0.0059 | 0.2962 | 0.0014 | 0.0031 | 0.0002 | 0.0050 | 0.0012 |
| 0.0007 | 0.0041 | 0.0037 | 0.0010 | 0.0186 | 0.0027 | 0.0205 | 0.0074 | 0.1977 | 0.0026 | 0.0069 | 0.0062 | 0.0007 | 0.0040 | 0.0010 | 0.0154 | 0.0704 |
| 0.0002 | 0.0003 | 0.0008 | 0.0012 | 0.0146 | 0.2314 | 0.0015 | 0.0008 | 0.0003 | 0.0042 | 0.0002 | 0.0065 | 0.0263 | 0.0074 | 0.0096 | 0.0017 | 0.0039 |
| 0.0000 | 0.0066 | 0.0004 | 0.0077 | 0.2036 | 0.0272 | 0.0047 | 0.0216 | 0.0084 | 0.0033 | 0.0008 | 0.0073 | 0.0010 | 0.0001 | 0.0024 | 0.0127 | 0.0004 |
| 0.0002 | 0.0003 | 0.0001 | 0.0474 | 0.0024 | 0.0919 | 0.0136 | 0.0045 | 0.0006 | 0.0122 | 0.0076 | 0.0189 | 0.0223 | 0.0394 | 0.0666 | 0.0435 | 0.0011 |
| 0.0014 | 0.0028 | 0.0080 | 0.0229 | 0.0247 | 0.0182 | 0.0758 | 0.0284 | 0.0031 | 0.0328 | 0.0067 | 0.0303 | 0.0008 | 0.0001 | 0.0000 | 0.0259 | 0.0019 |
| 0.0003 | 0.0098 | 0.0001 | 0.0050 | 0.0477 | 0.0585 | 0.0014 | 0.0674 | 0.0088 | 0.0270 | 0.0008 | 0.0035 | 0.0084 | 0.0010 | 0.0069 | 0.0025 | 0.0316 |
| 0.0026 | 0.0141 | 0.0004 | 0.0002 | 0.0006 | 0.0001 | 0.0021 | 0.0081 | 0.0126 | 0.0192 | 0.0008 | 0.0008 | 0.0001 | 0.2999 | 0.0006 | 0.0035 | 0.0001 |
| 0.0084 | 0.0035 | 0.0000 | 0.0000 | 0.0002 | 0.0009 | 0.0027 | 0.0007 | 0.0000 | 0.0020 | 0.0046 | 0.0028 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.4078 |
| 0.0000 | 0.0065 | 0.0240 | 0.0005 | 0.1969 | 0.0007 | 0.0025 | 0.0025 | 0.0005 | 0.0024 | 0.0003 | 0.0033 | 0.0249 | 0.0032 | 0.0157 | 0.0184 | 0.0178 |
| 0.0000 | 0.0134 | 0.0033 | 0.0000 | 0.0016 | 0.0056 | 0.0053 | 0.0047 | 0.0012 | 0.0000 | 0.0422 | 0.0186 | 0.0007 | 0.0042 | 0.0054 | 0.3234 | 0.0000 |
| 0.0067 | 0.0019 | 0.2433 | 0.0013 | 0.0001 | 0.0035 | 0.0000 | 0.0057 | 0.0006 | 0.0010 | 0.0120 | 0.0009 | 0.0022 | 0.0074 | 0.0111 | 0.0000 | 0.0020 |
| 0.0071 | 0.0095 | 0.0193 | 0.0213 | 0.0142 | 0.0136 | 0.0006 | 0.0000 | 0.0014 | 0.0033 | 0.0006 | 0.0652 | 0.1171 | 0.0044 | 0.0001 | 0.0019 | 0.0120 |
| 0.0000 | 0.0040 | 0.0010 | 0.0009 | 0.0496 | 0.0042 | 0.0605 | 0.0872 | 0.0093 | 0.0132 | 0.0030 | 0.0069 | 0.0001 | 0.0022 | 0.0311 | 0.0095 | 0.0007 |
| 0.0003 | 0.0496 | 0.0282 | 0.0140 | 0.0142 | 0.0211 | 0.0013 | 0.0516 | 0.0039 | 0.0030 | 0.0082 | 0.0238 | 0.0002 | 0.0001 | 0.0127 | 0.0028 | 0.0244 |
