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ELECTRONIC SUPPLY CHAIN MANAGEMENT SYSTEMS IN MANAGING THE BULLWHIP EFFECT ON SELECTED FAST MOVING CONSUMER GOODS

By

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DECLARATION

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My work is dedicated to,

My daughter Minenhle and my son Zwelihle.

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Abstract:

The amplitude in order variability as orders surge upstream a supply chain epitomises a phenomenon commonly called the bullwhip effect. The real consumer demand orders are comparatively and tentatively evinced less variability while trading supply chain members on the midstream and upstream stages experience the amplified order vacillations. The oscillator effect reveals a number of pernicious problems throughout the supply chain networks, as downstream sites include harmful bloated inventory and shortages with poor customer service, and the midstream and upstream sites depict the disharmonic capacity on improper planning and inconsistent scheduling in production. This study investigates the selected fast moving consumer goods (FMCG) industry on the amplified consumer demand order variability as orders cascade from downstream (retailers) to the midstream as well as upstream sites of the supply chain network.The effect of electronically-enabled supply chain management (e-SCM) systems remains the central hypothesis for instant information sharing on inventory positioning, integrated supply chain management processes and improved profitability through positive performance targets and outcomes across supply chain trading partners. The main objective aims to understand the on extent of the relationship to which the phenomenon of bullwhip effect can be explained by e-SCM system diffusion, optimal inventory positioning, strategic information sharing and global optimisation strategies. These seamless linkages between supply chain partners seem to entrench velocity on quasi-real-time information flow in consumer demand and supply sides, inventory status and availability, and capacity availability. This study found empirical research evidence on e-SCM systems that retail supply chain businesses have fastidiously adapted to technology clockspeed for the last five years. The majority of the respondents (92%) for both upstream and downstream echelon categories agreed that e-SCM systems have a significant role to play in mitigating the consumer demand order variability in the supply chain network. This study further discovered that the migration from in-house IT systems to integrated e-SCM systems (65%) would entrench close integration of information exchange and processes across different parts of the organisation and inter-organisational linkages. The e-SCM systems diffusion also depicted a positive linear relationship to the extent to which the organisations efficiently and timeously communicate the future strategic needs and demand order replenishments throughout the entire supply chain network. However, the access to advance economic information negatively related to e-SCM systems with the virtue of legal constraints and template-based information attachments.

Key concepts: Bullwhip Effect, e-SCM systems, Inventory Positioning, Information Sharing, and Global Optimisation Strategies.

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Abbreviations:

Abbreviations	
ABC	Activity-based costing
ADI	Advance demand information
ANOVA	Analysis of variance
AR	Autoregressive
ARIMA	Autoregressive Integrated Moving Average
ARMA	Autoregressive Moving Average
ASN	Advance Shipment Notice
ATS	Assemble-to-Stock
B2B	Business-to-Business
B2B IT	Business-to-Business Information Technology
BBBEE	Broad Based Black Economic Empowerment
BFT	Build-to-Forecast
BO	Backorders
BPR	Business Process Reengineering
BTO	Build-to-Order
BTOSC	Build-to-Order Supply Chain Management
BWE	Bullwhip Effect
CDC	Central Distribution Centre
CDE	Coordination-data exchange
CEO	Chief Executive Officer
CIFM	Centralised Information flow mapping
CORBA	Common Object Request Broker Architecture
CPFR	Collaboration Planning Foresting and Replenishment
CPG	Consumer Packaged Goods
CRM	Customer Relationship Management
CscD	Centralised Supply Chain Distribution
CscDC	Centralised Supply Chain Distribution Centre
CSCMP	Council of Supply Chain Management Professionals
CTM	Collaborative Transportation Management
CTO	Configure-to-Order
DC	Distribution Centre
DCM	Demand Chain Management
DCOR	Design Chain Operations Reference Model

DF	Degree of Freedom
DoV	Demand Order Variability
DP	Demand Planning
DscD	Decentralised Supply Chain Distribution
DV	Dependent Variable
EAI	Enterprise Application Integration
e-collaboration	Electronic Collaboration
E-commerce	Electronic Commerce
e-CPFR	Electronic Collaboration Planning Forecasting and Replenishment
ECR	Efficient Consumer Response
EDI	Electronic Data Interchange
EDLP	Everyday Low Pricing
EOQ	Economic Order Quantity
EPC	Electronic Product Code
e-POS	Electronic Point-of-sale
e-Procurement	Electronic Procurement
ERP	Enterprise Resource Planning
e-SC	Electronic Supply Chain
e-SCD	Electronic Supply Chain Design
e-SCM	Electronically enabled-Supply Chain Management
e-SCN	Electronic Supply Chain Network
ETO	Engineer-to-Order
EWMA	Exponentially Weighted Moving Average
FMC	Fast Moving Consumer
FMCG	Fast Moving Consumer Goods
H-L	Hosmer-Lemeshow
HP	Hewlett-Packard
ID	Independent Variable
IDT	Innovation Diffusion Theory
I-eSCM	Integrated e-SCM
IL	Inventory Level
IMA	Integrated Moving Average
IOS	Interorganisational System
IP	Inventory Position
IT	Information Technology

JIT	Just-in-time
JITD	Just-in-Time Distribution
KMO	Kaiser-Meyer-Olkin
KPI	Key Performance Indicators
KZN	KwaZulu Natal
LTI	Linear and time-invariant
MA	Moving Average
MIT	Massachusetts Institute of Technology
MPC	Manufacturing Planning and Control
MPS	Master Production Schedule
MS	Mean Square
MSE	Mean Square Error
MTO	Make-to-Order
MTS	Make-to-Stock
MTTR	Mean Time to Repair
mySAP SCM	mySAP Supply Chain Management
OH	On-hand Stock
OL	Organisational Learning
Onto-SCM	Ontologies of Supply Chain Management
OO	On-order
OOS	Out-of-stock
P&G	Proctor & Gamble
PAC	Percentage Accuracy in Classification
PCA	Principal Component Analysis
PCP	Partnership-collaboration-processes
PCSO	Process of Collaboration store ordering
POS	Point-of-Sale
RBM	Retail Business Model
RDF	Resource Description Framework
RFID	Radio Frequency Identification Device
RMI	Retailer Managed Inventory
ROA	Return-on-assets
SAP (currently)	Systems, Applications and Products in Data Processing
SAP (originally)	System Analysis and Program Development
SAP APO	SAP Advanced Planner and Optimiser

SAP ERP	SAP Enterprise Resource Planning
SBT	Scan-based Trading
SCA	Supply Chain Analytics
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference Model
SDM	Supply-Demand Management
SMEs	Small and Medium-sized Enterprises
SMI	Supplier Managed Inventory
SNP	Supply Network Planning
SoV	Supply Order Variability
SPSS	Statistical Package for the Social Sciences
SRM	Supplier Relationship Management
SSL	Sum of Squared Loadings
SvcCM	Service Chain Management
UKZN	University of KwaZulu Natal
URI	Universal Resource Identifier
VE	Virtual Enterprise
VIF	Variance Inflated Factor
VMI	Vendor Managed Inventory
VMR	Vendor Managed Replenishment
VRM	Value Reference Model
WIP	Work-in-Progress
WMS	Warehouse Management System
WWW	World Wide Web
XML	Extensible Markup Language

Chapter One
Introduction to the Study

1.1 Introduction

The amplitude in demand order variability (DoV) as orders surge upstream the supply chain network epitomises a pestilent effect known as the bullwhip effect. The real consumer demand orders are comparatively evinced less variability while trading supply chain members on the midstream and upstream stages experience the amplified order vacillations. The oscillator effect reveals a number of pernicious problem throughout the supply chain networks, as downstream sites include harmful bloated inventory and shortages (Makui, 2007), or excessive inventories (Croson, Donohue, Katok and Sterman, 2005), and poor customer service at other times (Lee and Whang, 2004). The midstream and upstream sites depict the disharmonic capacity (Davis and Heineke, 2005), and improper planning and inconsistent scheduling in production (Balan, Vrat and Kumar, 2009), ensuing costs in capacity investment and working time adjustments (Heizer and Render, 2008; Jacobs and Chase, 2008), and subsequent deliveries by expedited transportation (Johnsson, 2008). The supply chain trading partners exert efforts to maximise profits by optimising the product flows and availability as the operational imperative underpinned by electronically-enabled supply chain management systems.

The theme of this study investigates the selected fast moving consumer goods (FMCG) industry on the amplified consumer demand order variability (DoV) as orders cascade from downstream (retailers) to the midstream and upstream (distribution centers, manufacturers as capacitated suppliers, and lead suppliers and *n*-tiers) sites of the supply chain network. Thus, despite the FMCG businesses showing a stable consumer demand for most consumer items, the study focuses on understanding the dynamics of less certainty in supply and volatility in demand orders on fast moving consumer items. Hence a demand on node-to-node (distributor, wholesale, manufacturer, lead supplier even *n*-tiers) levels varies due to the cascade effect. Simchi-Levi, Kaminsky and Simchi-Levi (2008) hinted that the variability in orders emanating from the downstream site to the upstream site is apically distended than the variability in quasi-stable real consumer demand in the form of magnified oscillations upstream.

1.2 Background and Motivation of the Study

The fundamental challenge for FMCG industry is to predict the uncertainty in consumer demand. Although the bullwhip effect on both stream sites of supply chain indicates uneven variance amplification, researchers have used robust diagnostic tests to detect existence of bullwhip effect. According to Ouyang and Daganzo (2006:1544), the variance amplification evades the early stages (retailers) but it intensifies in the upstream sites (capacitated suppliers) along the operating policies. The robust stability analysis in the multi-stage chains stabilises the supply chain network with operating strategies (Ouyang and Li, 2009), and chains with stochastic supplier behaviour and operating uncertainties (Boccadoro, Martinelli and Viligi, 2006; Ouyang and Daganzo, 2008). The impact of orders from multiple node-to-node information sharing networks affects each supplier's ordering decision, and Ouyang and Li, (2009:799) attributed this distortion and order variability from multiple participants at different levels of the supply chain network and the degree of relationships, coordination and collaboration among the trading supply chain members. Procter & Gamble (P&G) discovered that the orders (diapers) from the distributors indicated variability that cannot be described by consumer demand vacillations alone (Lee, Padmanabhan and Whang, 1997; Simchi-Levi *et al.*, 2008). Although consumption cycle of the end product was stable, orders for raw material were highly variable, increasing costs and making it difficult for supply to match demand (Chopra and Meindl, 2007; Cachon and Terwiesch, 2009).

Although Cachon *et al.*, (2005) and Sucky (2009) argue on demand volatility as one move up the supply chain that, anti-bullwhip effect should be reflected as manufacturers depict less demand volatility than retailers through production smoothing relative to consumer demand. Notably, a number of companies tend to entrench active coordination in an extended cross-enterprise integration to enhance supply chain performance outcomes. In the industry practices, supply chain coordination is instituted in different ways through shared demand data such as point-of-sale data under the vendor managed inventory (VMI) model. These strategic methods assist to understand current inventory positions of components with suppliers via the Internet, and to avoid unnecessary oscillations in supply and orders placed. These precursive extant studies and belligerent statements on this background provided a thematic framework on the following statement of problems.

1.3 Problem Statement

Generally, the bullwhip effect depicts the dynamics of accumulating order rate by the downstream site that exceeds the tentatively stable actual demand rate as one communicates demand orders to the upstream supply chain site. The pernicious effect ascribes to the dearth of a holistic view of the supply chain as a cause for cascading demand order variability (DoV) upstream. The supply chain partners normally experience the cascading order variability at each supply chain echelon stage, with higher oscillations from node-to-node roaming upstream the supply chain network. The excessive oscillations of consumer demands have the propensity to epitomise wider swings upstream in the supply chain. The effect of an electronically enabled-supply chain management (e-SCM) system remains the central hypothesis for instant real-time information sharing on inventory positioning, integrated supply chain management processes (electronic linkage for supply- and demand-side partners) and improved profitability through positive supply chain performance targets and outcomes across supply chain trading partners.

1.4 Research objectives and questions

The purpose of the study aims:

- To analyse the challenges of bullwhip effect from the perspective of electronically-enabled supply chain management (e-SCM) systems, information sharing, inventory positioning and global optimisation strategies on selected fast moving consumer goods (FMCG) industry.
- To understand the discrete dimensions in the pattern of interrelationships among the bullwhip effect challenges together with mitigation strategies into reduced underlying sets of grouped dimensions.
- To examine the relative magnitude of advance economic information sharing in optimising the integrated supply chain activities in the consumer goods industry.
- To assess the relative role of electronically-enabled supply chain management systems as consumer demand orders cascading upstream supply chain network in the FMCG industry.
- To evaluate the relative optimal positioning of inventory systems and order process replenishment frequencies among the trading supply chain members.
- To understand the relationship of the extent to which the phenomenon of bullwhip effect can be explained by electronically-enabled supply chain management systems diffusion, optimal inventory positioning, strategically-advanced economic information sharing and global optimisation strategies.

- To establish the strength of the relationship and likelihood of odds between the supply chain business performance targets on the proportion of consumer demand order variability outcome that is associated with a set of categorised predictors.

Research questions:

- What are the challenges of bullwhip effect from the perspective of electronically-enabled supply chain management (e-SCM) systems, information sharing, inventory positioning and global optimisation strategies on selected fast moving consumer goods (FMCG) industry?
- What are the discrete dimensions in the pattern of interrelationships among the bullwhip effect challenges together with mitigation strategies into reduced underlying sets of grouped dimensions?
- Why the magnitude of advance economic information sharing is related to the optimal integrated supply chain activities in the consumer goods industry?
- Why the role of electronically-enabled supply chain management systems is related to the consumer demand orders cascading upstream supply chain network in the FMCG industry?
- Why the optimal positioning of inventory systems relates to the order process replenishment frequencies among the trading supply chain members.
- What is the relationship of the extent to which the bullwhip effect can be explained by electronically-enabled supply chain management systems diffusion, optimal inventory positioning, advanced economic information sharing and global optimisation strategies?
- What is the strength of the relationship and likelihood of odds between the supply chain business performance targets on the proportion of consumer demand order variability outcome on the underlying associated set of categorised predictors?

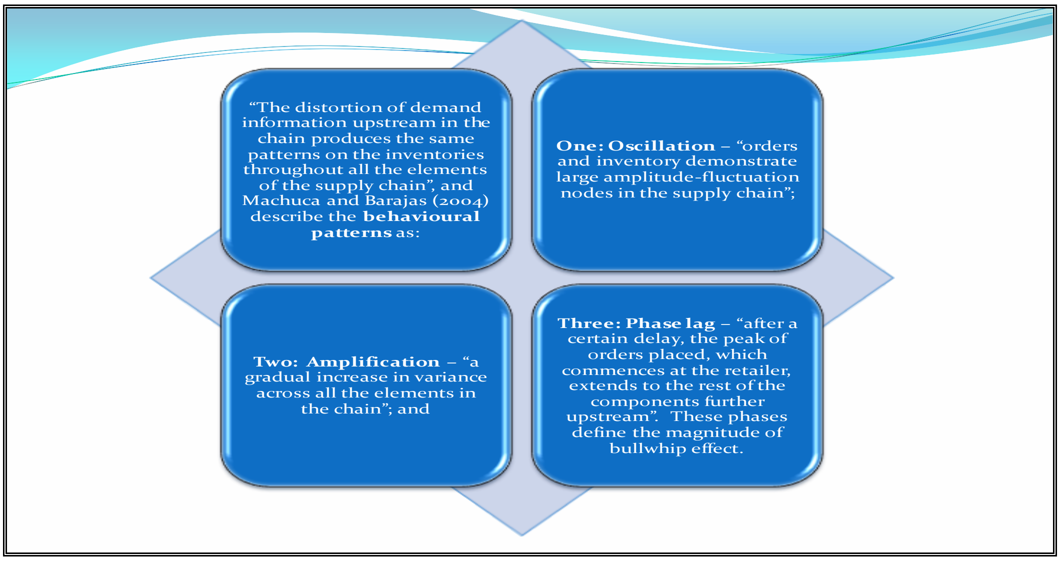
1.5 Theoretical framework

The adoption of e-SCM has significant effects on business process change, collaborative relationships among trading partners and even business transformation (Giminez and Lourenco, 2008; Wu and Chang, 2012). It is viewed as information technology (IT) adoption that refers to the adoption of new methods, processes, or production systems. IT adoption intends to retain or improve firm performance and to respond to changes in the external environment while e-SCM utilises broad features such as information exchange capabilities, joint decision making support and business process integration, to conduct value chain activities (Liu, Ke, We, Gu and Chen, 2010; Ke, Liu, Wei, Gu and Chen, 2009). The perspective of e-SCM adoption in this study involves the propensity towards diffusion and the extent to which the firm had implemented e-SCM to underpin various business functions in the extended supply chain management networks. Rogers (2003), adoption refers to the decision of any person or organisation to use an innovation while diffusion is the process in which an innovation is communicated over time through certain channels among members of a social system. In achieving the integrated value chain activities, e-SCM uses Internet and related technologies to perform integration activities across extended enterprises and throughout the supply chain networks. In South Africa's rapidly changing consumer landscape, fast moving consumer goods (FMCG) retail outlets as well as suppliers are gradually acknowledging the need for the efficient strategic diffusion of electronic information through integrated supply chain information technology (SCIT). The technology-organisation-environment (TOE) framework (Tornatzky and Fleischer (1990), reflects the perceived technological attributes, descriptive characteristics of the organisation (size, scope and structure) and the retail consumer landscape industry and its dealings with supply chain trading partners, competitors and market environment manifest critical challenge on the underlying technology-organisation-environment (TOE) framework. The framework is appropriate as major determinant of the decision to adopt e-SCM as enabled by the characteristics of IT innovation itself, while the extent of e-SCM adoption is driven by organisational readiness, and influenced by environmental factors, especially the situation of suppliers, customers and competitors (Zhu, Dong, Xu and Kraemer, 2006:601). According to In forecasting South African fast moving consumer goods (FMCG) retail product sales, the product sales are promotion-driven to boost the sales of the focal products using competitive marketing activities such as prices and promotions of competitive products. The supply chain partners on underlying TOE framework are required to generate conjoint forecasting accuracy and to entrench quasi-real-time response to any random customer demand and volatile market changes to mitigate the bullwhip effect (Chen, 2013:518).

1.5.1 Defining Bullwhip Effect

The literature on bullwhip effect has extensively discussed the effect of this phenomenon, its reduction, simulating the system behaviour and experimental validity. Ouyang (2007:1107) referred to the bullwhip effect as "a phenomenon in supply chain operations where the fluctuations in the order sequence are usually greater upstream than downstream of a chain" (Ouyang, 2007:1107). In terms of supply chain management as a dynamic decision task, Croson, Donohue, Katok and Sterman (2005) indicated that with the dearth of quality performance risks coordination, collaboration and stability in the multi-node process, decisions are independently taken by trading supply chain members. The preceding section attempts to entrench the conceptual framework within the parameters of two constructs (bullwhip effect and electronic supply chain management) underlying industry practices and extant research studies. Wu and Katok (2006:839-850) defined the bullwhip effect as "the observation that the variability of orders in supply chains increases as one moves closer to the source of production".

Figure 1.1: Description of behavioural patterns in the bullwhip effect



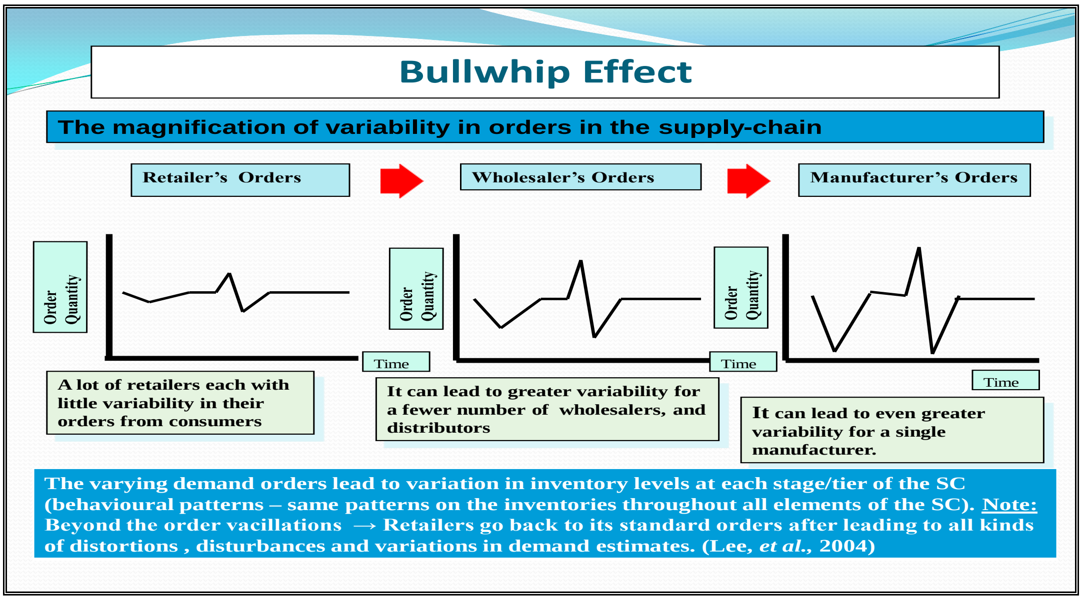
Source: Designed by the researcher from behavioural patterns by Machuca and Barajas (2004)

The distortion of consumer demand information upstream the supply chain produces the same patterns on the inventories throughout all the elements of the supply chain. Machuca and Barajas (2004:209) described the behavioural patterns as: Oscillation – orders and inventory demonstrate large amplitude-fluctuation nodes in the supply chain; Amplification – a gradual increase in variance across all the elements in the chain; and Phase lag – after a certain delay, the peak of orders placed, which commences at the retailer, extends to the rest of the components further upstream.

Seemingly, the cascading demand variability manifests negatively on dimensioning of capacities (Heizer and Render, 2008), variation in inventory level and high level of safety stock (Hopp and Spearman, 2009). In the broader perspective, Disney (2009) observed bullwhip effect in the multiple successive echelons in the supply chain as the tendency of the variability of order rates to increase as orders pass through the echelons of a supply chain towards producers and raw material suppliers. According to Cachon and Terwiesch (2009) the companies should carefully plan their capacity and demand forecasting in order to avoid bullwhip effect and to ensure on-time delivery of customer orders and minimal stocks. The inherent uncertainty on both the demand side and the supply side of supply chains frequently creates a mismatch as the variation amplifies the upstream supply chain (Chase, 2005; Heizer and Render, 2008; Cachon and Terwiesch, 2009). It denotes an extreme change in the supply position upstream in a supply chain generated by a small change in demand downstream. This phenomenon has the propensity to cause immense problems due to the disproportionate inventories it generates from the poor demand forecasts it implies.

In encapsulating with inference the amplification of demand orders, Chopra and Meindl (2007:525) explain that “the phenomenon that fluctuation in orders increases as one moves up the supply chain from retailers to wholesalers to manufacturers to suppliers in referred as the bullwhip effect. It moves all parties in the supply chain away from the efficient frontier and results in a decrease of both customer satisfaction and profitability within the supply chain”.

Figure 1.2: Supply chain echelons with magnitude of demand order variability (DoV)



Source: Lee, L. H., Padmanabhan, V and Whang, S (2004). ‘Comments on information distortion in a supply chain: the bullwhip effect’. *Management Science*, 15, 1887-1893

Bullwhip Effect: The phenomenon that occurs in a supply chain when order size variability is amplified as orders move upstream in the supply chain from the retailer to the manufacturer (Goyal, 2002). In other words, when there are multiple levels to supply chain – *n*-tiers, lead supplier, manufacturer, distributor, original equipment manufacturer customer and user – the further up the chain, the less predictable the order quantities are. The approach claims that distorted demand information can lead to inefficiency in a supply chain network. Jacobs and Chase (2008:184) further indicate that "even a slight change in consumer sales ripples backward in the form of magnified oscillations upstream, resembling the result of a flick of a bullwhip handle. Although the period of shortage is bound to be over, retailer goes back to its standard orders after leading to all kinds of distortions and variations in demand estimates". The argument from Lee *et al* (1997) is different from Forrester (1961) and Sterman (1989) where the researchers attribute the deleterious bullwhip effect on rational than irrational behaviour of decision makers in the supply chain network.

1.5.2 Dimensional Concepts of Chain Management

The phenomenon of bullwhip effect has extemporary emerged within supply chain networks from the lack of accurately visualising the true relationship between supply chain entities. The supply chain network represents the complex nature of relationships and flows of information, services and materials on five-dimensional chains such as the development chain, demand chain, service chain, distribution chain and supply chain management. In developing a comprehensive reality in multiple supply chain echelons, the supply chain network needs coordination and accurate estimation of demand and to share real-time information among supply chain entities.

The supply chain entities through an integrated philosophy strive for strategically coordinated management of seamless value-added processes. These processes encompass all network activities associated with the upstream, midstream and downstream flow of information, physical goods and services from multiple channels to the end consumers. Mentzer *et al.*, (2000:549) substantiate on the development and integration of people and technological resources as well as the coordinated management of materials, information, and financial flows underlie successful supply chain integration and sustainable network relationships.

1.5.2.1 Development Chain Management

Development chain management focuses on new product introduction, and is characterised by a set of challenges through technology clock speed and short product life cycle of innovative products (Fisher, 1997), make/buy decisions regarding what to make internally and what to buy for outside suppliers (Leenders *et al*., 2006), and product structure on the level of modularity or integrality of the product (Simchi-Levi *et al*., 2008). The integrated philosophy assists to mitigate the phenomenon of extemporal bullwhip effect through the framework for matching product design and optimum business performance targets along the development chain clock speed and the supply chain (demand uncertainty).

According to Simchi-Levi *et al.*, (2008:3) the demand chain is "the set of activities and processes associated with new product introduction that includes the product design phase with capabilities and knowledge on sourcing and production plans. The authors recommend the Design Chain Operations Reference (DCOR) model "to provide a framework that links business process, metrics, best practices, and technology features into a unified structure to support communication among design chain partners and to improve the effectiveness of the extended supply chain including the development chain". It is organised around the processes of plan, research, design, integrate and amend on product refresh and new product and technology. Unlike Supply Chain Operations Reference (SCOR) that includes plan, source, make, deliver and return, it goes a step further by including supply chain decisions in the design phase and creating a value chain that unites the design chain and the supply chain.

The Value Reference Model enables organisations to effectively develop and gain knowledge of the comprehensive process architectures in their value chains. The Value Reference Model (VRM) supports the key issues and the gearing together of processes within and between the individual units of networks. It aims to benefit Planning, Governing, and Execution (information - financial - physical flows) to increase the business supply chain performance targets of the total chain and support the ongoing evolution. Orchestration of a supply chain implies more than coordination and integrated manufacturing planning and control (MPC) design in the context of development chain stage. Vollmann *et al*., (2005:589) recommend that "the orchestration of the entire supply chain is electronically-based in order to achieve the end-to-end visibility / linkages, as well as to pass the exact execution requirements to all of the key suppliers on a timely basis for fulfilling end consumer demands and precise requirements." The hubs as virtual warehouses will enhance the network optimisation among chains of development, demand and supply management.

1.5.2.2 Demand Chain Management

The demand chain management is fundamentally implied as the need to jointly cater to the more exact needs of customer segments or even individual customers, but to do so routinely (Vollmann *et al.,* 2005). The demand chain focuses its operations on rapidly fulfilling end customer demands with minimal chain inventories through make-to-order format (Gunasekaran and Ngai, 2005) and planning the overall capacity needed (Heizer and Render, 2008). According to Bowersox *et al.,* (2013:127) "demand management works collaboratively and interactively both across the intra-organisational and inter-organisational on extended cross-enterprise supply chains to develop a common and consistent integrated forecast from customer information scheduled demand orders and marketing activities as well as sales history for more responsive echeloned marketplace changes". The demand performance cycle, in terms of link and nodal arrangement, reflects a network of flexible and responsive performance cycles integrated in a multi-echeloned design and structural framework.

Selen and Soliman (2002:667) have defined demand chain management (DCM) as "a set of practices aimed at managing and co-ordinating the whole demand chain, starting from the end customer and working backward to raw material supplier". Similarly, Vollmann and Cordon (1998:684) stress that DCM starts with the customers, working backward through the entire chain, to the suppliers of the supplier. Jones and Riley 1985:16-26) identify the limitations of supply chain management focus from its efficient matching of supply with demand because "it does not provide answers to the customer conundrum,in terms of what the customer perceives as valuable, and how this customer-perceived value can be translated into customer value propositions". Rainbird (2004:230-251) strongly suggests that supply chain efficiency by itself will not increase customer value and satisfaction. Similarly, Bechtel and Jayaram (1997:18-19) propose that "a better term would be seamless demand pipeline, where the end user and not the supply function drives the supply chain".

According to Christopher and Payne (2002) DCM as a macro level process uses demand processes (responding to customer demand through value creation) rather than supply processes (comprising the tasks necessary for fulfilling demand), which includes all activities that companies undertake in their quest to create and deliver needs-based customer value propositions. The proposal by Christopher (2011:3) has noted a similar meaning, that supply chain management is the network of mutually connected and interdependent organisational linkages that involve, "the management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole". Meaningly, a supply chain network comprises of cross-functional and extended cross-enterprise in coordinating integrated activities from lead suppliers to the ultimate consumption cycle stage.

In other words, "demand chain management is the management of upstream and downstream relationships between suppliers and customers to deliver the best value to the customer at the least cost to the demand chain as a whole" (Christopher, 2011:3). The author strongly argued that "supply chain management should be termed demand chain management to reflect the fact that the chain should be driven by the market, not the suppliers while the word 'chain' should be replaced by 'network' as multiple suppliers indicate suppliers to suppliers as well as multiple customers depict customers' customers in the total system". Demand chain management on the perspective of the pull supply chain system along the consumption cycle emphasises: 1) Demand-driven supply network (method for building supply chains in response to demand signals) through alignment (create shared incentives); 2) Agility (respond quickly to short-term change); and 3) Adaptability (adjust design of the supply chain) to create sustainable competitive advantages (Chen *et al.*, 2003; Vollmann *et al.*, 2005; Gunasekaran and Ngai, 2005).

The demand chains are characterised by long delivery cycle times, non-availability of products in certain parts of the country and increased customer complaints (Rabinovich and Bailey, 2004). According to Simatupang and Sridharan (2004:9-30) "these demand chains are further challenged by inaccurate demand forecasts based on insufficient customer information shared among the supply chain partners, inability to align incentives and synchronisation of process decisions in the supply chain collaboration arrangements". The sharing of real-time information, synchronisation and incentive alignment assist the supply chain members to maximise their market share and ensure reliable and timely delivery of products to customers (Gunasekarana, *et al.*, 2004; Sandberg, 2007).

Simatupang (2004:9-40) defines decision synchronisation as "a joint decision making process in planning and other operational contexts or levels while incentive alignment is the extent to which demand chain members share costs, risks and benefits realised from collaborative arrangements". Among the these processes, information sharing forms a starting point for effective collaboration in demand chains by involving the capturing and dissemination of timely, accurate and relevant information.

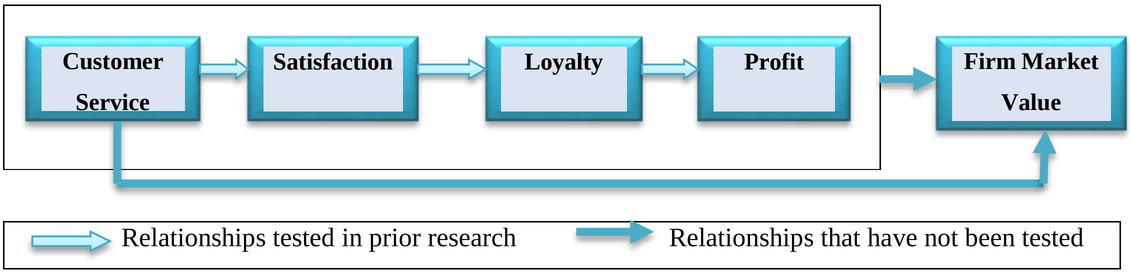
1.5.2.3 Service Chain Management

Service excellence is a critical success factor among trading supply chain partners to leverage supply chain performance and competitiveness. The service-dominant logic that indicates a collaboratively extended value-creation enterprise alliance to achieve a certain level of integrated business goal is formulated through an interdisciplinary study known as Service Science (Lunch *et al*., 2008; Larson, 2008). Jung (2011:2206) regards a business alliance as "service chain management (SvcCM) which enables service and/or product organisations to improve customer satisfaction and reduce operational costs through intelligent and optimised forecasting, planning and scheduling of the service chain, and its associated resources such as people, networks and other assets". The fast moving consumer goods retail stores attempt to address service chain activities through CscD systems by centrally synchronising activities to release their workforce for consumer-oriented activities. According to Basole and Roule (2008:53-70) "the service chain is configured for a better understanding of service chain management from the perspective of the value network composed of consumers, logistics service providers, multi-tiers of suppliers and auxiliary enablers of technologies and systems".

The semantic approach to business alliances, value networks and service chains is to automate interoperability processes between heterogeneous businesses for ontology-based supply chain management, which entrenches electronic supply chain systems for quasi-real-time information sharing (Jung, 2011:2207). In the FMCG industry, the retailer's customer service efforts enhance and increase customer attraction, retention and reputation. These dimensions of retail store customer service are described by Wiles (2007:23) as "provision of information (knowledgeable retail personnel answering questions and furnishing product information and usage), provision of solutions (thoughtful and customised information and recommendations), emphatic relationship and dedication to customers, warm and approachable, friendly customer service, intelligible understanding of customer needs, and shopping ease with a convenient shopping experience".

In a broader perspective, customer service creates positive customer cognition and behaviour that generates financial benefits for the firm. Although Anderson and Mittal (2000:107-120) argue that the relationship between service and satisfaction is non-linear, Zeithaml (2000:67-85) interprets that service leads to increased customer satisfaction while satisfaction leads to increased retention. In a linearity between service and satisfaction, Sirdeshmukh *at al*., (2002:15-37) assert that "customer service efforts have been found to increase customer satisfaction, leading to increased repurchase intentions, willingness to recommend, and share-of-wallet". The diagrammatical presentation in the linearity perspective by Wiles (2007:20) shows that Service-Profit chain customer service creates financial benefits for the firm in terms of revenue, cash flow and profitability. Wiles' research further indicates that the firms can be confident that their investments in customer service are justified as one of the best routes for raising shareholder value.

Figure 1.3: A model of the relationship between service, profit and firm market value



Source: Wiles, M.A. (2007) "The effect of customer service on retailers' shareholder wealth: The role of availability and reputation cues". Journal of Retailing, 83(1) 19-31

The service package can be delivered by relieving retail store staff of order replenishment and the manual updating of inventory by shifting to electronic supply chain management and CscD systems. The centralised distribution centre, underpinned by a regional distribution centre network, and cross-dock network, positions the product closer to customers to enable shorter order lead times, which allows retailers to respond quicker to fluctuating consumer demands (Aberdeen Group, 2010). These supply chains require dyadic context between retailers and vendors to work together to synchronise the flow of products and information by investing resources in personnel and technological systems. Durham (2011:11) describes a CscD system as "the standard modus operandi for the fast moving consumer goods industry through the benefits of a fully efficient streamlined supply chain, that 1) reduces out-of-stock at store level; 2) reduces stock room space requirement; 3) manages larger volumes through the central facilities, and; 4) fewer delivery vehicles at store level with more efficient turnaround time for trucks". In terms of service chain management at store level in this analysis, fast moving retail stores direct the focus mostly on customer service level than managing inventory and orders to ameliorate the bullwhip effect. Improving customer service levels through integrated frequencies of replenishment rate between the echelon stages will drive the inventory positioning and product availability.

1.5.2.4 Distribution Chain Management

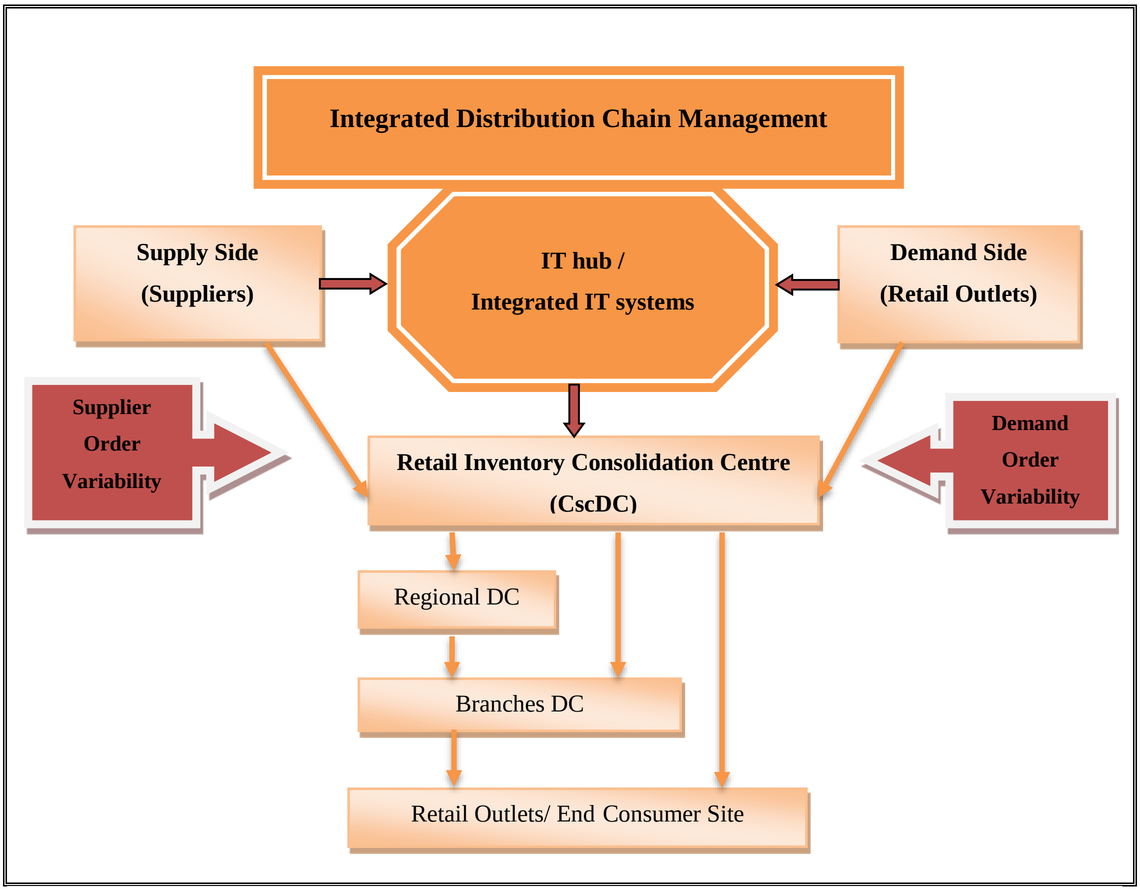
The distribution chain system across the network has the value-adding strategic role of integrated consolidation, with transportation consolidation (shipping full truckloads) and product mixing for customer orders (Bowersox *et al.*, 2013). Rabinovich and Bailey (2004:651) infer that the distribution chain system is "of quality if it's reliable and ensures availability and timely delivery of products to the consumption cycle". According to Coyle *et al*, (2013) the system enhances customer service and, contingency protection (delays and vendor stockouts) allows for a smooth manufacturing process and the integrated service allows for a consolidation of products for delivery and expedites premium transport services combined with supply chain information technology. The CscD centre is able to rapidly process customer orders and to maximise delivery performance with the support of electronically-enabled supply chain management systems. Coyle *et al.*, (2013:466) suggest that supply chain inventory positioning on time and place utility of the distribution operations achieves shorter lead time cycles, increases product availability in proximity of the consumption cycle and effectively and efficiently delivers reduced costs.

The streamlined distribution system is sometimes segmented into national distribution centres, regional and zone distribution centres, and local branches. National distribution centres ship directly to customers and replenish regional and zone distribution centres. Regional and zone distribution centres are responsible for replenishing numerous branches and sometimes ship products directly to customers. Shipping costs and excess inventory are reduced through identifying products to ship based on inventory quantity and distance. Coyle *et al*., (2013:474) recommend using a regional or local inventory positioning network design to assist in reducing customer delivery costs and order cycle time.

From an operational perspective, Bowersox *et al*, (2010:249) note that, firstly, the CscD system enables both the inbound movement from origin and the outbound movement to destination to be consolidated into a larger size shipment, which generally results in lower transportation charges per unit and most often quicker delivery. Secondly, the system benefits in terms of break-bulk operations at district level. While the business buys and receives a single large shipment from different suppliers, the system synchronises the arrangements for full-truckload local delivery to multiple retail outfit destinations. Seemingly, the centralised inventory distribution system depicts the long distance to customers that extends lead times with higher transportation costs.

Despite these effects the supply chain performance benefit of this consolidation strategy has greater control over supply chain inventory positioning and reduced demand variability due to risk pooling (Bowersox *et al*., 2013; Synder and Shen, 2011).

Figure 1.4: Distribution chain dynamics in CscD Centre



Source: Developed by the Researcher for the thematic perspective of this study

The CscD centre acts as an information-based hub in the midstream site (electronically monitoring sales and inventory from the retail outlets while updated on capacity level upstream supply chain, that is, triggers replenishment orders from upstream capacitated suppliers. There are three types of distribution models: a) Segmented levels national DC – Decentralised, b) CscDC (Retail outlets owned DC), and c) Manufacturing DC (Based mostly on VMI system). Figure 1.4 indicates the success of the CscD system, depending on mitigation strategies in both consumer demand order variability (DoV) and supply order variability (SoV) in the distribution chain management. The integrated information technology hub will increase service performance to desired levels in the strategic central consolidation model (demand side – available data and supply side – available resources and capacity for a successful CscD system).

According to Simchi-Levi *et al*., (2008) and Snyder and Shen (2011) the centralised system at the node-to-node of supply chain network at each stage of the chain receives the retailer's forecast mean demand and follows a base-stock inventory policy based on this demand although the demand variability depicts the total lead time cycle between echelon stages and the retailer. By the same token, a supply chain is a set of nodes which consist of product plants, a central distribution centre/warehouse, regional warehouses and point-of-sales (Wu *et al*., 2010:6435). This echelon-based chain dyadically links suppliers and customers, beginning with the production of products by a supplier, and ending with the consumption of a product by the customer.

1.5.2.5 Supply Chain Management

The supply chain management focuses on the flow of physical products from suppliers through manufacturing and distribution all the way to retail outlets and customers (Simchi-Levi, *et al.*, 2008:1). While the demand management recognises forecast development and works with the supply side to adjust the inflows of materials and products (Cachon and Terwiesch, 2009). Although demand management analyses the consumption of the sales forecast by the actual sales order rate on a continuous basis, the flow of consumer demand order information comes from many sources in supply chains. The oscillation effect on distorted order information traveling up stream indicates amplified consumer demand order variability and results in diluted accountability, fosters distrust of information and a bloated inventory level.

Seemingly, the integration of development chain, demand chain and supply chain through information sharing mechanisms and electronically-enabled supply chain management on multi-level echelons has the propensity to enhance customer-centric business strategies and ameliorate the pernicious problem of bullwhip effect. Schroeder (2008) states that supply chain management involves a sequence of value-added processes that try to match supply and demand, while demand chain focuses on creating and managing the quantities of one or more products that can be served by a supply chain. The establishment of correlated interrelationships among these several-dimensional chains gives a chance to mitigate an accelerator effect of demand changes in the supply chain. According to Coyle *et al.*, (2013:16) supply chain management is viewed as "a pipeline or conduit for the efficient and effective flow of products/materials, services, information and financials from the supplier's suppliers through the various intermediate organisations out to the customer's customers or the system of connected networks between original vendors and the ultimate final consumer".

This study interprets supply chain management as: 1) broad and comprehensive synchronisation of flows, integrated-based activities and extended enterprise; 2) the extended enterprise crosses the boundaries of several individual organisations on underlying demand chain, demand flow, information flow, design chain, value chain, value network and service chain; 3) the supply chain performance benefits span the related and connected process activities into schematic network of interrelationship and interconnectivity between its elements in order to minimise system wide costs while satisfying service level requirements.

The extant research studies have acknowledged and dealt with the pernicious effect of amplified demand orders variability on both downstream and upstream sites of supply chain. Nevertheless, there is no, evidence that the FMCG industry has fully espoused electronically-enabled supply chain management systems diffusion, nor that is has underpinned the global optimisation dimensions to tame the bullwhip effect. Hence the central thematic framework of bullwhip effect challenges in this study is entrenched in exploring the quasi-real-time and advance economic order information sharing, optimal supply chain inventory positioning, global optimisation strategies and electronically-enabled supply chain management systems diffusion to palliate and contain the effect of fluctuations in supply and orders placed across trading supply chain partners.

1.6 Structural Constructs of the Study

1.6.1 Supply Chain Management

Supply chain management focuses on positioning organisations in such a way that all participants in the supply chain benefit. Thus, effective supply chain management relies on high levels of trust, intelligent collaboration, and active communications. The extant literature and professional institutions have brought forth meaningful definitions of supply chain management. The meaning of supply chain management engenders the integrated business activities across the internal and external supply chain processes for the purpose of adding value for trading supply chain partners and customers. Miragliotta (2006:366) defines bullwhip effect as “a supply chain phenomenon revealed by a distortion (variability amplification and /or rogue seasonality) of the demand signal as it is transmitted upstream from retailers to suppliers”. The demand vacillations prevail in the multiple echelon-stages as orders roaming to the upstream site of the network. Wu and Katok (2006:839-850) define the bullwhip effect as “the observation that the variability of orders in supply chains increases as one moves closer to the source of production”.

These definitions indicate value creating systems and movement of orders linked to multiple nodes as the description of network chain structure and linkage. This study interprets the chain networks as a complex web of interconnected nodes (representing the entities or facilities such as suppliers, distributors, factories and warehouses), and links (representing the means by which the nodes are connected on supply chain mapping flows).

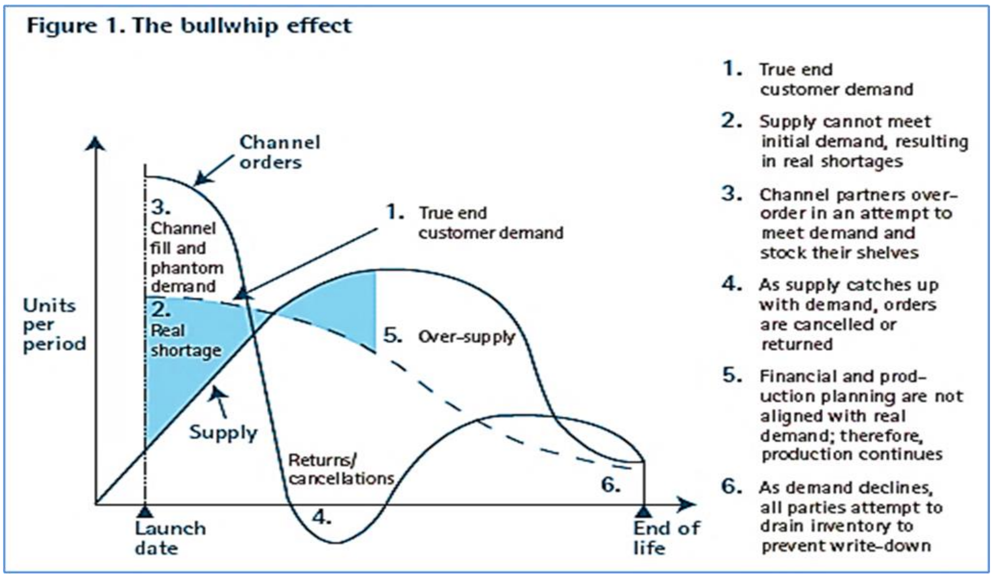
The Institute for Supply Management describes supply chain management as the design and management of seamless, value-added processes across organisational boundaries to meet the real needs of the end customer (Glossary of Key Purchasing and Supply Terms, 2000). If supply chain management is a discipline that matches supply and demand, the discipline coordinates all activities in the multiple channel partners and integrates network activities from the downstream to upstream supply chain as value-adding system to the customer. The study agrees on the idea of integrating related activities on node-to-node supply chain network to track inventory, and to manage order entries and order management systems through electronically-enabled supply chain management tools. The integrated product-related activities among the trading supply chain members enhance efficiency, improve trust in sharing advance economic information, ameliorate fluctuations in production levels, and advance service quality to customers. In theory, supply chains work as a cohesive, singularly competitive unit, accomplishing what many large, vertically integrated firms have tried and failed to accomplish.

1.6.2 Information Sharing

Information sharing is the optimisation strategy to enhance active coordination and integration in the chain network, and it extenuates challenges from consumer order demand variability. Chen (2003:341) has presented a comparative analysis where a focus has been on the demand-side information, which optimises portion of the overall flow chain network. While the supply-side information evinces limited retail sales information and wavering inventory at point of sales. Consequently, the capacitated suppliers engender long lead time, overrun plant operations and overshoot inventories in manufacturing and distribution cycles while retailers are inundated with new product launches on replenishment cycles. The balanced approach should accentuate the essence of sharing forecasts, sales and operations information on both supply chain stream sites among trading partners during strategic rollovers.

This balance indicates that "when demand variability increases, information sharing saves more costs, and when supplier knows exactly the lead time and supply availability for every replenishment order and product rollover, upstream information sharing improves supply chain performance targets and benefits channel partners of supply chain entities" (Chen, 2003:341-422).

Figure 1.5: The bullwhip effect and advance economic information sharing



Source: Derrick, R.D. (2003). 'Challenging the bullwhip effect with advanced information sharing', *Accenture*, Council of Logistics Management's 2002 Annual Conference Proceedings. Available: Research & Insights, www.accenture.com

Figure 1.5 indicates "the bullwhip effect where slight discrepancies between channel demand and real demand can cause ever-larger ripples as the orders travel upstream through the supply chain. The quasi-stable actual consumer demand (point 1) is distorted downstream with channel partners over-order in an attempt to meet demand and stock their shelves (point 3) and supply seemingly cannot meet initial demand, resulting in real shortages (point 2) because financial and production planning are not aligned with real demand (point 5). As supply catches up with demand, orders are cancelled or returned (point 4) because all parties attempt to drain inventory to prevent write-down as demand declines (point 6). This is attributed to the dearth of creating a more flexible and accurate supply chain through economic information sharing" Derrick (2003:1-2). Despite the increasing importance of extended enterprise strategies (Bowersox *et al.*, 2013:351) that "build on a more open exchange of quasi-real time information, the nature and scope of that information remains limited". The real time information sharing should be the starting point to underpin the synchronisation of extended enterprise network and incentive alignments towards better interconnectivity.

“The belief is that companies are overlooking the opportunity to share advanced economic information to help improve supply chain business performance benefits through better pricing and costing strategies, lower inventories and decreasing manufacturing disruption” (Derrick, 2003:1-2). The advance economic information sharing (demand forecasting and product life cycle planning) points to four areas of focus (Accenture, 2003) product economics (internal economics on the sum of a product’s costs and its profitability), technology (technological capabilities and tailored enterprise resource management software products), culture (culturally-feasible and development of a culture of trust), and legal (appropriate legal representation in light of scrutinised anti-trust). Economic information as yield benefit can be in terms of (Derrick, 2003:1-2) “Execution time frames as data-exchange activities associated with electronic replenishment, VMI and transactional collaboration such as procurement, invoicing and billing; 2) Tactical time frames such as demand forecasting, new product introductions, end-of-product-life planning and material planning; and 3) Strategic time frames for tighter communication about product designs, product life cycle planning, financial planning and category planning”.

In the value quantification of lead time information, the inventory system is sometimes embroiled with no information (Chen and Yu, 2005), the retailer has to rely on the history of order arrivals to deduce the lead time and an attempt to align replenishment decisions must be made. The prowess of distinct analytical techniques in inventory systems entrench arguments that information sharing is persistently not benefiting the capacitated suppliers. Apparently, the retailer cordially access manufacturer’ inventory information and retailer vacillating inventory policy (Jain and Moinzadeh, 2005); and the supplier on the upstream supply chain is overwhelmingly provided discrete information about the products life period (expiration date) on existing stock or available stock (Ferguson and Ketzenberg, 2006). “The manufacturers can rollover new and advanced products over an extended planning period using the solo-oriented strategy. When the periodic-review inventory system is coordinated, information sharing enhances the performance of both supply chain streams of trading partners” (Li and Gao, 2008:522). However, the authors further notify that “it is not possible to achieve embellished supply chain performance targets and benefits without proper coordination and better collaboration”.

Choudhury *et al.*, (2008:117-127) test the belief that “the benefit is increased by sharing relevant information (sharing demand and inventory information) among players in an entire supply chain”. The balanced information sharing on both stream sites (Chen model) and degree of supply chain performance benefits (Li and Gao model) provide the underlying theoretical framework to address the challenges of bullwhip effect on business operations from a profit maximisation point of view. In a stimulant continuous information exchange mechanism, Lee and Whang (2000) study the benefits of supply chain information sharing including” price discount and replenishment lead time reduction” to entice retailers to share real-time demand information with the manufacturers. In an extended Lee and Whang model, information sharing, a transparent retail order replenishment policy, and a reliable inventory status leads to a reduction in inventory level and costs (Cheng and Wu, 2005).

According to Chiang and Feng (2007:1429) “information sharing is more beneficial for the manufacturer than for the retailers in the presence of supply uncertainty and demand volatility, and value of information sharing for the manufacturer can increase or decrease with production yield variability with different cost structures and demand patterns”. As the bullwhip effect deteriorates supply chain performance by propagating demand variability up the supply chain, Schroeder (2008) maintains that the consolidated increase in coordination across firms and within firms achieve efficient consumer demand responsiveness in the FMCG businesses in the context of electronic supply chain management. It is critical in this study to examine the arguments by Cachon and Terwiesch (2009) that rational and self-optimising behaviour (silo-oriented approach) by each part of the supply chain does not necessarily lead to optimal supply chain performance and does not guarantee the absence of bullwhip effect.

1.6.3 Electronic Supply Chain Management

The study is more inclined towards electronic commerce and Internet-based projects that have evolved with business process engineering approaches and integrated business processes. These putative processes aim to simplify information flow, inventory positioning and order replenishment optimisation across supply chains. The electronically-coordinated business activities (Sebastian and Lambert, 2003) are likely to extenuate the variance amplification through electronically-enabled supply chain management (e-SCM) systems diffusion. Lin and Huang (2012:164) define e-SCM systems diffusion as “a process form internal diffusion among functional units within an organisation to external diffusion across inter-organisational trading partners when e-SCM becomes an integral part of the value activities”.

This study believes that the rationale to invest in infrastructural information technology (IT) projects and remodel the electronic supply chain procedures will epitomise suppliers' willingness to cooperate and collaboratively espouse e-SCM diffusion. In a similar vein, Yeh (2005:327-335) performs the correlation of factors in an e-SCM relationship where "resource dependence, trust and relationship commitment are positively related to the continuity of the cooperative electronic supply chain relationship; and risk perception is negatively related to the continuity of the cooperative electronic relationship". Despite these empirical results, Oliveira *et al*., (2010) and Ifinedo (2011) maintain that the importance of the perceived benefits of implementing technological innovations entrenches the benefit of organisation members in terms of real-time communication, decreased inventory and increased service levels. Lin and Huang (2012:162) reveal that "perceived benefits, knowledge management capability, and trading partner influence are important factors shaping e-SCM systems diffusion".

Understanding the concept of supply chain management as the effective coordination of business processes from a number of tiers, manufacturers, intermediaries, retailers and financial transactions between supply chain trading members, the information technology (IT) (Wu and Chuang, 2009), can be utilised as a diffusion attainability mechanism to enhance competitiveness of supply chain members (Lin and Lin, 2006). Electronically-enabled supply chain management (e-SCM) diffusion basically "involves both internal diffusion among functional units within an organisation and external diffusion across a large number of inter-organisational trading partners" (Wu and Chuang, 2009:302).

The systems diffusion allows real-time information sharing on inventory position and product development among trading supply chain partners, and thus, generates a synergic effect (Yao, *et al.*, 2007:884). Although technological challenges facing organisations include the lack of employee training and education needed to understand the benefits and goals of e-SCM as well as the poor implementation of e-SCM (Migiro and Ambe, 2008), e-SCM systems diffusion improves accelerated e-SCM development and provides new ways to integrate web-based technologies with core businesses that affect both cross-functional (inside) and extended cross-enterprise (outside) value chain networks (Wu and Cheng, 2009; Tarofder *et al.*, 2010). The diffusion of IT innovation as the spread of use of new methods, processes, or production systems (Rogers, 2003), it should significantly impact the intra- and inter-organisational business process change, diffusion innovative supply chain solutions and even business transformation (Lin and Huang, 2012).

Wu and Chuang (2012:103-115) advise that "e-SCM systems diffusion is complex and dynamic while involving various both internal integration within organisation and external diffusion across many inter-organisational trading partners". The benefits from e-SCM systems can be distributed in distinct proportion in favour of influential supply chain supremos. The likelihood is that, the compelling portion of supply chain partners will benefit more than dependent businesses in supply chain networks (Subramani, 2004). "The dominant firm affects the focal firm's eSCM systems adoption through their effects on the focal firm's trust and perceived institutional pressures. The uncertainty of e-SCM systems adoption consequences impedes firms from adopting this innovation, and the insufficiency of e-SCM systems adoption is regarded as major critical failure factor of supply chain management" (Ke *et al*., 2009:839-851).

This study underpins the internal and external collaborative relationships between participants that mainly concern the degrees of active communication, mutual trust, and interdependence (Wu and Chuang, 2009). In the context of global optimisation strategies, electronic collaboration (e-collaboration) means performing critical roles in process agility, absorbing costs and improving customer service levels in the supply chain entities (Ovalle and Marquez, 2003). In spite of the communication of information having to go through multiple intermediaries between the consumers and the raw material sources each upstream supplier could have a stable sale and each downstream customer could order a stable amount of products (Marquez, 2004).

1.7 Significance of the Study

The primary goal of this study is to analyse the effect of amplified demand variability as order quantity travels upstream (supplier) and exceeds the demand from downstream (retailer). The bullwhip effect as a pernicious phenomenon prevails in distorted retail sales information coalesced with order size from downstream where supplier upstream supply chain experiences order variance amplification. It is essential to discover strategic ways of taming and controlling order variability and prevent excessive inventory through the electronic supply chain systems. The variance amplification is pervasively influential without effective collaboration and integration systems to prohibit insufficient or excessive capacity, avoid product unavailability, eliminate high costs, shorten lead time and formulate effective collaborative and integrative systems.

The significance of this study is to establish the relationship between bullwhip effect and constructs of information exchange, inventory flow and electronic supply chain management and its global optimisation strategies. The overall objective of the research is to develop dimensions that will produce an architectural business convergence structure to simulate an echelon-based model of supply chain management performance. The study aims to assist businesses to comprehend the pernicious effect of demand order variability and the significance of sharing advance economic information and applying electronically-enabled supply chain management tools to synchronise supply chain business processes.

1.8 Justification of the study

The study focuses on assisting the transformation of the fast moving consumer goods industry into optimal electronically-enabled supply chain management savvy. In other words, supply chain management with information technology (IT) projects will be used to enhance performance, competitiveness and profitability. Eventually, grocery industry firms will compete on supply chains versus supply chains, rather than having a silo-oriented approach. The degree of electronically-enabled supply chain management diffusion is confined within each echelon node (logistics and distribution – RFID, retail – electronic point-of-sale (e-POS), manufacturing – electronic data interchange (EDI) and suppliers – e-POS and EDI). The study will present an opportunity for this industry to improve SCM activities, and electronically integrate activities across supply chain networks. In terms of value of the study, it is to produce an academically-scientific thesis to contribute to a new body of knowledge, and subsequently, develop future research areas in business management and beyond. It will produce publishable articles locally and internationally. It will enhance the strategic thinking and holistic approach throughout the context of interdisciplinary approach.

1.9 Dissertation Structure

Chapter 1: Introductory chapter and problem statement

The prologue of this study is articulated in this chapter. It formulates the underlying foundation in terms of the motive, objectivity, scientific probing and focused scope of the study. It includes the background, motivation of the study, empirical research objectives and questions, and a brief synopsis of the constructs (the key variables such as bullwhip effect, inventory positioning, information sharing and electronically-supply chain management systems diffusion).

Chapter 2, 3, 4 and 5: Literature review chapters

These chapters review the extant research literature on bullwhip effect, global company profiles on selected FMCG stores, inventory systems and information sharing and electronically-enabled supply chain management systems from an epistemological viewpoint to understand, describe, explain and infer the review. The scientific paradigm can enable a cohesive referencing to literature that coincides with empirical data analysis. The chapters are configured to include definitions and empirical models to heed conventional theories of constructs and comprehension of extant research studies. This review of the pertinent literature is concatenated to the research objectives and dimensions of bullwhip effect, inventory systems, information sharing and electronic supply chain management as constructs.

Chapter 6: Research Methodology

This chapter articulates the research design together with the research procedure and methodology in the study. It explains the tactical procedures of data collection and provides a descriptive analysis of population selection, sample size and sampling method. The measurement instruments are explained in sectional design and how the instruments were developed central to the research problem and questions. In the same vein, the research methodology has been selected to seek possible inferences to empirical research questions. The assessment methods aim to validate the study and to advocate the reliability of result findings.

Chapter 7: Data Analysis and Presentation of Results

The research analyses the data collected through questionnaire and interview instruments using SPSS software. The univariate, bivariate and multivariate analyses are applied statistical techniques to examine the differences, relationships and interrelationships of variations among variables in the study. Although the univariate presents the distribution of categories on one variable at a time, the comparative analysis of two classification variables can be instituted in cross-tabulation and chi-square to test the goodness of fit.

Chapter 8: Discussion of Results

The discussion of the findings in this study has four sections. Section one delineates the demographic and company profile, section two focuses on the descriptive statistics, section three examines the bivariate analysis by determining the statistical significance of associated relationships and differences between two variables, and section four investigates interrelationships between variables and relationships between dependent and independent variables. These sections constitute the empirical research component that was based on a judgmental and convenience sample technique of 448 respondents. This study intended to capture insight into the phenomenon of bullwhip effect and the role of e-SCM systems in the FMCG industry. The primary objective of this study was to analyse the challenges of bullwhip effect and the role of e-SCM systems on the selected FMCG industry.

Chapter 9: Recommendations, Conclusion and Future Research

This chapter presents the summary and conclusion and recommendations based on findings, limitations and suggestions for future research.

Bibliography, Appendices, Sample questionnaire, Ethical clearance letter, Turnitin Report

Chapter Two

Bullwhip Effect on Fast Moving Consumer Goods (FMCG) Industry

2.1 Introduction

The previous chapter introduced the key variables that constitute the literature framework for this study. This chapter discusses the challenges and dynamics of the phenomenon of bullwhip effect as consumer demand order variability increases upstream in the network. Supply chain management as an extended cross-enterprise and dynamic synchronised-decision making process, Wu *et al.*, (2006:839-850) indicate that "multiple echelon channel stages are involved in the process, whose performance depends on the quality of other supply chain members' decisions". While supply chain tends to involve multiple echelons with a variety of practices and policies, Wu *et al.*, 2009:302) indicate that "those complexities result in a higher degree of supply uncertainty" and create volatile demand order dynamics within a supply chain network (Paik and Bagchi, 2007). Bowersox, Closs and Stank (2003:18) maintain that the distinctive yet interrelated flows produce value-added chains for the ultimate consumers, and Paik and Bagchi (2007:308) further recognise the complexity of the network that "all companies involved in a supply chain network are important in establishing a desired level of customer service in the supply chain and satisfying their customers' requirements".

Paik and Bagchi (2007:310) imply that "each member of the supply chain requires to increase the level of stocks in order to maintain established service levels causing increased inventory holding costs due to overstocking throughout the supply chain, and leads to inefficient use of resources, and eventually results in poor customer service and profitability". The authors' implication emanates from their analytical study on significant causes of bullwhip effect, demand forecast, length of channel stages, and price vacillations as "these factors explained about 53 percent of the variation in demand amplification factor in the statistical model". These compelling analyses exhort the retailers to exchange the real demand information and actively communicate coordinated operational activities with the trading partners to control demand variability. Tulluri *et al.*, (2004:64) take a different view on the challenges of determining optimal order quantities, optimal production quantities, safety stock levels and other inventory policies.The authors underpin the optimal inventory aggregation as a strategic approach for decreasing safety stocks without sacrificing customer service levels.

Apparently the central holding of the slow moving items and decentralising of fast moving items to attenuate the cascading phenomenon are recommended, although this study is confined to the consolidated strategy for the FMCG industry, commonly known as the central supply chain system. Some researchers underpin the reengineering processes, while Sheu (2005:797) focuses on "information integration in supply chain by using stochastic model for a multi-layers demand-responsive logistics designing" and Chen *et al*., (2000:436) suggest that "centralised customer demand information". The emphasis is on the principles of information transparency and reduction of channel-echelons (Geary *et al.*, 2006), as Sterman (2006) interpreted three behavioural patterns from multiple nodes (retailers/capacitated suppliers) as: "oscillation, amplification and phase lag".

Simchi-Levi *et al.,* 2008:161) further admit that "sharing centralised information can significantly reduce, but will not eliminate, the bullwhip effect". Despite all channel stages of the network using the similar forecasting technique (Chen *et al*,. 2000), inventory policy and no information lead time (all stages see consumer demand at precisely the same moment as demand orders arrive), Snyder and Shen (2011:273) interpret the variance increase as "the increase in demand order variability is additive in the centralised system but multiplicative in the decentralised system". These contrasting views will hypothetically be tested in the literature and empirical sections of this study.

2.2 Evolution in Bullwhip effect

Although bullwhip effect reflects the initial scientific discovery of Simon (1952) and Forrester (1961), its celebrity flourished with the Beer Distribution Game, (Beer Game Simulation, Massachusetts Institute of Technology (MIT) from the concept of Industrial Dynamics). Sterman (1989:321-339) reported scientific findings on the bullwhip effect in the "Beer Distribution game and, the experiment involved a supply chain with four players who made independent inventory decisions without consultation with other chain members, relying only on orders from the neighbouring players as the sole source of communications".

Wu and Katok (2006:839-850) summerise the echelon-based rendition of the "beer distribution game" , as "the game simulates a multi-echelon serial supply chain consisting of a Retailer (R), a Wholesaler (W), a Distributor (D) and a Factory/Manufacturer (M) with exogenous customer demand. Assigned one of these roles, each participant manages her own inventory by placing orders to the upstream supplier for replenishment so as to satisfy demands downstream over multiple periods. Each period begins with the arrival of shipments, which increases one's inventory.

Next orders placed by the downstream customer are received, which are either filled when inventory is available or become backlogged. Each participant then makes an ordering decision and carries any remaining inventory/backlog over to the next period. The decision task is complicated by the existence of lead-times/delays in the supply chain: order processing delays (two periods) and shipment delays (two periods) or production delays (three periods and only for the manufacturer)". In an experimental inventory management context, Balan *et al.,* (2009:282) discover that the linear orders amplify as one moves up the supply chain, confirming the bullwhip effect.

In terms of remedy, Rinks (2002:443) resorts to "a simulative approach to replicate the Beer Game scenario, showed that eliminating the bullwhip effect may reduce supply chain costs by 50%". Senge (1990), and Senge and Sterman (1992) ascribe to bullwhip effect from the Beer Game with the dearth of systems approach, that is, a systematic view that seeks the holistic perspective to tame bullwhip effect. Although Miragliotta (2006:365) argues that the system thinking school has "set high standards in terms of holistic comprehension, systematic knowledge and sometimes mathematical skills since one has to understand the supply chain dynamics before one is able to control and prevent the bullwhip effect. System theory in the supply chain management is the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain". The purpose is to improve the long-term supply chain performance targets of the individual companies and the supply chain performance outcomes on inter- and intra-organisational configurations.

The effective supply chain paradigm of networks seeks to entrench organised and coordinated supply chain performance processes from virtual value-added chain of multiple cross-enterprises (Simchi-Levi, *et al.,* 2008) by integrating supply chain activities on the basis of the formal apparatus provided by systems theory. Although the system perspective does present a challenging network framework that atomises into silo-oriented businesses (Zhang and Dilts, 2004), the functionality of extended enterprise can serve markets in order to achieve complex dynamic goal-oriented processes. . The Global Supply Chain Forum views supply chain management as the integration of key business processes across the supply chain for the purpose of adding value for customers and stakeholders (Lambert, 2008).

The concept (Forrester Effect) is ingrained and embedded ground in Jay Forrester's Industrial Dynamics (1961) demonstrated as DYNAMO Simulation (relation between inventory and orders. Forrester (1958, 1961) uses computer simulation models to exhibit the amplified order variability upstream than the real consumer demand variability downstream the supply chain. Forrester describes the irrational behaviour of trading supply chain partners as the mainspring of order variability and the lack of a holistic view of the supply chain. The impact of demand signal processing and non-zero lead times has in the past been called the "Demand Amplification" or the "Forrester Effect" after Jay Forrester (1961) who identified the deleterious effect in many real-world supply chains and demonstrated it via DYNAMO simulation. The illustration of the Forrester Effect has pointed towards the findings of industrial dynamics or time varying behaviours of industrial-based organisations. In other words, the underlying policies produce obnoxious behaviours with the assumption of a narrow view and a lack of appreciation of the integrated supply chain network which can result in the amplified demand variability.

Table 2.1: Evolution in Bullwhip Effect

Authors	Bullwhip effect perspectives
Burbidge (1961);(1984)	Looks at Law of Industrial Dynamics by reducing cycle time and synchronising order processes. It implies that demand variation increases under stock control ordering system as demand transmitting along a series of inventories.
Bhaskaran (1998)	Uses simulation at a lesser extent when analysing a manufacturing supply chain, the study shows the interaction that the dearth of active coordination results to valley and peak, and to an increased inventory level.
Kahn (1987)	Shows a serially correlated demand results in the bullwhip effect.
Blackburn (1991)	Focuses on lead time cycles that should be shortened.
Van Ackere and Larsen (1993)	Distinguish three different approaches: "1) redesigning the physical process (such as lead-time reduction and eliminating a channel in the supply chain), 2) redesigning the information channels (such as providing customer demand data throughout the chain), and 3) redesigning the decision process (using different replenishment rules)".
Naish (1994)	Views uncertainty in demand and errors of forecasts as a comprehensive understanding to cause bullwhip effect. Sees the bullwhip effect as "a rational reaction to isolated and well perceived factors", with information sharing / channel alignment / operational efficiency as solutions (Miragliotta, 2006).
Lee *et al.*, (1997)	Employ demand assumption, and use cost minimisation technique to depict that vacillations in demand emanates as retailers optimise and/or inflate orders from accumulating replenishment lead-time.
Sterman (1989)	Describes bullwhip effect from irrational decision making of participants in the Beer Distribution Game. Sterman concluded that the participants of the game underestimated delays in ordering process and as orders placed, the participants lack holistic approach to supply chain inventory dynamics. Sterman (1989) shows that "misperceptions of feedback" by human decision makers give rise to bullwhip effect.
The Systems Dynamics Group (1996)	Massachusetts Institute of Technology (MIT) experiment the inventory management by simulating a make-to-stock supply chain with four tiers. The experiment evinces the solo-oriented inventory decisions among the four players in the supply chain. "The neighbouring player independently takes order replenishment decision without consolidating the forecasts and actual consumer demand information from trading supply chain partners".
Croson and Donohue (2003)	Similarly, the sentiments focus on utilising the experiment on known demand distribution and information sharing between participants. "These behavioural approaches in the Beer Game both concluded that information sharing reduces the bullwhip effect".
Mason-Jones (1998)	Underpins the information enrichment strategy and advocates that a node-to-node variance amplification is reduced with information sharing.
Cachon and Fisher (2000)	Affirm that "information sharing decreases total costs by slightly over two percent".
Paik and Bagchi (2006)	Understand that the deplorable decision emanates from evaluating intricate feedback loops compounded by time delays.
Nienhaus, Ziegenbein and Duijts (2004)	Describe the bullwhip effect as deleterious phenomenon regarding "Dimensioning of capacities; Variation in inventory level; and Dimension of high level of safety stock".
Makui and Madadi (2007)	Interpreted "the role of lead times (phase lag), between the participants of a supply chain in occurring the cyclical effect for Lyapunov exponent is very important and their descending of ascending order can influence dramatically the bullwhip effect". The Lyapunov exponent may be understood as "the average factor by which an error is amplified within a system, and it could be interpreted as the amplification behaviour in the supply chain".
Jonsson (2008)	Suggests that "the significance of the effects from the viewpoint of management and financial impact increases with the complexity and the length of the supply chain and describes this as the Cascade effects, as variations in demand double with each step in the supply chain".

Source: Compiled by the researcher from the listed literature review.

Forrester ascribes to behaviours of the members and Sterman's members depict extensive irrationality on human factor from decision making process misperceptions. However, the study attempts to capture the valuable aspects of rational decision making, optimising behaviours of members and optimal decision fate of managers. These intriguing approaches (Forrester, 1961 and Sterman, 1989) have made progress in taming the bullwhip effect through behavioural changes and coordination among trading supply chain members. Essentially, the study has a chance of overcoming the pernicious bullwhip effect by focusing on inter-organisational infrastructure and electronic supply chain project-related processes. Lee *et al.*, (1997:93-102) isolate "demand forecast updating, order batching, price fluctuations, and rationing and shortage gaming" as the cause of bullwhip effect. The study is not investigating the causes, but rather trying to understand the model and possibly mitigating the bullwhip effect through electronic supply chain management solutions. However, Lee *et al.*, (1997) dispute Forrester (1961) and Sterman's (1989) argument on irrational behaviour and ascribe rational behaviour as the trigger for the phenomenon of bullwhip effect.

This effect leads to inefficiencies in supply chains, since it increases the cost for logistics and lowers its competitive ability. The researchers, Towill, (1991); Towill *et al*., (1992); Evans *et al.*, (1993); Mason-Jones and Towill, (1999); and Towill and McCullen, (1999) utilised Forrester's simulation model as the benchmark that comprises of four echelons (retailer, distributor, factory warehouse and factory). The computer simulation indicates that the procrastination of information and material among these participants has the proclivity to cause the bullwhip effect and demonstrates the distinct reduction in amplified consumer demand as the time delays are expunged from the simulated equation. Ackere, Larsen and Morecroft (1993) and Hong-Minh, Disney and Niam (2000) reinforce the outcome (reduction of variance amplification) from the elimination of one or more intermediaries from the supply chain network by acknowledging the channel alignment and architectural supply chain structure as impeding factors).

The researchers further show that "the centralisation can reduce the Lyapunov exponent generated among the participants of the supply chain, and also outlined that the proposed measure is suitable for amplification and phase lag, as the lead time, but cannot detect the case of pure oscillation (oscillation without amplification)" (Chen *et al*., 2000; Sterman, 2006; Makui and Madadi, 2007).

Table 2.2: Contemporary Perspectives on Bullwhip Effect

Authors	Bullwhip Effect
Taylor (2000)	The antithetical approach analyses the upstream supply variability as major contributor to the bullwhip effect such as machine reliability demises (unreliable) gives asymmetrical outputs , and the oscillation triggers the variability on the demand side and quality challenges. The model presents a demodulated approach to detect bullwhip effect from upstream site in the study.
Yao (2001)	Studies the bullwhip effect from the variety of order policies echelon channel design in the network
Merkuryev and Petuhova (2002)	Study the bullwhip effect from centralised and decentralised information exchange strategies with" min-max inventory policy and stock to inventory control policies in a four stage forward supply chain problem". The comparison of the centralised and conventional approach of a multiple nodes seems to depict the advantages on the centralised approach.
Cullen and Towill (2002)	Demonstrated how proven material flow control principles significantly reduce bullwhip in a global supply chain.The study depicts the principles of material flow control to manage bullwhip effect in the global operations.
Miao (2003)	Introduces some measures on strategic alliance between the supply chain members (retailer and the supplier) as strong ally to palliate bullwhip effect.
Warburton (2004)	In coordinating order replenishment for supply and demand sides, the author looks at time as a continuous variable.
Disney and Towill (2003)	Analyse the influence of vendor-managed inventory (VMI) system, and consumer demand indications effect that exhibits lower order variance with VMI system.
Dejonckheere *et al..*, (2003), and Disney and Towill (2003)	Show that the bullwhip effect is inevitable under "order-up-to-replenishment policy", on any forecasting method. The proposal indicates that net stock and order inventory discrepancies are only fractionally taken into account by using a control systems engineering approach.
Svensson (2003)	Introduces a "see saw model and a topology" for an inter-organisation echelons.
Jose and Rafael (2004)	Demonstrate positive outcomesof simulator on electronic data interchange (EDI).
Balakrishnan *et al.*, (2004)	Look at order smoothing by downstream stages that serves as an effective mechanism to control and dampen variability through provision of advance order information. The suppliers should adopt a variability-centric viewpoint for coordinating supply chains that yields temporal risk-pooling benefits as well as a reduction in the supplier's effective order uncertainty
Chatfield *et al.*, (2004)	The viewpoint for coordinating supply chains through swift information sharing quality, and information sharing reduces total variance amplification and stage (node to node) variance amplification, and decelerates bullwhip effect.
Fiala (2005)	Studies cooperative policy on information exchange under system dynamics simulation method.
Croson *et al.*, (2005)	Identify behavioural effect on underlying risk from poorly coordinated activities and decision uncertainty.
Wu and Katok (2006)	The controlled environment of laboratory enables to explore and isolate the impact of institutional or structural changes to the supply chain on mitigating the bullwhip effect behaviour. The researchers allude to innovations such reducing ordering and shipping delays. The laboratory-based environment with level of control assists to probe and identify the effect of structural changes. The shortening of lead time cycle on ordering and shipping providing additional inventory information sharing point-of-sale information

Source: Compiled by the researcher from the listed literature review.

An organisational learning (OL) perspective by Cangelosi and Dill (1965) views learning that occurs at multiple level (Crossan, Lane, White and Djurfeldt, 1995): "*information is processed and transformed into insights and innovative ideas by individuals first; then knowledge is shared and mutual understanding is developed among groups; and some individual or group learning further become institutionalised as organisation artifacts"* (Wu *et al.,* 2006:839-850). Organisational Learning (OL) paradigm recognises competence value on enhancing supply chain collaboration relationships (Preiss and Murray, 2005). Boudreau *et al.,* (2003:179-202) on more unifying framework, propose to bring human resource management context, Wu *et al.,* (2006:839) "examine to what extent training and communication impact the local ordering decision-making process and the global learning and behaviour of supply chain as an organization". The researchers suggest that the better communication has propensity to palliate bullwhip effect while the participants confine to training requirements and protocols. Wu *et al.,* (2006:845) reveal that combining training and communication together (virtual value-creating competence and knowledge) improves control on bullwhip effect.

2.3 Quantifying the Bullwhip Effect

The quantification has propensity to demonstrate the magnitude of the increase in variability and to entrench the relationship between the forecasting technique, the lead-time and the increase in variability. Metters (1997) uses a two-stage channel simulation under differing conditions with an attempt to "quantify the excess costs". Similarly, Chen *et al.,* (2000) expand the echelons by quantifying the bullwhip effect in the K-stage supply chain where an assumption was made on deterministic lead time and stochastic demand (Chatfield *et al*., 2004; Miragliotta, 2006). The multiple-stage supply chain constrains the sharing of consumer demand information, although Chen *et al.,* (2000) argue that the bullwhip effect emanates from the anticipatory model (forecast-driven) in trying to capture the quasi-real-time consumer demand information. In the meanwhile Burt, Dobler and Starling (2003) indicate that the dearth of both accurate forecasting and sharing advance economic information results in dilated inventory levels.

2.3.1 Bullwhip Effect on Information Sharing

Mason-Jones (1998) in the exploratory approach to several variations of the information enrichment strategy, determines that information sharing was beneficial despite the reduced vacillations. Croson and Donohue (2003:1-11) also "show a decrease in the bullwhip effect in their Beer Game with information sharing" and Cachon and Fisher (2000) acknowledge the quintessence of exchanging information.

The understanding is that when information on demand orders is centralised, individual members in the network draw demand data from the central hub to estimate the average demand. Conversely, when demand data is decentralised without exchange, the individual echelon stage must use the orders placed by the previous node-to-node to estimate the average demand. According to Simchi-Levi *et al.,* (2008:164) orders placed by previous stages are more variable than the actual customer demand data, and thus the forecasts created using these orders are more variable, leading to more variable orders. The analysis indicates that decentralised demand information can significantly increase the variability while the centralised demand information can significantly reduce, but will not eliminate, the bullwhip effect (Simchi-Levi *et al.,* 2008; Snyder and Shen, 2011).

If ratios are considered for measuring the bullwhip effect, Miragliotta (2006:365-381) suggests that the variance ratio is utilised as a measurement on the bullwhip effect, and it is defined as “the ration between the demand variance at the downstream and at the upstream stages; when this ratio is greater than 1, then one has bullwhip effect at that stage”. Taylor (1999:55-70) suggests that “analysis at both demand data (passed from company to company) and activity data (like, production orders registered within the company), in order to gain more insight on what is really happening”. El-Beheiry *et al*., (2004:259-274) introduce “a modified variance ratio to isolate the batching effect (where companies look for economies, like large quantities discounts, full truck shipments) from the observed amplification”.

The intensive measures were observed on seasonality coefficients (Metters, 1997) and the coefficient of variations (Fransoo and Wouters, 2000) because of the ability to monitor the scale of the phenomenon. In the analytical approach by Warburton (2004; Miragliotta, 2006), the authors use the ratio on order quantities from downstream sites to upstream sites. Riddalls and Bennett (2001:159-168) focus on the “peak order amplification in response to a demand impulse”, similarly to Disney and Towill (2003:625-651), who used the “peak order rate overshoot: these measures help to highlight the ability to smooth isolated peaks in demand”. However, Miragliotta (2006:365-381) argues that these approaches are impractical except in the laboratory-based environment, rather than in conventional networks.

2.3.2 Bullwhip Effect measurement on Forecasting and Lead time

Based on modifications to Sterman's model, Wright and Yuan (2008:587) study "how different ordering policies and forecasting techniques, either separately or in combination, can control the bullwhip effect. The authors identified a range of ordering policies for which bullwhip effect can be alleviated by using either Holt's or Brown's forecasting method". Order rate is decided by requisitions received from the upstream trading partner, the gap between desired and actual inventory, and delay in inventory. By changing the definition of desired and actual inventory, Kohli (2005) gave a new equation for ordering policies including lead time, safety stock, and order frequency, while Sterman (1989) applied generic stock acquisition and an ordering heuristic in the model (Basic Model, BM).

Wright and Yuan (2008) showed that "the bullwhip effect can be substantially reduced, and hence the supply chain can be stabilised, by using Holt's or Brown's forecasting techniques, despite the fact that the bullwhip effect can still be present". In other words, the orders should be placed with suppliers based on the forecasted demand plus two adjustments for how far; a) the stock levels; and b) the supply line are from desired values (these adjustments will provide the most stability when combined with either Holt's or Brown's forecasting method).

Although, Disney *et al.,* (2004:295-309) argue that "the bullwhip alone does not give the real value of the global performance of the chain since low bullwhip in the demand can be obtained at the cost of having high oscillations in the inventories". Caloiero *et al.*, (2008:631) observe that, "in order to maintain small oscillations in the inventories and bullwhip values near to one, one has to increase α (smoothing constant) values and therefore increase **(*T*)** the importance of given to short-term demand".