| 0.0136 | 0.0525 | 0.0304 | 0.0119 | 0.0239 | 0.0087 | 0.0033 | 0.0049 | 0.0065 | 0.0000 | 0.0007 | 0.0179 | 0.0030 | 0.0040 | 0.0004 | 0.0001 | 0.0928 |
| 0.0085 | 0.0424 | 0.0533 | 0.0018 | 0.0426 | 0.0000 | 0.0005 | 0.0004 | 0.0284 | 0.0081 | 0.0004 | 0.0003 | 0.0266 | 0.0857 | 0.0045 | 0.0003 | 0.0010 |
| 0.0001 | 0.0150 | 0.0039 | 0.0010 | 0.0137 | 0.0068 | 0.0046 | 0.0062 | 0.0050 | 0.0373 | 0.0216 | 0.0384 | 0.0276 | 0.0024 | 0.0149 | 0.0684 | 0.0100 |
| 0.0072 | 0.0002 | 0.0055 | 0.0000 | 0.0022 | 0.0061 | 0.0022 | 0.2511 | 0.0002 | 0.0006 | 0.0001 | 0.0167 | 0.0146 | 0.0017 | 0.0000 | 0.0112 | 0.0064 |
| 0.0043 | 0.0001 | 0.0003 | 0.0063 | 0.0060 | 0.0016 | 0.0007 | 0.0026 | 0.0039 | 0.0031 | 0.0011 | 0.0011 | 0.0013 | 0.0009 | 0.3938 | 0.0008 | 0.0000 |
| 0.0013 | 0.0045 | 0.0048 | 0.1986 | 0.0085 | 0.0081 | 0.0001 | 0.0032 | 0.0007 | 0.0012 | 0.0015 | 0.0185 | 0.0038 | 0.0153 | 0.0213 | 0.0088 | 0.0093 |
| 0.0135 | 0.0079 | 0.0063 | 0.0461 | 0.0087 | 0.0013 | 0.0193 | 0.0444 | 0.0018 | 0.0018 | 0.0075 | 0.0178 | 0.0356 | 0.0142 | 0.0119 | 0.0234 | 0.0377 |
| 0.0061 | 0.0348 | 0.0117 | 0.0388 | 0.0003 | 0.0040 | 0.0129 | 0.0037 | 0.0252 | 0.0337 | 0.0032 | 0.0100 | 0.0580 | 0.0055 | 0.0001 | 0.0007 | 0.0190 |
| 0.0033 | 0.0092 | 0.0031 | 0.0001 | 0.0008 | 0.0002 | 0.0072 | 0.1709 | 0.0080 | 0.0377 | 0.0001 | 0.0083 | 0.0001 | 0.0045 | 0.0039 | 0.0641 | 0.0012 |
| 0.0001 | 0.0096 | 0.0010 | 0.0017 | 0.0001 | 0.0143 | 0.0080 | 0.0379 | 0.0023 | 0.0222 | 0.0038 | 0.0001 | 0.2220 | 0.0000 | 0.0135 | 0.0001 | 0.0002 |
| 0.0087 | 0.0365 | 0.0078 | 0.0012 | 0.0036 | 0.0486 | 0.0278 | 0.0046 | 0.0027 | 0.0017 | 0.0190 | 0.0067 | 0.0090 | 0.1017 | 0.0173 | 0.0102 | 0.0043 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0137 | 0.1090 | 0.0125 | 0.0000 | 0.0241 | 0.0022 | 0.0074 | 0.0261 | 0.0025 | 0.0000 | 0.0012 | 0.0182 | 0.0022 | 0.0036 | 0.0023 | 0.0092 | 0.0009 |
| 0.0039 | 0.0716 | 0.0165 | 0.0049 | 0.0002 | 0.0001 | 0.0434 | 0.0026 | 0.0053 | 0.0124 | 0.0040 | 0.0026 | 0.0002 | 0.0185 | 0.0628 | 0.0173 | 0.0000 |
| 0.0000 | 0.1300 | 0.0009 | 0.0092 | 0.0007 | 0.0057 | 0.0149 | 0.0147 | 0.0044 | 0.0391 | 0.0002 | 0.0007 | 0.0046 | 0.0041 | 0.0028 | 0.0204 | 0.0056 |
| 0.0045 | 0.1359 | 0.0003 | 0.0053 | 0.0007 | 0.0041 | 0.0003 | 0.0148 | 0.0022 | 0.0001 | 0.0094 | 0.0053 | 0.0250 | 0.0127 | 0.0017 | 0.0002 | 0.0165 |