Hong and Ping (2007:26-33) investigate demand variability caused by forecasting technology, such as the moving average (MA) method, the exponentially weighted moving average (EWMA) method or the mean square error-optimal (MSE-optimal) forecasting method on the basis of the AR(1) stochastic (stationary) process model for consumer demand (the consumer demands seen by the retailer are the stationary) and simulation model of bullwhip effect. Graves (1999:50-61) uses an EWMA forecasting method for the ARMA (0;1;1) (Autoregressive moving average) demand process. The author considers the demand process as an autoregressive integrated moving average (ARIMA), and shows that the net inventory in case of the non-stationary demand is more than that for the case of independent and identically distributed demand. Chen *et al.,* (2000:436-443) use MA and EWMA models, neither of which are optimal for an AR (Autoregressive) demand case.

Alwan *et al.,* (2003:207-219) analyse the bullwhip effect using an order-up-to policy and an AR (1) (Autoregressive process of the first order) demand process using MA, EWMA and MMSE models (Minimum mean squared error). These authors show that when an MA or EWMA method is used, the next upstream node faces a complex demand process in terms of the higher moving-average terms. However, when an MSE-optimal forecasting scheme is used, the upstream level realises an ARMA demand process, which is much simpler to identify.

Firstly, the study reveals that under employing MA and MSE-optimal forecasting methods, which one is smaller in the bullwhip effect with $\boldsymbol{\rho}$ (correlation parameter) increasing is related to the value of lead time. There is a critical value of lead time $\boldsymbol{\ell^*}$**,** when lead time $\boldsymbol{\ell < \ell^*}$**,** the MA forecasting method will be better than the MSE-optimal method for decreasing the bullwhip effect. When $\boldsymbol{\ell > \ell^*}$**,** MSE-optimal forecasting method is better than the MA for decreasing bullwhip effect. The value $\boldsymbol{\ell^*}$ increases as $\boldsymbol{\rho}$ increase. Secondly, the bullwhip effect for EWMA and MSE-optimal forecasting methods as $\boldsymbol{\rho}$ increase. There is a critical value of lead time $\boldsymbol{\ell^*}$. When $\boldsymbol{\ell < \ell^*}$**,** the EWMA forecasting method will be better than the MSE-optimal method for decreasing the bullwhip effect. When $\boldsymbol{\ell > \ell^*}$**,** MSE-optimal forecasting method is better than the EWMA for decreasing bullwhip effect. The value $\boldsymbol{\ell^*}$ increases as $\boldsymbol{\alpha}$ (smoothing constant) decrease (Hong and Ping, 2007).

Agraval *et al.,* (2009:576) argue that the reduction of lead times is more beneficial than belabouring information sharing to utilise sophisticated forecasting techniques. Along the same argument, Johnsson (2008) adds that the length of lead-time always leads to larger variations than shorter lead-times. If order cycle times become longer, order quantities and safety stocks increase too, which exacerbates the bullwhip effect on demand. Schroeder (2008) affirms that even with perfect information available to all levels, an accelerator effect in the supply chain will still be observed due to replenishment lead times. The author suggests that the best way to improve the supply chain is to reduce the total replenishment time and to feed back actual demand information to all levels. The time lags in the supply chain only serve to create fluctuations in orders and inventories. Agrawal *et al.,* (2009) suggest that lead-times reduction is more beneficial than information sharing so as to have a better controlling effect on the bullwhip effect phenomenon. Sucky (2009:311) focuses on analysing supply chains and supply networks, "where supply chains possess a network structure. In practice, supply chains can be considered as networks of geographically dispersed facilities, whereby raw materials, intermediate and finished products are produced, tested, modified and stored, and transportation links that connect the facilities".

In other words, the reflection of one supply chain member is prevalent in each stage of the network. In reality, however, there are multiple echelon channel members with a number of capacitated suppliers receiving materials from numerous lead suppliers. The author further emphasises the multiple participation on a single stage as the network. It is an extension from Chen *et al.*,'s (2000:436) analysis on network configuration in which "risk pooling can reduce the bullwhip effect on every individual stage". Risk pooling effects arise, "when the orders a retailer receives from its customers are statistically correlated with a coefficient of correlation less than one" (Cachon and Terwiesch, 2009:321).

2.3.3 Bullwhip Effect measurement on Inventory

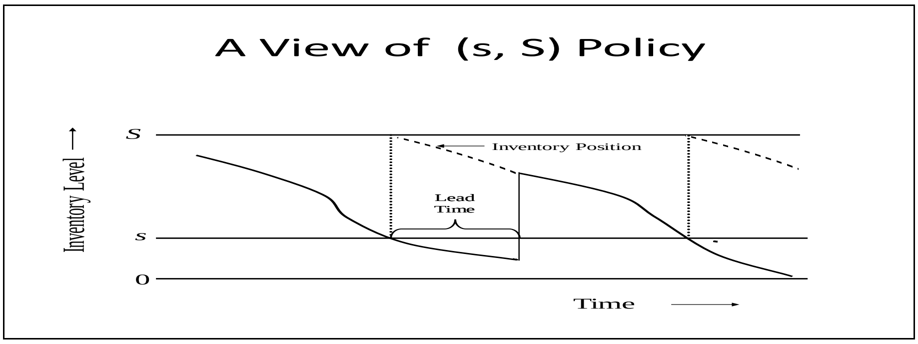
Despite the academic descriptions of the bullwhip effect by Forrester (1961), Burbidge (1961) revealed a methodology for controlling production and inventory as a link to bullwhip effect. Furthermore, Burbidge (1984:1-14) describes bullwhip effect as: "if demand for products is transmitted along a series of inventories using stock control ordering, then demand variations will increase at each transfer". Towill (1997:622-632) emphasises that "the expression demand variation can be instanced in two distinct effects: the pure demand variations amplification effect, and the rogue seasonality effect, which refers to the absence of a stable seasonality pattern, with demand peaks and valleys alternating with no customer-driven periodicity". Miragliotta (2006:365-381) simply defined bullwhip effect as "a supply chain phenomenon revealed by a distortion (variability amplification and /or rogue seasonality) of the demand signal as it is transmitted upstream from retailers to suppliers.

The demand signal is represented by the sequence of orders issued among the actors at the various stages of the supply chain". These information flows have a direct impact on the production, scheduling, inventory control and delivery plans of individual members in the supply chain (Ouyang, 2007, and Balan *et al*., 2009). The literature in bullwhip effect has extensively discussed the effect of bullwhip, its reduction, simulating the system behaviour and experimental validation. Caloiero *et al.,* (2008:631-645) attempt to understand order policy and inventory vacillations in a serial single-product (four echelons), and analyse "the impact of discontinuities of this order policy on the bullwhip and maximum oscillation surfaces. The study attempts to analyse how this order policy may be optimised to reduce the bullwhip and oscillations in the inventories under different customer demand with and without noise.

The study reveals that the surfaces of bullwhip and the ones of maximum oscillations of inventories can be obtained as a function and the model parameters: **α** (weight given to the history of the demand) and **T** (the importance given to the last incoming order). It means that the bullwhip and the maximum oscillation surfaces have a similar characteristic shape for all demands'.

Caplin (1985) and Blinder (1982) discuss the use of **(s,S)** type inventory policies by retailer results in the variance of replenishment orders and the variance of demand. Kahn (1997667) shows that "the presence of positive serial correlation in demand and backlogging are also result in the bullwhip effect". Graves (1999:50-61) studies the bullwhip effect under a myopic base-stock policy when an optimal forecast is used for a particular non-stationary process, namely an integrated moving average process or IMA. The replenishment policies used in inventory management combined with demand forecasting can in themselves be inducers of the bullwhip effect. Chen *et al.*, (2000:436-443) study the bullwhip effect under order-up-to-policy under two common, but simplified, forecast schemes. Aviv (2003:210-227) derived "further results for general correlated demand processes and order-up-to policies". Although the bullwhip effect is certain to occur when using the order-up-to policy, this information might lead to focus attention on replenishment policies for which demand pattern smoothing may achieve the reduction or even elimination of the bullwhip effect (Jaksic and Rusjan, 2008). According to Chen *et al.*, (2000:440) "the moving average (MA) and exponential weighted moving average (EWMA) method are used for a particular stationary process, namely a first order autoregressive process, or AR(1) in a forward supply chain".

Figure 2.1: Inventory level as a function of time in a (Q,R) policy



Source: Simchi-Levi, Kaminsky and Simchi-Levi (2008). ***Designing and Managing the Supply chain: Concepts, Strategies and Case Studies.*** **3rd Ed., Boston: McGraw-Hill pp. 43.**

Figure 2.1 depicts the inventory level under the **(S,s)** policy. The objective function will, in general, be expressible as a function of two variables S and **s**. The resultant optimisation problem consists in determining the optimal values of **S** and s to achieve the selected extension. The optimal decision is characterised by **s** – reorder point and **S** – an order-up-to-level, and if the initial inventory level is smaller than the reorder point, then order up to level, **S** – otherwise no order is placed. The linkage between demand and replenishment orders is why a base-stock policy is also known as a one-for-one replenishment policy. The frequency of replenishment orders in a base-stock policy matches the occurrence of demands (Webster, 2008).

Daganzo (2004:909) argue that "all operationally efficient (rational) inventory control policies trigger the bullwhip effect, independent of the demand process". Daganzo also shows that if one allows for advance demand information (ADI) by introducing future order commitments, then the bullwhip effect can be eliminated without giving up efficiency with a generalised family of order-up-to policies. Dejonkheere *et al.,* (2004:727) use "control theory to derive demand-dependent variance formulae for a generalised family of order-up-to policies and numerically illustrate the bullwhip effect". Ouyang and Daganzo (2006:1107) present: "a system control framework for analysing the bullwhip effect in decentralised, multiechelon supply chains operated with linear, time-invariant, and demonstrated the beneficial effect of operating with commitments and advance demand information (ADI) for linear and time-invariant policies. In an ADI chain, suppliers inform the immediate upstream neighbours the orders one will place in some future periods and commit to these quantities with a contract. The commitments received by suppliers are then integrated into the policies to generate commitments for orders placed with the upstream neighbours". The authors suggest that ADI palliates demand order variability for any decentralised linear and time-invariant (LTI) policy.

Dejonckheere *et al.,* (2003:567-590) analyse the bullwhip problem by exponential smoothing algorithms in both "standalone" passing-on-orders mode and within inventory controlled feedback systems. The proposal has "a new metric called noise bandwidth both to detect the bullwhip effect and to evaluate the capacity requirements needed to deal with the amplified demand" (Miragliotta, 2006:365-381). Zhang (2004:15) derive a forecasting procedure that minimises the mean squared forecasting error for the specified demand process, that is, "to measure the bullwhip effect by observing the number of occurrences the demand variance is magnified, as orders are transmitted upstream". Hosoda and Disney (2006:344) discuss variance amplification in a three-echelon supply chain with minimum mean square error forecasting.

2.4 Supply Chain Management and Bullwhip effect

While supply chain management may allow organisations to realise the advantages of vertical integration, certain conditions must be present for a successful supply chain to occur. Perhaps the single most important prerequisite is compatibility than change in the corporate cultures of all participating members in the supply chain to make companies more conducive to supply chain management. Wisner *et al*., (2009) suggest that more traditional organisations cultures emphasise short-term, company-focused performance, which in many ways conflict with the objectives of supply chain management. Nevertheless, supply chain management focuses on positioning organisations in such a way that all participants in the supply chain benefits through a seamless integrated value-added network. Thus, effective supply chain management seems to rely on high levels of mutual trust, business process cooperation and strong collaboration with active communication on inter- and intra-organisational supply chain performance capabilities. A number of similar definitions are available in the literature and among professional associations, although the definition of supply chain management has evolved overtime as the purposes and components of supply chains have changed:

The Institute for Supply Management describes supply chain management as the design and management of seamless, value-added processes across organisational boundaries to meet the real needs of the end customer (Glossary of Key Purchasing and Supply Terms, 2000).

The Council of Supply Chain Management Professionals defines supply chain management as follows: "Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, it integrates supply and demand management within and across companies" (Council of Supply Chain Management Professionals (CSCMP), 2011). According to Snyder and Shen (2011:1) supply chain management is "the set of practices required to perform the functions of the supply chain and to make them more efficient, less costly and more profitable. The supply chains are schematic network that illustrates the relationships between its elements, echelon at each vertical level of the supply chain, a stage or node at the location in the network, the flow of goods, information or money as links between stages and portion of the supply chain from which products originate (upstream site) and the demand end (downstream site)".

The consistency across these definitions is the idea of coordination, active communication and extended integration across business functions and enterprises on number of process- and product-related activities among trading supply chain participants. There is an incination to improve supply chain operating efficiencies, business performance targets, process quality, and customer service in order to gain a sustainable competitive advantage for all of the collaborating organisations.

A synthesis of the current theory and practice has the point of departure on this definition: Supply chain management (SCM) is "a management philosophy aimed at integrating a network (or a web) of upstream linkages (sources of supply), internal linkages inside the organisation and downstream linkages (distribution and ultimate customers) in performing specific processes and activities that will ultimately create and optimise value for the customer in the form of products and services which are specifically aimed at satisfying customer demands" (Hugo *et al.,* 2002:29). This definition describes the network of organisations 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 customer. It further stresses cohesion in the supply chain where the management philosophy and organisational structure seamlessly integrate all activities and processes across functional and organisational boundaries. This synchronisation assists to optimise customer value, cohesion forces relationship management and the sharing of information (Hugo *et al.*, 2006). The supply chain management as a management philosophy relies on elements of system approach, strategic orientation toward cooperative efforts and customer focus. Mentzer *et al.,* (2001) define supply chain orientation as "the recognition by an organisation of the systematic, strategic implications of the tactical activities involved in managing the various flows in a supply chain".

In terms of internal and external integrated processes, Wisner *et al.,* (2009:447) define process integration as "coordinating and sharing information and resources to jointly manage a process. Process integration can sometimes be an extremely difficult task, because it requires proper training and preparedness; willing and competent trading partners; trust; and, potentially, a change in one or more organisational cultures". Wisner *et al.,* (2009) point out challenges for integration such as a silo-oriented approach, lack of transparency, trustworthiness and knowledgeability. Wisner *et al.,* (2009:447) suggest that "silo mentality manifests itself in the form of using the cheapest suppliers, paying little attention to the needs of customers, and assigning few resources to new product and service design.

Eventually, these firms will create quality, cost, delivery timing, and other customer service problems that are detrimental to the supply chain". However, a silo mentality can be overcome by aligning business performance incentives to achieve the overall supply chain performance outcomes.

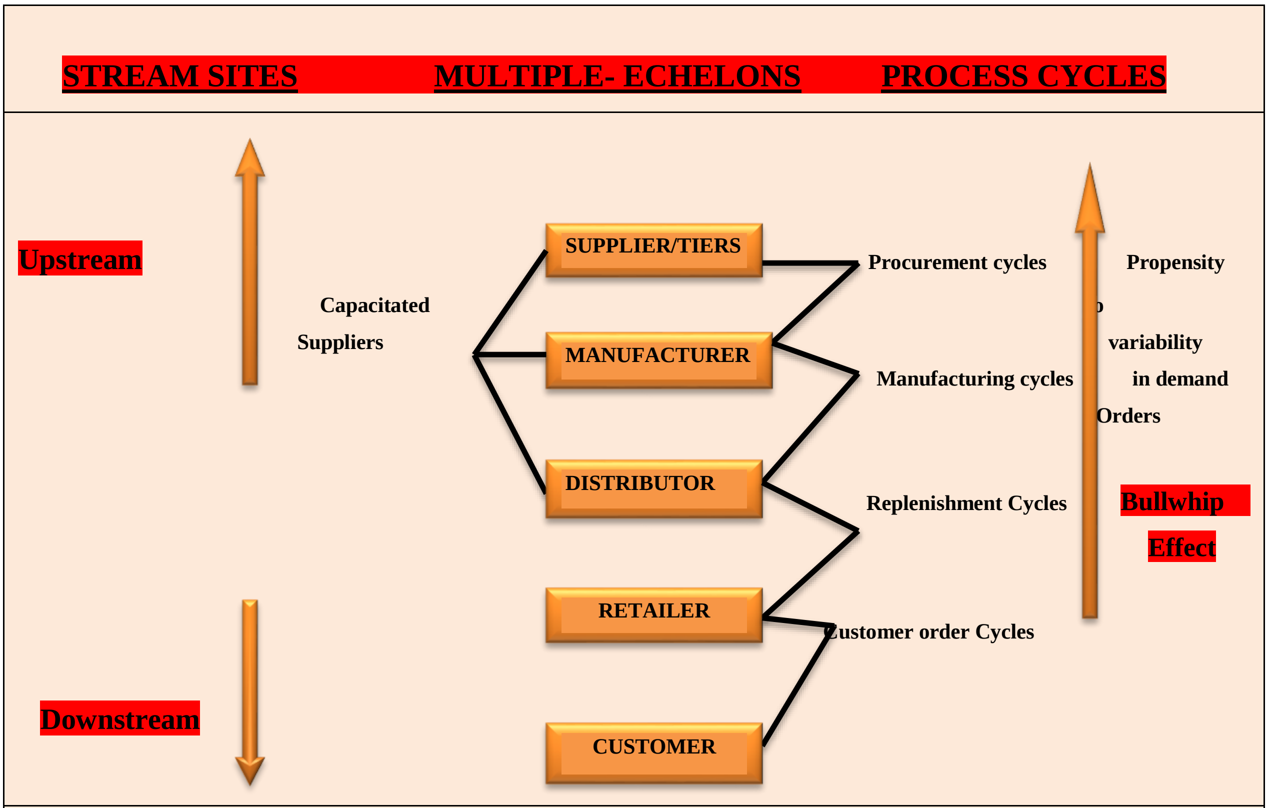
Whonder-Arthur (2009) puts emphasis on the influences of the Forrester effect on supply chain management "whereby: 1)conflict between supply chain players as a result of no coordination amongst individual demand forecasts; 2) large demand and supply fluctuations result in the need for high inventories to prevent stock outs; 3) poor customer service as all demand might not be met especially from the reliably suppliers; 4) production scheduling and capacity planning becomes difficult due to large order swings; 5) extra plant expansion to meet peak demand as a result of low stock or increased demand; 6) high costs for corrections-large unexpected orders or supply problems necessitate expedited shipments and overtime".

These implications depict vacillations in demand in the network. Suppliers, manufacturers, sales people, and customers have different views on demand order quantities, as the echelon stage control limited part of the network sometimes influences the network through inflated orders or shortage gaming. Paik and Bagchi (2006:306) note that "all the companies involved in the network are important in establishing a desired level of customer service in the supply chain and satisfying the customers' requirements. These companies are interdependent in such a way that an individual company's performance affects the performance of other members of the supply chain. If there is a problem in one company, the problem consequently causes other problems in other areas and weakens the effectiveness of the whole supply chain". An effective supply chain network is supposed to provide a quality and quasi-real-time information flow among the channel members, and include expedited reliable delivery of material to the customer. The fundamental challenge for companies is to achieve active coordination in spite of multiple ownership and increased product variety (Chopra *et al*, 2007).

2.5 Business Process Analysis: The perspective

A supply chain is viewed as a sequence of processes and flows that take place within and between different stages and combine to fill a customer's need for a product (Chopra and Meindl, 2007). The study focuses on five stages of a supply chain where all supply chain processes can be broken down into four process cycles. The interface between two successive echelons of the supply chain defines the process cycles as follows.

Figure 2.2: Process cycles on echelons and stream sites



The magnification of variability in orders from downstream to upstream in the supply chain (Bullwhip Effect – Oscillation Effect – Amplification Effect)

"A lot of retailers each with little variability in their orders from the customers" (Customer order cycles)	"Retailers' orders can lead to greater variability for a fewer number of wholesalers and distributors" (Replenishment cycles)	"Distributors' orders can lead to even greater variability for a single manufacturer including the impact to suppliers/tiers" (Manufacturing and Procurement cycles)

The information transferred in the form of orders between the nodes of a supply chain tends to be distorted when it moves from downstream to upstream. A network topology – each supplier's ordering decisions may be influenced directly by orders from multiple neighbor, or indirectly via network-wide information sharing. As a result variability of orders increases from the retail to manufacturing as one move upstream in the supply chain.

Source: Designed and compiled by the researcher from thematic perspective of this study

The South African consumer goods supply chains in which the retailer stocks finished-goods inventories and places replenishment orders with a distributor is reflected in four cycles on the diagram. However, it is possible to bypass the retailer and distributor and sell directly to customer as an alternative way of decelerating bullwhip effect. Chopra and Meindl (2007) present a similar supply chain process cycle that starts with the marketing of products to customers. The retailer / buyer ensures frequencies of replenishment of stock to enhance customer service levels while placing an order with the supplier and then capacitated suppliers (distributor / wholesaler, manufacturer and supplier)to complete the ordering cycle.

Figure 2.2 depicts the cycle view of a supply chain that is divided into processes of echelon stages. Each cycle starts with an order placed by one stage (customer to retailer, that is, customer order cycles) in the supply chain, progresses to the next (retailer to distributor, that is, replenishment cycles) and ends when the order is received from the supplier stage. The distributor, manufacturer and supplier are considered to be capacitated suppliers in this study and these echelons handle the processes of manufacturing and procurement cycles as orders move upstream sites. The arrow on the right hand side suggests a propensity to variability in demand orders, that is, bullwhip effect. The structure demands collaboration outside the physical walls of the firms to create value in the cycle processes. The highly desegregated value chains in the process cycles (customer order, replenishment, manufacturing and procurement cycles) have the majority of operational efficiencies and revue-enhancement opportunities that can only come from greater visibility, integration and synchronisation among firms in a value network.

The degree of accuracy is influenced by difficult in coordinating information exchange, multiple ownership and increased product variety. The magnitude of challenges and fluctuations in orders increase as orders move upstream in the network (Davis and Heineke, 2005). According to Anand and Goyal (2009:438-452) "the bullwhip effect distorts demand information within the supply chains, with each stage having a different estimate of what demand looks like". The consumption stage of the end product is normally stable while orders from raw materials are highly variable, increasing costs on the upstream site and making it difficult for supply to match demand (Chase, 2005). The mismatch shows the lack of visibility for true end user or consumer demand where an amplification of the predicted demand is created (bullwhip effect). Ireland and Crum (2005) describe the amplification of demand as supply chain nervousness, supply chain roller coaster effect and supply chain tail of the dog.

2.6 Causes of Bullwhip Effect

Each firm in a supply chain depends on other firms for services, materials, or the information needed to supply its immediate external customer in the chain. Typically, the firms are owned and managed independently, and the actions of downstream supply chain members (positioned nearer the end user of the service or product) can affect the operations of upstream members. The slightest change in customer demands can ripple through the entire chain, with each member receiving more variability in demands from the member immediately downstream (Johnsson, 2008). In other words, the retailer's orders to the manufacturer exhibit more variability than the actual demands from the consumers. The manifestation of supply patterns would not match demand patterns (Chase, 2005; Cachon and Terwiesch, 2009), inventories accumulate in some firms and shortages occur in others. Krajewski, Ritzman and Malhotra (2007) attribute the unexpected changes in demands or supplies on a number of external and internal causes:

Externally: A firm has the least amount of control over its external customers and suppliers which can periodically cause disruptions. If the market demands short lead times, the firm needs a quick reaction from its suppliers as the volume changes**.** The firm is susceptible to changes in production schedules, thereby affecting its suppliers as the service and product mix changes. In the same vein, late deliveries of materials or delays in essential services can force a firm to switch its schedule from production of one product model to another with schedule disruptions resulting. On the upstream site, suppliers that send partial shipments do so because of disruptions at one's own plant with underfilled shipments.

Internally: It is assumed that the firm's own operations can be a culprit in what becomes the source of constant dynamics in the supply chain. A number of shortages within the firm creates disruptions and affects the suppliers and customers. The shortages emanate from any part of the firm (Simchi-Levi *et al.*, 2008), such as machine breakdowns or inexperienced workers, strikes at a manufacturing plant that affects the trucking service or a high turnover rate. The dearth of engineer synchronisation means that changes to the design of services or products can have a direct impact on suppliers. In the development chain, a firm decides on the number of introductions, as well as the timing, and hence introduces a dynamic into the supply chain.

New service or product development encourages a common promotion practice of firms producing standardised services or products by using price discounts to promote sales. This practice creates a spike in demand that is felt throughout the supply chain.

Many disruptions are simply caused by ineffective coordination in the supply chain because so many firms and separate operations are involved (Krajewski *et al.,* 2007). Nonetheless, the challenge for supply chain managers is to remove as many disruptions as possible and minimise the impact of those disruptions that cannot be eliminated. The way to minimise supply chain disruption is to develop a supply chain with a high degree of functional and organisational integration. Additionally, cross-silo synchronisation enables systematic root-cause analysis, and creates a proactive and concerted response. By enabling cross-silo synchronisation across the ecosystem, organisations can move to one version of the truth that is shared and acted upon.

2.6.1 Major causes and mitigating strategies of Bullwhip Effect

Bullwhip effect impacts upstream stages in the supply chain, which must directly face the impact of variable demand. The phenomenon also indirectly affects downstream stages in the supply chain, which must cope with less reliable replenishments from upstream stages. The pernicious effect does not enhance the performance of a supply chain but it increases volatility at any point in the supply chain (Cachon and Terwiesch, 2009). The bullwhip effect is present in a supply chain if the variability of demand at one level of the supply is greater than the variability of demand at the next lower level in the supply chain (Davis and Heineke, 2005), where variability is measured with the coefficient of variation. Cachon *et al.*, (2009:321) suggest that "if the coefficient of variation in the supplier's demand (which is the sum of the retailer's orders) is greater than the coefficient of variation of the retailer's total demand, then the bullwhip effect is present in the supply chain". Hence, it is extremely important that its causes be identified so that remedies, or at least mitigating strategies, can be developed. Lee *et al*., (1997:93-102) advocate the first four major causes of the bullwhip effect, Simchi-Levi *et al*., (2008:156) add two more causes and Cachon and Terwiesch (2009:348) identify the last more major cause of the bullwhip effect.

2.6.1.1 Demand forecast updating – Forecasting Effect

Demand forecast updating improves the anticipatory modes as the estimations of the mean and the standard deviation (or variability) of customer demands are regularly modified. An increase in orders leads to higher demand forecasts, which is transferred to the next link by increased order quantities. Hopp and Spearman (2008:636) suggest the view that "the basic reason that forecasting aggravates the bullwhip effect is that each level updates its forecast on the basis of the demand it sees, rather than on actual customer demand".

If the demand forecast of a company is based on orders of the succeeding tier instead of the effective demand of the end customer, the variation of demand is amplified up the supply chain (Lee *et al*., 1997; Slack, 1995). This fact is analytically proven under the assumption of constant planning lead times (Schonsleben *et al*., (2003:41). On the strategic approach to mitigate the variation of demand in supply chain, Fransoo and Wouters (2000:78) recommends “a single source of forecasting that can be determined for the entire supply chain”, and Wisner *et al*., (2005) identify point-of-sale (POS) data as a system that can electronically make data available moving upstream in the network and members can in quasi-real-time update demand order forecasts to respond to the market changes.

Hopp *et al*., (2008) allude to the fact that alliances using vendor-managed inventory can pool inventory across levels enabling partners to operate with substantially less inventory than is needed in uncoordinated supply chains. This practice can generally reduce inventories substantially, because the buyers allow suppliers to observe demand, create a forecast, and determine the resupply schedules. The author further observes that safety stock increases with replenishment lead time, hence lead time reduction can reduce demand volatility due to forecasting. Wisner *et al*., (2005) uphold that developing just-in-time ordering and delivery capabilities results in smaller, more frequent orders being placed and delivered, more closely matching supply to demand patterns. In the similar reduction approach, reducing the length of the channel can also manage the vacillations by reducing the number of occasions where forecasts are calculated. Some other firms bypass distributors and resellers and sell directly to consumers. Firms can thus see actual end-consumer demand, resulting in much more accurate forecasts (Wisner *et al*., 2005).

2.6.1.2 Order batching – Burbidge Effect

Order batching is “the practice of placing orders down the supply chain (or on the manufacturing process) in batches in order to earn economies of scale in set-up activities (such setting up a machine or placing and receiving an order)”, and it is also known as the Burbidge Effect (Burbidge, 1991). It is often the result of an Economic Order Quantity (EOQ) computation, whereby demand pulls inventories to point of replenishment (reorder) wherein the decision to order with the supplier is taken. For the class of order-up-to policy (also known as base-stock policy) Chen *et al*., (2000:442) demonstrate that “if a retailer periodically updates the mean and the variance of demand based on observed customer demand data, then the variance of the orders placed by the retailer will be greater than the variance of demand”. The frequency of replenishment orders in a base stock policy matches the occurrence of demands (Webster, 2008).

It denotes that demands accumulate before issuing an order, and variability of orders placed with the suppliers becomes higher than the demands the firm itself faces. Possible remedies include:

In this regard, information visibility assists in decreasing the effect by making consumer demand data available throughout the chain, reducing batch sizes and increasing order frequencies. Wisner *et al*., (2005) argue that when suppliers know that large orders are occurring because of the need to spend budgeted monies, for instance, one will not revise forecast based on this information. Electronic Data Interchange (EDI) and Counteract full truckloads or container loads do tame the variation of demand in the supply chain by avoiding administrative order costs and the high unit cost of transporting at less-than-truckload quantities.

2.6.1.3 Price fluctuations – Promotion Effect

Price variations is "the practice of the offering products at reduced prices to stimulate demand", and it known as Promotion Effect (Disney and Towill, 2003:157). In other words, the price of a product fluctuates because of special promotions, quantity discounts and trade deals, which increases variability of demand. Fransoo and Wouters (2000:78) construe that "when the price of a product is low, a customer buys in bigger quantities than needed, and when the price returns to normal, the customer buys less than needed to deplete its inventory". The price vacillations result from forward buying approaches and these occurrences between echelons contribute to inaccurate forecasts. Since variation drives demand volatility, the apparent remedy is to stabilise prices.

The specific policies for underpinning more stable prices can be an everyday low pricing (EDLP). The way to stabilise prices is to simply reduce or eliminate reliance on promotions using discounting to reduce the amplification effect. Wisner *et al*., (2008:170) critique these practices that "if these price discounts become commonplace, firms will stop buying when prices are undiscounted, and buy only when the discount prices are offered, even further contributing to the bullwhip effect". In terms of Activity-Based Costing (ABC), Hopp *et al*., (2008) argue that traditional accounting systems may not show the costs of some practices resulting from promotional pricing, such as when regional discounts cause retailers to buy in bulk in one area and ship product to other areas for consumption. Activity-based costing systems account for inventory, shipping, handling, and so forth, and hence are useful in justifying and implementing an everyday low-pricing strategy.

2.6.1.4 Rationing and Shortage Gaming – Houlihan Effect

Rationing and shortage gaming describe the gaming behaviour whereby customers use the orders in a gaming fashion. This is also known as Houlihan Effect, Houlihan (1987:51-66) recognise that "as shortages or missed deliveries occur in traditional supply chains, customers over-load their schedules or orders. This in turn places more demands on the production system that inevitably leads to more unreliable deliveries. Customers then increase the safety stock target that further distorts the demand signal via the Forrester Effect (Forrester, 1961), giving rise to the bullwhip problem". Fransoo *et al*., (2000) raise an argument that introducing rationing methods based on past sales rather than on orders placed takes away the incentive for customers to inflate order sizes. Wisner *et al*., (2008:173) offer the valid view point that "when these types of shortages occur due to gaming, suppliers can no longer discern the true demand, and this can result in unnecessary additions to production capacity, warehouse space, and transportation investments". These alternatives for reducing the incentive to game orders include the allocation of shortages according to past sales.

If a supplier facing a product shortage allocates its supply on the basis of historical demand, rather than current orders, then customers do not have an incentive to exaggerate orders in shortage situations (Hopp *et al*., 2008). The fundamental issue of gaming behaviour can use more stringent time fencing, and the frozen zones are also known as slushy zones. This means that an initial number of periods in the master production schedule (MPS), in which changes are not permitted to reduce the problems caused by nervousness and time fences are tools used to place restrictions or penalties on customers for making changes in orders. When small change in the MPS results in a large change in planned order releases, that is, nervousness and, the earliest time fence is absolutely frozen – no changes can be made. If customers cannot freely cancel orders, then gaming strategies become more costly. Of course, a supplier must decide on a reasonable balance between responsive customer service and demand stabilisation.

2.6.1.5 Lead Time Cycles – Lead time Effect

Lead times: the increase in variability is magnified with increasing lead times of information and material (Lee *et al*., 1997; Simchi-Levi *et al*., 2000). In other words, the extended lead time cycle with manageable demand variability reflects considerable effect on safety stock and base-stock level (Graves, 1999), and vacillations on order quantities. Strategically, the electronic point-of-sale data sharing system can eliminate the lead time by expediting purchase orders and velocity of information flows hence the manufacturing processes and schedules have difficult challenges.

Fitzsimmons and Fitzsimmons (2008) state that point-of-sale data at the retailer can be aggregated at the distributor level to alert manufacturing in planning production schedules to problems, which will avoid either inventory buildup or lost sales, and ultimately mitigate the bullwhip effect. This is a significant benefit to supply chain coordination in utilisation of downstream information (Sheu, 2005). In the Network Model, the physical goods supply chain can be interpreted as a network of value-adding material-processing stages each defined with supply input, material information, and demand output. Conversely, the independent stages in the supply chain, unaware of the true nature of final demand, overreact to orders from downstream customers (Cachon *et al*., 2009), and delays in orders (Blackburn, 1991) being filled create the oscillation in inventory stocks that are propagated upstream, thus generating the bullwhip effect.

2.6.1.6 Inflated Orders – Bloated orders Effect

Inflated orders are manifested when the downstream site anticipates shortages. According to Hong and Ping (2007:26-33) order-up-to policy indicates the amount ordered in any period equals the amount demanded in the previous period. If all retailers use an order-up-to policy (with a constant order-up-to level **S**), then the standard deviation of the retailer's orders in one period equals the standard deviation of consumer demand in one period (Caloiero *et al*., (2008); that is, there is no bullwhip effect. Cachon *et al*., (2009) substantiate that the amplification effect does not occur when every member at the same level of supply chain implements a "demand-pull" inventory policy each period (Simchi-Levi *et al*., 2008), that is, the orders each period exactly match the demands. Simchi-Levi *et al*., (2008) claim that pull-based supply chains lead to a reduced demand variability due to lead time reduction.

Cachon *et al*., (2009) provide the explanations for these outliers, firstly, they occurred merely due to random fluctuations; and secondly, they could signal that demand has shifted, suggesting the product's actual expected demand is higher than previously thought. These explanations imply that the retailer should increase order quantity to cover the additional future demand, otherwise the retailer will quickly stock out. The intimate knowledge based experience can be functional through data warehouses to strengthen the relationships and to control the flow of information among supply chain members and improve the productivity of the marketing and inventory management efforts. However, Levy and Weitz (2007) claim that retailers and vendors are sometimes collaborating more to improve supply chain efficiency, reduce lead time, increase product availability, lower inventory investment, and reduce overall logistics expenses.

2.6.1.7 External Factors – Exogenous Effect

The exogenous/externalities factors are drivers of bullwhip effect, and it denotes that bullwhip effect cannot be eliminated completely as there are other factors, which are beyond the influence of suppliers and organisations such as government policies and environmental factors.

The bullwhip effect has been perceived as an unavoidable effect of demand variation, and it is imperative to develop innovative strategies and methods to manage this amplification effect. While Fisher (1997) has captured important demand characteristics, Lee *et al*., (2002) points out that there are uncertainties revolving around the supply side that are equally important drivers for the right supply chain strategy. Lee (2002:6173) characterises four types of supply chain strategies, and information technologies that play an important role in shaping such strategies; "efficient supply chains, risk-hedging supply chains, responsive supply chains and agile supply chains".

The limited control of these drivers means that the remaining demand is fulfilled by a smaller base of suppliers with short-term contracts. Partners can respond quickly to changes in demand, and with slightly higher unit prices but guaranteed availability, to cover uncertainties in demand variability (Billingham, 2002). This portfolio approach has advantages to deal with procurement issues by diversifying the manufacturer's risk and to protect against uncertainties that are out of the manufacturer's control (Frahm, 2003). In other words, short-term contract relationships with these suppliers allow manufacturers to quickly adjust to shifts in demand (Heizer and Render, 2008).

Alternatively, mass customisation is a strategy to provide products in lot of sizes in high volume, but it depends on economies of scope, that is, a high variety of products from a single process (Schroeder, 2008). Consequently, mass customisation comes from a different economic basis, a common process rather than a common product, and modular production with modular design can provide a variety of options using an assemble-to-order process. According to Hopp and Spearman (2008) the concept of postponement, in which the product and production process are designed to allow late customisation, can be used to facilitate rapid customer response in a highly customised manufacturing environment, a technique sometimes referred to as mass customisation (Feitzinger and Lee, 1997).

2.7 Strategic Supply Chain Leagility

Supply chain agility as an operational strategy focuses on inducing velocity and flexibility in the supply chain. In a nutshell, a supply chain is the process of moving goods from the customer order through the raw materials stage, supply, production, and distribution of products to the customer. Yusuf *et al*., (2004:379) stress that "an equal amount of emphasis is now paid to downstream collaboration with customers and lateral collaboration with competitors as a means of integrating the total value creation process. The agility of a supply chain is a measure of how well the relationship involved in the processes (of series of linked activities amongst firms) enhances the pivotal objectives of agile manufacturing".

Hoek *et al*., (1999, 2001) and Lowson *et al.,* (1999) identify four objectives that enhance agile system that is, underpinned by agile suppliers, organisational agility, and a demand-driven supply chain:

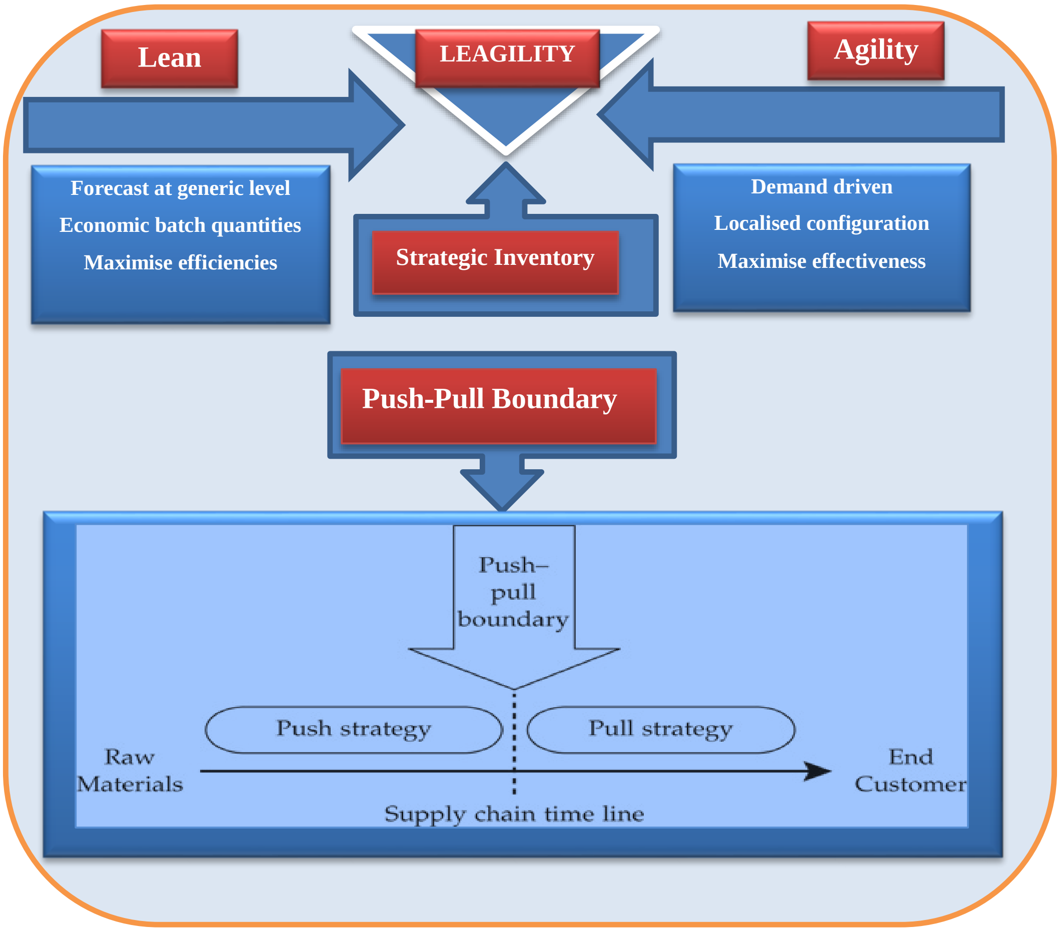
- Customer enrichment ahead of competitors
- Achieving mass customisation at the cost of mass production
- Mastering change and uncertainty through routinely adaptable structures, and
- Leveraging the impact of people across enterprises through information technology

Christopher and Towill (2005:206-213) propose that "a framework for agility that is contingent upon the context in which the business operates, and thus sought to bring together the lean and agile philosophies to highlight the differences in the approach but also to show how these approaches might be combined for greater effect". Initially, Lengyel (1994:1-8) advocated an agile system as "the ability of an enterprise to survive in a competitive environment with continuous and unanticipated change and to respond quickly to rapidly changing markets that are driven by the customers valuing the products and services". Mason-Jones *et al*., (2000:54-61) describe an agile system as "one with volatile demand, high product variety, shorter product life cycle, and availability-driven customers, while a value stream in lean depends on a customer and cost perspective, rather than the organisation's viewpoint".