| 0.0019 | 0.0006 | 0.0014 | 0.0021 | 0.0020 | 0.0597 | 0.0000 | 0.0009 | 0.0067 | 0.1908 | 0.0031 | 0.0012 | 0.0001 | 0.0082 | 0.0208 | 0.0016 | 0.0024 |
| 0.0316 | 0.0401 | 0.0024 | 0.0431 | 0.0044 | 0.0000 | 0.0116 | 0.0101 | 0.0005 | 0.0024 | 0.0283 | 0.0057 | 0.0036 | 0.0142 | 0.0016 | 0.0421 | 0.0029 |
| 0.0263 | 0.0096 | 0.0035 | 0.0029 | 0.0014 | 0.1509 | 0.0011 | 0.0154 | 0.0074 | 0.0017 | 0.0013 | 0.0015 | 0.0098 | 0.0000 | 0.0012 | 0.0056 | 0.0321 |
| 0.0034 | 0.0038 | 0.0093 | 0.0176 | 0.0313 | 0.0004 | 0.0000 | 0.0016 | 0.0002 | 0.0175 | 0.1260 | 0.0009 | 0.0659 | 0.0116 | 0.0228 | 0.0344 | 0.0350 |
| 0.0049 | 0.0001 | 0.0016 | 0.0004 | 0.0021 | 0.0007 | 0.0010 | 0.0000 | 0.0043 | 0.0012 | 0.3092 | 0.0065 | 0.0001 | 0.0000 | 0.0008 | 0.0046 | 0.0107 |
| 0.0241 | 0.0476 | 0.0000 | 0.0008 | 0.0051 | 0.0276 | 0.0243 | 0.0012 | 0.0085 | 0.0083 | 0.0495 | 0.0208 | 0.0051 | 0.0012 | 0.0004 | 0.0770 | 0.0117 |
| 0.0001 | 0.0086 | 0.0004 | 0.0148 | 0.0021 | 0.0200 | 0.2165 | 0.0012 | 0.0079 | 0.0002 | 0.0261 | 0.0003 | 0.0004 | 0.0002 | 0.0205 | 0.0112 | 0.0057 |
| 0.0067 | 0.0020 | 0.0006 | 0.0078 | 0.0106 | 0.0120 | 0.0136 | 0.0098 | 0.0105 | 0.0005 | 0.1221 | 0.0001 | 0.0071 | 0.0499 | 0.1057 | 0.0068 | 0.0012 |
| 0.0010 | 0.0004 | 0.0401 | 0.1849 | 0.0028 | 0.0064 | 0.0028 | 0.0025 | 0.0075 | 0.0003 | 0.0001 | 0.0171 | 0.0001 | 0.0103 | 0.0013 | 0.0005 | 0.0050 |
| 0.0001 | 0.0060 | 0.1082 | 0.0212 | 0.0009 | 0.0001 | 0.0184 | 0.0023 | 0.0001 | 0.0065 | 0.0103 | 0.0288 | 0.0520 | 0.0282 | 0.0109 | 0.0000 | 0.0002 |
| 0.0079 | 0.0088 | 0.0261 | 0.0001 | 0.0087 | 0.0002 | 0.1796 | 0.0013 | 0.0006 | 0.0080 | 0.0004 | 0.0101 | 0.0233 | 0.0000 | 0.0011 | 0.0004 | 0.0040 |
| 0.0034 | 0.0017 | 0.0667 | 0.0049 | 0.0090 | 0.0009 | 0.0935 | 0.0036 | 0.0181 | 0.0002 | 0.0139 | 0.0033 | 0.0294 | 0.0550 | 0.0133 | 0.0084 | 0.0080 |
| 0.0049 | 0.0061 | 0.1396 | 0.0119 | 0.0127 | 0.0001 | 0.0056 | 0.0016 | 0.0215 | 0.0014 | 0.0029 | 0.0003 | 0.0026 | 0.0431 | 0.0150 | 0.0151 | 0.0105 |
| 0.0006 | 0.0054 | 0.0560 | 0.0489 | 0.0226 | 0.0001 | 0.0117 | 0.0004 | 0.0065 | 0.0917 | 0.0159 | 0.0003 | 0.0040 | 0.0252 | 0.0005 | 0.0395 | 0.0059 |
| 0.0168 | 0.0027 | 0.0024 | 0.0010 | 0.0002 | 0.0000 | 0.0064 | 0.0116 | 0.0024 | 0.1978 | 0.0109 | 0.0023 | 0.0142 | 0.0021 | 0.0001 | 0.0002 | 0.0005 |