Lean and agile systems share some interface with several other types of performance improvement, including flexible, adaptable, and mass customisation to overcome the rippling oscillator effect in the supply chain. Leagility is described as a system in which the advantages of leanness and agility are combined, and was originally developed to describe manufacturing supply chains (Katayama and Bennett, 1999; Naylor *et al*., 1999; Mason-Jones *et al*., 2000).

Increasingly, managers need to understand how market conditions and the wider operating environment will demand not a single off-the-shelf solution, but hybrid strategies, which are context specific. Customers are becoming more and more aggressive in demanding new products and services within a short period of time, and the conjoint of agile and lean (leagile supply chain) presents an interesting attempt to tame and manage consumer order demand variability in the supply chain as an extension to the four types of supply chain strategies.

Figure 2.3: De-coupling point on Leagility and Push-Pull System



Source: Compiled by the researcher from the perspectives of Decoupling Point (Simchi-Levi et al., 2008; Christopher, 2011)

Figure 2.3 shows the hybrid system on 'leagile" strategy that should build an agile response upon a lean platform by seeking to follow lean principles up to the de-coupling point and agile practices after that point. The bottom part indicates push-pull boundary "when the point in time, the firm switches from managing the supply chain using one strategy (push system), to managing it using a different strategy (pull system)" (Simchi-Levi *et al.*, 2008:190). Christopher (2011:100) recommends "lean on high volume, low variety and predictable environment and agility on less predictable environments where the demand for variety is high".

Bowersox *et al*., (2010:12) interpret an anticipatory business model as push system (produce product based upon a market forecast while responsive business model is associated with pull system (relies on timing and agility) on reducing forecast reliance and improving joint planning and real-time information exchange. Van Hoek (2000:196) describes postponement as "the basic thesis of leagility, the delaying of operational activities in a system until customer orders are received rather than completing activities in advance and then waiting for orders. The lean processes are on the upstream side of the decoupling point, and the agile processes are on the downstream side". The decoupling point also acts as a strategic point for buffer stock, and its position changes depending on the variability in demand and product mix (Mason-Jones *et al*., 2000). An increase in product mix and fluctuating volume would force the decoupling point to move upstream, making the supply chain system more agile to ameliorate the magnified oscillations upstream.

The use of supply chain information technology (IT) to share data between buyers and suppliers is value-creating a virtual supply chain as information-based rather than inventory-based. Christopher (2011:103) stresses that "supply chain partners can only make full use of quasi-real-time shared information through process alignment with collaborative working between buyers and suppliers, joint product development, common systems and shared information". The underpinning view of an extended enterprise with a higher level of collaboration and synchronisation on an underlying network of agility, the supply chain system should epitomise no boundaries and an ethos of trust and commitment along with a process of integrated strategic determination and transparency of information.

Originally, Goldman *et al*., (1995:73-5) outline four principles for agile organisations: "enriching the customer, cooperating to enhance competitiveness, organising to master change and uncertainty, and levering the impact of people and information". In other words, the enrichment of customer through optimisation process and customer driven-demand from pull-based supply chain (Simchi-Levi *et al*., (2008), understanding demand variation, order oscillations and demand uncertainty (Jacobs *et al*., (2008), and behaviour of supply chain partners as orders move upstream and information sharing systems (Cachon *et al*., (2009).

Chapter Three

Global Company Profiles on selected FMCG Stores

3.1 Introduction

Fast moving consumer goods (FMCG) enterprises epitomise the fast-paced transfer of information and active communication along the supply chain to yield advantages on lower costs, improved throughput, shorter cycle times and higher levels of customer service. Interestingly, the enhancement of information flow has been entrenched through electronic supply chain management applications in the supply chain networks. In the context of South Africa, this creates efficiencies and reduces risks such as incorrect information being forwarded when demand orders cascading up the supply chain. The enterprises have the propensity to use the inventory aggregation system in terms of nascent propitiously centralised supply chain distribution (CscD) system for multiple local retail outlets. Subsequently, the central supply chain system ensures that their world-class procurement and replenishment strategies are not compromised by aspects such as the unclear monitoring of inventory volumes, supplier relations, and consumer order variability travelling up supply chains. This understanding allows an extensive analysis of the strategic choices of FMCG retail efficient business models in terms of value of information, and electronic supply chain management within major retail outlets in South Africa, such as Pick ‘n Pay, Woolworths, Shoprite Group, Massmart Group, SPAR Group and few selected retail suppliers.

Simchi-Levi *et al*., (2008:1) define supply chain management as “a set of approaches utilised to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the locations, and at the right time, in order to minimise system wide costs while satisfying service level requirements”. The CscD system that is modelled by the South African FMCG industry recognises the customer-supplier duality where suppliers deal with a retailer’s central distribution centre in a bidirectional way, with few echelon-levels of interaction (Fitzsimmons and Fitzsimmons, 2006:478). Notably, information technology is the impetus behind the CscD system’s ability to coordinate the many interrelated activities commonly performed by upstream independent companies. “The convergence of supply chain management and information technology has created a technology-based supply function that integrates supply management with other business functions and with suppliers and consumer markets” (Hugo *et al.,* 2008:258).

The integration of information technology allows for the efficient transmission of information throughout the supply chain which in-turn facilitates supply chain integration for amelioration of bullwhip effect. These analyses of FMCG retail outlets and suppliers is deliberated in terms of common strategic diffusion of the central supply chain distribution (CscD) system, supply chain structure, supply chain information technology, inventory management, expansion to African countries, improved efficiency and effect of order variability. According to Sorescu *et al*., (2011:7) retail business model (RBM) innovation is defined as "a change beyond current practice in one or more elements of a retailing business model (retailing format, activities and governance) and their interdependencies, thereby modifying the retailer's organising logic for value creation and appropriation". If the business model represents the firm's distinctive logic for value creation and appropriation (Teece, 2010; Zott and Amit 2010), the strategy epitomises a central, integrated, externally oriented concept of how the business will achieve these essential strategic objectives (Hambrick and Fredrickson, 2005; Gambardella and McGahan, 2010).

In the retail perspective, the retailers must constantly look beyond the organisational boundaries to evaluate and integrate the resources and capabilities of their suppliers and customers. Ganesan *et al.*, (2009:84) advocate multi-directional "retail leverage on upstream and downstream relationships in the supply chain network that 1) involves a move toward sourcing practices on a worldwide basis; 2) pertains to the disaggregation and innovation that arises from employing a multichannel route to market and the delicate power balance and conflict management needs that result; and 3) considers how the nature of interfirm ties between retailers and the organisational partners might better facilitate either product or process innovations among players". This then, creates superior value and a competitive advantage that companies might sustain over time. Competitive advantage implies the creation of a system that has a unique advantage over competitors to create customer value in an efficient and sustainable way. Heizer and Render (2011:68) advocate "competitive advantage in terms of competing on response strategy where a set of values relate to rapid, flexible, and reliable performance".

3.2 Nature of the FMCG industry

The fast moving retail outlet is a self-service store, offering a wide variety of food and household merchandise, organised into departments. It is usually situated near a residential area, in a shopping mall or in the city centre in order to be convenient to residents and working consumers. Its basic appeal is the availability of a broad selection of goods under a single roof, at relatively low prices. Consumers normally spend a limited period of time at the retail outlet and purchasing decisions tend to be made when customers look at the shelves. The CscD system, with its comprehensive pattern of reliable delivery (daily deliveries from the central warehouse) ensures that products are visible on the shelves when consumers make their decisions about what to put in their baskets. This system brings simplicity to inbound (suppliers) and outbound (retail outlets) distribution, and enables an integrated supply chain to deliver and sustain the cost-effective availability of a wide product range in different stores across broad geographic locations (Hugo *et al*., 2008). In terms of diverse geographic locations these retail stores are supplied by the central, through the regional distribution centres of their parent companies, which operate numerous retail stores across South Africa and the African continent.

The retail outlets offer products at low prices by reducing their economic margins, as the stores cater to upscale neighbourhoods, townships and lower income market segments (GAIN Report, 2010). However, the CscD system assists the retail stores to make up for the lower margins through a higher volume throughput, a higher overall volume of sales, the sale of higher-margin items, and giving each product section a sense of individual difference and altering customer's perceptions of the atmosphere (Gajanayake, Gajanayake and Surangi, 2011; Browne, 2010). These retail stores are known as fast moving consumer goods (FMCG) or consumer packaged goods (CPG) outlets. The retail goods are generally replaced or fully used up over a short period of time, be these days, weeks, a month or within one year. Although the absolute profit made on FMCG products is relatively small, they generally sell in large quantities, so the cumulative profit on such products can be large (Shoprite Report, 2011).

3.3 South African context of FMCG industry

South Africa presents opportunities as a gateway for regional markets, and major South African supermarket chains are fending off fierce global completion while gaining a competitive edge through reputable image and highly efficient service provision. Pick n Pay and Shoprite authenticate head-to-head more on price and shopping experience to enjoy better bargaining power. The South African FMCG industry is dominated by five major chains: Shoprite/Checkers, Pick 'n Pay, Woolworths, SPAR, and Massmart, with the last two performing both retail and wholesale functions (FASWorldwide Report, 2007). These major retail chains have developed highly centralised procurement systems, with distribution centres located in the major metropolitan areas throughout South Africa.

According to the GAIN Report (2010:8) these retail groups seem to dictate the buying terms to suppliers through CscD system as suppliers are expected to deliver products to central depots, warehouses or the retail groups. The products are then distributed to their supermarkets and retail outlet stores using their own transportation trucking system. In terms of supermarket retail chains' presence in the urban and rural areas, Shoprite and SPAR are very strong in the predominately black areas (townships) whereas Woolworths is stronger in the smaller up-market segments (GAIN Report, 2010).

3.4 Bullwhip Effect and Fast Moving Consumer Goods (FMCG) Industry

3.4.1 Bullwhip effect on Retailer and Manufacturer

Retailers attempt to minimise their inventory while maintaining sufficient on hand to guard against fluctuations in demand. Burt *et al*., (2003) advocate accurate demand estimations and real-time information sharing among trading entities to avert bloated inventory levels. Poor demand data forces businesses in the network to either possess excess inventory beyond the desired level or lengthen their lead time cycle on underlying uncertainty. In this asymmetric proportion, Warburton (2004) aligns the inventory balance equation where "the inventory, ***I(t),*** is depleted by the demand rate, ***D(t),*** and increased by the receiving rate, ***R(t).*** A different situation through endogenous and exogenous factors, a retailer sometimes detects a surge in consumer demand and adjusts the orders so that the inventory is made up without suffering either deficits or overshoots". The retailer anticipates that a cascading inventory level has deleterious effect, augmenting the likelihood of independent constructs like, stock-outs and backlogs/forward buying, inflated orders, capacity utilisation and poor customer service. These constructs either mitigate or elevate the magnitude of demand variability and different extant research studies and approaches have been developed to ameliorate the rate at which the order variability is amplified moving upstream site the supply chain.

Arguably, the retailer seems to inflate orders to the manufacturer that amplify moving upstream the supply chain. The lengthy echelon channels in the network complicates the manufacturer's situation because the uncoordinated operations processes reflect depleted standard orders rather than operating under a centralised system with accomplished orders (Simchi-Levi *et al.,* 2008). Hodgson and Warburton (2004), and Burt *et al.,* (2003) indicate that the downstream orders affect the inventory level and positioning of the upstream capacitated suppliers. The overshoot of the order cycle and the shortage as the retail order decision responds to market demand vacillations, describe the amplification of order variability along the supply chain.

The report analysis (Warburton, 2004; Hodgson *et al.*, 2004) describes how the retailer's order rate quickly grows to exceed the constant consumer demand rate as the amplification in orders is attributable to the retailer's ordering policy. As the manufacturer consolidates their order policy, the service levels should be dependent on frequencies of replenishment rate. The manufacturer's situation is complicated by both shipments to multiple retailers and orders to many suppliers. Warburton (2004); Lee *et al.,* (2000) and Towill (1996) advocate that the sharing of retail sales information is a major strategy for countering the bullwhip effect, and the manufacturer's ordering policy to reduce inventory overshoot can be created through communicating the size of the consumer demand to the supplier.

3.4.2 Supply Chain Management dynamics in Retail Industry

Supply chain management as a matter of coordination has become the main challenge that dictates a eulogised force positioning above the functional silos and focusing on the complete horizontal organisation (Mongan and Christopher, 2005). Matchette and Lewiski (2005:1-12) state that supply chain management is a strategy which requires distinctive, hard to replicate capabilities, which can be a key to executing excellence as well as market creation. The authors stress that companies must adopt new supply chain practices, technologies and organisation structures that enable one to quickly capitalise on new revenue opportunities. In other words, companies must be able to continuously refresh and renew the distinctive capabilities to maintain the competitive essence. In a similar view, Barratt (2004:30) advise that "it is not possible for a company to have close supply chain management-based collaboration with all other supply chain members because of its resource intense characteristics".

The retail industry seeks the ability to match changes in a marketplace where design innovations and volumes fluctuate substantially. If the Fast Moving Consumer Goods (FMCG) (also known as Consumer Packaged Goods) have the main characteristic of having a high turnover and relatively low cost, the retail low-cost leadership earmarks to achieve maximum value as perceived by the customer. Consequently, its rapid transportation of goods reduced warehousing and distribution costs, reduced overhead costs, and direct shipment from manufacturers would result in high inventory turnover and become a low-cost leader (Heizer, e*t al.,* 2011:68). Although the absolute profit margin made on FMCG products is relatively small; the large numbers, the companies sell can yield a substantial cumulative profit (Pourakbar, Sleptchenko and Dekker, 2009).

Notably, Ganesan, George, Jap, Palmatier and Weitz (2009:84) investigate directions in which "retailers are leveraging upstream and downstream relationships in the supply chain to create key performance outcomes for brands, reputation, revenues, innovation, and long-term prospects". These trends describe the representation of new and emerging paths by which retailers and the supply chains can grow the reciprocal benefits. In this reciprocal interdependence, there is a need to connect with partners to innovate, which increases the importance of strong and diverse relational ties with supply chain partners. In aggregate, effectively managing supply chains takes on increasing importance for the financial performance of retailers, although the complexity and interconnected nature of modern supply chains, which remain embedded in rapidly changing environments, make supply chain network functionality difficult with retailer's supply chain performance affected (Ganesan *et al.,* 2009:88).

In many cases, technology advances have enabled retailers to collect new information about consumers, which can combine with supply chain partners' capabilities to lead to radical and incremental innovations. Efficient consumer response (ECR) has the potential to remove significant costs from the grocery supply chains through better cooperation and coordination of the activities of trading partners within supply chains. It is mainly enabled by timely information sharing using electronic commerce technologies for massive synthesis of the data (especially accurate data captured at point-of-sale (POS) from retailer checkout counter) (Kurnia and Johnston, 2003). The statement implies that efficiency at all levels within supply chains can be increased, leading to reductions in inventory levels and operating costs.

According Frankel, Goldsby and Whipple (2002:57-72) many managers adopt delay tactics (a wait and see approach) to ECR, while others lack the resources or knowledge to know where to get started in implementing ECR programmes. In other words, business will remain as usual for these firms until ECR is proven successful on a large scale and reaches a critical mass of adoption. Although retailers are more powerful than manufacturers as they lead manufacturers in ECR adoption coupled by lack of cooperation and trust (Kurnia and Johnston, 2003), information sharing that allows visibility of point-of-sales, demand forecasts, inventory, capacity and shipment plans can achieve an acceptable level of intelligent supply chain management (Lee, 2002).

3.4.3 Electronic Supply Chain Management and FMCG Industry

Retailers recognise the maximisation of service levels by fulfilling the demands of as many consumers as possible. Van Donselaar, Van Woensel, Broekmeulen and Fransoo (2006:462) state that "a supermarket-assortment classification based on the shelf life concept, and define shelf life as the number of days counting from the day it is produced until the product becomes unacceptable for consumption. Perishable items typically need (very) short lead-times to guarantee the largest possible shelf life in the stores". Thus, leadtime cycles emerge in cross docking at the distribution centres or direct delivery to individual retail store outlets.

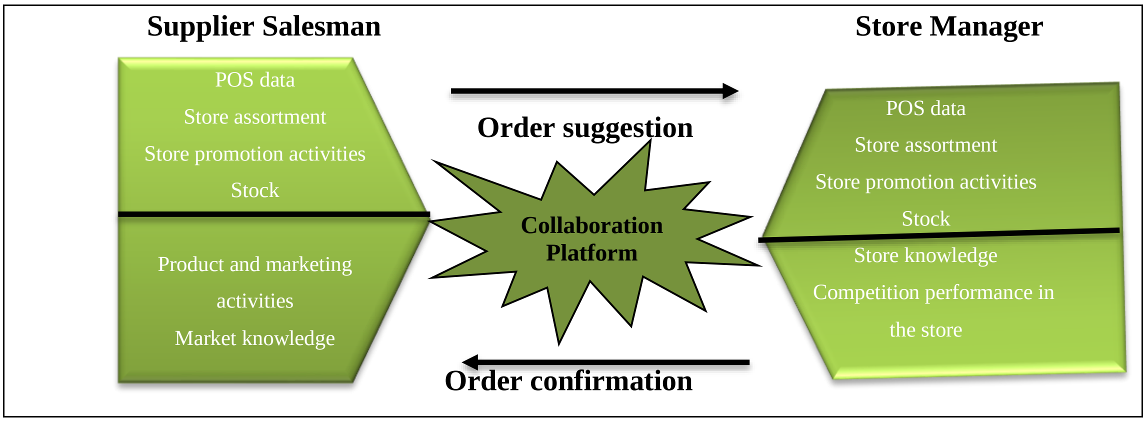
The understanding of customer behaviour in times of out-of-stocks (OOS) for perishable products is essential, because "perishables have high-average daily sales per unit" (Van Donselaar *et al.*, 2006:458). Sloot *et al*., (2002) stress that "OOS of non-perishable products have several consequences such as store switching, product switching, delaying the purchase, canceling the purchase, category switching or brand switching". Van Donselaar *et al.*, (2007:470) allude to the rationale that "the customer only sees the inventory on the shelves, and as such consumer does not know about the inventory". Campo *et al*., (2000:219-242) identify three consecutive decisions made by customers: "first, the customer decides whether one is going to buy from a certain category; secondly, if customer wants to buy from the category, customer decides which products to buy from the category; and third, customer decides upon the quantity of the chosen product". Bell and Fitzsimons (2000) have studied the impact of OOS on category sales, while other studies have analysed the possible consumer reactions to OOS from a marketing and retail management perspective (Campo *et al.,* 2000).

3.4.4 Collaborative Approach in retail industry

Electronic interconnectivity facilitates the exchange of information across the echelon channel network in an attempt to tame bullwhip effect for the consumer goods industry. The industry trend is to leverage the supply chain performance benefits obtained through "visible information sharing across the supply chain network in order to improve operational supply chain performance, customer service level, and solution development" (Swaminathan and Tayur, 2003:387). Collaboration Planning Forecasting and Replenishment (CPFR) operates as "a set of business processes in which trading partners agree to mutual business objectives and measures, develop joint sales and replenishment plans" (Holmstrom *et al*., 2002). In CPFR, the parties (especially manufacturer and retailer) jointly collaborate to generate an updated sales forecast and operational plan for that forecast. Holmstrom *et al.,* (2002:136-145) further suggest that "collaborative planning will only be successful if it involves very little extra work for the retailers".

The objectivity should reflect active mass collaboration across extended cross-enterprises to earn economies of scale and economies of distance from a delivery perspective

Figure 3.1: Information sharing between retailer and supplier in the process of collaborative store ordering (PCSO)



Source: Pramatari and Miliotis (2008). "The impact of collaborative store ordering on shelf availability", *SCM: An International Journal,* 13(1) 49-61.

Figure 3.1 gives an overview of the information available to the store managers and the supplier salesmen for the products and stores supply chain members have in common. "Part of this information is common between the two (above the line) and part of it is unique to each of the members (below the line). In a user-friendly format, the parties see the products per category or brand, the sales of each product (average weekly sales, sales since last replenishment cycle), the product's stock in the store as well as visual indications 'flags'. The supply chain partners can identify exceptional cases such as new products, promotional products, not-selling items. Based on this information, the supplier salesman prepares an order suggestion, which a salesman sends for confirmation to the store manager. The store manager, having the same information available and using one own intuition and knowledge, can then confirm, change or reject the supplier's suggestion" (Pramatari and Miliotis, 2008:49-61). "The collaboration platform in the middle can be operated by the retailer, following the model of a buyer-oriented marketplace, or by a business-to-business (B2B) intermediary, also referred to as an 'exchange' or 'hub" (McIvor and Humphreys, 2004:241-249).

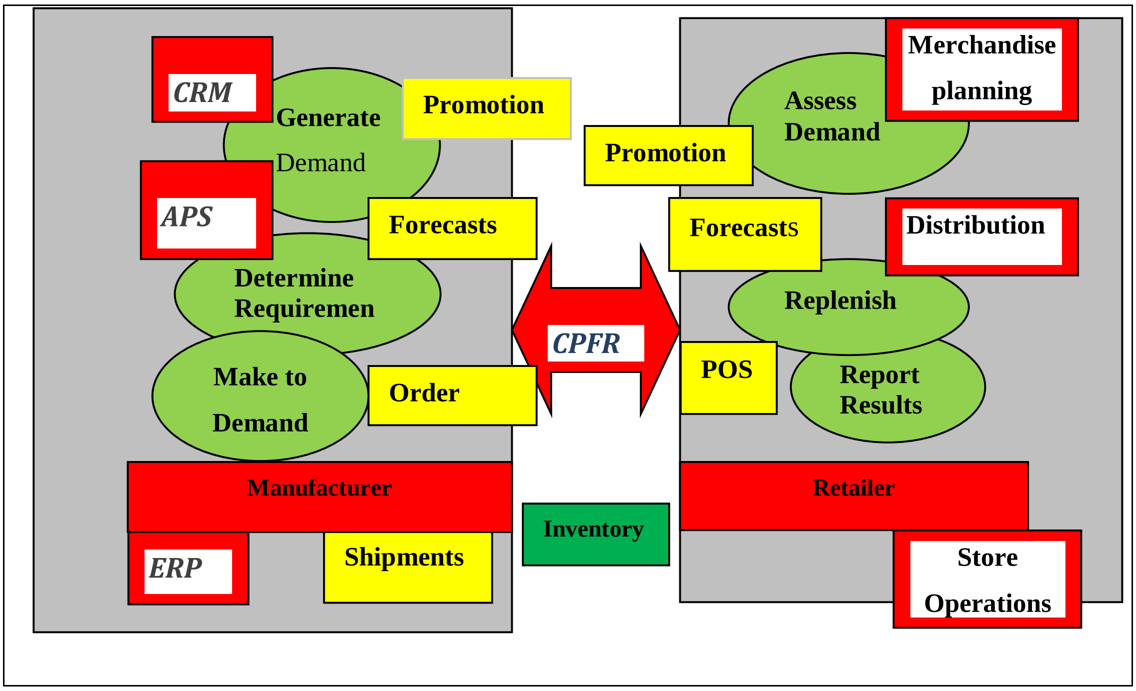
According to Pramatari and Miliotis (2008:49-61) the "process of collaborative store ordering (PCSO) can be used both for products delivered to the store directly by the supplier and for products delivered via the central warehouse, providing store personnel with a common user interface". The centralised system for ordering allows for the gradual diffusion of active collaboration activities without internal operations disruption among echelon members.

While on the upstream site, PCSO exhorts capacitated suppliers to participate in the ordering process of a centralised system with accessibility to quasi-real-time information. According to Pramatari *et al.,* (2008:49-61) this will give "the possibility to separate the physical distribution of products from the ordering process, combining the logistics benefits of centralised deliveries and the merchandising and order-accuracy benefits of direct-store-deliveries. Their study further indicates that PCSO gives a supplier the opportunity to move to centralised replenishment without losing control over the store ordering process. In terms of centralised products, PCSO gives retailers the possibility to outsource the store ordering process to the suppliers, which is not the current practice at the moment, where the internal data hosted on the platform of an application service provider."

Berger (2003) accentuates its critical role in facilitating processes on the data-alignment between the network members. If suppliers are attached with vendor managed inventory (VMI) to observe inventory levels from the retail site, it will enhance performance of the capacitated suppliers. Regarding the supply chain management perspective, information technology as a critical enabler of supply chain optimisation (Wamba and Boek, 2008:92-105), enables members in supply chains to exchange demand and inventory data in real-times.

In the retail sector, CPFR underpins active collaboration relationships on retail promotions, distribution systems, store replenishment and assortment planning. CPFR describes "a framework for the sharing of data between buyers and sellers in a supply chain in support of their planning, forecasting and replenishment processes" (Markus and Gelinas, 2006:24-42).

Figure 3.2: Role of CPFR technology in integrating retailer and manufacturer processes.



Source: Ghosh and Fedorowicz (2008). "The role of trust in supply chain governance". ***Business Process Management Journal*****, 14(4) 453-470**

The key to success with CPFR is to establish a common set of processes within which to support the exchange of information. The strong collaboration relationships assist in dealing with sales and demand forecasts to improve frequencies of order replenishment rates, avoid excessive buffer inventory, curtail expediting costs and returns, and avert stockouts. The manufacturer-retailer relationship is strengthened by collaborative promotion (when generating and assessing demand) and forecasts (when determining requirements and order replenishing). The manufacturer will be subjected to make-to-demand for the retailer's shared point-of-sales scanned data system to update the inventory positioning.

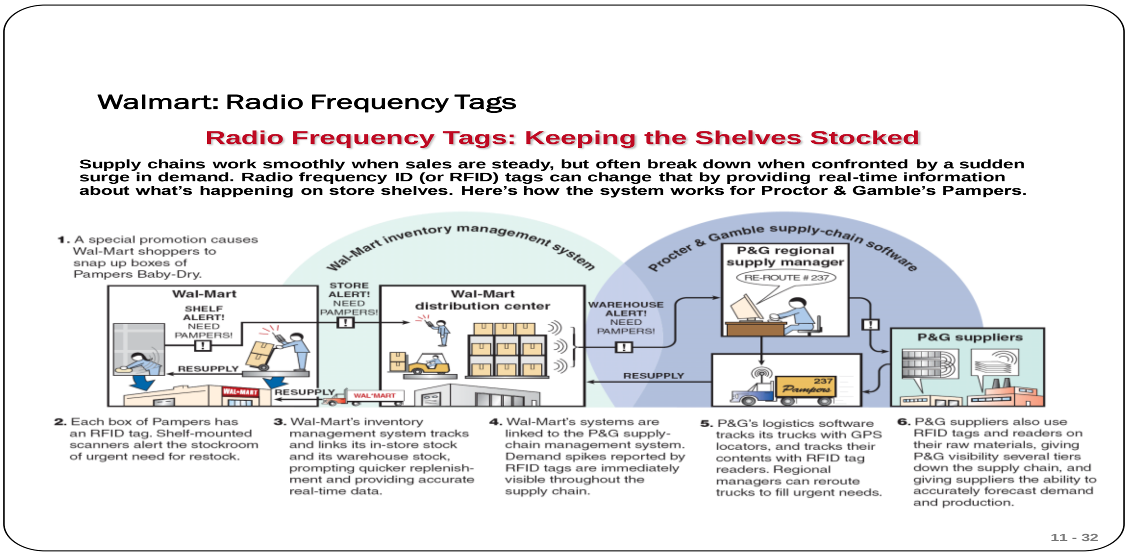
3.5 Supply Chain Information Technology

Information technology is an essentially impetus tool for global supply chain competitiveness to enable a high degree of visibility, connectivity, responsiveness and flexibility in supply chain configurations. Ngai *et al.*, (2011:237) focus on information technology integration that includes "the exchange of knowledge with partners up and down stream of the supply chain, allowing them to collaborate and to create synchronised replenishment plans".

In the information technology (IT) flexibility point of view, the IT infrastructure should be cost-effective on the basis of the market situation, and enable the company to respond to market changes from cascading effects at the most appropriate time. The adaptability of IT infrastructure to incremental changes and amplified demand order vacillations upstream the supply chain (bullwhip effect) has mitigating characteristics through (Byrd and Turner, 2000; Find and Neumann, 2009; Ngai *et al*., 2011): firstly, the connectivity as the ability of the information technology component to attach to other components within the organisation or with other organisations; secondly, the compatibility as the ability to share information across any IT component within the organisation or with other organisations; and finally, the modularity that denotes the ability to add, modify, and remove IT components with ease and without negative effect on performance. Ngai *et al.,* (2011:246) discover that "higher-competitive environment encourages supply chain partners to collaborate and develop supply chain and IT integration competence to achieve satisfactory supply chain agility".

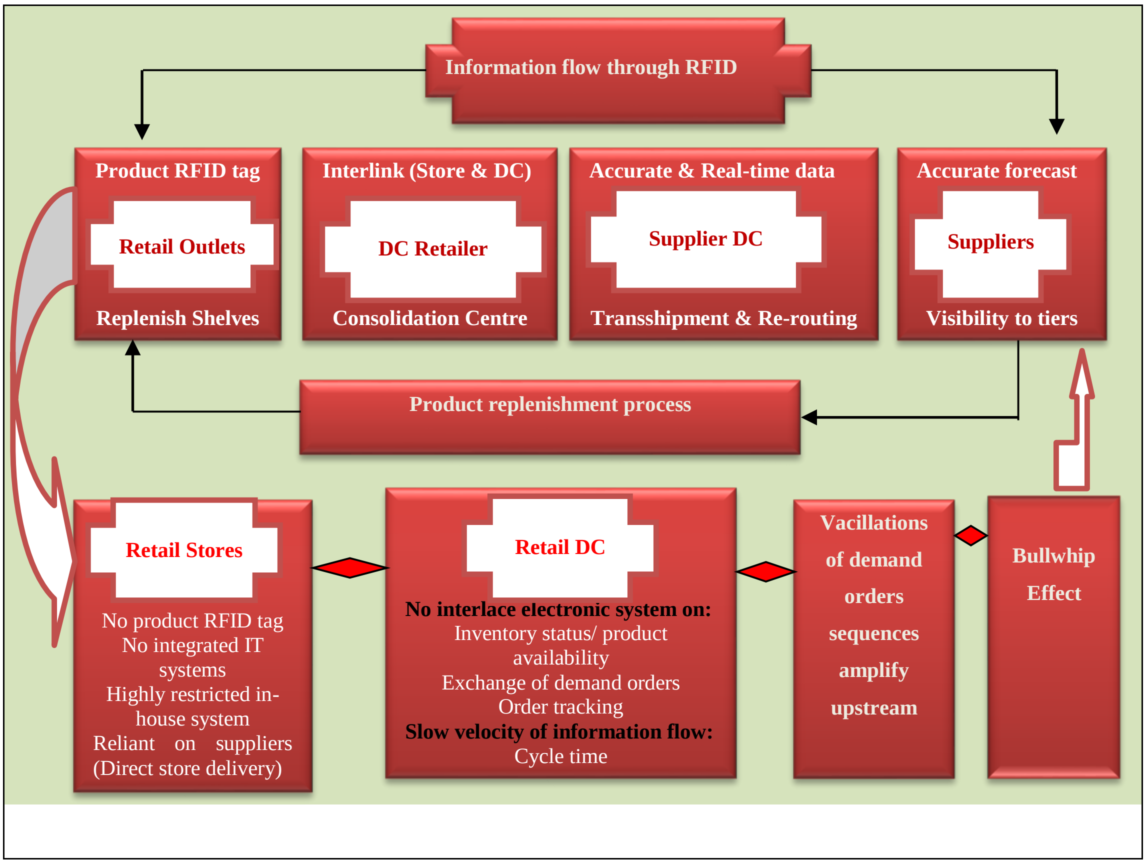
FMCG retail stores create value for their customers and extensively appropriate value from the markets through innovative retail business models (Sorescu, Frambach, Singh, Rangaswamy and Bridges, 2011:3). Certain retail companies like Walmart (Global company) and the Shoprite group (South African company) seem to be competitively positioning ahead of others in their territory through constant innovative business models. The following figures epitomise the essence of supply chain IT such as Radio Frequency Identification (RFID) system (Figure 3.3 – Walmart RFID), and possible pictograph of supply chain IT and bullwhip effect interface in the South African context (Figure 3.4). According to Visich *et al* (2008:19) "RFID has reduced the time items spend in the supply chain and the use of item level tracking has fully automated the shipping and receiving process". This means that RFID will allow for efficient cross-docking since the real-time information will support swift reactions and decision making with regards to distribution. Thiesse and Fleisch (2008:533) add that "RFID provides information that helps visualise and control even weakly structured processes in real-time to achieve a high level of supply chain performance targets". The use of RFID in the retail environment leads to reductions in inventory levels and enables better collaboration in the supply chain (Wamba *et al*, 2008:620), even though Schuster *et al*, (2007: 135-158) argue that the use of RFID at the retail level is solely to prevent theft.

Figure 3.3: Radio Frequency Identification (RFID) for Walmart.



Source: Heizer, J. and Render, B. (2011). *Principles of Operations Management*. 8th Ed., New Jersey: Pearson Education.

Figure 3.4: Interface between supply chain IT and Bullwhip effect



Source: Developed by the researcher from contextual, conceptual and reflective supply chain learning approach.

Seemingly, inventory is managed from the point of the consumption cycle along the supply chain until it reaches the desired location of the distribution cycle - either retail central DC, manufacturer DC or supplier DC. The first type of inventory as procurement cycle is handled as raw materials from lead suppliers and/or *n*-tiers to the manufacturer for production and quality assurance to emerge as the work-in-progress or finished goods in the manufacturing cycle. The final product is then sorted and packed / pre-packaged / pre-merchandised ready for shipment from the manufacturer to the warehouse (supplier DC or retail DC). The inventory in the form of a final product is normally delivered to the retailer DC based on the order as the retailer placed orders on demand in respect to the inventory system with the replenishment cycle and individual retail outlets received pre-merchandised inventory for central consolidated cross docking.

Essentially, the visibility of information flow through the RFID system (figure 3.3) facilitates the forecast accuracy, real-time data and interlink among the supply chain partners (suppliers, supplier DC, retailer DC and retail outlets) to enhance frequencies of replenishment rate. If the integrated e-SCM system is not utilised, the vacillations of demand orders sequences amplify upstream in the supply chain network (known as bullwhip effect). This means that the retail store outlets are highly restricted on in-house system and extensively reliant on suppliers with direct store delivery while the retail DC experiences slow information flow with no interlace electronic system on inventory status/ product availability, exchange of demand orders, or order tracking with RFID.

Hugo *et al.,* (2008:258) underpin an implacable information technology from both figures (figure 3.3. and 3.4) as "one of the major integrating impetus behind the development of supply chain management". The real-time accessibility to accurate and massive information in the network is greased by integrated information technology. According to Simchi-Levi *et al.,* (2008:188) "supply chain management revolves around efficient integration of downstream, midstream and upstream supply partners in the network". Although the challenge of extended cross-enterprise integration processes rely on actively coordinated activities in the network, the figures assert the improvement on the performance of extended enterprise by absorbing cost, improving service levels, ameliorating the bullwhip effect, better optimising resources, and effectively responding to changes in the marketplace. Skjott-Larsen *et al.,* (2007:140) state that "the benefits of supply chain integration are endless and the integrated supply chain assists an organisation achieve and maintain a competitive advantage".

Simchi-Levi *et al.*, (2008:405) further note that “the importance of information technology to achieve supply chain integration is emphasised when applying strategies that reduce lead time and increase the service level, the timeless and availability of relevant information is critical”. The efficient flow of information among supply chain partners is enabled and facilitated by adopting an integrated information technology system that underpins swift responsiveness and accurate information flow along the supply chain network.

3.6 Electronic Tools for FMCG Industry

Modern technology enhances the ability to impart EDI, XML, and ASCII links to customers and suppliers. It allows business systems to exchange orders, receive and dispatch information, as well as product availability and detailed inventory status. The integrated supply chain information technology systems should also be capable of being interlaced to other electronic systems whether this be a customers’ system, an in-house system or a suppliers system. The FMCG retail industry has a number of operational activities including vendor managed inventory, inventory status and availability, and order placement and tracking to mitigate consumer demand order amplification, and the facility to enter and view information through an electronic supply chain communications hub allows for a cost-effective and responsive business model in the growing customer service requirements. The velocity of relevant information flow on consumer demand, inventory positioning, order fulfilment and cycle time makes electronic supply chain management highly desirable for customers and suppliers to enjoy seamless linkage.

The electronic transfer of data and documents between trading partners and the recent development of the internet and its use in business have swayed the perception of how electronic tools like e-commerce were initially conducted. Hugo *et al.,* (2008:272), state that “e-commerce involves the use of information technology to enhance communications and transactions with all of the organisations stakeholders. Such stakeholders include customers, suppliers, government, regulators, financial institutions, managers, employees and the public at large”. Mendes (2008:143) states that “e-commerce refers to the paperless exchange of business information using electronic data exchange, electronic mail, electronic bulletin boards, electronic fund transfer and other network-based-technologies”. The essence of e-commerce is the convergence of information technology and internet into the business function, allowing for more efficient and faster exchange of information when conducting business (Hugo *et al*., 2008; Mendes, 2008).

Seemingly, electronic data interchange (EDI) takes precedence as an efficient computer-to-computer transfer of business documentation in a standard, machine process able format, with the major global retail stores using the system to link their ordering systems with the order processing systems of their suppliers (Pycraft *et al.,* 2010:260). According to Hugo *et al.,* (2008:267) EDI indicates that "orders placed with suppliers, orders received from customers, payments made to suppliers and payment received from customers, can all be transmitted through information networks". The advancement of information technology in the business function has not only been limited to EDI, but Management Information Systems (MIS) are also used by organisations to enhance the decision making process, especially in planning and control activities. MIS technology is mainly concerned "with inventory managements, the timing and scheduling of activities, demand forecasting, order processing, quality management" (Pycraft *et al.,* 2010:269).

The principle of information sharing acknowledges the accurate and near real-time information that assists in improving supply chain performance by making information on end-consumer demand available to the upstream side. However, the biggest challenge tends to be the lack of trust among the partners and the vulnerability of supply chains to disruption with agility supply chain. Slack, Chambers and Johnston (2007:426) stress the importance of supply chain technology systems like electronic point-of-sale (EPOS) to consolidate and transmit aggregated sales data and necessary information from individual retail stores to the CscD centre. In turn, this centralised system assists to share information among the supply chain trading partners through electronic data interchange (EDI) and MIS to activate the agility of the whole supply chain system.

Bottani and Volpi (2006:230) assess "the impact of radio frequency identification (RFID) technology implementation using the grounded method on the Supply Chain Operation Reference (SCOR) model" as a conceptual framework for the analysis of distribution centres of the FMCG supply chain. The authors describe the SCOR model as "a process reference model that provides standard guidelines for companies with the aim of examining their supply chain configuration, and identifying and measuring matrices from the conjoint of four processes (Plan, Source, Make and Deliver)". Prater *et al.,* (2005) focus on distribution activities where the specific benefits of RFID introduction are the availability of real-time information, an increase in inventory visibility, stock-out reduction, real-time access and updating of current store inventory levels, availability of accurate points of sales data and better control of the whole supply chain (Bushnell, 2000).

Firms have been able to re-engineer their supply chains through real-time information sharing, enabled by electronic commerce (e-commerce). Adopting a broader perspective, Li *et al* (2009:128) underpin that this technology has the ability to provide timely, accurate and reliable information in which the costs of transacting are reduced amongst the trading supply chain partners. Notably, the VMI system, together with the electronic point-of-sale system provides faster and cheaper order processing. According to Darwish and Odah (2010:473-484) the trading supply chain partners achieve accurate forecasts by communicating real time data that improves visibility and demand smoothing. Due to the accurate forecasts, the supplier is in a better position to meet customer demand.

3.7 Inventory Management on FMCG Industry

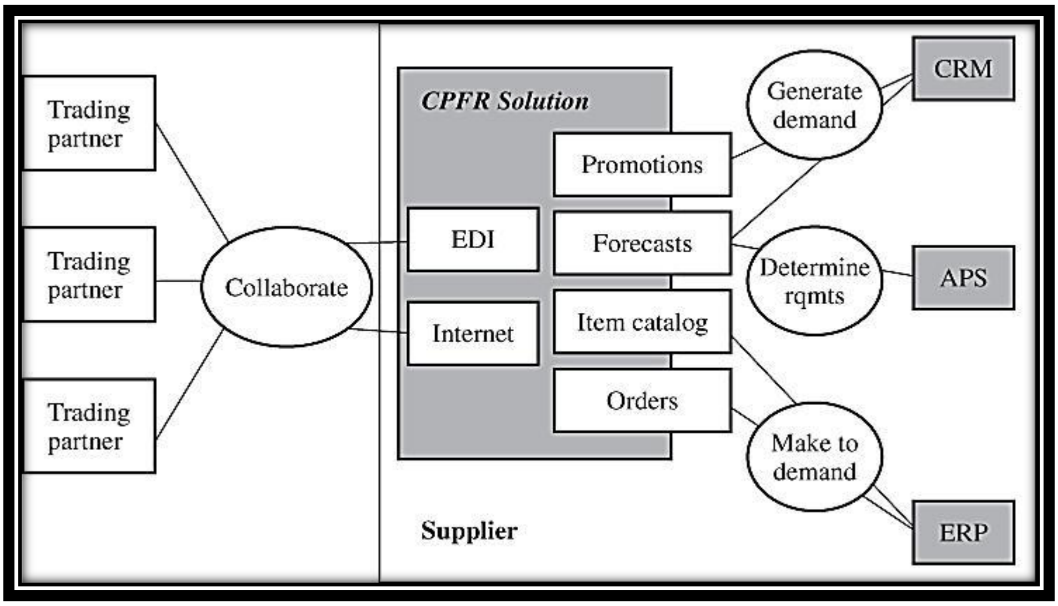
The concept of inventory can be defined "as the goods and/or services that an organisation holds in stock while considering the different types of inventory or inventory categories", (National Barcode, 2008). The first category is known as materials and components, which consists of important items that are needed in the creation or production of the final product. The second category is also known as Work In Progress (WIP). The third category is the finished goods, which is the most common type of inventory, that is, ready to be consumed by the market (National Barcode, 2008). The most complex process of inventory is keeping track of the item along the supply chain. According to Nahmias (2009) a central distribution centre inventory allows risk pooling among stores and facilitates redistribution of store inventories that might be out of balance. West (2003:230) refers to inventory as "the stock of products held to meet future demand" while inventory management is defined by Desselle and Gzarrick (2005:382) as "the practice of planning, organising and controlling inventory, which is the main contributor to the profitability of a business".

In the macro perspective, inventory includes raw materials, goods in production, and finished goods that are all considered to be part of a company's assets as they are either ready or will be ready for sale to generate revenue for the company, while stock refers to "all the raw materials, finished goods and those that are in the warehouse ready to be delivered to the customers or clients" (Sucky, 2009:311-322). Stock pertains to goods only, both in terms of quantity as well as its monetary value. "Inventory management can be defined as the process of efficiently controlling the constant flow of units into and out of an existing inventory" (BarcodesInc, 2010). Proficient inventory management also seeks to manage the costs associated with the inventory, from both the perspective of the total value of the goods and the tax burden generated by the cumulative value of the inventory.

Inventory management has to do with keeping accurate records of finished goods that are ready for shipment. Accurately maintaining figures on the finished goods and centrally delivered inventory makes it possible to quickly convey information to sales personnel as to what is available and ready for shipment at any given time (BarcodesInc 2010). In retail management, there is a greater variety of products to store and a great deal more of each product. In fact, the warehouse may never be big enough to hold all the merchandise that the company needs to keep in stock, and it can be difficult to maintain the right number of any particular item at any given time.

The system of Collaborative, Planning, Forecasting and Replenishment (CPFR) in the distribution centre includes all storage points in the supply chain, from retail shelves to improved product availability and positioning inventory, to raw material warehouses to build anticipated orders into future production plans and improve replenishment accuracy (Colleen and Palmatier, 2004; Chopra and Meindl, 2007; and Bowersox *et al*., 2010).

Figure 3.5: CPFR in the Retail Information Technology Environment



Source: Bowersox, D.J., Closs, D.J. and Cooper, M.B. (2010) Supply Chain Logistics Management, 3rd Ed. Boston: McGraw-Hill

Figure 3.5 shows the CPFR that coordinates the requirements planning process between supply chain partners for demand creation and demand fulfillment activities, which is initiated by the consumer products industry. The system is developed to reduce unplanned and uncoordinated events that distort the smooth flow of product throughout the supply chain.

According to Bowersox *et al*., (2010) indicate CPFR process steps: 1) develop a joint business plan; 2) create a joint calendar to determine product flow; 3) create a common sales forecast based on shared knowledge of each trading partner's plan (share a common forecast between retailer and suppliers; use an iterative process to share the forecast and requirements plan); and 4) use the common sales forecast to develop (production plan, replenishment plan and shipment plan). The managerial aspect of inventory aims to minimise the amount invested in inventory and the procurement and carrying costs, while balancing supply and demand. Inventory management dynamics revolve around impending stock-outs and excess inventory, although it is easier to spot empty places on the shelves than the excess inventory.

Cachon and Terwiesch (2009:338) indicate that the distribution centre provides the retailer with a centralised location for inventory, while still allowing the retailer to position inventory close to the customer. In contrast, the location pooling strategy merely creates a centralised inventory location. A central inventory location within the supply chain can exploit lead-time pooling to reduce the supply chain's inventory investment while still keeping inventory close to the customers. Cachon *et al.,* (2009:340) further emphasise that "this strategy is most effective if total demand is less variable than demand at the individual stores and if the lead-time before the distribution centre is much longer than the lead-time after the distribution centre". In this understanding, the South African FMCG retail stores are expected to invest huge capital for new DCs around African continent to avert longer lead time from South African DC deliveries to individual retail stores around the African continent.

3.8 Market Share Expansion to African Continent

"Expansion can be regarded as a direct result of globalisation, and organisations expand to international markets in order to capture new markets and growing customers. The decision to expand organisational operations is driven by objectives and mission" (Singh and Chalwa, 2010). According to Heizer and Render (2011:43) expansion can take place in two ways, one being diversification and the other being international market expansion. "Diversification relates to the organisation expanding product and service offering, for reasons of expanding what the organisation offers to customers and potential customers" (International Expansion Report, 2010). A recent strategic choice in the South African FMCG sector saw, Pick n Pay, Shoprite, SPAR and Massmart adding liquor stores in the scope of their business units, while Pick n Pay has also, ventured into clothing a diversification strategy. Business expansion, on the other hand, refers to "the business expanding its business processes, procedures and business model to markets outside the country of origin while attempting to grow the business and ultimately gaining profits and customers" (International Expansion, 2010).

It can ultimately be viewed that diversification and business expansion are exercised as a corporate strategy to increase profitability through greater sales volume obtained from new products and new market. Business Partners Ltd. (2010) argues that even though planned expansion can take the organisation to higher levels, over expansion is one of the biggest dangers of this volatile process if a proper feasibility study is not done. Expansion should not exceed the business' financial and skills capacity. Ehlers and Lazenby (2007:113-114) cite Porter (1987) on three tests: firstly, the attractive test whereby the industry that has been chosen has to be either attractive or capable of being made attractive. Secondly, the cost-of-entry test, the cost of entry must not capitalise all future profits. Lastly, the better-off test, the new unit must either gain competitive advantage from its link with the corporation or vice versa.

The FMCG retail stores are constantly striving for a bigger market share and to become the supermarket of choice and the consumer's champion. According to the *Business Times* (2011:1) Pick 'n Pay's market share has dropped to 34.1% (forecast for 2011) from 36.5% in 2007, including franchises; Shoprite has increased its share from 32% to 34.1% excluding franchises; Woolworths' share also dropped from 7.5% in 2007 to 6.4% in 2011, but the company is back on a growth track; and SPAR's share has edged up from 24% to 24.9%. Pick 'n Pay is losing market share to Woolworths at the top end, and to Shoprite in the middle and lower income markets. Although Pick 'n Pay has decided to adopt a centralised distribution model, the better performers, including the retail star performer Shoprite (*Business Day*, 2010:1) have already adopted the model to improve efficiency, reduce operational costs and ensure daily deliveries from the central warehouse (SPAR was the first to introduce the practice; followed by Woolworths; Shoprite is expanding its existing Centurion distribution centre to 107563m², which is larger than Pick 'n Pay's centre; which measure 65000m²; and Massmart has a new 70 000m² distribution centre in Germiston, Gauteng).

Retail stores acknowledge that rising income, rising expectations and greater levels of individualism have changed the customer base. The unpredictable nature of consumer behaviour impacts on retailers' costs and the level of complexity of their operations. The retail stores need to find the most efficient and effective way to balance customer demand and unpredictability with logistics costs in the supply chain. Normally, the retail outlets reflect the desires of specific customer behaviour in the stores through real-time point-of-sale data.

This study attempts to understand the electronic order replenishment process with a single point of customer demand forecasting and deliveries to a centralised distribution centre from multiple suppliers in the South African perspective.

The centralised system synthesises continuous flow, and near real-time information and offers the stores ongoing planning information updates (Cachon and Terwiensch, 2009; Bowersox *et al*, 2010; Heizer and Render, 2011). This central repository synergy synchronises the individual retail outlets' changes on planograms, emergency and planned promotions, and continuous flow of information and customer behaviour with no artificial barriers to impede the reaction time (Vendrig, 2008; Simchi-Levi *et al*, 2008).

3.9 Distribution Centres (DCs) on FMCG Industry

The terms "distribution centre" and "warehouse" are sometimes used interchangeably. The Council of Supply Chain Management Professionals (CSCMP) (2005:36) defines a distribution centre as "a warehouse facility that holds inventory from manufacturers pending distribution to the appropriate individual stores". De Villiers, Nieman and Niemann (2008) describe a warehouse as a place where raw materials, work-in-process goods or finished goods are stored. The warehouse receives finished goods from various upstream manufacturers, puts them together in a package and sends them on to a retailer who is the customer. Certain retail store outlets/supermarkets own their outbound warehouses and fast moving distribution centres. The main purpose of distribution centre ownership is to achieve economies of scale through quantity purchasing discounts (Leenders *et al.,* 2008) and forward buys from suppliers (Simchi Levi *et al.,* 2008) wherein, the selling prices to the end-consumer are reduced (Hugo *et al*., 2008).

In understanding De Villiers *et al*.,'s (2008:57) analysis, the fast moving distribution centres support the store's customer service policies by prioritising items like A and B items in the ABC analysis. This system underpins the just-in-time programmes of suppliers, vendors and customers to overcome the time and space differentials that exist between the upstream products and downstream customers (Heizer and Render, 2011:658). It further involves the lowest possible total cost logistics corresponding with a desired level of customer service. These centralised distribution centres are unique, cost efficient and effective in the consolidation of huge volume replenishment for a short-term storage facility, large volumes inventory for full-truck loads to individual retail stores, and outbound delivery vehicles with a full capacity of well-planned, electronically tracked and traced loads *en route* to retail outlets or customers (Kurmar, 2009; Pienaar and Vogt, 2009; Bowersox *et al.,* 2010). The fast moving retail outlets rely on consolidation of inventory, reliably efficient delivery loads and sales volume to maximise their profitability. The CscD centres, with their supply chain technologies, seem to enhance the retail stores' financial rewards and reduce the price that customers ultimately pay for goods.

3.9.1 Retail Distribution Centres

Multu and Cetinkaya (2011:360) differentiate between two approaches to retail distribution centres as, "the decentralised approach is determined by the objectives of individual members of a supply chain in terms of cost structure and profitability. The resulting interaction is sub-optimal from the perspective of the entire supply chain. In contrast, in the centralised approach, decisions are based on the overall objective of the supply chain in terms of total cost / profit, where the individual members are controlled by a central decision making centre". The authors maintain that the centralised approach is more efficient for the supply chain as a whole, although different members of the chain are seldom controlled by a central decision maker and the individual objectives are often conflicting. In the context of how much the variability grows as demand order variability moves from stage to stage in supply chain network, Simchi-Levi *et al*., (2008); Snynder and Shen (2011) confirm that the variance of the orders grows additively in the total lead time for the centralised supply chain, while the increase in multiplicative for the decentralised supply chain.

Collins *et al*., (1999:105) describe the consolidation centres owned by large retailers as "retail distribution centres (RDCs) that specialise in combining or consolidating inventory from multiple origins into an assortment for specific retail outlets or customers". These retail centres are underpinned by cross-docking and mixing consolidating methods to reduce overall product storage in the supply chain, achieve customer-specific assortment (through pre-allocation/packaged cross-docking) and minimise transportation costs (Bowersox *et al*., 2010). Hugo *et al*., (2006:285) identify the advantages of CscD centres as consolidated hub systems that service a number of retail customers: firstly, they promote efficiency through the principle of postponement; secondly, they facilitate economies of scope, ensuring that full load-deliveries are made to retail depots; and lastly, they promote greater supply chain visibility as participating retailers can view stock in the system through the use of common information systems. Consequently, the individual retail stores can place orders for stock on view with much greater confidence, permitting inventory reduction and creating sufficient storage space at retail level. The individual retail stores further have lower inventory levels, increased frequency of deliveries to enhance product availability, greater product variety, improved product alignment with customer demand from mitigated order variability and shorter time in stock (Collins *et al.,* 1999; Simchi-Levi *et al.,* 2008; Bowersox *et al.,* 2010). This flow-through distribution system allows for active storage that includes the receiving and assembly of goods from various upstream suppliers (inbound product flow), the combination of goods, and shipping the combined orders to customers (outbound product flow) (Hugo *et al.,* 2006; Bowersox *et al*., 2010).

3.9.2 Processes of Distribution Centres

The centralised supply chain distribution centre (CscDC) or warehouse in this context is the facility in the supply chain network that receives goods from the upstream side, stores them in the centre, and ships them to the downstream individual retail stores. Arguably, a distribution centre is the antithesis of a warehouse; the centre forms the nexus between retailers and their suppliers to ensure incoming deliveries match purchase orders, and routes orders for shipment to the correct store. In the streamlined and consistently evolving distribution process, Coyle *et al.,* (2003) note that the system of national, regional and zone distribution centres, and local branches support new opportunities and demands. The system allows for improved customer service, contingency protection (delays and vendor stockouts) and smooth operations in the manufacturing process.

In South Africa, the current trend is towards purchasing supply chain centralisation for the fast moving retail stores. The distribution centres owned by retail chains can take advantage of economies of scale and other benefits such as higher order quantity discounts on purchase volume, sound policy decisions and better-negotiated controls. The centre uses sales and inventory information to trigger replenishment orders from upstream suppliers/manufacturers by generating volume purchase orders compounded by quantity discounts (Kuchru, 2009). "In the systematic benefits through break-bulk operation at district level, the business buys and receives a single large shipment from different suppliers, the system synchronises the arrangements for full-truckload local delivery to multiple retail outlets" (Bowersox *et al*., 2010:247). The CscD model allows for an integrated service that consolidates products for delivery and expedites the services of premium transportion, combined with supply chain information technology.

The practice of passive warehousing storage has shifted to a strategic assortment of supply chain distribution centres. These supply chain distribution performances offer upstream manufacturers a way of reducing the holding or dwell time of materials and parts that would eventually become integral to just-in-time (JIT) and stockless production strategies. This flow-through distribution system allows active storage that includes the assembly of goods from various upstream suppliers, the combination of goods and the shipping of the combined orders to customers. According to Bartholdi and Gue (2004:235-244) cross-docking favours the timely distribution of freight and better synchronisation with demand, with the distribution centre essentially acting as a high throughput sorting facility.

Arguably, the distribution centre is just one link in a sequence; being efficiently connected to the upstream segment can be as important as being connected downstream in order to ameliorate the oscillation of the bullwhip effect. Although the major South African supermarket chains seem to be migrating towards the shared business solution of a CscD system, it is still to be seen whether lean supply chains and the speed of products from supplier to shelf within shorter time frame impact on profitability. Wyatt (2008) also argues that major food stores achieve competitive advantage by their product assortment, availability and price not necessarily by how those products arrive at the store.

3.10 Strategic Consolidation to mitigate Bullwhip Effect

The companies from diverse markets have observed a phenomenon, in which order vacillations increase as orders move upstream. Ouyang (2007:1107) refers to the bullwhip effect as "a phenomenon in supply chain operations where the fluctuations in the order sequence are usually greater upstream than downstream of a chain". The phenomenon influences profitability throughout the network with costly inventory levels and positioning (Chopra and Meindl, 2007:525). A firm's ability to establish and maintain satisfactory customer relationships requires an understanding of buying behaviour, that is the decision processes and acts of people involved in buying and using products. According to Pride and Ferrell (2009:171) consumer buying behaviour refers to "the buying behaviour of ultimate consumers, those who purchase products for personal or household use and not for business purposes". The CscD system allows most consumers to spend little time or effort selecting products from the shelves. Eventually, the system enhances the decisions and activities that make products available to customers when or where they want to purchase them.

Cachon and Terwiesch (2009) also note that CscDs have the potential to allow manufacturers (source of production) and raw material suppliers (tiers spikes) to meticulously plan their capacity and demand forecast within a central location (either a retailer or manufacturer's central distribution system) and retailers can ensure on-time delivery of customer orders with minimal stock. Chopra *et al* (2007:495) stress that "information exchange and technology optimise the chance of trading supply chain partners making the best supply chain decisions". Schoeder (2008); Cachon and Terwiesch (2009) note that centralised supply chain decision-making requires reciprocal interdependence between echelon stream sites of the supply chain network. The authors add that firms benefit from better coordination, sharing demand information through electronic supply chain management (E-SCM) systems and removing pathological incentives to mitigate the bullwhip effect.

The e-SCM system in particular provides an integrated plan for product availability and product demand chain operations from inbound and outbound shipping systems for product ordering. Wanke and Saliby (2009:678) consider consolidation efforts in terms of inventory centralisation, order splitting and transshipment as cornerstone tools to measure inventory costs, service levels and total costs. “Inventory centralisation physically consolidates stock at a limited number of locations (often a single facility) from which all demand is satisfied (this results in demand pooling), although distribution costs are higher when compared to decentralised systems” (Wanke, 2009:107-124). The basic idea is that inventory increases as the standard deviation of either demand or lead-time increases, and, as a result, companies may attempt to reduce inherent variation by pooling it. Evers (1999:121-139) describes order splitting as “a stock keeping location that operates independently of all facilities in filling its demand, but divides its reorders (not necessarily evenly) among multiple suppliers”. Thomas and Tyworth (2006:245-257) are of the view that there is “a lack of attention to transport economies of scale, as well as to the safety stock benefits from a total system cost perspective, despite the worthwhile pooling of lead time risk by simultaneously splitting orders”. Transshipment occurs when a facility satisfies every demand coming from another territory. It implies that a given proportion of demand is supplied from facilities located in different markets, regardless of whether there is sufficient inventory in the original serving facility (Wanke and Saliby, 2009:679).

In terms of consolidation, transshipment facilitates the shipment of goods to an intermediate destination, and from there, to yet another destination. Rojas (2007:8) reports that the system combines small shipments into a large shipment, dividing the large shipment at the other end through either transloading (from ship to road transport) or transport hubs. The fast moving retail stores have central and regional transshipment that underpins risk pooling in supply chain management, where the demand variability is reduced by aggregating demand across locations as high demand from one customer will be offset by low demand from another (Simchi-Levi *et al* 2008:66). In the CscD system, the distribution centre serves all customers, which leads to a reduction in variability measured by either the standard deviation or the coefficient of variation (Cachon and Terwiesch, 2009; Wanke, 2009). The higher the coefficient of variation, the greater the benefit obtained from centralised systems, that is, the greater the benefit of risk pooling. The central repository synergy for fast moving retail stores synchronises the individual retail outlets’ changes on planograms, and emergency and planned promotions, and allows for a continuous flow of information and customer behaviour with no artificial barriers to impede the reaction time (Vendrig, 2008).

3.11 Strategic Alliances to mitigate Bullwhip Effect

Increasingly, companies are building strategic collaborative and alliances with trading supply chain partners in order to achieve efficiencies, flexibility, and competitive advantage. In the same token, the retail distribution centres and logistics service providers are continually seeking improvement in outbound shipments. Economies of scale reduce costs as the optimal shipments dispatching plan in full collaboration freight consolidations and strategic alliances is effectively undertaken (Zhou, Hui and Liang, 2011:18). A strategic alliance is defined as "an agreement in which managers pool or share their organisation's resources and know-how with another organisation, and ultimately share the rewards and risks of pursuing the venture" (Ehlers and Lazenby, 2006:296). These strategic alliances are an agreement to collaborate among firms. Ouma, Park and Zhang (2000) describe a strategic alliance as a medium-to long-term partnership formed by two or more firms with a common goal of improving competitiveness.

Zhou *et al* (2011:29) suggest that the effects of full collaboration have a strong influence on price competition on the demand side and reduce operating costs on the supply side. Corsten and Kumar (2005) and Dougherty *et al,* (2006) list the benefits for firms engaged in long-term collaborative relationships as improved visibility, higher service levels, increased flexibility, greater end-customer satisfaction, and reduced cycle time to create unique value that neither partner can create independently. The focus should be on the practices, mutual efforts, and derived value within the relationships among strategic supply chain partners. Corsten and Kumar (2005) posit that trust results in greater openness between suppliers and retailers and thus, greater knowledge and appreciation of each other's contribution to the relationship. Pienaar and Vogt (2009:304) note that "strategic collaboration and alliances in terms of inventory replenishment reduce reliance on forecasting in the supply chain and facilitate the positioning of inventory on a just-in-time basis from all streams".

It should be noted, however, that effective, collaborative, centrally located inventory requires a great deal of cooperation and information sharing among the supply chain trading partners. Cao and Zhang (2011:163) acknowledge that "goal congruence between supply chain partners is determined by the extent to which supply chain partners perceive that their own objectives can be satisfied by accomplishing the supply chain objectives". Strategic alliances and collaboration are attractive because "they emphasise governance through relational means in addition to governance through contract means" (Nyanga, Whipple and Lynch, 2010:101).

The study acknowledges that strategic alliances among supply chain partners dovetail with the consolidation of activities to enhance profitability through large volume discounts, lower prices and greater service to end-consumers. In terms of the downstream stock policy, Pourakbar *et al*., (2009:48) report that "the use of the CscD system may lead to lower storage costs at retail outlets and a shorter order lead time without a demand fill rate decrease to impact customer service levels".

3.12 Global Company Profiles: International Companies

Studies on the apparel and grocery industries have shown a similar phenomenon. If the manufacturer is not aware of the planned promotion, it may interpret the larger order as a permanent increase in demand and place orders with suppliers accordingly. The manufacturer and suppliers thus have a lot of inventory right after a retailer finishes its promotion. The lack of information sharing between the retailer and manufacturer thus leads to a large fluctuation in manufacturer orders. According to Chopra and Meindl (2007:423) the managerial levers which help a supply chain to achieve better coordination fall into two broad categories: firstly, action-oriented levers include information sharing, changing of incentives, operational improvements, and stabilisation of pricing. Secondly, relationship-oriented levers involve the building of cooperation and trust within the supply chain.

The accessibility of quality information from echelon channels enhances the efficient customer responsiveness. Companies use that "information to forecast demand and to determine which products require replenishment based on upper and lower inventory limits previously established with each retailer. In lieu of the availability of information about demand activities and inventory status of the products to parties in a supply chain, inventory and replenishment policies that incorporate and use such information need to be considered and analysed" (Moinzadeh, 2002:414-426).

Table 3.1: Global company profiles on Bullwhip Effect

Global Company	Bullwhip Effect Perspectives
Procter & Gamble (P&G)	Discovered that "the diaper orders issued by the distributors have a degree of variability that cannot be explained by consumer demand fluctuations alone" (Lee, Padmanabhan and Whang, 1997). Farther down the chain, when sales at retail stores were studied, it was found that the consumers of diapers (babies) at the last stage of the supply chain used diapers at a steady rate.
Hewlett-Packard (HP)	'The orders placed to the printer division by resellers have much bigger swings and variations than customer demands, and the orders to the company's integrated circuit division have even worse swings" (Lee *et al.*, 2004:1887). This made it difficult for HP to fill orders on time and increased the cost of doing so.
Ford Motor Company	Thousands of suppliers from Goodyear to Motorola presents a greater challenge, and each of these suppliers has many suppliers in turn. "Information is distorted as it moves across the supply chain because complete information is not shared between stages" (Anand and Goyal, 2009:438). The growth of business-to-business (B2B) electronic commerce is reducing ordering costs, whereby General Motors and Ford will require many of the suppliers to be equipped to receive orders on the Web in an attempt to make ordering more efficient and mitigate bullwhip effect.
Barilla Spa (Italian manufacturer of pasta)	Hammond (1994) observes that weekly orders placed by a local distribution centre fluctuated by up to a factor of 70 in the course of the year, whereas weekly sales at the distribution centre (representing orders placed by supermarkets) fluctuated by a factor of less than three. Indeed, while variability in aggregate demand for pasta is quite small, orders placed by the distributors have a huge variability. According to Simchi-Levi *et al*, (2008) in the proposed Just-in-Time Distribution (JITD) programme, Barilla decided to take charge of the channel between the Central Distribution Centres (CDCs) and the distributors and decide on the timing and size of shipments to its distributors.
Palliating Bullwhip Effect	
Wal-Mart and P&G	Build a strategic partnership that will be mutually beneficial and help reduce the bullwhip effect. In essence, and attempt to create reciprocal interdependence (parties come together and exchange information and inputs in both directions) through collaborative forecasting and replenishment.
Campbell Soup - Continuous Replenishment Programme (Fisher, 1997)	Establishes electronic data interchange (EDI) links with retailers. "Re-engineering efforts have resulted in more coordination and cooperation between parties in the supply chain in the form of alliances and partnerships" (Moinzadeh, 2002:414).

Source: Compiled by the researcher from the listed literature review.

3.13 Global Company Profile: Pick n Pay South Africa

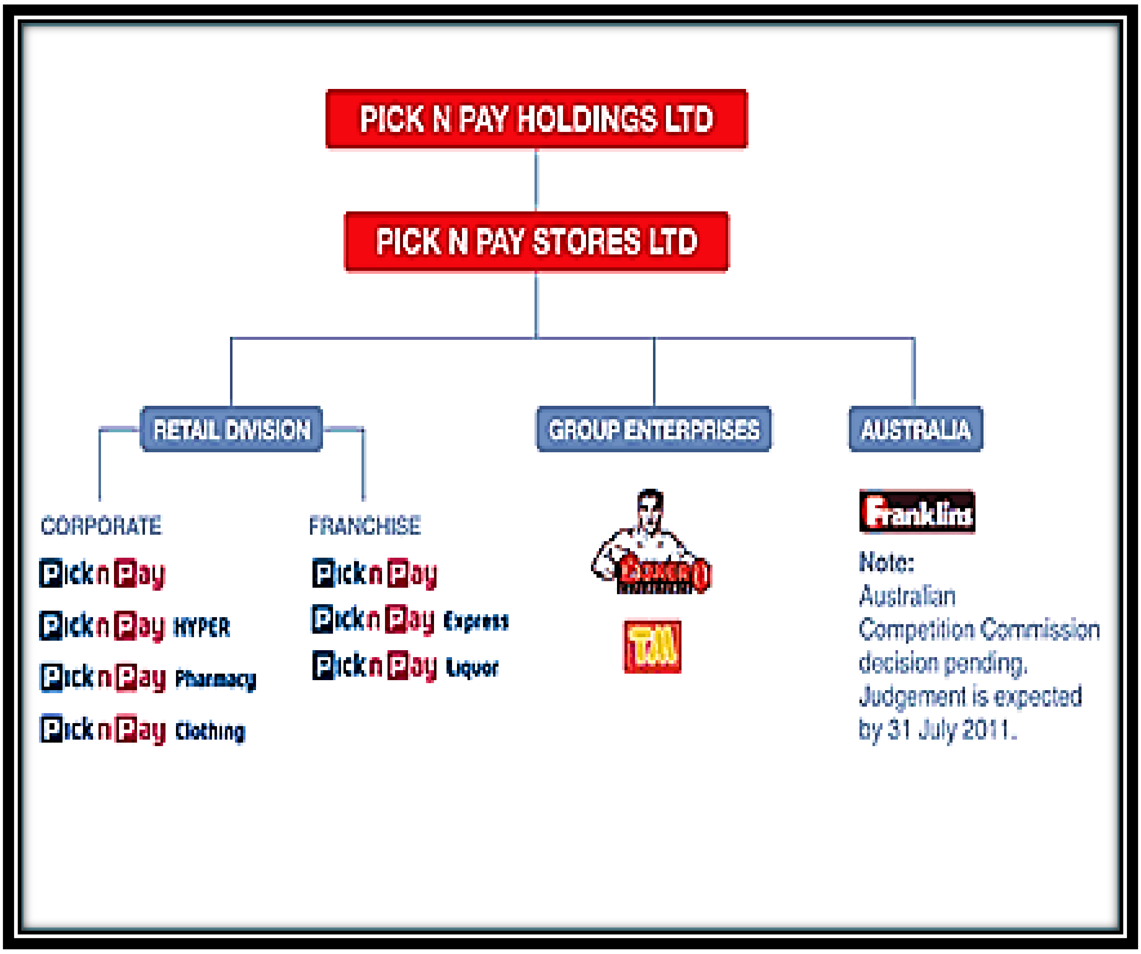
3.13.1 Introduction

Pick n Pay originally started in Cape Town as four shops owned by businessman Jack Goldin. In 1967 after losing his job at a Checkers store, Raymond Ackerman, the retired Chief Executive Officer (CEO) of Pick n Pay, acquired the stores from Goldin at a purchase price of R620 000 for four stores with a number of employees close to 250 (Pick n Pay, 2010). Shortly afterwards, Pick n Pay expanded to Port Elizabeth in order to be able to effectively compete in the price wars that it was facing from Shoprite and OK bazaars. By 1969 Pick n Pay was already being listed in the Sunday Times Top 100 companies due to its success in the Cape Town retail market, and four years later Pick n Pay was strong enough to diversify into hypermarkets. The first hypermarket opened in 1975 in Boksburg, bringing the "one-stop-shopping" concept to the South African consumer for the first time. Pick n Pay has a total of 20 Hypermarkets in South Africa as the largest store format and each Pick n Pay Hypermarket is a model of a one-stop discount retailer, featuring a mix of foods and general merchandise. The organisation also boasts over 160 supermarkets nationwide (IDE-JETRO, 2010) with an overall Pick 'n Pay group of 775 stores (Pick 'n Pay, 2010).

Concentrating on food, general merchandise, and clothing, the Pick n Pay group is managed through two divisions: Pick 'n Pay Retail Division and the Group Enterprises Division. Each division has its own management board. "The Retail Division today, which focuses on Pick n Pay's core business, comprises Hypermarkets, Supermarkets, Family Franchise stores, Butcheries and Financial Services. The Pick n Pay Family franchise stores represent the company's first venture into a franchise operation. Family stores, which fall under the control of the company's Retail Division, have allowed Pick n Pay to extend its reach to smaller convenience locations with longer opening hours" (Pick n Pay Report, 2011). As part of the Group Enterprise Division, Pick n Pay purchased the Boxer chain in 2002, which is a low cost, low margin operation concentrating primarily on retailing merchandise to South Africa's rural market.

Pick 'n Pay also ventured into the Australian market through procurement of the Franklin's chain of store (Pick n Pay Report, 2011), however recently, Pick 'n Pay found it best to sell their Franklins stores to Metcash resulting in them leaving the Australian market. Pick n Pay is now able to focus on its African market, which includes the corporate and family stores in South Africa, Mozambique, Zambia, Botswana, and recently Mauritius, together with the 50 TM stores that Pick n Pay operates in Zimbabwe (Maritz, 2011).

Figure 3.6: Pick 'n Pay structural design and grouping of stores



(Prior to the approval of the Franklin's sale to Metcash it was argued that the takeover would allow Sydney-based Metcash to have a monopoly on wholesale grocery distribution in New South Wales. However, on 30th November 2011, the Federal Court of Australia dismissed the appeal by the Australian Competition and Consumer Commission (ACCC) against the sale of Pick n Pay's Australia operations, Franklins to Metcash)

Source: Pick n Pay, Annual Report (2011) [Online], Available: http://www.thereretailer.co.za/retailers/39-retailers/28-picknpay. Accessed: 2/9/2011

3.13.2 Pick n Pay's Centralised Distribution System

Although the improved availability of products as benefits of the group's investment in central distribution begin to be realised, Kagiso Securities (2010:16) indicates that competition for locally sourced products are intensified exposing the shortcomings of Pick 'n Pay namely, diluted negotiating power brought about by its decentralised regional procurement structure; the increasingly inefficient and cumbersome nature of Pick n Pay's direct store delivery model; and the group's inability/historic unwillingness to source products internationally. The company has four different distribution centres in four different regions, with an inland distribution centre (DC) for Gauteng and the Free State, other DCs in the Eastern Cape, Western Cape and Kwa-Zulu Natal, and recently launched a major DC in July 2010 situated at Longmeadow, Gauteng (Business Report, 2011). Roelf (2011) confirms that "the company will make use of money received from the sale of its Australian unit (Franklins) to revamp and roll-out its distribution centres such as two inland DCs as well as facilities in the KwaZulu Natal (KZN), Western Cape and Eastern Cape" (Whichfranchise, 2010:3).

The investment into distribution centres epitomises the strategic move towards centralised supply chain distribution that is aligned with the company's strategy (Pick n Pay, 2011): "1) to improve its core retail business, 2) reduce the costs of doing business, 3) simplify the organisational structures and 4) enhance the way the company uses information technology". Badminton (2010:31), the company Chief Executive Officer (CEO) also states that "the company's move to centralised supply chain distribution was motivated by the changes in South Africa's retail landscape, which proved the company to be falling behind its competitors, who were investing significantly in their supply chains and in improved service to their stores through centralised distribution systems" (Whichfranchise, 2010:4).

Like Woolworths, Pick n Pay was also "driven by the realisation that their current distribution operations were running over capacity and had started becoming inefficient" (Business Report, 2011). This resulted in stores being overstocked and deterioration in customer service levels from the impact of bullwhip effect. In another report, Badminton (2010:31) hints that the strategic move would compromise efficiency in the short term, although "it would enable the company to comprehensively learn from the experience of its competitors and to build a world class distribution centre; deploying the most up-to-date and state-of-the-art warehouse management software solutions" in an attempt to mitigate bullwhip effect.

"In conjunction with the SAP implementation, SAP warehouse management is also used to manage the distribution facility, which has enabled to enhance functionality resulting in efficient use of resources, such as mechanical equipment and people; accurate management and tracking of stock and visibility of the status of the operation" (Whichfranchise, 2010:3). The supply chain performance benefits enable the group "to hold stock centrally rather than at individual stores, helping to eliminate congestion at the back door of their stores, cut down on storage space at individual shops", and improve frequency replenishment of stock with the right product at the right time and at the right price. The centralised supply chain system with integrated suppliers' consolidation seems to be a significant success with increased optimisation of the vehicle fleet, improved turnaround times at the back door while eliminating the need for heists and pallet jacks and increased stock availability to stores.

3.13.3 Pick n Pay's Alliance with Suppliers

The value of information relates to the central issue in inventory management, in terms of warnings from customers on frequency of order replenishment rate, and demand information acquirement and acquisition. Sometimes the value of demand information is also reflected by the trade-off between make-to-order and make-to-stock systems. Chen (1998: 222) states that "the proliferation of advanced information technologies in supply chains has exhorted more and more companies to realise the importance of better active communication in mitigating the bullwhip effect. Centralised supply chain systems lead to improved levels of customer service levels while local decentralised systems can increase demand variability on decreasing the value of information". The new Longmeadow distribution centre will strengthen the formation of an alliance with major suppliers such as Nestle. Tony Domingo, Director of Supply Chain at Nestlé Southern African Region, infers that "the Longmeadow facility has created the capability to drive consistent stock flow and optimise product with great benefit to consumers" (Business Report, 2011).

Although the appropriate degree of availability varies with the characteristics of the product and the target customers, Mullins and Walker (2010:313) suggest that "the market and competitive factors in the FMCG influence a firm's ability to achieve a desired level of product availability through effective use of e-SCM systems and functional CscD systems to enhance customer service". Consequently, a customer practices routinised response behaviour when buying frequently purchased low-cost items, requiring very little search and decision effort (Pride *et al.,* 2009:172).

The company has also formed "strategic partnership with logistics service provider Unitrans and the new grocery extension will distribute approximately 40% of inland grocery volume by October this year (2011). This has been a massive undertaking that has been demonstrated by the fact that currently the Longmeadow operation is distributing approximately 20% of the inland region's grocery volume. This amounts to close to 500 000 cases per week, and by the end of October this will increase to approximately 40% of grocery volume, or some 1 million cases per week. The initial aim is to distribute 40% of grocery volumes through the facility and to increase this to 80% once the slow-moving distribution centre is live" (Whichfranchise, 2010:3). This move to a centralised DC for South Africa's dominant retailers like Pick n Pay, SPAR and Shoprite has been very much influenced by competition from the world's biggest retailer (Wal-Mart) which owns 51% of Massmart" (Roelf, 2011). In turn, Wal-Mart has set out an aggressive price and margin strategy to grab market share in Africa's largest economy (Massmart Report, 2011).

Although the company had planned to control its inventory through real-time visibility of inventory across the whole supply chain, the essence of supply chain performance capability is to ameliorate any form of demand and supply order variability. The optimum electronic replenishment decisions are vital in relation to the introduction of convenience food lines to improve integration strategies with its current suppliers. The ability to support a centralised supply chain distribution facility, Longmeadow DC, was earmarked as state-of-the-art SAP WM system to underpin all stores in the inland regions, with up to 120 000 cases per day (USC Solutions, 2009).

3.13.4 Pick n Pay expansion to Africa

The Pick n Pay group currently owns and manages a single store in Zambia, seventeen in Namibia, 12 in Botswana, 7 in Swaziland and 1 in Lesotho. During the 2010/2011 financial year, the group went deeper into the African market through an acquisition of a 24% stake of Zimbabwe operation TM Supermarkets and increased ownership of TM supermarkets to 49%. TM Supermarkets is the largest retailer in Zimbabwe, currently owning 51 stores; this is due in part to TM supermarkets outsourcing the control to Meikles Limited (Bizcommunity, 2010). The group also secured a franchise territorial agreement with a Mozambique franchising group, Retail Masters. The entry into Mozambique was just one of the many expansion deals set by the group to penetrate deeper into the African market (Bizcommunity, 2010). The group plans to open stores in Malawi, Mozambique, Mauritius, Angola and further penetrating Zambia by opening four more stores.

The expansion strategy into Africa has largely been through partnering with locals and the franchise route, which has seen more success than simply owning stores in markets unfamiliar to South Africa (Bizcommunity, 2010). In Zambia, however, the group developed corporate-owned stores, meaning the organisation owned and managed the group management. Pick ‘n Pay’s focus for 2011 was the opening of four stores in Mozambique before the end of the fiscal year, with the first 3000m store in Maputo (Bizcommunity, 2010). The group will ensure that local farmers and suppliers are supported to stimulate and assist economic growth in Mozambique. The group will require logistics expert companies which have extensive knowledge regarding transportation and supply issues in African market and currently service the current Zambian operations (Pick n Pay, 2010). The group has realised that developing local suppliers in these markets could lead to a stronger supply chain and increased market influence. The supply chain performance benefits of the centralised systems allow suppliers to deliver to distribution warehouses, allowing for goods to be delivered to individual stores. Advantages to centralised system include huge batch discounts and the location of the centralised system being closer to stores which need servicing.

3.13.5 Pick n Pay supply chain information technology

The Enterprise Resource Planning (ERP) system has allowed the organisation to improve relationships with suppliers, as the system enabled better information sharing between the supply chain partners to mitigate demand order variability. The retailer chose the SAP for Retail Solutions (including SAP Forecasting and Replenishment and SAP POS Data Management), SAP ERP Application, SAP Net Weaver Business Warehouse Component, and SAP Business One application for successful implementation of the system underpinned by top-level management, extensive training of all users and commitment from all stakeholders (USC Solutions, 2009). With these consistent companywide processes in place, the retailer can support electronic trading and payment, as well as electronically-streamlined processes allocations, order replenishment, and coordinated promotions. Full support for forecasting and replenishment enables better customer service with lower overall inventory levels. The software is also helping improve supplier conformance to delivery schedules, packaging, and product quality including the support for Warehouse Management System (WMS) within its newly built distribution centre. Bowersox *et al*., (2010:263) defines WMS as “an integrated procedures and software support to standardise storage and handling of work procedures”.

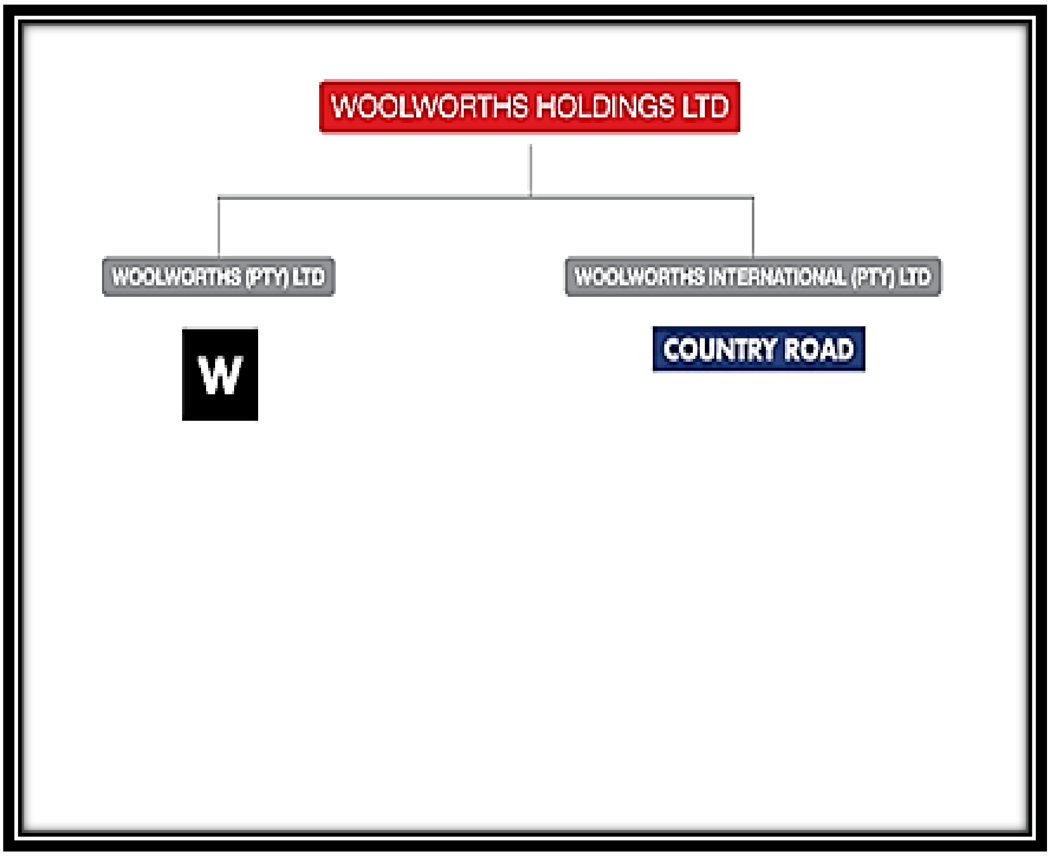
It is interpreted as a software control system that improves product movement and storage operations through efficient management of information and completion of distribution tasks. An integrated view of the group environment helps franchisees ensure smoother replenishment, optimising stock holding and cash flow. In terms of coordinating order selection either discrete or wave/batch selection, the company aims to achieve a high level of control, inventory accuracy and productivity to mitigate bullwhip effect.