| 0.0104 | 0.0000 | 0.0106 | 0.0004 | 0.0008 | 0.0000 | 0.0003 | 0.0039 | 0.2690 | 0.0003 | 0.0068 | 0.0012 | 0.0016 | 0.0033 | 0.0166 | 0.0209 | 0.0005 |
| 0.0056 | 0.0136 | 0.0003 | 0.0287 | 0.0001 | 0.0020 | 0.0000 | 0.0028 | 0.2063 | 0.0191 | 0.0000 | 0.0142 | 0.0002 | 0.0119 | 0.0032 | 0.0007 | 0.0159 |
| 0.0708 | 0.0056 | 0.0001 | 0.0000 | 0.0107 | 0.0349 | 0.0012 | 0.0025 | 0.0144 | 0.0019 | 0.0102 | 0.0758 | 0.0000 | 0.0433 | 0.0033 | 0.0116 | 0.0027 |
| 0.1589 | 0.0000 | 0.0008 | 0.0017 | 0.0001 | 0.0135 | 0.0001 | 0.0129 | 0.0000 | 0.0010 | 0.0257 | 0.0031 | 0.0054 | 0.0021 | 0.0006 | 0.0023 | 0.0002 |
| 0.1457 | 0.0057 | 0.0016 | 0.0044 | 0.0103 | 0.0000 | 0.0000 | 0.0047 | 0.0023 | 0.0011 | 0.0105 | 0.0027 | 0.0000 | 0.0091 | 0.0069 | 0.0002 | 0.0167 |
| 0.0097 | 0.0093 | 0.0000 | 0.1203 | 0.0022 | 0.0100 | 0.0137 | 0.0068 | 0.0091 | 0.0163 | 0.0055 | 0.0067 | 0.0086 | 0.0001 | 0.0087 | 0.0076 | 0.0005 |
| 0.0099 | 0.0137 | 0.0039 | 0.0211 | 0.0065 | 0.0466 | 0.0185 | 0.0025 | 0.0085 | 0.0180 | 0.0190 | 0.0000 | 0.0447 | 0.0204 | 0.0071 | 0.0016 | 0.0094 |
| 0.1267 | 0.0024 | 0.0063 | 0.0035 | 0.0035 | 0.0015 | 0.0028 | 0.0029 | 0.0009 | 0.0548 | 0.0075 | 0.0052 | 0.0020 | 0.0017 | 0.0161 | 0.0008 | 0.0060 |
| 0.1343 | 0.0100 | 0.0081 | 0.0025 | 0.0027 | 0.0025 | 0.0023 | 0.0016 | 0.0283 | 0.0091 | 0.0064 | 0.0015 | 0.0129 | 0.0006 | 0.0004 | 0.0030 | 0.0032 |
| 0.0654 | 0.0000 | 0.0001 | 0.0005 | 0.0002 | 0.0178 | 0.0206 | 0.0060 | 0.0037 | 0.0248 | 0.0011 | 0.0265 | 0.0598 | 0.0007 | 0.0016 | 0.0008 | 0.0071 |

Formula used = Factor loading/Eigen value

# APPENDIX IX

## Summary of MVI

| Missing Variable | Missing | | Valid N | Accuracy of the Developed Model for Missing Imputation | Parameters Considered during Model Development |
|---|---|---|---|---|---|
| | N | % | | | |
| TO2 | 2 | 1.70% | 118 | 95.00% | IO15,IO7, RO10, RO1b, IO2, RO9b, TO3, IO1, RO9c |
| IO9 | 1 | 0.80% | 119 | 92.00% | IO12,IO4,R08,TO6,ITO5,IO6,RO1F,ITO2,RO7,IO5 |
| RO9c | 2 | 1.70% | 118 | 91.30% | RO10,IO10,IT05, IO14,ITO2,RO1b,RO1d |
| RO9f | 2 | 1.70% | 118 | 91.00% | IO13,RO7, RO9b, RO5, ITO4, RO10 |
| RO8 | 4 | 3.30% | 116 | 79.90% | IO6,RO1F,ITO2,RO7,IO5 |