The migration of the legacy in-house system to a fully integrated world-class packaged solution would enable a wide range of strategic business initiatives and increase competitiveness (UCS Solutions, 2009). In underpinning central supply chain distribution, the company needs the most integrated solution with widest range of functionality, including retail, finance, information and warehouse management. In a synchronised supply chain system, an electronically-enabled supply chain management system has the potential to integrate all supply chain activities across the trading supply chain partners and assists towards an efficient distribution capability in all geographical regions and migration to a centralised supply.

3.14 Global Company Profile: Woolworths Group South Africa

The method of speciality and novelty counters in 1881 emerged as the Woolworths brand by Frank Winfield Woolworth and was further developed by his young brother, Charles Summer Woolworth. The Woolworths brand reached South African shores in 1931 when the first Woolworths store was established by Max Sonneberg in Cape Town, and eventually Durban, followed by branches opening in Johannesburg and Port Elizabeth as a country wide expansion got underway (Woolworths Report, 2009) (www.moneyweb.co.za). Woolworths has stores located throughout the country which varied in the combination of retail product offerings such as only food, a combination of food and homeware and the full-line stores with the Woolworths total range (Woolworths Report, 2011. Woolworths has also expanded into garage side "quick stop" stores which can be sited at the location of many petrol stations.

Figure 3.7: Woolworths organogram



Source: Woolworths (2007). Sustainable Distribution Centre Excellence. [Online], Available:http://www.lpcinternational.co.uk/pdf/news/woolworths-platinumaward2.pdf, Accessed: 21/11/2011

3.14.1 Woolworth's Centralised Supply Chain Distribution System

The decision to build a distribution centre (DC) was driven by a need to consolidate the distribution effort and ramp up capacity that would serve the aggressive store roll-out policy (Woolworths Report, 2007). In terms of the food supply chain, the DC's turnaround time has been substantially reduced with upgraded facilities. The design of the DC means that the company will only handle stock once when the bulk deliveries are broken up to build specific pre-merchandised customer requirements. The CscD system is expected "to provide a simplified distribution for suppliers (a single drop or pick up), deliveries to stores, lowering the cost of operations and improving the control of the key aspects of logistics (cold chain and monitoring in-transit stock). Furthermore, the CscD model will enable the supply chain to deliver and sustain cost-effective availability of a wider product range in different store types across broad geographic locations such as full-line stores, food stand-alone and Engen Food Stop convenience stores" (Woolworths Report, 2007).

Leeman (2010:52) describes a centralised distribution as "a process where all merchandise flow to one central point for redistribution to customers". In a centralised supply chain system, "synchronised decisions are made at a central location for the entire supply chain to constrain the magnitude and demand order variability. This global optimisation attempts to minimise the total cost of the system subject to satisfying some service level requirements of individual retail outlets and other customers" (Simchi-Levi *et al*., 2008:136). Inventory and order aggregation processes pool the risk to consolidate the effect of centralised distribution of any retail outlet. Gaur and Ravindran (2006) describes risk pooling as "an efficient way to lessen safety stocks carried in a supply chain, and safety stock contributes towards inventory holding costs for a supply chain, thus, reducing operational efficiency". Supply chains maintain safety stocks as insurance to avoid the risk of running out of inventory due to uncertainties in customer demand variability and order replenishment lead time. Bowersox *et al.*, (2010) note that, in a decentralised supply chain, safety stock has to be maintained at each warehouse to meet demand variability at that retailer, thereby, increasing the total safety stock carried in the supply chain to meet all retailer demands. Whereas in a centralised supply chain, the retailer demands are aggregated, this increases the accuracy of demand forecast and results in a decrease in demand variability and hence less safety stock in the supply chain (Guar and Ravindran, 2006).

3.14.2 Risk Pooling of FMCG retail stores

Aggregating many products across many upstream supply chain partners into a centralised centre helps individual retail outlets replenish their stock faster. The process allows for better supply chain planning by starting with the end-user's needs. Better collaborative forecasting allows for better capacity upstream arising from better information handling and analysis to prevent oscillation effect (Lawrence *et a.l*, 2003; Slack *et al.*, 2007). "The centralised purchasing system helps to consolidate purchases from different individual retail stores into larger orders with quantity discounts, and allows retailers to then negotiate more favourable terms with the best supplier to reduce end-consumer prices" (Monczka *et al.*, 2009:92).

Chopra and Meindl (2007) assert on improved forecasts that a more accurate view of customer demand leads to a better match between supply and demand, with a less pernicious effect on demand order variability. The CscD system allows for aggregation of inventory that improves product availability from sharing demand information among supply chain partners. The aggregation role means that "the consignments in large quantity discounts are delivered from the upstream manufacturers to the central distribution location for the retailer" (Jonsson, 2008:215). The sharing of planning and forecasting information on the inventory translates into retail outlets having more of the goods that customers demand and less inventory that is unwanted (Simch-Levi *et al.*, 2008). The forecasts are critical because the distribution system requires collaboration on an aggregate forecast to mitigate demand order variability while each store must share detailed point-of-sale data (Chopra *et al.,* 2007).

3.14.3 Woolworths' supply chain business models

South African retailers like Woolworths, Pick n Pay, Shoprite, Massmart, and SPAR acknowledged the migration from decentralised to centralised distribution centres (DCs). "Retail outlets like Woolworths who recently employed the strategy of centralising its distribution centres have received a platinum award for distinction in logistics for creating sustainable supply chain excellence in centralised distribution (Woolworths Report, 2007). Woolworths had five DCs running at capacity and there was a need for the delivery of cost effective availability. An extensive network of analysis study, a centre-of-gravity study as the ideal location was instituted. Heizer and Render (2008:319) define centre-of-gravity method as "a mathematical technique used for finding the location of a distribution centre that will minimise distribution costs". "This method accounts for the optimal location of markets, volume of goods shipped to those markets, and shipping costs in finding the best location for the distribution centre" (Davis and Heineke, 2005:383).

In this study, road networks and traffic patterns were studied as an essential part of the feasibility investigation. This resulted in Woolworths building a DC design of 78,000 m^2 with the flexibility to extend to 150,000m^2, from which all Woolworths products, from all supply chains and temperature regimes could be delivered to retail stores in a single delivery. The Midrand DC currently processes Gauteng, Free State and 80% of the KZN volumes to absorb possible consumer demand order variability from individual retail outlets travelling upstream the supply chain network (Woolworth's Report, 2007).

In ensuring "the right products in the right store at the right time, the company has been utilising the integrated retail technology, investing in supply chain solutions to drive additional benefits around demand planning, allocation and replenishment management. The company realised the need to reduce inventory and streamline range planning to improve its business overall processes and increase profits" (Real Results Magazines, 2011). As a result, JDA Buying & Assortment Management was adopted to assist the retailer to deal with the challenge of identifying and meeting customer needs. According to Henshilwood (2011) Central Planning Director, "the company had a disjointed planning process and poor visibility into stock and a new integrated technology systems and efficient business model were needed across the business units" (Real Results Magazines, 2011). By aligning distribution centre receipts with store receipts with less impact of the phenomenon bullwhip effect, the company is dramatically reducing reserve stock and achieving significant cost savings.

3.14.4 Woolworths Supply Chain Information Technology

Woolworths converted to an integrated information technology (IT) system that will more accurately predict daily consumer demand for every food store, thereby helping to ensure that all stores are sufficiently stocked. Other systems upgrades include "improvements of call centre technology and Woolworths' point-of-sale system which has had a positive impact on customers' check-out process" (Cobweb Information, 2010:3). Woolworths Holdings Limited "leverages a wide range of JDA Software's forecasting, merchandise planning, replenishment, buying and assortment management, and master data management solutions to increase sales and manage inventory" (Woolworths Report, 2010). The company has invested in supply chain solutions as the cutting-edge technology to drive additional benefits around demand planning, allocation and replenishment management.

This impetus emanated from a need to reduce inventory and streamline range planning to improve its overall business processes and increase profitability (Real Results, 2011:1).

Woolworths is positioned to "better calculate optimal order replenishment, minimising overstock and stock-out situations while increasing sales and potentially lowering inventory levels" (Real Results, 2011:2). According to Henshlwood (2011:2) "the JDA Buying and Assortment Management functionality groups stores together based on turnover, customer segmentation and store size", and increases sales due to improved product availability. In addition, the strategy for adopting this technology was to incorporate it into its point-of-sale system, create a computerised system that identifies each item, in and out of the outlet and accurate storing of items sales movement for use in analysing and reordering inventory (Woolworths Report, 2011). Adopting the technology has enabled accurate and fast flow of information regarding inventory or merchandise and it has facilitated the retailers supply chain integration - especially with suppliers.

3.15 Global Company Profile: Shoprite Group South Africa

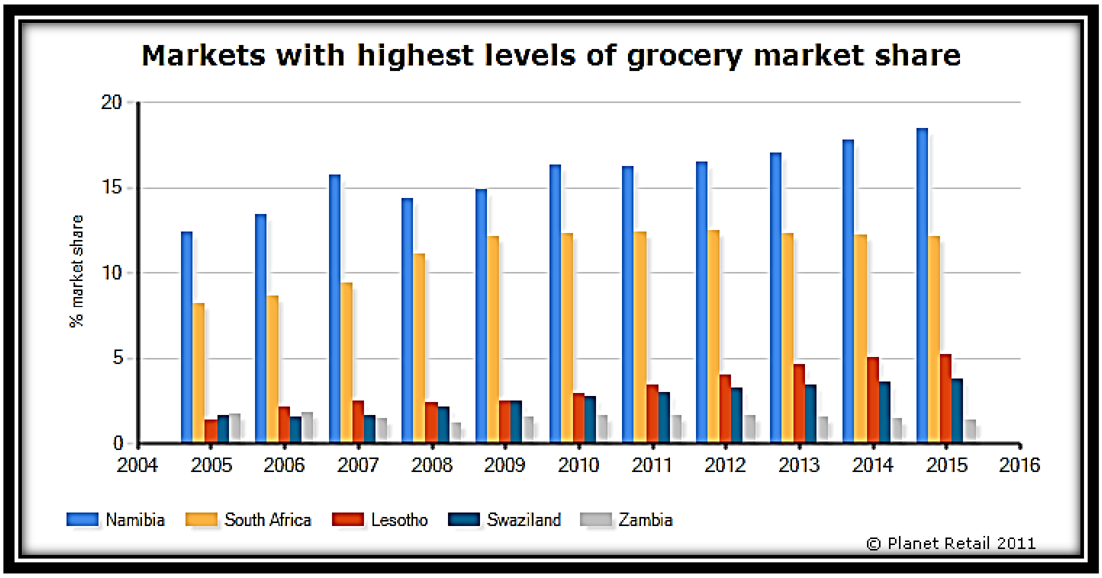
Shoprite Holdings is an investment holdings company whose combined subsidiaries constitute the largest fast moving consumer goods (FMCG) retail operations on the African continent. Across the Sub-Saharan region the company has various hyper markets, stores and outlets offerings, and value added services such as money market services, medi-rite pharmacies and other services. The company mostly benefits from targeting the lower and middle income groups through targeted product offers, wider private label ranges and aggressive marketing.

Figure 3.8: Shoprite Holdings LTD Organogram

Source: Fastmoving (2010). Shoprite holdings ltd retailer profiles South Africa. Available: http://www.fastmoving.co.za/retailers/retailer-profiles-132/shoprite-holdings-ltd-197. [Acccessed: 12/09/2011].

Shoprite Holdings Ltd now comprises of Shoprite supermarket group, Checkers supermarkets, Checkers Hypers, Usave stores, 20 distribution centres supplying group stores with groceries, non-foods and perishable lines, OK furniture outlets, OK Power express stores and Hungry Lion fast food outlets (Shoprite Report, 2010). Figure 3.8 illustrates Shoprite Holding's group of companies. In 2010, Shoprite made the decision to disinvest from India and focus on investment opportunities in the commodity rich countries of Western Africa in line with its long term growth plan. In 2011, Shoprite acquired Metcash holdings (Datamonitor, 2011). According to Farfan (2011) "Shoprite holding has moved up its global position from 130th to 95th position between the year of 2010 and 2011, and the success is due to efficient information system, logistic infrastructure, cost control and reduced stock losses". As the company extends markets deep into Africa, its competitive advantage will be entrenched by a central distribution strategy that controls supply chain activities and absorbs stockholding cost. The figures below detail the market share for Shoprite during the 2010 on grocery and non-grocery market share.

Figure 3.9: Shoprite grocery market share



Source: PlanetRetail, (2010). Company Report. Shoprite. [Online] Available: [www.planetretail.com.](http://www.planetretail.com) [Accessed: 2/10/2011].

3.15.1 Supply Chain Structure

The Shoprite Group partners with more than 5 000 suppliers who provide in excess of 200 000 product items to its 604 supermarket outlets. Shoprite has a centralised distribution system that "controls the distribution of goods from the time of manufacture to the time when the customer purchases the item from the shelf at retail outlets" (Shoprite Report, 2011).

The supply chain controlling system has made it possible for Shoprite to buy in bulk (break-bulk system), achieve cost savings efficiency and low prices for customers through economies of scale. The value-added services that create a greater value for customers like customer accommodation, Bowersox *et al.*, (2010:249) appropriate the use of centralised warehouse capacity through consolidation and break-bulk arrangements to improve transportation economics, timely and controlled delivery , and reduced congestion at a customer's receiving dock. A central supply chain distribution system gives the group the ability to provide goods on the shelf on time, and can deliver to stores when required, thereby keeping their assuage custom and their loyalty (Shoprite Report, 2011). Shoprite's winning philosophy is "to offer customers a convenient shopping experience in stores where customers can be assured paying highly competitive prices which are often the lowest, on basic food and household items. This system also allows the group not to be dictated by suppliers on delivery schedules, and the quality of products is not hampered. By controlling its supply line, goods can be buffered, and supply lines can be stabilised when supplier service levels drop" (Shoprite Report, 2011).

By the same token, the group has recognised the significance of strategice investments into supply chain with improved levels of product availability that contributes to supply chain market performance benefits through: 1) entrenching the impetus to absorb the levels of inventory; and 2) accelerating sales growth and new retail outlets. The supply chain integrated linkage has been facilitated by information to mitigate possible consumer demand order variability and the flow of information. The critical strategy of central supply chain distribution to ameliorate the phenomenon of bullwhip effect gives "an opportunity to re-engineer its retail stores and improve its utilisation of space by dedicating the minimum area to storage and the maximum area to trading space" (Shoprite Report, 2010:11).

Figure 3.10: Distribution of Operations

DISTRIBUTION OF OPERATIONS

A. Corporate outlets

	Shoprite	Checkers	Checkers Hyper	Usave	OK Furniture	OK Express	House & Home	Hungry Lion
South Africa	331	154	26	189	205	17	48	109
Angola	4			7	1			2
Botswana	5			2	6			7
Ghana	2			1				
Lesotho	4			3	5	1		2
Madagascar	7							
Malawi	2			3				
Mauritius	1							
Mozambique	6			2	2			
Namibia	14	4		14	10		2	6
Nigeria	2							
Swaziland	6			2	2			1
Tanzania	3							
Uganda	2							
Zambia	19				1			8
Zimbabwe	1							
Total	**409**	**158**	**26**	**223**	**232**	**18**	**50**	**135**

B. Franchise stores

	OK Foods	OK Grocer	OK MiniMark	OK Value	Megasave	Sentra	Enjoy
South Africa	13	72	26	26	17	57	15
Botswana					1	1	
Namibia	2	9	2	7	10	11	
Total	**15**	**81**	**28**	**33**	**28**	**69**	**15**

C. Ancillary Services

	Shoprite Liquor	Checkers Liquor	Shoprite Medi-Rite	Checkers Medi-Rite
South Africa	69	48	40	80
Namibia	2	1		
Swaziland			1	
Total	**71**	**49**	**41**	**80**

Source: Shoprite, (2010). Corporate Responsibility Sustainability » Overview. [Online] Available:http://www.shopriteholdings.co.za/pages/1019812640/corporate-responsibility/sustainability/overview.asp. [Accessed: 09/09/2011].

Figure 3.10 indicates the vast amount of deliveries to stores, integrating the operations of the DC and transport links whereby these deliveries to individual retail outlets do not depend on suppliers as the CscD system reduces the probability of stockouts. RedPrairie (Retail Productivity solutions) has also helped the group to increase product freshness, reduce waste, improve customer service through improved product availability and increase sales in defined areas of the business (RedPraire, 2010).

The RedPrairie solution standardised the range of products, improved data accuracy, and further ensured the freshness of in-store products. The approach has contributed immensely to the group's philosophy of quality customer service that encompasses "the consumers preferred choice for shopping with a shopping environment on quality products, accessibility, security, reliability, flexibility and lastly a comfortable shopping experience" (Shoprite Report, 2011). These practices are realised through tight and measured cost controls and the increased efficiencies from the investments in sourcing and distribution systems. Applying international best practice to all aspects of the business, management continued to strengthen the low price-positioning of these brands.

3.15.2 Supply Chain Information Technology

South African supermarkets are expanding and diversifying at an accelerating growth with consistent infrastructural development in the country. The fast moving consumer goods (FMCG) industry is mainly composed of five major chains the Shoprite group (acquired Metro Cash and Carry), Pick 'n Pay group, Massmart merger with Walmart, Woolworths and, SPAR with these last two performing both retail and wholesale functions. Shoprite's Information Technology (IT) department uses a technological innovator in the retail sector to "provide for rapid business expansion and develop the ability to adapt to fast changing market conditions" (Shoprite, 2008). If e-SCM technology averts a cascading effect on demand order vacillations, it enables "suppliers to monitor stockholding down the branch level while gradually moving towards a complete vendor managed inventory (VMI) solution" (Shoprite Report, 2011).

The Group aims to continue improving transparency of information to improve interaction among the trading supply chain partners. Shoprite is "the largest distributor of fast moving consumer goods and considered as the leader in associated technology" (Annual Report, 2010). However, it has not maximised the technological investment to further integrate the supply chain activities on the upstream, midstream and downstream sites. The supply chain's advanced electronic systems further require the service of specialists in information technology to integrate with central supply chain distribution system.

IT functions incorporate every component of the supply chain, from the contents and scheduling of advertising to the design of store check-outs. The integrated information technology system has the propensity to improve efficiency, time and cost-effectiveness within the supply chain, therefore creating and sustaining a healthy value chain. The group was able not only to retain the loyalty and support of customers across the spectrum, but also to extend its customer base by increasing its investment in information technology in recent years (Shoprite, 2010). It is further expected that Wal-Mart will attempt to transform retailing in South Africa and set its sights on becoming the biggest force in food retailing. Likewise, Shoprite has positively responded by increasing its own global sourcing capacity significantly, taking heed that a key element of Wal-Mart's model is global sourcing at the lowest prices (Stafford, 2011).

3.15.3 Expansion to African Countries

Shoprite Holdings Limited is an investment holdings company whose combined subsidiaries constitute the largest fast moving consumer goods (FMCG) retails operation on the African continent (IDE-JETRO, 2010). The primary business of the Shoprite Group of companies is food retailing to consumers of all income levels, and management's goal is to provide all communities in Africa with food and household items in a first-world shopping environment, at the lowest prices. At the same time, the Group is inextricably linked to Africa, and contributes to the nurturing of stable economies and the social upliftment of its people (Fastmoving, 2010). The group's operations have been generally successful in most countries and in some cases income has exceeded their projections and expectations. Shoprite's choice of expansion programme has largely been opening up its own stores in the countries where it operates. This strategy allows the company to have absolute control over all its operations, both local and foreign, and managing them from its head office in Cape Town.

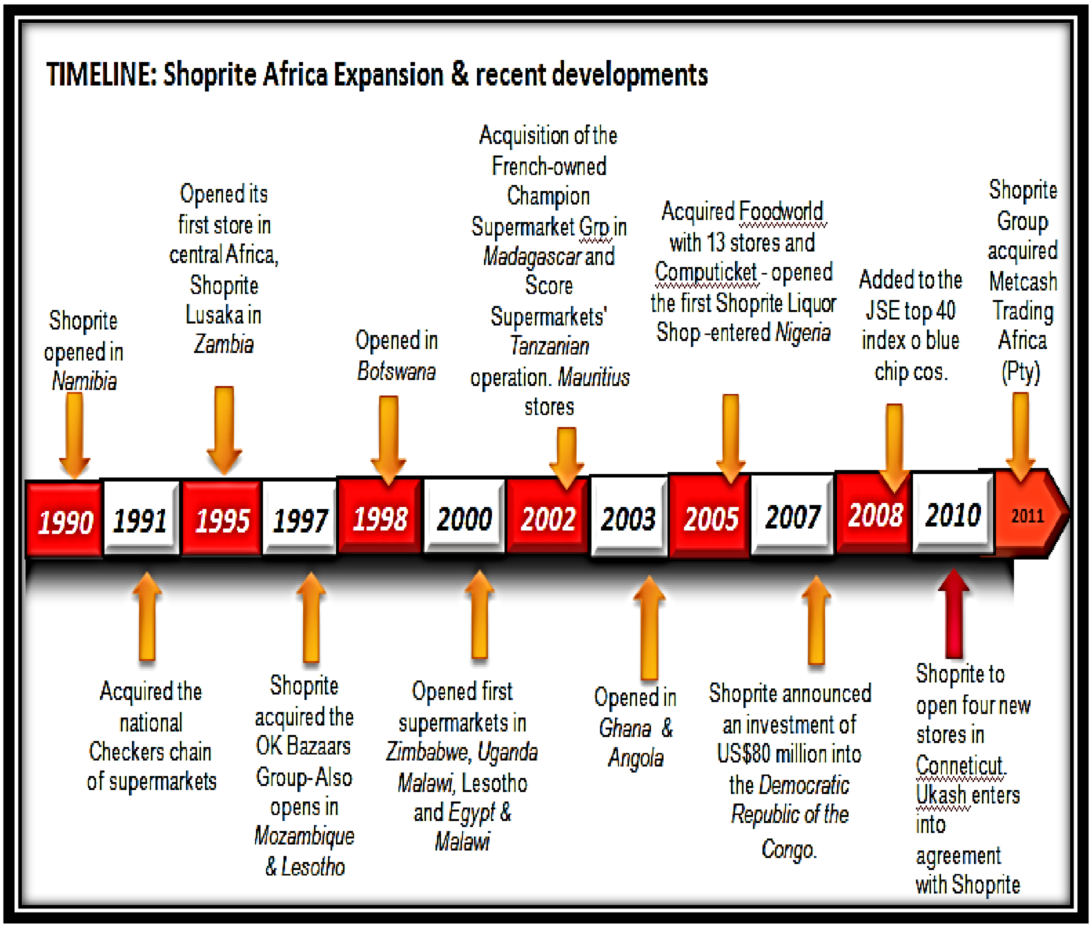
Shoprite Holdings plans to open 106 new stores to cope with increased competition following the precipitated entry of Walmart into the market. In 2010, the group opened more than 96 outlets, and it planned to add another 106 by the end of June 2012. Of the planned stores, 74 would be supermarkets. In the last fiscal year, Shoprite's store count was 1,246 (RBR Staff Writer, 2011). According to the company, the food retail market is likely to intensify this year (2011), as Walmart made its first venture into South Africa by taking a controlling stake in Massmart Holdings.

Figure 3.11: Shoprite global outlet network

Source: PlanetRetail, (2010). Company Report. Shoprite. [Online]. Available: www.planetretail.com. [Accessed: 01/10/2011].

Shoprite's ability to control its supply chain has been a major success and eventually made it possible for the company to introduce cost saving efficiencies. As a result, the company has been able to maintain product availability, lower stock turn over and decrease costs. Its successful information technology department has enabled the company to communicate more effectively and efficiently with customers and suppliers.

Figure 3.12: Shoprite Africa Expansion and Recent developments

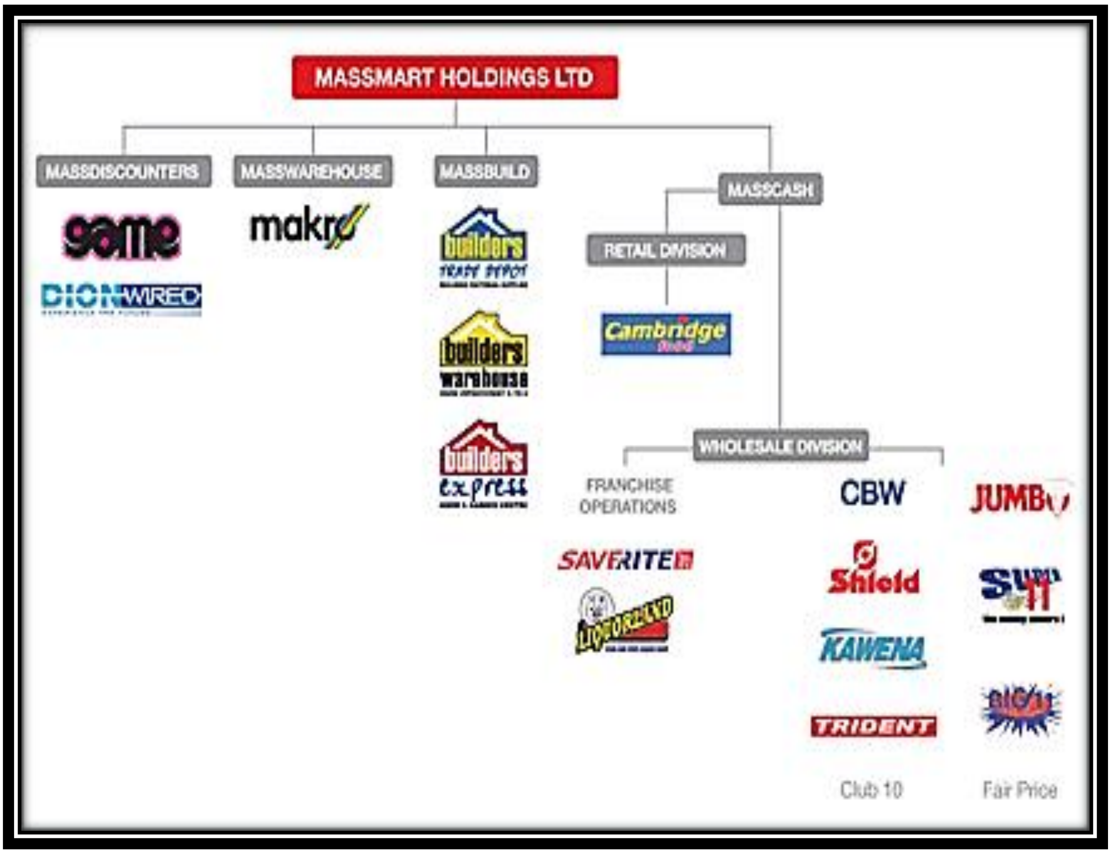


Source: Games, D. (2010). ***South African retail sector in Africa. Unlocking Africa's Potential: the role of corporate South Africa in strengthening Africa's private sector*****. Johannesburg: SAIIA. Kolbe RH.**

3.16 Global Company Profile: Massmart Group

The Group has four operating divisions of retail and wholesale stores, Massdiscounters, Masswarehouse, Massbuild and Masscash, which consist of a portfolio of subsidiary companies. The Group's subsidiary companies are: Game, Dion Wired, Makro, Builders Warehouse, Builders Express, Builders Trade Depot, CBW, Jumbo Cash and Carry and the Shield buying group with a total of 232 stores in South Africa (Brown, 2010; Massmart, 2011). The group's objective is to achieve commercial success by adopting a cost-effective mass distribution and price leadership distribution model that offers stakeholder benefits on both ends of the retail value chain without compromising commitment to socially responsible business practice (Massmart, 2010).

Figure 3.13: Massmart holdings with subsidiaries



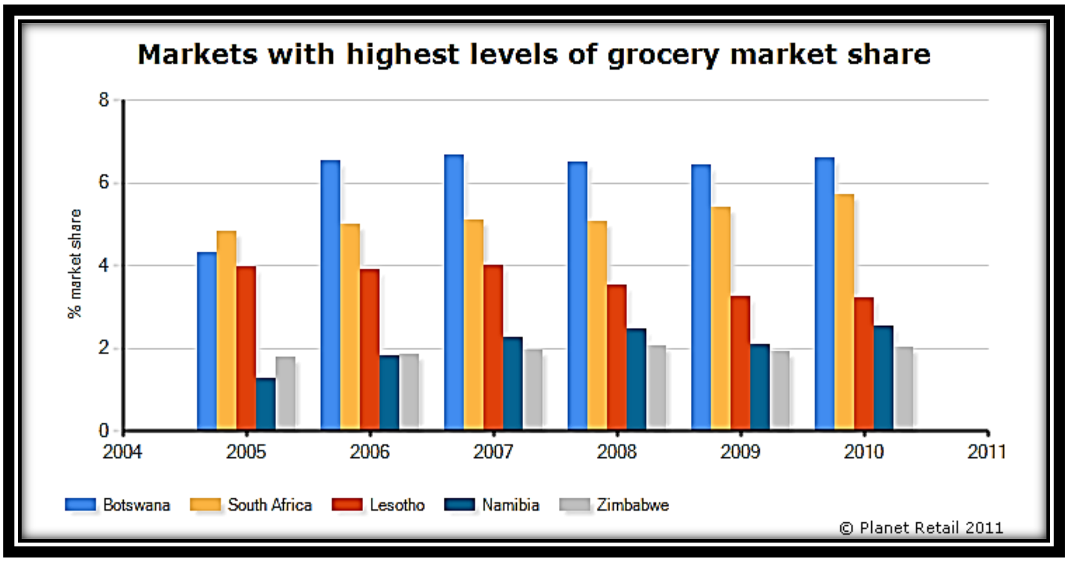
Source: Trade Intelligence (2011). Trade Profiles. (SPAR, Shoprite, Massmart, Woolworths, Pick n Pay).

Available: http://www.tradeintelligence.co.za/TradeProfiles/massmartredirect.aspx. , [Accessed: 11/24/2011]

3.16.1 Market Share

Massmart is aiming to double its food retail market share in South Africa over the next five years (Business Report, 2011). If Massmart's current market share is about 10 percent with an expected increase of between 15 percent and 20 percent over next five years, Wal-Mart's claim of 51 percent stake in Massmart will elevate the expansion of the grocery chain to compete against leading food retailers such as Shoprite, Pick n Pay, Woolworths and SPAR (Business Report, 2011).

Figure 3.13: Massmart grocery market share



Source: Ibtimes (2010). S.Africa's Massmart sees lower profit, shares fall. [Online] Available: http://www.ibtimes.com/articles/44116/20100819/s-africa-s-massmart-sees-lower-profit-shares-fall.htm. [Accessed: 27/09/2011].

3.16.2 Supply Chain Distribution Structure

Massmart's management structure is decentralised with centralised support systems such as accounting systems, supplier relations and business management (Massmart, 2010). This implies that a hybrid structure is utilised which is most likely adopted to achieve group volumes and low prices while allowing each division to cater to its own target market. Wal-Mart adopts a centralised structure that purchases in bulk and achieves cost savings through economies of scale to achieve its mission of offering goods at low prices (Nordnet, 2011). It is most likely that Massmart will continue to operate under its current structure despite the acquisition by Wal-Mart, given that each division has its own target market with the overall mission being the realisation of low prices.

The internal trend in bulk consumer goods retailing is to centralise distribution through facilities with large, well-run warehouses that offer unparalleled efficiency. In terms of new regional distribution centres (RDC) that will serve 62 South African Game stores, plus eight of the chain's stores in other African countries, Game stores will benefit from a reduction in the number of delivery vehicles dropping off goods at the back door (Massmart, 2011). This means stores do not have to re-check each order, so there's no delay in getting stock onto shelves through a green light receiving system. A natural diffusion into centralised distribution for Massdiscounters will control the supply chain more effectively and far more cost-efficiently.

3.16.3 Supply Chain Information Technology

The electronically-enabled supply chain management system requires integration of retailer's information with the supplier, and a certain level of trust with strategic and stock information. I-Comm system is providing sales and inventory information to the suppliers daily including stock available for sale and the daily rate of sale by store and line item. I-Comm is majority owned by Makro's holding company Massmart. Makro places orders with trading supply chain partners using its in-house order system, and enables it to track the order status including order requested, order rejected, order picked, order packed, order shipped and order received. The Massmart Annual Report (2007) states that the business continues to derive substantial benefits from SAP FICO and Retail software systems, with the SAP Customer Relationship Management system producing high quality customer insight and service at a lower cost through implementation of a number of supply chain initiatives.

Cambridge Food, a recently acquired division of Massmart, should also invest hugely in electronic systems. "As the company is about to undergo a huge expansion drive, it will be imperative for the company to adopt a leading supply chain systems platform to provide more competence, and an easier and quicker way to supply the fast-expanding chain of stores" (SC Junction, 2011). "The system will work in an integrated fashion to provide the retail chain with better visibility of stock, efficient warehouse management and improved order fulfilment while at the same time reducing overall costs" (SC Junction, 2011).

3.16.4 Individual Retail Store Inventory

An accurate and real-time visibility of inventory is vital in meeting planned sales targets, preserving margins, and meeting customer expectations. Leenders *et al.,* (2006) states that inventory is required to provide good customer service, streamline the flow of goods and provide protection against demand uncertainty. Bloomberg (2010) states that Wal-Mart intends to accelerate Massmart's growth by opening new stores and upgrading current stores to offer customers a wider variety of products while lowering excess inventory and saving on storage costs. Massmart (2011) clearly defines its vision "as being the first choice of consumers when seeking goods and services. The mission supports its vision by seeking continuous improvement of performance to its customers, maintaining high market share and developing an excellent management structure". Massmart (2011) further states that its operational structure in ensuring efficiency and effectiveness is a four part channel structure. Firstly, common opportunities in the Massmart divisions are identified so that they may be leveraged. Secondly, common principles in their business approach to servicing customers is standardised across all divisions. Thirdly, a peer review function is used to improve employee service levels, and lastly, internal and external learning takes place.

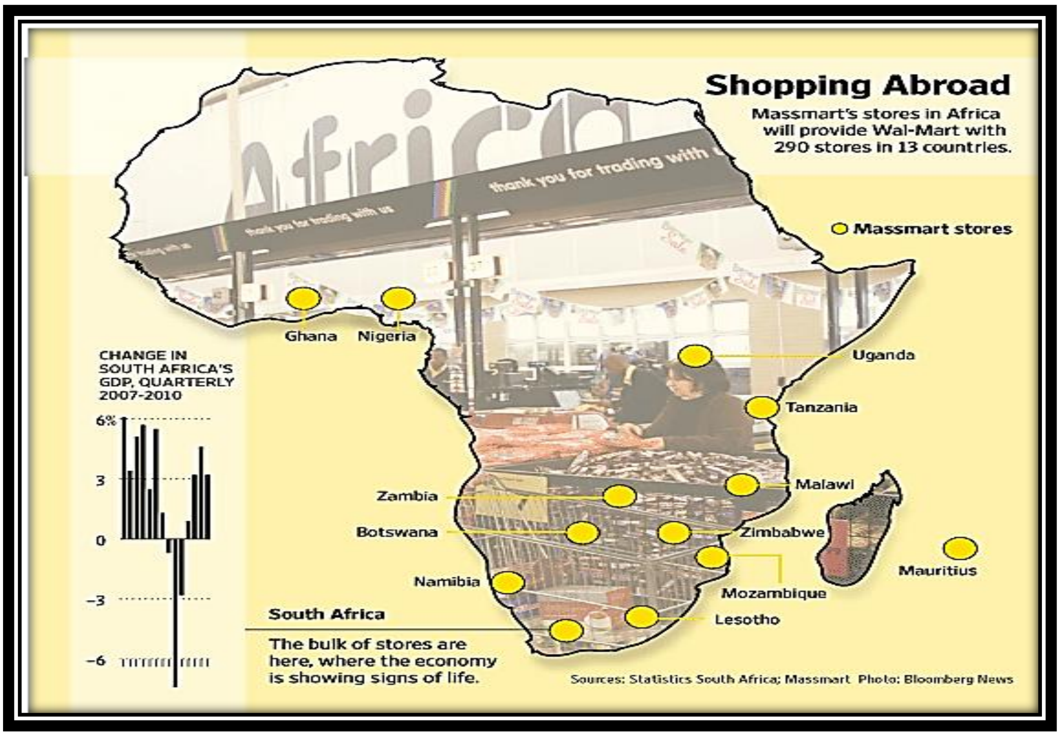
These divisional structures should be achieved via benchmarking divisions or through external learning. Massmart has switched their information technology from 'Best-of-Breed' to 'Best-of-Suite' to reduce the level of system complexity and improve long term agility. The new system is cheaper to deploy and support, is less prone to abuse by users and is highly resistant to viruses. An additional efficiency is manifested in the use of a handheld device and printer that allows for previously desk-bound jobs to be completed on the floor. The new technology saves time and provides the opportunity for additional tasks to be completed (Massmart, 2011). Wal-Mart intends to improve efficiencies within Massmart through its purchasing power and international supplier relations to lower Massmart prices of goods offered to consumers. In addition, Wal-Mart's expertise and supply chain structure intends to assist Massmart in procuring goods faster and improving service delivery (Deloitte, 2011).

One of the conditions of the acquisition indicates that Wal-Mart set-up a R100 million supplier development programme. Specifically in terms of fresh food growth, Wal-Mart and Massmart have committed to ensure that the vast majority of those products will be sourced from South Africa and a substantial programme is being planned for the training and development of many thousands of local farmers, with a specific BEE focus, to aid in the delivery of the fresh food strategy (Competition Tribunal, 2011).

3.16.5 Expansion to African Countries

Massmart operates in 14 countries in Sub-Saharan Africa through the Group's four operating divisions – Massdiscounters, Masswarehouse, Massbuild and Masscash (Massmart, 2011). Massmart currently has stores in South Africa, Botswana, Ghana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Game has a geographic presence in South Africa, Botswana, Ghana, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Tanzania, Uganda and Zambia while Dion Wired only has geographic presence in South Africa.

Figure 3.14: Location of Massmart Group stores at points in Africa



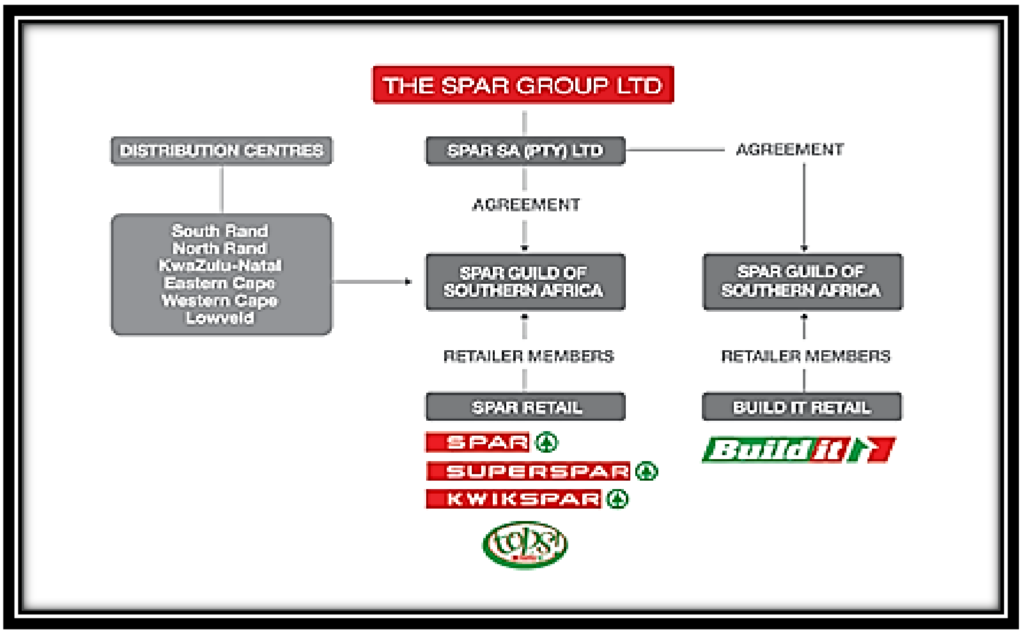
Source: Bustillo, M., Sonne, P. & Stewart, R.M. (2010). The wall street journal. Wal-Mart Bids $4.6 Billion for South Africa's Massmart. [Online], Available:http://online.wsj.com/article/SB10001424052748704654004575517300108186976.html [Accessed: 19/09/2011]

Wal-Mart's acquisition of the Massmart Group will result in changes to Massmart's business operations and financial performance, followed by a significant impact on the South African and African retail industry.

3.17 Global Company Profile: SPAR Group

South African wholesaler, the SPAR Group, has stores in Namibia, Botswana, Mozambique, Swaziland and Zimbabwe, and is also venturing into business opportunities in Africa. The group is a wholesaler that distributes to independent retailers who own and operate about 850 Spar stores in South Africa and Southern Africa (Business Report, 2011). Outside South Africa the group has stores in Namibia, Botswana and Swaziland and owns 35 percent stake in a Zimbabwean business that operates 68 Spar stores. The relationship between the SPAR Group Limited and its independent retailers is one of a "voluntary trading" partnership. The philosophy is that all parties will benefit by working together in a spirit of close cooperation. The company actively drives and manages its brands and provides a full range of support services to independent retailers (Fastmoving, 2011).

Figure 3.15: Spar Group structure



Source: Trade Intelligence (2011). Trade Profiles. [Online], Available: http://www.tradeintelligence.co.za/TradeProfiles/sparredirect.aspx. [Accessed:11/24/2011]

3.17.1 SPAR Distribution Centres and Information Technology

The SPAR group is made up of two types of members: SPAR retailers (independent store owners), and SPAR distribution centres (provide leadership and services to the SPAR retail members in the respective regions). The centre of control is the local distribution centre in each six geographic areas. The system works effectively to unite the organisation in its ongoing drive to remain at the forefront of food retailing in Southern Africa. The Annual Report (2007) indicates the value proposition in enhancement of customer service, improved efficiencies and cost reduction in both wholesale and retail, however, the traditional software systems (such as Radio Frequency Identification and Voice Activated Processes) retract the operational efficiency without integrated electronically-supply chain management system. In other words, the direct delivery to store software programme and new backdoor operating software affect operational efficiencies at group, retailer and supplier level. SAP solutions and world class electronic systems can assist to integrate radio frequency identification (RFID) effectively and seamlessly with silo-centric existing warehouse and retail inventory management software. SPAR can gain real-time visibility of all inventory and material flows, streamline warehouse processes and automate process control.

The SPAR group's principal activity is wholesaling and distributing goods and services to SPAR retail grocery stores and outlets. As the sector is characterised by intense rivalry on high volumes and low margins, SPAR group operates six distribution centres and supplies goods and services to almost 850 SPAR stores in South Africa (Planet Retail, 2010). In the same token, Massmart has increasing servicing the needs of both the wholesale and retail sectors. According to Cobweb (2010:1) Massmart combines traditional wholesale cash-and-carry with retail direct to the customer, where Masscash supplies goods wholesale through its subsidiaries CBW, Jumbo and buying group Shield, as well as the hybrid stores, such as Cambridge and PowerSave. SPAR South Africa has undertaken a huge investment programme over the last four years to extend and modernise its network of Distribution Centres (Business Report, 2011). "SPAR Distribution Centres (DCs) distributes millions of consumer goods a year to retailers around South Africa. In 2007, SPAR replaced the paper-based picking system in various South African DCs with a system that used Psion Teklogix' speech technology. The results were so significant with improved productivity, increased quality, and reduced costs.

The SPAR group has chosen to implement the same system at its distribution centres in Nelspruit and Cape Town with immediate and significant savings, increased productivity and improved accuracy"(Psion Teklogix, 2009). According to Currie (2009), Group Logistics Executive for Spar, "the volume of orders created difficulties for the paper-based picking system used by the company as distribution centres were constantly faced with re-work, stock shortages, miss-picks, and a variety of other errors that affected its quality of service provided to retailers". According to Currie (2009) the system has numerous benefits for improved efficiency of operations: firstly, "Speech has enabled the company to significantly increase accuracy and improve the retailers trust with the systems of the distribution centre".

Secondly, the support structures that were put in place to deal with the technological changes reduced the challenges faced by workers when switching to the new system. The result has shown an improvement in worker morale, an increase in productivity between 5 and 10%, and further ensures the highest level of efficiency when offering real value to the customers (Trade Intelligence, 2011).

Chapter Four

Inventory Systems and Information Sharing

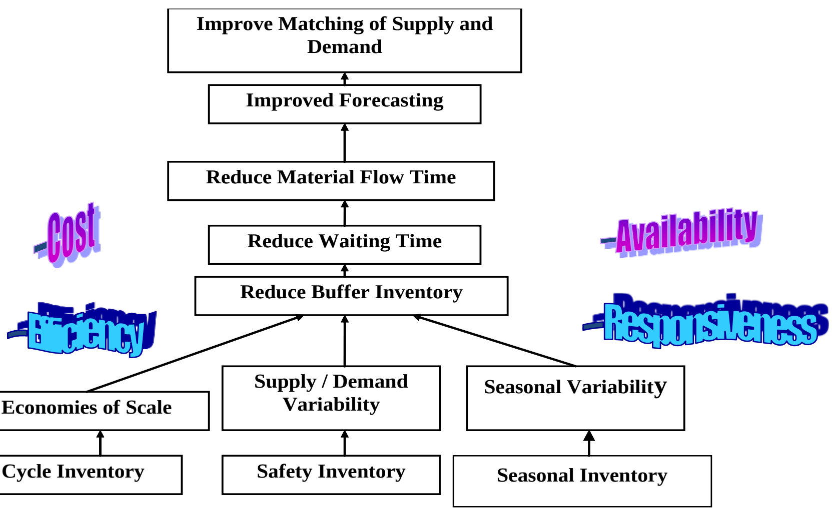
4.1 Introduction to Inventory Systems

The fast moving consumer goods (FMCG) companies are constantly trying to improve their financial performance and customer satisfaction. As a result, companies attempt to change how products are designed in the development chain (Simchi-Levi *et al*., 2008), how order replenishment is triggered in the demand chain (Burt *et al*., 2003, Vollmann *et al*., 2005), and how inventory policies are calculated (Hopp and Spearman, 2009). Consumer packaged goods firms that stand out in adopting supply chain inventory initiatives and technology-supported processes optimise inventory investment by using postponement (Simchi-Levi, *et al*., 2008), and risk pooling strategies (Cachon, *et al*., 2008) to leverage the inventory management capabilities of the supply chain trading partners. Aberdeen Group (2004:1-30) reports that "companies should seek supply chain technology that allows one to optimise the positioning of inventory globally across supply chain stream sites, rather than locally, and enables collaborative inventory processes with suppliers. In this regard, supply chain inventory practices should be involved in managing the flow and positioning of inventory holistically across multiple channel stages in the supply chain, including upstream, midstream and downstream demand sites". Eventually, the supply chain inventory tactical approach should allow companies to maximise responsiveness with underpinning systems of product pooling, risk pooling and postponement strategies (Cachon and Terwiesch, 2009).

Although, Aberdeen Group (2004:1-30) reports on polemic suggestion that "products be designed specifically to support postponement (in which inventory is held in a generic state until a true demand pull) or modular component risk pooling (in which a buffer stock is calculated once for a common component instead of for each of its independent demand streams), both which can lower overall inventories". It is argued that these practices (postponement and risk pooling) increase inventory levels of lead suppliers and manufacturers (in process or raw materials) despite its shortened lead time cycle and logistics costs due to transport economics (Frahm, 2003; Gerchak and He, 2003; Jacobs and Chase, 2008). In a different perspective, retailers have the tendency to order excess for the central distribution hubs, and suppliers build products to a forecast with an anticipatory model (Ozer and Wei, 2006).

The supplier would be left with excess inventory in the distribution hub from the phenomenon impact of bullwhip effect (Croson *et al*., 2005) as the forecast gets off the mark. Heizer and Render (2011:110) indicate that 'forecasting is seldom perfect' as companies cannot predict or control the impact of forecasts. Despite the shared forecast data (Chopra, *et al*., 2007), moving to a pull-based supply chain replenishment process does reduce that liability (Aberdeen Group, 2004). The successful implementation of min/max replenishment policy uses a supplier collaboration platform to exchange information and provide views of inventory status by entering in promises for future ship dates with projected quantities, and provide advanced shipment notice (ASN) information for products shipped (Simchi-Levi *et al*., 2008). Aberdeen Group (2004:1-30) reports that a "virtual inventory bin takes a number of forms, it includes allocating orders while in-transit, assigning new shipping instructions to divert in-transit inventory to higher-demand destinations, and holding unallocated inventory at a deconsolidator until there is a true demand pull". Enterprises with long transit time should investigate different ways to use in-transit inventory as a virtual inventory bin to lower safety stock levels, reduce total delivered costs, and maximise revenue opportunities.

Figure 4.1: Role of Inventory in the Supply Chain



Source: Atilim University, Department of Industrial Engineering: Inventory and Risk Pool

Figure 4.1 indicates that trading supply chain partners build cycle, safety and seasonal inventory positioning in response to its respective. The supply chain inventory system as an integrated system decreases the variability and costs in the supply chain network system due to the reduction in buffer inventory, waiting time and material flow time. The important aspects of achieving the mitigation of bullwhip effect depends on improved forecasting and matching of supply and demand through the integrated supply chain network system of inventory positioning.

4.2 Build-to-order supply chain management (BOSC)

Supply chains are required to elevate their competitive levels locally and globally on responsiveness and cost structures underpinned by BOSC and agile systems. According to Schroeder (2008) mass customisation has become a major objective with the development of build-to-order supply chain to enforce flexibility and responsiveness. In a manufacturing perspective, Mason-Jones, *et al.*, (2000:54-61) describe an agility response as "one with volatile demand, high product variety, shorter product life cycle, and availability-driven customers". Hsu and Wang (2004:183) substantiate that "market environment is characterised by diverse customer tastes and preferences, rapid developments in technology and the globalisation of management.

In capturing the variability of demand through electronically-enabled mass customisation addresses the lead times and optimises the responsiveness and production schedules". The delays or lead times for the delivery of the product can be associated with conceptual utilisation with make-to-order (MTO) whereby components and parts are made and then assembled, and build-to-order (BTO) whereby the components and parts are ready for assembly. An MTO strategy should be underpinned by running a leagility system, "while building systems to order means that there is no finished product inventory in the channel to manage" (Bowersox *et al*., 1999:557-568).

Olhager and Ostlund (1990:135-142) describe the manufacturing continuum in terms of "classification as make-to-stock (MTS), assemble-to-stock (ATS), make-to-order (MTO), and engineer-to-order (ETO). The authors further claim that: 1)build-to-forecast (BFT) is similar to MTS and ATS (the product is built against a sales forecast, and sold to the customer from finished goods stock such as the grocery and retail sectors); 2) BTO is similar to MTO (the product is based on a standard design, but component production and manufacture of the final product is linked to the order placed by the final customer's specifications such as high-end motor vehicles and aircraft); and 3) configure-to-order (CTO) is similar to engineer-to-stock

(ETS) (the product is designed and built to customer specifications as one-off products such as large construction projects). Assemble-to-order (ATO) focuses on the product that is built to customer specifications from a stock of existing components from modular product architecture". The order fulfillment strategies are sometimes based on "the **P:D** ratio, where **P** is the production lead time (how long it takes to manufacture a product)", and **D** is the demand lead time (how long customers are willing to wait for the order to be completed) (Simchi-Levi *et al*., 2008; Snyder and Shen, 2011). The order fulfillment strategy determines the decoupling point (Olhager, 2003), as the change-over from the push system (forecast-driven) (Heizer and Render, 2011) to a pull system (demand-driven) (Simchi-Levi *et al*., 2008). It has become increasingly necessary to move the decoupling point in the supply chain to minimise the dependence on forecasts from an anticipatory model and to maximise the reactionary or demand-driven supply chain elements for a responsive model (Bowersox *et al*., 2010). This approach is related to BOSC in terms of responsiveness to market changes.

Gunasekaran and Ngai (2005:425) define BOSC as "a strategy of value chain that manufactures quality products or services based on the requirements of an individual customer or a group of customers at competitive prices, within a short span of time by leveraging the core competencies of partnering firms or suppliers and information technologies such as Internet and World Wide Web (WWW) to integrate such a value chain". The authors further delineate the strategic importance of BOSC that can attenuate the possible order variability magnification, known as bullwhip effect, in the supply chain upstream , "firstly, it provides a level of responsiveness, cost, effectiveness, and flexibility that enables companies to deliver the products that customers have chosen at the time they requested it, secondly, this chain reduces the dependence of forecasts, batches, inventory, or working capital; thirdly, it results in substantial cost advantages by eliminating the inventory, forecasting, expediting, and setup required to customise products or services; fourthly, it helps companies utilise people, machinery, and floor space more efficiently; and finally, it allows a manufacturer to react on time with the market and even shape the behaviour of the market".

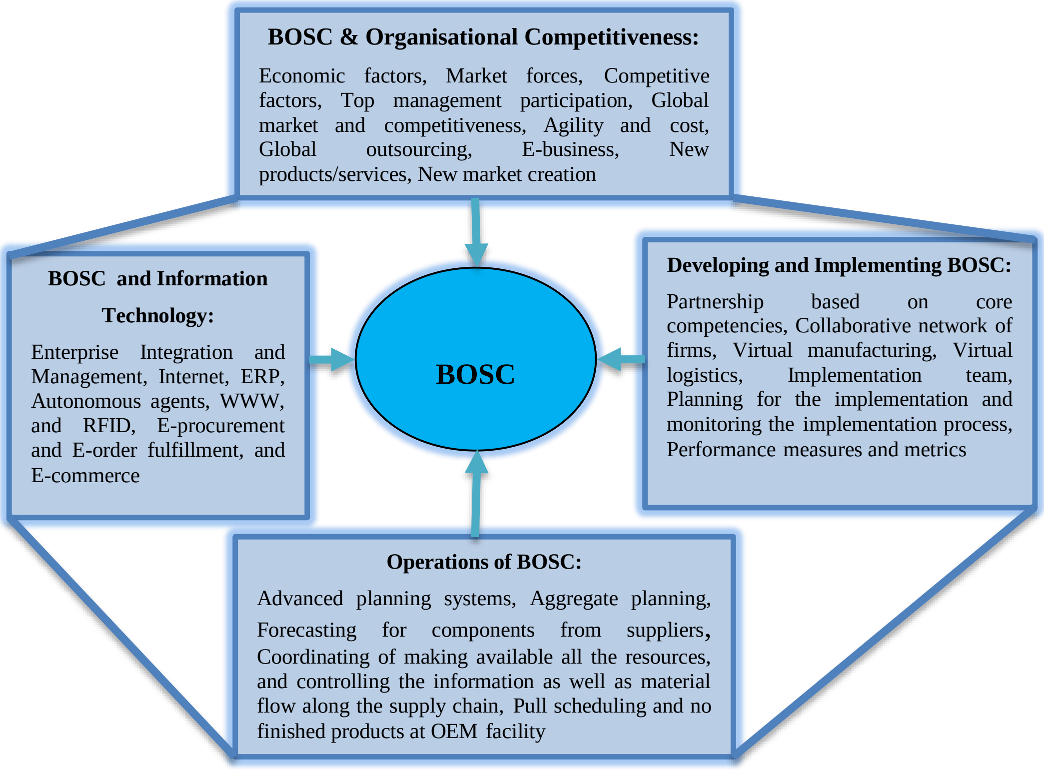
The build-to-order (BTO) concept as a production strategy attempts to fulfill customer orders in short lead times through responsive manufacturing and information exchange (Miemczyk *et al*., 2004). Chen *et al*., (2003:25-37) highlight that "build-to-order production systems rely strongly on the information sharing for tight integration of the upstream supplier of parts, the midstream manufacturer and assembler of components, and the downstream distributor of finished goods in the supply chain". Similarly, Lyons *et al*., (2004:658-666) highlight the importance of "information flow leading to information sharing across tiers of suppliers".

The usual lack of information visibility across tiers is directly linked to the variability of the demand signal amplified upstream in the chain and precludes second-tier build-to-order (Lyons, Coronado and Michaelides, 2006). In a build-to-order supply chain, the quasi-real-time information exchange strengthens the active collaboration and communication with propensity to ameliorate the phenomenon of bullwhip effect.

In developing interfaces of active communication between customers and suppliers along BOSC, eSCM systems become essential to BOSC in terms of: "1) the configuration of forms and capabilities in the supply chain that creates the greatest degree of flexibility and responsiveness (Heizer and Render, 2011); 2) changing market/customer requirements in a cost-effective manner while incorporating certain characteristics of agile enterprise based on a collaborative and responsive approach utilising shared consumer demand information systems" (Graham and Hardaker, 2000; Griffiths and Margetts, 2000; Gunasekaran, *et al*., 2005; Sheu *et at*., 2006). BOSC is an oriented paradigm (knowledge-driven and centred on customer services) that manufactures a low volume of products of a pre-determined high variety. It further uses modular products that are driven from a push approach, in line with actual orders. Waller (2004:10-19) suggests that "it requires real-time information flow and responsiveness among supply chain partners in order to achieve whole system of value-based optimisation".

These extended enterprises are entrenching an integrated network of collaborative relationships and active communication systems providing desired service especially downstream the consumption cycle. Biswas and Narahari (2004:704) recommend "the development of a decision-support system for supply chains through object modeling, which enables strategic, tactical, and operational decisions to be made in supply chains to avoid the order variability as one move upstream in the chain". In BOSC, enterprises require market alertness, responsiveness and sensitivity (Cigolini, Cozzi and Perona, 2004) and to benefit on information technology diffusion, absorb hybrid systems, and embrace product differentiation tactics (Simchi-Levi, *et al*., 2008).

Figure 4.2: A framework for the development of BOSC.



Source: Gunasekaran and Ngai (2005). 'Build-to-order supply chain management: A literature review and framework for development'. *Journal of Operations Management,* 23 (5) 423-451.

Figure 4.2 reveals four major issues when developing BOSC (Gunasekaran and Ngai, 2005:423-451), "firstly, BOSC and organisational competitiveness (strategic planning considers the factors that are internal and external to business organizations; secondly, developing and implementing BOSC (the process involves making decisions about at which stage along the supply chain the differentiation of products should occur, and about the integration of suppliers and customers with an enterprise resource planning system; thirdly, operations of BOSC (require making decisions such as planning and forecasting, and coordinating and monitoring, that is, determining the demand for components, and the timing and volume of orders to suppliers); and finally, BOSC and information technology (information technologies such as EDI, the Internet, the WWW, ERP, and RFID facilitate the integration of customers and suppliers or partnering firms along supply networks)".

4.3. Risk Pooling

Wisner *et al*., (2008:324) describe risk pooling as "the relationship between the number of warehouses, inventory, and customer services". It can be explained intuitively when market demand is random, and it is very likely that higher-than-average demand from some customers will be offset by lower-than-average demand from other customers (Cachon and Terwiesch, 2009:323). It means that as the number of customers served by a single warehouse increase, these demand variabilities will offset each other more often, thus reducing overall demand variance and the likelihood of stockouts. Consequently, the amount of safety stock required to guard against stockouts. Jacobs and Chase (2008:188) describe "risk pooling as a strategy that aims at pooling and sharing resources in a supply chain so that the risks in supply disruption like, bullwhip effect can be shared".

The strategy of risk pooling has been designed to "bring about demand aggregation across locations or time, in order to reduce the variability which is measured by either the standard deviation or the coefficient of variation" (Cai and Du, 2009:709). Risk pooling assumes that the demand at the markets served by the warehouses is negatively correlated ("when demand at one market is greater than average, then demand at another market will be less than average"). It means that the greater the positive correlation between demands, the smaller the benefit due to risk pooling (Hopp and Spearman, 2008, Wisner *et al*., 2008, Cachon and Terwiesch, 2009).

Simchi-Levi *et al*., (2008) look at supply chains with centralised demand information where individual echelon-stages of the supply chain receive the retailer's forecast mean demand and follow a base-stock inventory policy based on this real demand. Retail stores normally share inventory, whereby information technology tends to facilitate the success of this strategy. The real-time information on inventory and demand (consumer demand orders) allows the most cost-effective management and transshipment of goods between partners sharing the inventory. Thus, risk pooling allows a dovetailed combination of real-time information sharing through technological systems to mitigate bullwhip effect.

4.3.1 Quantifying Risk Pooling

The dynamics of demand create erratic behaviour from the markets; there is always imbalance with low or high demand. The supply chains should understand that the markets can absorb the peaks and valleys as the reduction in variability allows an inventory positioning and reduced safety stock (Simchi-Levi *et al*., 2003).

The risk pooling provides an advantageous practice that if the demand is higher than average at some territories, then it is likely to be lower than average at others as Simchi-Levi *et al*., (2008); Hopp and Spearman (2009); Cachon and Terwiesch (2009) describe standard deviation as the measure of how much demand tends to vary around the average, and the coefficient of variation as the ratio of standard deviation to average demand, that is,

Coefficient of variation = Standard deviation / Average demand

It means that the standard deviation measures the absolute variability of customer demands while the coefficient of variation measures variability relative to average demand. The higher the coefficient of variation, the greater the benefit obtained from centralised systems; that is, the greater benefit from risk pooling. However, the benefits from risk pooling depend on the behaviour of demand from one market relative to demand from another. Cai and Du (2009:709-722) elaborate on two inventory systems that aim at minimising the expected system cost and mitigate bullwhip effect along the supply chain, "firstly, decentralised system, as a system in which a separate inventory is kept at individual territory to satisfy each source of demand and there is no reinforcement between locations, so the surplus supplied location is not allowed to supply the deficient supplied location.

The system aims to keep the optimal stocked level $\mathbf{s_i}$ (the stocked level at the $_i$th location) to decrease the expected total cost $\mathbf{H_D}\ (\mathbf{s_i})$ within this system, which is achieved by minimising the sum of the individual location costs $\mathbf{H_i}$. Secondly, centralised system is a system in which inventory is kept at a central distribution centre (DC). As the random demands are aggregated across different locations in the centralised system, it becomes more likely that high demand from one location will be offset by low demand from another". The system aims to keep the optimal stocked level $\boldsymbol{s_o}$ and "the expected total costs $\boldsymbol{H_C}\ (\boldsymbol{s_o})$ within this system, which is achieved by minimising the aggregated total costs $\boldsymbol{H_o}$. It is noted that the average demand faced by the centralised distribution center is the sum of the average demand faced by each of the individual warehouse in the decentralised system". Based on measurements of the standard deviation or coefficient of variation, the variability faced by the centralised distribution centre is proved to be "much smaller than the combined variabilities faced by the separate warehouses" in the decentralised system. They mathematically provide that:

$$\boldsymbol{H_C}\ (\boldsymbol{s_o}) \leq \sum_{\mathbf{i=1}}^{\mathbf{n}} \boldsymbol{H_D}\ (\boldsymbol{s_i})$$

Thus, the cost of the centralised system is reduced compared to the decentralised system on the underlying situations.

They are using risk pooling effectively matching supply with demand, and ultimately mitigating the impact of bullwhip effect. The previous chapter alludes to the CscD system as an efficient business model for FMC retail stores to deal with the pernicious effect of demand order variability while underpinned by electronically-enabled supply chain management systems. According to Snyder and Shen (2011:273) “the information in variability is additive in the centralised system but multiplicative in the decentralised system with shared demand information as a significant factor to reduce bullwhip effect”.

The risk pooling strategy focuses on minimising the supply chain cost through extensive use of newsvendor model. Simch- Levi, *et al*., (2008), and Cachon and Terwiesch (2009) describe the newsvendor model or the newsboy model as “a single-period single-product inventory mode, which is a desirable tool for making a decision” when there is a “too much-too little” challenge. According to Cai and Du (2009:710) “bet too much and there is a cost, such as the cost for holding the leftover inventory; however, bet too little and there is a different cost, such as the opportunity cost of lost sales”. In other words, the newsvendor model determines the optimal order quantity in a single period probabilistic demand framework, “which minimises the expected cost or maximises the expected profit during that period” (Cherikh, 2000:755-761). The total expected costs of the decentralised systems are “the sum of the expected costs of individual locations, as the holding cost $\mathbf{h}(\mathbf{x})$ or penalty cost $\mathbf{p}(\mathbf{x})$ of each location depends only on its own inventory level and is unrelated to any other location’s inventory level. While in a centralised inventory system, all demands are satisfied from one centralised distribution centre where the surplus location is allowed to supplement the deficient one by transportation” (Dong and Rudi, 2004:645-657). Electronic technology such as Radio Frequency Identification (RFID) tags enhance inventory re-routing and re-stocking management systems by giving suppliers the ability to accurately forecast demand and production. It is helpful in tracking demand spikes and valleys and linking in-store stock and warehouse stock, prompting quicker replenishment and providing accurate real-time data (Heizer and Render, 2011).

According to Simchi-Levi *et al*., (2008) “the benefit of risk pooling in a centralised system depends on the standard deviation **(σ)** or the coefficient of variation **(σ/μ)** among the different markets with support of eSCM system”. The higher the standard deviation or coefficient of variation, the greater the potential benefit from a centralised system, although the benefit of risk pooling also depends on the demand correlation among the different markets. Gerchak and He (2003:1027) prove that the benefit of risk pooling may decrease when the demand variability increases under some situations.

4.3.2 Lead time Pooling

The clustering of the inventory from numerous territories into a centralised location with likely reduced costs of storage and demand variability is described as location pooling (Cachon and Terwiesch, 2009). Under the circumstances this pooling system indicates the distance between inventory hub and consumption cycle. Simchi-Levi *et al*., (2008) recognise that the variance of the orders from echelon-stage in the network is an increasing total lead time cycle between that stage and the retailer. That is, ***Li*** is the lead time between stage ***i*** and stage ***i+ 1*** (it means an order placed by facility ***i*** at the end of period ***t*** arrives at that facility at the beginning of period ***t + Li*)** (Snyder and Shen, 2011)**.** The concept of lead time pooling seems to reduce the inventory while keeping it close to customers. In clustering the lead times for multiple inventory locations, the consolidated distribution strategy attempts to keep inventory close to customers while hedging against the second form of uncertainty. Cachon and Terwiesch (2009:336) describe consolidated distribution as "a strategy that uses lead time pooling to provide some of the benefits of location pooling without moving inventory far away from customers".

Firstly, product pooling with a universal design is useful but might limit the functionality of the products offered. Secondly, delayed differentiation as the analogous strategy with respect to product pooling hedges the uncertainty associated with product variety without taking the variety away from customers. This requires redesigning the product/process and may introduce a slight delay in fulfilling demand. Thirdly, capacity pooling as the practice of combining multiple capacities to deliver one or more products or services, can increase sales and capacity utilisation but requires flexible capacity (it is probably not free and may be quite expensive). Cai and Du (2009:709-722) describe "the effect of decreasing marginal returns in lead time pooling practice as similar to that in location pooling, where both lead time pooling and location pooling strategies create the centralised inventory location, and decrease the uncertainty with respect to the total demand".

The authors further outline the differences that distribution centres in the consolidated system allow "the retailers to position inventory close to the customers and therefore avoids the uncertainty with respect to the allocation of the uncertain demands". In contrast, location pooling provides "the retailer with a centralised location for inventory but eliminates the retail stores close to customers".

4.4 Demand–Supply Mismatch

The inventory optimisation as the discipline of continuously managing inventory policies can optimise supply chain performance against business objectives, changing market conditions, risks, and supply chain constraints. Thus, the ability to rapidly respond to unplanned demand or demand variability and supply changes can prove to have significantly reduced supply chain costs (Simchi-Levi *et al*., 2008) and better supply chain responsiveness (Heizer and Render, 2011). The challenge of the newsvendor problem is the possibility of a demand–supply mismatch whereby one can order too much and inventory is left over at the end of the season, but order too little and one can incur the opportunity cost of lost sales.

Cachon and Terwiesch (2009:257) describe the expected demand-supply mismatch cost on two components in the newsvendor model; firstly, ordering too much means there is left over inventory at the end of the season (that is, the cost for each unit of leftover inventory is the overage cost – label $\mathbf{C_o}$). Secondly, ordering too little means there are lost sales (that is, the cost for each lost sale is the underage cost – label $\mathbf{C_u}$). It is quantified as:

Mismatch = (C_o x Expected leftover inventory) + (C_u x Expected lost sales)

C_u = Underage cost, C_o = Overage, μ = Expected demand, σ = Standard deviation of demand

The equation displays the mismatch cost in the newsvendor model that includes both a tangible cost (leftover inventory) and an intangible opportunity cost (lost sales). Cachon *et al*., (2009) further reveal that the expected demand-supply mismatch cost becomes larger as demand variability increases, where demand variability is measured with the coefficient of variation (Simchi-Levi *et al*., 2008), σ / μ, (the ratio of the standard deviation of a random variable to its mean). Intuitively, the mismatch cost increases as demand variability increases, while the lower critical ration increases demand-supply mismatch costs. Thus, the expected demand-supply mismatch becomes larger as the critical ratio, $C_u / (C_o + C_u)$, becomes smaller (Cachon, *et al*., 2009).

In the manufacturing perspective, Krajewski, Ritzman and Malhotra (2010:642) define critical ratio as “a ratio that is calculated by dividing the time remaining until the job’s due date by the total shop time remaining for the job. It is defined as the setup, processing, move, and expected waiting times of all remaining operations, including the operation being scheduled”. A very high critical ratio means there is a large profit margin relative to the loss on each unit of excess inventory, although lost sales result in a higher mismatch cost than excess inventory (Cachon and Terwiesch, 2009).

Thus, mismatch costs are high when a product has a low critical ratio and/or a high coefficient of variation. In other words, a low critical ratio implies that the cost of leftover inventory from the impact of bullwhip effect is high relative to the cost of lost sales.

4.5 Vendor-Managed Inventory (VMI)

The ideal partnership should mean achieving a level of information sharing and active collaboration. Normally, vendors are heavily involved in forecasting and planning as well as performing functions such as inventory management, data analysis, and order replenishment. Mishra and Raghunathan (2004:445) describe "retailer-managed inventory (RMI) systems where the retailer places orders with the manufacturer who fulfills these orders". The retailer is seen as the sole custodian of information about the consumer demand and there is limited chance of sharing information with greater amplification effect moving upstream. Tentatively, the manufacturer has limited access (through orders placed by the retailer) to real-time inventory level information.

The information flow is susceptible to order variability through shortage gaming, order batching, trade promotions and order synchronisation when the increasing volatility pattern moving upstream the supply chain (Lee and Whang, 2000; Burt, Dobler and Starling, 2003). The bullwhip effect can be dampened by practices that assign replenishment responsibility across the supply chain to a single entity (Chopra and Meindl, 2007). A single point of replenishment decisions is sought to ensure visibility and a common forecast that drives orders across the supply chain. The manufacturer or supplier instead of the retailer is found better positioned to control the replenishment decision with real-time information in the supply chain (Hopp and Spearman, 2009).

A more aggressive way to ensure that forecasting is done using low-level demand data is to have a single entity do it. The fact that alliances using VMI can pool inventory across levels (Cachon and Terwiesch, 2009) enables one to operate with substantially less inventory than is needed in uncoordinated supply chains (Hopp *et al*., 2008). In a "vendor-managed inventory" (VMI) system, sometimes called a "vendor-managed replenishment" (VMR) system, the supplier decides on the appropriate inventory levels of each of the products (within previously agreed-upon bounds) and the appropriate inventory policies to maintain these levels (Simchi-Levi *et al*., 2008). In other words, the vendor involves the approval from retailer in the initial stage, although the VMI programme tends to eliminate retailers' extensive involvement oversight on specific orders.

Cachon and Terwiesch (2009:390) identify general features of VMI:
Firstly, the retailer no longer decides when and how much inventory to order. Instead, the supplier decides the timing and quantity of shipments to the retailer. The firms mutually agree on an objective that the supplier will use to guide replenishment decisions (a fill rate target).

Secondly, if the supplier is going to be responsible for replenishment decisions, the supplier also needs information. Hence, with VMI the retailer shares demand data with the supplier.

Thirdly, the supplier and the retailer eliminate trade promotions, hence, the adoption of VMI usually includes some agreement that the supplier will maintain a stable price and that price will be lower than the regular price to compensate the retailer for not purchasing on deal.

Scan-base trading (SBT) is the process where suppliers maintain ownership of inventory within retailers' warehouses or stores until items are scanned at the point of sale. The benefits to the supplier to implement scan based trading include improved retailer relationships, increased sales, improved visibility of product sales, and reduced cost of inventory and stock outages. Tempelmeier (2006) emphasises the benefits of using VMI: "Firstly, vendors benefit from more control of displays and more contact to impart knowledge on employees. Secondly, retailers benefit from reduced risk, better store staff knowledge and reduced display maintenance outlays. Thirdly, consumers benefit from knowledgeable store staff who are in frequent and familiar contact with manufacturer (vendor) representatives when parts or service are required". In the reciprocal approach, many retailers are exhorting capacitated suppliers to adopt VMI in return for sharing demand information. Thus, the scan based trading has the ability to transmit sales information from the retailer to the supplier to inform the supplier of sales by location.

Demand forecasting is essential for inventory planning, especially when the demand environment is highly dynamic and the procurement lead times are long. How to adjust the inventory planning decisions according to demand forecasting updates is of great interest to managers. A decentralised supply chain allows the manufacturer to greater proximity to consumers with quasi-actual demand information (Simchi-Levi *et al.*, 2008). The asymmetrical forecast information allows an incentive problem, whereby "the manufacturer can influence the supplier's capacity decision by exaggerating the forecast in the absence of information sharing mechanisms".

Table 4.1: Competitive Contracts in VMI

Authors	Contract Mechanisms
Ozer and Wei (2006:1238-1257)	Outline the structured contracts that "the supplier can offer to achieve credible forecast information sharing. These contracts induce credible forecast information sharing by requiring the upstream supply chain partners to back up the forecast". Authors recommend that: "When forecast information is symmetric, the supplier can always increase this as well as the manufacturer's profit with a coordinating linear capacity reservation contract or a payback contract over those of any wholesale price contract. When forecast information is asymmetric, the advance purchase contract with an appropriate payback agreement coordinates the system while enabling arbitrary sharing of profits".
Erkoc and Wu (2005:232-251)	Study "the capacity reservation contract with linear prices and consider the capacity decision in a supply chain when parties have full information. The assumption is that the supplier knows the manufacturer's forecast information".
Cachon (2004:222)	Shows "how an advance purchase contract shifts excess inventory risk from the supplier to the manufacturer".
Tang *et al.*, (2004:465)	"Study the application of an advance purchase discount between a retailer and consumer, and in their model, supply chain coordination (hence information sharing) is not an issue. The contract terms can be negotiated through an iterative process or the contract could be offered by one party to another as a take-it-or-leave-it offer".
Tomlin (2003:317)	Shows that "channel coordination can be achieved by sharing the upside potential of high demand through the quantity premium contract".

Source: Compiled by the researcher from the listed literature review.

4.6 Supply Chain Information Sharing Networks

Different information management strategies are needed to manage for different types of products especially in the presence of supply chain risks and order variation on the upstream side. The previous chapter alluded to Fisher (1997:105-116) whereby "most consumer products can be classified as fashion (innovative) products or functional products". The former usually has shorter life cycles and higher levels of demand uncertainties than the latter. Paton *et al.*, (2011:257) stress that "supply for innovative products should have supply chain market-responsive in order to unpredictable and magnified demand variability while functional products require efficient and stable supply chains to retain high utilisation rated of manufacturing". However, the study is basically confined to functional products such as grocery items with efficient supply chain, and market information is critical for generating accurate demand forecasts in managing products with long life cycles. Normally, supply chain members with the exception of retailers do not have first-hand market information such as point-of-sales data, customers' preferences, and customer response to various pricing.

If supply chain operations efficiency is concerned with activities that improve supply chain performance benefits, Barratt and Oke (2007:1217) recommend supply chain visibility as "the extent to which partners within a supply chain have access to or share information which they consider as key or useful to their supply chain operations efficiency and which they consider will be of mutual performance benefit". According to Barratt and Barratt (2011:515) meaningful supply chain operational benefits depends on critical information sharing outcome in terms of its quality, timeliness and usefulness of the information in creating visibility. The authors depict "the information performance benefits that arise from visibility such as improved market-responsiveness process, improved planning, improved frequent replenishment capabilities and improved active communication decision-making process".

4.6.1 Framework of Information Sharing

Information sharing is closely linked with active supply chain communication and coordination and to palliate the challenges from consumer order demand variability. Chen (2003:341) presented a comparative analysis where a focus has been on "the downstream or demand-side information (the sales information or inventory status at point of sales), and the upstream or supply-side information, such as lead time, new-product introduction, and plant operations". It denotes that the demand-side obsorbs a limited portion of the total information flow cycle in the network. The balanced approach should depict an important congruence of sharing critical upstream information with supply chain members on design and rollover of the product to avert increased demand variability on both stream sites.

When lead suppliers, manufacturers and retailers know precisely the lead time cycle and supply availability for every replenishment order from the downstream site and product rollover from upstream site, the upstream information sharing visibility improves supply chain performance outcomes and benefits channel partners of supply chain entities. Meanwhile, under the optimal contract, Li and Gao (2008:522-531) maintain that "the manufacturer has no incentive to mislead the retailer about new-product information in the information sharing model". Choudhury *et al*., (2008:117-127) test the supply chain performance benefits on increased sharing of quasi-real-time and relevant information (sharing demand and inventory information) among players in an entire supply chain:

Firstly, the observation that as the end item of demand variance increases, the benefit due to the availability of real time inventory information increases;

Secondly, the observation that the potential benefit of information sharing between channel members increases as the supplier's capacity increases;

Thirdly, the allocation of inventory by the supplier's among retailers reaps benefits.

There is a critical Demand to Capacity (D/C) ratio beyond which the Retailer Managed Inventory (RMI) policy is indifferent to end item demand variance, but that need not be the case for the vendor managed inventory (VMI) policy (that is, VMI scenario is more beneficial than the RMI scenario). Choudhury, *et al*., (2008) describe RMI where the supplier has the knowledge of the retailers' daily inventory status and the demand experienced by the retailers, but the retailers decide the order quantity based on the stock on-hand (Jacobs and Chase, 2008) and order-up-to level policy (Simchi-Levi *et al*., 2008). While in the VMI the supplier has real time information on the inventory status of the retailers (Hopp and Spearman, 2008), and the supplier assumes control of the stock management and is responsible for deciding the quantity of shipments to the retailers (Chopra and Meindl, 2007). This study implies that inventory allocation among supply chain channel partners under real-time information sharing condition and visibility has greater impact in cost reduction and ameliorating demand order variability than only coordination between supply chain players by information sharing (Choudhury *et al.*, 2008; Barratt and Barratt, 2011). A number of studies has outlined the advantage of information sharing in SCM:

Firstly, "information sharing improves coordination between supply chain processes to enable the material flow and reduces inventory costs; secondly, information sharing leads to high levels of supply chain integration" (Jarrell, 1998:58) by enabling organisations "to make dependable delivery and introduce products to the market quickly; thirdly, quality information sharing contributes positively to customer satisfaction" (Spekman, Kamauff and Myhr, 1998) and partnership quality (Lee and Kim, 1999:26); fourth, "information sharing impacts supply chain performance in terms of both total cost and service level" (Zhao, Xie and Zhang, 2002); and finally, according to Li, Huang and Li (2002) "the higher level of information sharing is associated with the lower total cost, the higher order fulfillment rate and the shorter order cycle time. Sometimes, organisations with high levels of information sharing and information quality are associated with low level of environmental uncertainty, high level of top management support and information technology (IT) enablers". Li and Lin (2006:1641) further note that "information sharing and information quality may be influenced by contextual factors, such as the type of industry, firm size, a firm's position in the supply chain, supply chain length, and type of supply chain".

Table 4.2: Evolutionary Approach to Information Sharing

Authors	Evolutionary Perspectives on Information Sharing
Berry, Towill and Wadsley (1994)	"There is a built-in reluctance within organisations to give away more than minimal information. The information disclosure is perceived as a loss of power and companies fear that information may leak to potential rivals".
Mason-Jones and Towill (1997)	Lament on dysfunctional effects of inaccurate/delayed information, as information moves along the supply chain.
Mason-Jones, *et al.*, (1997)	Organisations will deliberately distort information that can potentially reach not only their competitors, but also one own suppliers and customers.
Lee *et al.*, (2000)	Study "the benefits of information sharing and further suggest various mechanisms including price discount and replenishment lead time reduction to entice retailer to share demand information with the manufacturer".
Feldmann and Muller (2003)	Question the divergent interests and opportunistic behaviour of supply chain partners, and informational asymmetries across supply chain affect the quality of information.
Childerhouse and Towill (2003)	The key to the seamless supply chain network is making available undistorted and up-to-date marketing data at every node within the supply chain and it is assumed that information sharing will bring the organisation competitive advantage in the long run.
Ross (2003)	Identifies significant trends in the rise of supply chain management that is, closely collaborating with t supply chain partners as cross-channel functions leveraging the interactive power of enabling information technologies and market requirement demands.
Chatfield *et al.*, (2004).	Information manifests the glue that holds the entire supply chain together and allows it to function, making information the most important supply chain drivers
Chen and Yu (2005)	Quantify the value of lead-time information cycle on inventory system, with no information. "The retailer has to rely on the history of order arrivals to infer the current lead time and make replenishment decisions accordingly".
Jain and Moinzadeh (2005)	Study an inventory system in which the retailer is allowed to access the inventory information of the manufacturer, and the retailer's inventory policy changes.
Cheng and Wu (2005)	Extend Lee *at al.*, model that information sharing would enable the manufacturer to reduce both the inventory level and the total expected cost as the retailers consistently share the replenishment policy and inventory level to the manufacturer.
Huang and Iravani (2005)	Choosing the right partner for selective-information sharing can significantly reduce the manufacturer's costs. The provision of insightful decision into the benefits of information sharing in systems with either full- or selective- information sharing, has improved the value of information flow. The selective-information sharing is attached to the retailer with the larger market share and it is assumed as the more beneficial partner for information sharing.
Li and Lin (2006)	Assess the antecedents of information sharing and information quality in supply chain management. "The authors find that information sharing is impacted positively by top management support, trust in supply chain partners and shared vision between supply chain partners, and negatively by supplier uncertainty".
Ferguson and Ketzenberg (2006)	Analyse an inventory system where "the supplier is endowed with private information about the expiration date of the available products", and the authors argue that "information sharing does not always benefit the supplier".
Chiang and Feng (2007)	Information sharing is more beneficial for the manufacturer than for the retailers in the presence of supply uncertainty and demand volatility. It means that the value of information sharing for the manufacturer can increase or decrease with production yield variability with different cost structures and demand patterns. Chiang and Feng simulation model finds that while the supply uncertainty has significant impact on the value of information for the upstream supply chain members, the impact is relatively insignificant for the downstream supply chain members
Chopra and Meindl (2007)	Information is essential for making good supply chain decisions because it provides the broad view needed to make optimal decisions, while

	information technology (IT) provides the tools to gather this information and analyse it to make the best supply chain decisions.
Li and Gao (2008)	"Study on periodic-review inventory system consisting of a manufacturer and a retailer, where the manufacturer introduces new and improved products over an infinite planning horizon using the solo-roll strategy. When the inventory system is coordinated, information sharing improves the performance of both supply chain entities although there is notification that it is not possible to achieve improved performance if the inventory system is not coordinated".
Choi (2008)	The whole channel systems through cyber-collaboration, the research shows the cost-saving benefits in the supply chain system from sharing either upstream or downstream information among supply chain members. Although sharing erroneous information can nullify the benefits or even cause cost increases for some operational settings.
Cachon and Terwiesch (2009)	Elucidate on reciprocal interdependence between the stream sites since it can be useful for the supplier or manufacturer to share information on availability with its downstream retailers. Greater information sharing about actual demand between stages on the supply chain is an intuitive step toward reducing the bullwhip effect
Durugbo et al., (2011)	Introduce diagrammatical tool (information channel diagram) to model the information flows within the delivery phase, and suggest that information is important as a input parameter for strategizing the delivery process and as a control measure for achieving high-level delivery performances.