| RO9d | 2 | 1.70% | 118 | 77.50% | RO9e,RO1d,TO10,ITO3, IT08, IO2, TO7, IO1,TO8, TO3 |
| RO1f | 1 | 0.80% | 119 | 76.67% | IT04, ITO6, TO6, IO9, TO8, ITO2, ITO5, RO9a, IO7, RO2 |
| RO3 | 1 | 0.80% | 119 | 76.67% | RO4, RO1a, TO9, RO5, IO13, ITO6, ITO1, RO1g, IO8, IO15 |
| RO9a | 1 | 0.80% | 119 | 76.40% | IO9, TO8, ITO2, ITO5, IO7, RO2 |
| ITO3 | 1 | 0.80% | 119 | 75.83% | ITO2,RO1g, ITO8, TO5, RO1O, RO9d,RO1b, TO7, TO3, ITO4 |
| IO1 | 1 | 0.80% | 119 | 74.20% | IO11,IO13,RO7, RO9b, RO5, ITO4, RO10 |
| ITO4 | 1 | 0.80% | 119 | 73.33% | RO1f, RO9g, TO6, IO3, RO1a, RO1c, IO12, IO8, RO7 |
| IT06 | 1 | 0.80% | 119 | 73.33% | ITO7, ITO1,RO1c,IO9, RO1d,IO12, IO10, IO13, IO15 |
| RO2 | 2 | 1.70% | 118 | 72.50% | IO6, RO9b, IO4, TO6, IO3, ITO6, IO11, RO6, IT05, IT02 |
| ITO7 | 4 | 3.30% | 116 | 72.30% | IO15,IO7, RO10, RO1b, |
| RO1d | 1 | 0.80% | 119 | 71.67% | RO4, IO12, RO7, RO9b, TO9, RO9d, ITO4, IO6, IO5, ITO5 |
| IT05 | 1 | 0.80% | 119 | 71.30% | TO6, IO16, RO8,RO1g, ITO3 |
| RO1a | 2 | 1.70% | 118 | 70.83% | RO9b, ITO1,IO12, RO1e, TO8, IO9, RO1b, RO3, TO1, RO8 |
| RO4 | 2 | 1.70% | 118 | 70.00% | RO3, IO15, RO10,IO10,IT05, IO14,ITO2,RO1b,RO1d |
| IT08 | 1 | 0.80% | 119 | 69.90% | IO7, TO6, IO16, RO8,RO1g, ITO3 |
| RO6 | 1 | 0.80% | 119 | 69.20% | RO9d,TO9,IT02, IO7, TO6, IO16, RO8,RO1g, ITO3 |
| IO10 | 1 | 0.80% | 119 | 69.17% | IO13, IO11, TO10, TO2, ITO8, ITO1, TO8, IO6, TO9, IO9 |
| IO16 | 3 | 2.50% | 117 | 69.17% | RO9b, TO4, IO11, RO5, TO3, IO4, IO6, TO10, IT01, R06 |
| IO2 | 1 | 0.80% | 119 | 69.17% | IO12, TO5, RO3, IO11,RO6, RO4, RO9g, RO1c, TO8, TO1O |
| IO5 | 1 | 0.80% | 119 | 69.17% | TO7, ITO7, TO6, RO1c, TO2, TO1, IO1, RO9a, IO11, RO9g |
| ITO1 | 2 | 1.70% | 118 | 69.17% | RO1b, IO2, RO9b, TO3, IO1, RO9c |
| RO9e | 2 | 1.70% | 118 | 69.17% | RO9f, RO9d,RO2,IO11, |
| IO15 | 2 | 1.70% | 118 | 69.17% | TO9,IT02, IO7, TO6, IO16, RO8,RO1g, ITO3 |

| | | | | | |
|---|---|---|---|---|---|
| RO9b | 2 | 1.70% | 118 | 69.17% | IO10,IT05, IO14,ITO2,RO1b,RO1d |
| RO5 | 3 | 2.50% | 117 | 69.17% | IO6, TO10, IT01, R06 |
| RO9g | 2 | 1.70% | 118 | 69.17% | TO1O, RO9a |
| RO10 | 2 | 1.70% | 118 | 67.80% | RO1b, RO3, TO1, RO8 |
| IO14 | 2 | 1.70% | 118 | 67.80% | RO5, RO3, TO3, IT01, IO10,R06 |
| IO11 | 3 | 2.50% | 117 | 67.50% | IO13,RO7, RO9b, RO5, ITO4, RO10 |
| RO7 | 2 | 1.70% | 118 | 67.50% | IO15,TO6,RO8,IO8,TO10,RO9b,IO10,IO14,RO1f |
| TO6 | 1 | 0.80% | 119 | 67.30% | RO9b, ITO1,IO12,RO8,IO8,TO10,RO9b,IO10,IO14,RO1f |
| RO1e | 1 | 0.80% | 119 | 67.30% | IO8, IO15, RO9e, TO9, RO1f,ITO7, RO6, IO1 |
| IO12 | 1 | 0.80% | 119 | 66.67% | IO13, IO15, IO5, TO5, TO3, ITO7, RO5, RO1c, ITO6, RO1f |
| TO4 | 1 | 0.80% | 119 | 66.67% | RO9d,RO5, RO3, TO3, IT01, IO10, TO8, IO9 |
| TO7 | 1 | 0.80% | 119 | 65.83% | IO5, ITO1, IO15, RO7, TO3, RO3, IO1, RO2, RO5 |
| RO1b | 2 | 1.70% | 118 | 65.83% | RO7, ITO2,IO12, RO8, IO15, TO10 |
| IO8 | 2 | 1.70% | 118 | 65.20% | ,IO4,R08,TO6,ITO5,IO6,RO1F |
| IO13 | 2 | 1.70% | 118 | 65.20% | IO12,IO15, RO9d,RO5, RO3, TO3, IT01, IO10, TO8, IO9 |
| RO1g | 2 | 1.70% | 118 | 65.00% | IO15, ITO8, RO9e, RO7, IO12, RO1e |
| IO7 | 2 | 1.70% | 118 | 65.00% | RO9d,RO5, RO3, TO3, IT01, IO10, TO8, IO9 |
| ITO2 | 1 | 0.80% | 119 | 64.17% | TO3, TO10, TO6, TO2, RO1e, RO7, IO1, IO13, IO11,IO5 |
| RO1c | 2 | 1.70% | 118 | 64.17% | IO4, IO6, TO10, IT01, R06 |
| IO4 | 1 | 0.80% | 119 | 63.00% | IO7, IO5, RO7, IO9,TO1, RO9d, RO9c, IO14, RO9b |
| TO8 | 1 | 0.80% | 119 | 62.30% | RO1f, RO9a, RO1d, RO8, ITO8,ITO4 |

**About the Research Scholar**

Ms Neha Grover is a Doctrol Research Fellow, with University of Petroleum and Energy Studies, Dehradun, India. She did her graduation in Science (Physics, Chemistry & Mathemathematics) from Garhwal University in year 2008 and MBA in Logistics and Supply Chain Management from UPES in year 2010. She was awarded University Gold Medal for the Best Post Graduate Student of College of Management and Economics Studies (2008-2010).

Along with being a full time scholar she is also engaged in teaching undergraduate students, subjects like Research Methodology, Understanding Logistics and Introduction to Logistics and Supply Chain Management. During her academics she developed a flair for reading, writing and editing articles. Thus in order to accentuate this avenue, she presented various research articles in several National and International Conferences. Her research interests include freight transport and logistics, impact of manufacturing and retailing techniques on logistics and transportation system in a global scenario, performance measurement supply chain network modeling and design, etc.