Source: Compiled by the researcher from the listed literature review.

4.6.2. Levels and school of thoughts on Information Sharing

Information sharing is assumed to decelerate the bullwhip effect when moving up the supply chain. The ability to manage and track the flow of relevant information across supply chain members has been greatly enhanced by electronically-enabled supply chain technology advances. In improving supply chain performance outcomes, the advances in information technologies seem to facilitate the level of active coordination and cooperation among the supply chain members, and provide an enabling means for real-time information sharing in the seamless integrated supply chain network (Chopra *et al*., 2007). Cheng and Wu (2005:1159-1165) have identified three levels of exchanging information in a two-level supply chain:

First, the manufacturer and the retailer belong to different organisations and operate in a decentralised fashion.

Second, the manufacturer and the retailer decide their inventory policies under coordinated control and the manufacturer has access to the customers' demand information, in addition to the ordering information from the retailer.

Third, the manufacturer and the retailer cooperate under centralised control through EDI and vendor-managed inventory (VMI).

Cheng and Wu (2005:1162) find that "firms' inventory cost and delivery have been greatly reduced and firms can improve the supply chain performance and obtain economic benefits for the long run". The study is confined to Cheng and Wu on level three of information sharing, whereby the supply chain information technology system is examined as a strategic tool to capture real-time information about the consumer goods retailing system. The retailers and the capacitated suppliers are expected to master the customers' demand information in a synchronised manner since the South African model permits the incorporation of formal and informal sector, and small and medium-sized enterprises (SMEs) and large firms in a supply chain network. Appendix A provides the school of thought that optimises inventory positioning on quasi-real-time information sharing. Information integration efforts between manufacturers (capacitated suppliers) and retailers, in the form of information sharing (within two scenarios, selective- and full-information sharing), synchronised replenishment, collaborative product design and development, have been cited as a major means to improve supply chain performance (Huang and Iravani, 2005).

4.6.3 Information flow mapping

Mapping information flows allows managers to identify how information is transmitted from one point to another both within the firm and externally, to suppliers and customers. According to Wisner and Stanley (2008:316) flow maps serve as "a basis for analysing information needs and the services necessary to align the firm's information collection and transfer capabilities with the information needs of its internal and external users". In each case, managers should consider the value of information as an intellectual asset on how information is captured, transformed, and exchanged. It is a flow mapping paradigm along with the interplay between the corporate information flow (flow from the firm to its customers), environmental information flow (customers to the firm) and internal information flow (flow within the firm). Information velocity is a term used to describe how fast information flows from one process to another, and information volatility as the uncertainty associated with information content, format, or timing, must be handled to add value to the supply chain (Wisner and Stanley, 2008; Simchi-Levi *et al.*, 2008). Wisner and Stanley (2008:316) further consider enabling information technologies as a replacement for human coordination, to reduce uncertainty, to promote new coordination structures and to substitute information and knowledge for inventory.

Relationships with suppliers and customers are thus impacted not only by the accuracy of information but also its availability, velocity and volatility (Wisner *et al*., 2008). Mapping information flows is sequential (Hibberd and Evatt, 2004:58-64) in the following series of steps:

Step 1: Information audit: determine the current internal and external customers, suppliers and users by uncovering current information sources and uses.

Step 2: Eliminate or consolidate information usage source: map the firm's and constituents' information flows to see where redundancies or overlaps exist.

Step 3: Optimise information requirement: identify information needs that are currently not being satisfied and determine common information needs and rank the needs based on the level of agreement. The analyst can be expected to weight reallocation of information sources, consolidation of information needs and optimise information flows while mapping information flow by uncovering information gaps or needs within the organization and its supply chain trading partners.

Step 4: Periodically review the dynamic information flow maps process: add any new information flows to the map as the decision to implement solutions for these requirements is made.Continuous improvement of the information flow map would identify better use of supply chain technologies and better flow arrangements and new requirements.

A basic information flow map is presenting the internal and external informational flows of a manufacturer and its suppliers and customers. In supply chains, successful partnerships are highly dependent on effective information flow and support. Supply chain partners require accurate real-time information on current inventory levels, order and delivery status, production and forecast changes, and the latest product design changes. According to Durugbo *et al.,* (2011:1) "the flow, deployment or delivery of goods in modern supply chains and businesses is characterised by the concurrent flow of information" that is analysed for improving customer service levels by exchanging information between customers and sales teams (Iskanius *et al*., 2004), and flow fulfillment in which customers are updated on the progress of orders (Childerhouse *et al.,* 2003).

4.6.4 Contracts and Information sharing

The importance of contract type as driver of the value of information sharing and the role of information sharing capability indicate a source of competitive advantage in electronically-enabling supply chain interconnectivity. The successful trends in the marketplace encourage firms to work together to optimise the supply chain so as to achieve a quantum jump in performance that cannot be achieved by optimising individual processes. As a result, the classical model of firm versus firm competition is giving way to a new model: supply chain versus supply chain competition (Taylor, 2003; Barnes, 2006; Heizer and Render, 2008). According to Ha and Tong (2008:714) "under this new model, it is essential for supply chain partners to have the right incentive and information to actively communicate and respond in a coordinated way to threats posed by competing supply chains". The challenge is to design incentive contracts to coordinate operational decisions in supply chains under horizontal competition and asymmetric information. Sometimes "the manufacturer offers a contract to the retailer of the same chain, and the retailers engage in Cournot competition by determining selling quantities based on the contracts" (Ha and Tong, 2008:71).

Table 4.3: Dynamics of Cournot duopoly model and bullwhip effect

Authors	Dynamics of Cournot duopoly model
Edgeworth (1897)	Considered to have given the authorative judgement on the indeterminacy of Cournot duopoly by showing that the imposition of a quantity constraint caused the market price to oscillate inside an interval.
Bowley (1924)	Mathematical Groundwork, explicitly introduced the firms' conjectures so one could experiment mathematically with how firms respond. A conjectural variation is a conjecture by one firm in a duopoly about how the other firm will adjust its action with respect to potential adjustments in the first firm's action.
Harrod (1934)	Proposed the consistency restriction and argued against determinacy by proposing the consistency condition to show how unrealistic it is.
Kahn (1937) and Fellner (1949)	Realised that the dynamic inconsistency of the conjecture variation model was its undoing, and thus paved the way for a modern game-theoretic approach. Fellner stressed that the response functions, being static, were destroyed as soon as one deviated from the static equilibrium of the intersection of the response functions (Meaning, the right response functions "for the wrong reason".

Source: Compiled by the researcher from the listed literature review.

The Cournot duopoly model is, however, of the type whereby each firm simply observes what the other does, and then adopts a strategy that maximises its own profits. The phenomenon of bullwhip effect is associated with instability and uncertainty in supply chain network. It makes no attempt to evaluate potential reactions by the rival firm to its own profit-maximising strategy. According to Harrod (1934:442-470) "the consistency restriction adds the requirement that firm ***i*'s** conjecture as to how firm ***j*** will react to a variation of ***i*'s** output is correct, such as that: For **i,j = 1,2:** $y_i = f_i(y_j)$ **and** $v_{ij}(y_i) = \partial f_j(y_i)/\partial y_i$, and this leads to the determinate outcome of a consistent conjectural equilibrium, but this did not solve other problems, namely that of dynamic inconsistency". If the endogeneity of information endowments for individual firms, Anand and Goyal (2009:440) stress that "the informational imperative drives the firm to maximise its profits by simultaneously managing not just its own information endowment, but also those of its competitors and suppliers".

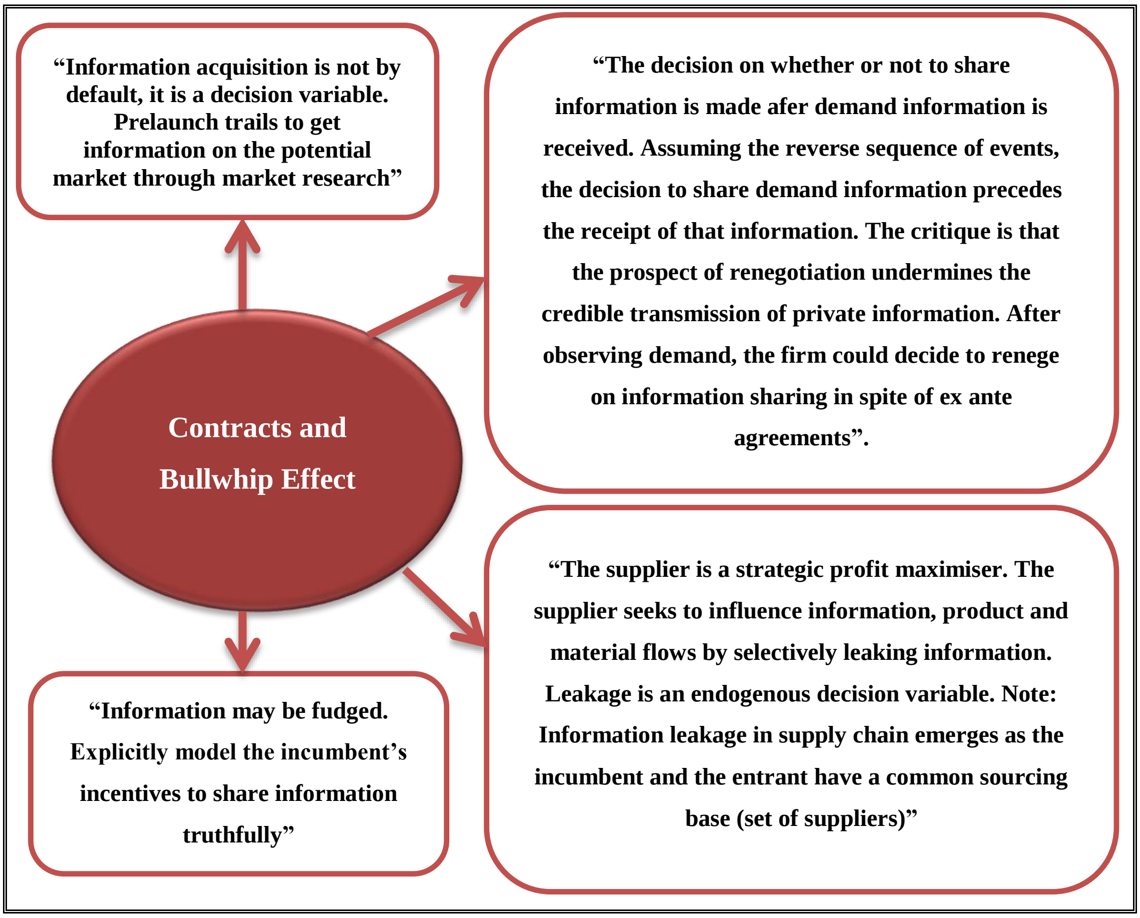
Daughety and Reinganum (1994:795-819) describe the model of Cournot competition as one "whereby the firms can acquire demand information at a fixed cost. In equilibrium, one firm acquires information and produces first, followed by the uninformed firm". Ha and Tong (2008:701-715) analyse the information sharing game on quantity-based contract menus and linear price contracts and "it leads to the insights: 1) under quantity-based contract menus, the information sharing always makes a supply chain better off but the competing supply chain worse off; 2) investment cost and contract type for information sharing decisions in supply chains; 3) when there is no competition, a manufacturer uses quantity-based contract menus to extract information from the retailer, supply chain efficiency suffers because of the quantity distortions caused by the contract menus.

These quantity distortions under Cournot competition will create not only inefficiency but also a strategic disadvantage because the competing supply chain will be induced to be more aggressive; 4) prisoner's dilemma, it is possible for the information sharing game to resemble the classical prisoner's dilemma game under quantity-based contract menus. That is, manufacturers invest in information sharing in equilibrium, even though one will be better off if neither invest. Prisoner's dilemma exists whenever there are gains to be realised by cooperation between a group of individuals, yet there are even greater gains possible for each individual if that party can cheat on the cooperative arrangement while all other parties continue to abide by it".

Managers should not only improve the information sharing capability of the supply chain but also adopt contracts that can create incentive for critical supply chain information sharing visibility. Ha and Tong (2008:712) reveal that "nonlinear price contracts (equivalent to the quantity-based contract menus when the demand state is continuous) are preferable to the linear price contracts commonly employed. When there is no information sharing and managers use sophisticated contracts to extract information from the supply chain partners". One has to account for the negative competitive effect of the quantity distortions caused by these contracts. Initially, a signaling game framework by Anand and Goyal (2009) underpin a "stylised model with perfect demand signal that the value of information sharing" depends on contract type, supply chain competition and how information sharing capability can be a source of competitive advantage for supply chains. Cachon and Leriviere (2005:30-44) show that "a revenue-sharing contract can coordinate a supply chain with one manufacturer selling to multiple retailers under stochastic demand". These supply chain contracts on better information sharing attempt to curtain the possible information leakage (how shared information could reach rival competitors either deliberately or otherwise).

Anand and Goyal (2009:442) "endogenise the information endowment of a supply chain by jointly determining the material, product and information flows within it, which interact through the potential for leakage of order quantity information to the competition and shortage gaming to the consumer demand variability". The dynamics of information sharing on the underlying contracts and bullwhip effect are modeled in the following:

Figure 4.3: Information sharing with contracts and bullwhip effect



Source: Compiled by the researcher from literature perspective

4.6.5 Relationships on information sharing

Supply chains constantly surge for improved performance outcomes underpinned by lean systems (Heizer and Render, 2011) and more efficient use of inter- and intra-competence of capabilities and technology, as well as creating a seamlessly coordinated chain network (Anderson and Katz, 1998; Simchi-Levi *et al.*, 2008). Within the collaborative paradigm, the business world is composed of a network of interdependent relationships. Wisner and Stanley (2008:212) advocate "close supply chain collaborative relationships with customers and suppliers on frequent active communications that add real-time information visibility to supply chains and mitigate the phenomenon of bullwhip effect and reduce safety stock problems".

Derrick (2003) maintains that many firms are overlooking opportunities to share advanced economic information such as demand forecasting and product life cycle planning to help improve business performance outcomes. The development of closer relationships in order to derive value from information sharing, Rinehart *et al*., (2004:25-43) classify relationships into schemes such as market governed situations, relationally governed systems, and ownership governed systems. The successful relationships for sharing real-time information in the supply chains are sometimes distinguished by attributes including trust, interaction frequency, and commitment. Such close relationships mean that "channel participants share risks and rewards and are oriented for long-term relationship" (Kotabe *et al.,* 2003:293). Moreover, through a long-term relationship, Chen *et al.,* (2004:333) infer that "the supplier will become part of a well-managed chain as a lasting continuous effect on the competitiveness of the entire supply chain network", and strategic relationships reduce the number of suppliers on closer working relationships business performance.

In this competitive edge, coordination and integration of these mapping flows and the interconnectivity activities within and across companies, the improved supply chain relationships can indicate critical effective supply chain performance management (Chin *et al*., 2004); Chin *et al*., 2004; Simchi-Levi *et al*., 2000) recommend that establishing trustworthy relationships among whole supply chain partners is the most important factor to share accurate information and establish effective and efficient supply chain management practices. If managed well, a reduction in system wide costs can be achieved, let alone increase customer service level and satisfaction.

4.6.6 Value of information sharing

Information flow and its visibility both within the firm and extending along its supply chains is perhaps the most crucial process component for firms proactively managing their supply chains. The value of information flow for the firm and its supply chain trading partners cannot be stressed enough, and the technologies and products available to help supply chains manage this information are immense and growing rapidly (Wisner *et al*., 2008). Information sharing is an important component of cooperation in supply chain management to mitigate bullwhip effect. Looking at information flow direction, the inventory information sharing and production plan information sharing is a two-way communication between the downstream and upstream organisations in the supply chain. According to Li *et al*., (2005:34-46) "the sale information sharing and demand forecasting information sharing are the flows from downstream companies to the upstream partners.

The order state information is provided by upstream organisations to their partners and information about retailers' daily inventory states, and customers' daily demand change should constitute a case of complete real-time information sharing visibility". Gavirneni *et al*., (1999), Cachon and Fisher (2000) and Moinzadeh (2002) focus on how information can be used to improve supply chain performance benefits and the conditions in which information is most valuable. Chen and Yu (2005:144) consider cases where information such as available supplier capacity and lead time is shared forward in the supply chain so that customers can reduce supply uncertainty while Ferguson and Ketzenburg (2006:57-73) address the value of a supplier sharing the age of its inventory with a retailer to improve replenishment decisions for a perishable product. The degree of visibility, transparency and synchronisation requires a high level of process alignment, which in itself demands higher levels of collaborative working.

The supply chain process needs to be linked on both stream sites to provide the foundation of supply chain synchronisation based upon the value-added exchange of information of extended enterprise and virtual enterprise as series of relationships among supply chain partners (Christopher, 2011).Information sharing among the firms is believed to enable better coordination in the supply chain, which eventually leads to lower costs for the entire supply chain. Ng *et al*., (2003:449-457) develop three scenarios of information exchange as the value of information sharing such as echelon demand history, end-user demand, and downstream order schedule. In assessing the value of information sharing for a particular supply chain operating under different combinations of system parameters, the decision maker has to assess several performance measures simultaneously and determine the value of information sharing for a particular combination of system parameters.

4.6.7 Information sharing and trust in supply chain relationships

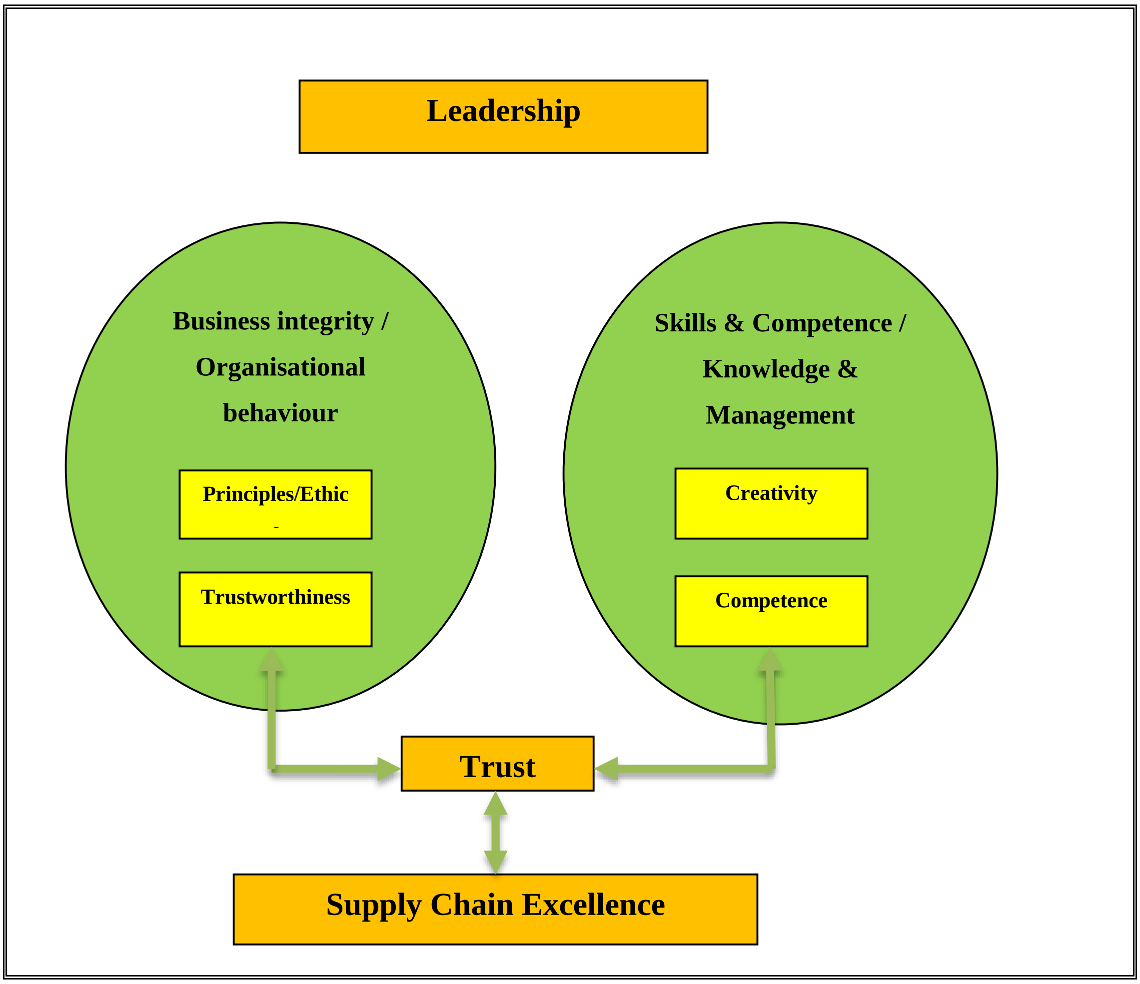
It is an essential requirement for a successful supply chain to have an effective integrated supply chain planning network that is based on shared information and meritorious degree of trust among partners. According to Kwon and Suh, 2004:4) a firm's trust in its supply chain partners is highly and positively related to perceived satisfaction, the partners' reputations in the market, and communication, while Chu and Fang (2006:224) claim that a partner's perceived conflict leads to a strong negative impact on trust. Although Anderson and Narus (1990:45) refer to trust as a "firm's belief in another company"; the performance actions should result in positive supply chain outcomes for enterprise integrated networks as well as not taking unexpected actions that result in negative supply chain outcomes.

Morgan and Hunt (1994:20-38) define trust as “a firm’s belief in its partner’s trustworthiness and integrity while commitment is interpreted as an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it by expressing an enduring desire to maintain a valued relationship”. Trust and commitment result in “greater openness between trading supply chain partners and much information sharing and as a result greater knowledge for each other’s contribution to the relationship”, and open information sharing and continuous inter- and intra-improvements are requirements for success collaboration (Li *et al.*, 2006; Dong *et al*., 2007; Wu *et al*., 2009).

Gounaris (2005:126) stresses that “both trust and commitment should stimulate a relational bond between the supplier and customer”, which facilitates the establishment of productive collaborations, while Gao *et al*., (2005:397) substantiate that if suppliers demonstrate trust and commitment in their contracts, the organisational buyers are likely to perceive less uncertainty in their purchase decisions. These viewpoints, (Gounaris, 2005; Gao *et al*., 2005) have the same conclusion asthat of Morgan and Hunt (1994) that when commitment and trust simultaneously rather than unitarily exist, it may enhance the efficiency, productiveness and effectiveness of successful supply chain performance. If the inter- and intra-organisational trustworthy relationships tend to be characterised by the nature of the commitment to the supply chain integrated network and mutually recognised and acknowledged collaboration (Daugherty, 2011:16).

The guiding principle is willingness to share real-time information on future strategic initiatives among supply chain participants to collectively meet customer demands faster and more efficiently while reducing risks related to inventory positioning. According to Bowersox *et al*., (2013:17) “the information sharing paradigm as the widespread belief should achieve a high degree of active cooperative behaviour requirements to which supply chain participants voluntarily share operating information beyond the scope of cross-enterprise collaboration and jointly plan strategies on extended enterprise integration on supply chain performance benefit, risk sharing, trust, leadership and conflict resolution”. Sometimes, the effective real-time information sharing is dependent on a high degree trust that commences within the firm and ultimately extends to supply chain partners.

Figure 4.4: Building trust in supplier relationships



Source: Van Weele, A.J. (2010). *Purchasing and Supply chain management.* 5th Ed., United Kingdom: Cengage Learning EMEA, pp. 395.

Figure 4.4 indicates that trading supply chain partners need to work both on competence and trustworthiness to generate trust. Van Weele (2010:394) suggests that "trust can be generated if company staff acts in a consistent and reliable manner while trustworthiness primarily stress from ethical principles and consistent organisational behaviour and integrity". Supply chain integration and trust in information sharing are built upon constructive, long-term supplier relationships among trading supply chain partners. The statement of supply chain excellence (figure 4.4) requires a fair degree of trust among the supply chain parties involved, and consistency and reliability in the way the company staff manages operations and behaves honestly towards external supply chain partners.

Bowersox *et al*., (2013:353-354) distinguish between dimensional forms of trust: "Reliability-based trust is grounded in an organisational perception of the potential partner's actual behaviour and operating performance where the partner is willing to perform and capable of performing as promised under trustworthy relationships. While character-based is based in an organisation's culture, leadership and philosophy considering the action's impact on the other". Although it might be unlikely to be trusted in character, the acts of fair and equitability with each other would mitigate silo-oriented behaviour among the supply chain partners to ameliorate the impact of bullwhip effect.

Komaik and Benbasat (2004:181), and Paul and McDaniel (2004) identify four types of trust that have the highest potential for explaining organisational-level performance impacts and coordination differences within supply chain relationships such as calculative trust, competence trust, trust in integrity and trust in predictability. "Competence trust develops when the skills needed to perform a task reside across partners, and the level of search is undertaken by one party, for those skills before selecting the right partner to enter into such a relationship (Heffernon, 2004). Integrity is based on experience from interpersonal relationships between the trustee and the trustor and more specifically on their perceptions of each other's past behavior. Integrity is important in a supply chain because of the presence of numerous players with sometimes, conflicting goals and the existence of written and oral promises to be fulfilled (Komaik and Benbasat, 2004; Ghosh and Fedorowics, 2008).

Predictability reflects the trustor's belief that a trustee's actions (good or bad) are consistent enough that it can be forecasted in a given situation. It is based on the premise that organisations are consistent, stable, and predictable in relation to past patterns of behavior". According to Komiak and Benbasat (2004:205) relationship development explained by this type of trust "depends on an ability to predict outcomes with a high probability of success, which is a key to the effective and uninterrupted operation of a supply chain".

Although the relationships among supply chain participants differ in their intensity and the extent of real collaboration, building trust in full and frank sharing of information is necessary for the effective functioning of the relationship (Bowersox *et al*., 2013:354). Thus, greater relationship commitment exists in supply chain relationship when leaders exercise power, leadership and cooperation in the form of rewards and expertise to management conflict and risk in the trustworthy relationship (Van Weel, 2010; Bowersox *et al*., 2013).

4.7 Supply Chain Collaboration Approaches

Close collaboration on real-time information sharing enhances inventory levels and positioning while fulfilling customer needs with trustworthy relationships (Barratt and Oliveira, 2001; Whipple et al., 2002; Simatupang and Sridharan, 2004). Decision synchronisation and incentive alignment influence better responsiveness performance (Fisher, 1997, Narus and Anderson, 1996), while information sharing has a moderate effect on responsiveness. According to Simatupang *et al*., (2005:44) it appears that responsiveness depends more on how the chain members share information to control or execute supply chain process and less on information sharing at the planning level. Finley and Srikanth (2005:31) suggest that a "successful supply chain collaboration requires strategic alignment within a unified channel among contiguous supply chain participants. These partners should apply quasi-real-time interconnectivity and channel-wide metrics focused on downstream demand to enable the delivery of tangible business performance benefits".

This statement describes collaboration as diverse entities working together, sharing processes, technologies and data to maximise value-added for the whole supply chain group and the customers they serve. Although most companies are structured to focus on their core competencies and collaborate with partners on capabilities that are not core, effective collaboration is still in its infancy (Finley *et al*., 2005). Bowersox *et al*., (2013:358) advocate the application of integrative principles that "allow multiple functions (to a certain degree with supply chain businesses) to be synchronised into value-creating competencies" to meet increasingly broad and demanding customer expectations future demand on ameliorated bullwhip effect.

When visibility of future demand is lacking, an interesting phenomenon (bullwhip effect) occurs as each partner in the supply chain tries to predict what is needed to support the end user or consumer demand (Lummus, Duclos and Vokurka, 2003). Lacking visibility of true end user or consumer demand, an amplification of the predicted demand is created (Ireland *et al*., 2005). A consequence of the bullwhip effect is assumed wasted supply chain opportunities and money. According to Ireland and Bruce (2000) the financial impact of the bullwhip effect is what is motivating companies to focus on supply chain interconnectivity. Many companies are developing a supply chain transformation strategy with supply chain collaborative relationships on quasi-real-time information sharing as an underlying supply chain strategic transformation.

Mclvor and Humphreys (2002:192) contend that “supply chain collaboration is described in simplistic terms, thus making the potential supply chain performance benefits appear easy to achieve when, in actuality, they are difficult to achieve”. Elmiliani (2003:107) attributes supply chain collaboration complexities on performance benefits to “the supply chain conflict between suppliers and retailers that is inevitable”. Davies (2006:34) describes two types of collaborative relationships in the supermarket supply chain with different operational and commercial characteristics:

Firstly, adversarial collaborative relationships entail the buyer working collaboratively with the supplier at an operational level to increase value, but competing with them commercially, to appropriate for themselves as much of this value as possible. Secondly, non-adversarial collaborative relationships entail close operational working and the equitable sharing of value at the commercial level. This strategic integration is likely to occur in situations where the buyer and supplier are interdependent. Heikkila (2002:747) recommends “the dependence of one company on a partner that refers to the firm’s need to maintain a relationship with partner in order to achieve mutual goals”, and Bowersox *et al*., (2013:354) interpret this relationship as the perceptive partner’s willingness to perform and capability to perfom as promised also known as reliability-based trust on supply chain collaborative relationships. According to Sheu *et al*., (2006:24) “high interdependence motivates willingness to negotiate functional transfer, share key information, and participate in joint operational planning”.

The continuous seamless collaboration and integration of organisations should lead to higher levels of trust however, Davies (2006:24) interprets trust as “a reduction of uncertainty in terms of being a useful component towards understanding collaborative relationships, but trust as an altruistic, unconditional concept is not particularly helpful in a business context”. These “close relationships, anchored in trust, commitment and loyalty between supply chain partners, assure the deployment of joint initiatives to maximise the flexibility of the supply chain as a whole” (Chang *et al*., 2005:1115-1132).

4.7.1 Collaborative Antagonism and Benchmarking

A considerable antagonism exists among retailing supply chain members due to mutual distrust and relationship difficulties before and during collaboration (Simatupang and Sridharan, 2002), and the commitment relationship, sometimes, develops supplier incentives that work on behalf of the buyer. Similarly, the buyer needs to make themselves attractive to the supplier by offering access to profitable markets with regular demand and/or increasing competition in the supply market through extending visibility and choice.

The collaborative supply chains need to identify the highest standards of excellence in customer services and processes and implement necessary improvements to match or exceed these standards (Simatupang and Sridharan, 2004). According to Camp (1995) benchmarking is defined as “the process of analysing the best products or processes of leading competitors in the same industry or leading companies in other industries”. Bowersox *et al*., 2013:377) define benchmarking as “a critical aspect of supply chain performance measurement that makes management aware of state-of-art business supply chain performance practice, it is adopted as supply chain tool to assess operations (many firms do not benchmark processes) in relation to these leading firms, both competitors and non-competitors, in related and nonrelated industries”. Benchmarking is an essential tool in the supply chain performance assessment of an organisation. Zairi (1996) infers that “the focal company gains an understanding of the appropriate performance level and drivers behind the success”.

Several research studies relate benchmarking schemes for specific single company and interorganisational levels in the supply chain (Hanman, 1997; Gilmour, 1999; Bowersox *et al*., 2000; van Landeghem and Persoons, 2001; Collioni and Billington, 2001). These collaborative efforts, which focused on co-managed inventory by considering different levels of demand uncertainty, enabled both parties to improve frequencies of fill rate, increase inventory turnover, and enhance sales (Barratt and Oliveira, 2001; Simatupang *et al*., 2004).
The focus on benchmarking shifts from a single company to an inter-organisational level, and Christopher (2011:237) argues that “supply chain benchmarking includes joint practices and achievements of the chain members in the supply chain”. Stewart (1997:62) provided the development of the supply chain operations reference (SCOR) model, and Geary and Zonnenberg (2000:42) “employ the SCOR model to show that the best-in-class performers gained considerable financial and operating advantages over the rest of the respective groups”.

Randas and Spekman (2000:3-21) on using system-wide revenues and costs, examined collaborative practices between high performers among innovative product supply chains and high performers among functional products supply chains. Functional products are associated with slow product clock speed, predictable demand and low profit margins; while innovative products are associated with fast product clock speed, unpredictable demand and high profit margins (Simchi-Levi *et al*., 2008). According to Sheu *et al*., (2006:24) "a supplier-retailer pair with specific level of collaboration can be gauged through interdependence, duration, trust, long-term orientation, inventory systems, IT capabilities, supply chain coordination structure, and communication/information sharing". The common theme is that electronically mediated exchange supports inter-organisational collaboration by facilitating interaction and dissemination of information at all organisational levels (Nohria and Eccles, 1992; Kulchitsky, 1997).

A research study by Myhr and Spekman (2005:179-186) reveals that "electronically mediated exchange is a more salient determinant of collaboration in supply chain relationships involving exchanges of standardised products while trust is more of a factor in achieving collaboration in exchanges involving customised products". It appears that trust seems to establish a base-line level of collaboration that is enhanced and reinforced through the use of electronically mediated exchange. Although, Morgan and Hunt (1994:20-38) argue that "constant communication is essential to help foster and build trust. Myhr *et al*., (2005:179) maintain that by constant interaction and information sharing via electronically mediated exchange", partners experience a closer bond and this serves to re-enforce trust that contributes to collaboration.

4.7.2 Collaboration Planning Forecasting and Replenishment (CPFR) Model

The supply chain collaboration and close relationships anchored by trust and commitment among chain members should epitomise the daily contact between the supply chain analyst and the supplier to agree forecasts, plan promotions and jointly place purchase orders. CPFR should be one part of a larger collaborative supplier strategy to mitigate demand volatility. The grocery industry has the propensity to successfully implement collaboration with the right corporate culture, processes, training and secure Internet-supported IT systems. Just-in-time (JIT) and vendor managed inventory (VMI) are often used by retail business as supply chain strategies to link replenishment, distribution, transport, and logistics in a quick-response mechanism.

Chang *et al*., (2007:200-209) argue that "these methods do no more than collate information among businesses, rather than promoting integrated cross-enterprise strategies and real process collaboration". The Voluntary Inter-industry Commerce Standard (VICS) (1998) proposed a model entitled "Collaborative, planning, forecasting and replenishment" (CPFR), with a view to integrating the supply-side and the demand-side, thus enabling the collective creation of an effective environment to meet consumer demands. In a retail-oriented supply chain, the so-called "bullwhip effect" (that is, the magnification of demand fluctuations as orders move up a supply chain) is often initiated when changes in market demand cause forecasting inaccuracies. This distortion of the demand picture imposes high supply chain costs in the form of suboptimal customer service levels, high inventories and low returns on assets. In response, Chang *et al*., (2007) suggested that many enterprises have implemented cross-enterprise operational models such as JIT, VMI and CPFR in an attempt to reduce the bullwhip effect in their supply chains. Table 4.3 presents literature that have been reviewed on CPFR (Chang *et al*., (2007:200-209):

Table 4.4: Literature review on CPFR

Authors	Literature
VICS (1998)	Attention to CPFR-related issues
Williams (1999(Procter & Gamble	Create value for the corporation, trade partners, and consumers
Foote and Malini (2001)	The incorporation of Data Warehouse with Walmart in CPFR enabled more accurate forecasting of operational processes
Barratt and Oliveira (2001)	Identified the potential difficulties that can arise in the implementation of CPFR and proposed five possible solutions to the identified difficulties.
Holmstrom *et al*., (2002)	Retailers can use existing item-management information for forecasting after implementing CPFR. Whereby, better methods of replenishment (such as VMI, transport planning, and software) can assist in implementing a more integrated CPFR model
Albright (2002)	CPFR implementation can reduce inventory levels, increase sales, and improve trade partnerships.
Sagar (2003)	Reviewed Whirlpool Corporation implementation of CPFR in 2000, and found that it significantly enhanced sales forecasting between the company and its suppliers
Steerman (2003)	The case of Sears, a major American retailer, and its supplier, Michelin, who collaborated in applying the CPFR model in 2001 – producing a reduction in their inventory level of 25 per cent.
Esper and Williams (2003)	Discovered in a case study, by implementing CPFR, collaborative transportation management (CTM) could bring about better outcomes and profits.
Barratt and Oliveira (2001)	Contended that CPFR could decrease inventory levels substantially
Sherman (1998)	The model could increase sales, improve management, enhance operational benefits, raise cash flow, and boost return on assets.
Fliedner (2003)	CPFR would become an indispensable instrument in any future supply chain

Source: Compiled by the researcher from the listed literature review.

Although the literature emphasises the application and benefits of CPFR, Chang *et al*., (2007) note that there is a lack of research into how a business might integrate other models with CPFR with a view to reducing the bullwhip effect. The study is attempting to investigate the capabilities of the CPFR model as the integrated cross-enterprise model using the electronic systems to mitigate the consumer order variability amplified in the supply chain. The study aims to discover the CPFR model that will enable an earlier detection and forecasting of demand fluctuations in the market, thus facilitating adjustments in sales forecast data and replenishment quantities to reduce the bullwhip effect. In other words, the CPFR represents the paradigm-breaking business model, that extends VMI principles by taking a holistic approach to supply chain management among a network of trading partners. CPFR has the potential to deliver increased sales, organisational streamlining and alignment, administrative and operational efficiency, improved cash flow, and improved return-on-assets (ROA) performance.

Table 4.5: Evolving dimensions of CPFR system

Dimensions	Basic CPFR	Developed CPFR	Advanced CPFR
Definition	It involves few key business processes and a limited integration with trading partners. Partners enter into collaborative relation based on exchange of stock level data.	It is characterised by increased integration in several collaboration areas. A network approach that "focuses primarily on frequent exchange of information and generation of trust in the relationships for improved client service to increase trade".	This collaboration deals with synchronising the dialogue between the parties. It is expanded to coordinate processes within forecasting, "replenishment and planning. The approach is combined with a resource-based and competency perspective".
Shared Information	Sales orders and confirmation, and Inventory data.	Demand data, order planning data, promotion data and production data.	"Demand data, order planning data, promotion and production data".
Type of relationship	Transactional	Information sharing	Mutual learning
Theoretical explanation	Transaction theoretical approach to collaboration	Network approach (frequent information exchange and trust in the relationships)	Resource- and competence-based approach.
Efficient governance structures (Occasional)	Non-Specific Investment: Market governance (classic contract)	Mixed Investment: Trilateral governance (neoclassic contract)	Idiosyncratic Investment: Trilateral
Efficient governance structures (Recurrent)	Non-Specific Investment: Market governance	Mixed Investment: Bilateral governance	Idiosyncratic Investment: Unified governance

Sources: Williamson, O.E. (1985). *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*. New York: The Free Press; Skjoett-Larsen, T, Thernoe, C and Andresen, C (2003). "Supply chain collaboration: Theoretical perspectives and empirical evidence". *International Journal of Physical Distribution and Logistics Management*. 33(6), 531-549.

“The level of the costs depends on three characteristics related to the transactions: the level of uncertainty under which the transaction is carried out, the frequency of the transactions and the degree of asset specificity (Williamson, 1985). Because the transaction cost theory implies the risk of opportunistic behaviour, there will always be uncertainty. If actors act opportunistically, it means that their actions might be based on their own interests in a conflict of goals, perhaps by cheating or retaining information. Table 4.5 identifies the dimensions of frequency and degree of asset-specific investments, where the parties want to develop a closer form of collaboration on a high frequency of transactions between the parties.

The investment in idiosyncratic assets between the collaboration partners functions as a safeguard, ensuring that none of the partners will act in an opportunistic way. Basic CPFR-relation: the investments are not very specific and might often be applied to other relations, whereby the investments may be simple technical data exchanging programmes that are only geared to deal with a limited amount of data. According to Williamson (1985) “the governance structure will be managed through market regulations (or classical contract)”.

Table 4.5 describes the following:
“Developed and advanced CPFR: the investments for both parties will be greater owing to the high level of information exchange. According to Skjoett-Larsen *el al*., (2003:531-549) there is “hard investment” (investments in material resources that can only be applied to one CPFR-relation such as technical investments – IT-software to carry out a specific CPFR-collaboration), and “soft investments” (which are more intangible, but extremely important, are investments in human resources). The bilateral and unified governance structures on developed and advanced CPFR respectively imply that the parties are fairly integrated and a joint spirit of collaboration exists, which will keep the parties from acting opportunistically”.

Generally, CPFR works best where the focus is on long-term relationships involving highly differentiated products with limited sources of supply (Skjoett-Larsen *et al*., 2003). According to Noekkentved (2000), implementation considerations are primarily monitored by trust relationships, power and exception-based management. Barratt and Oliviera (2001:266-289) found that “enablers of the CPFR process involved defining the agenda for collaboration in terms of stabilising the collaborative goals, expanding the collaborative projects in terms of complexity and scope, and trust in the relationship and ensuring information sharing”.

Scheraga (2002:83) argues that there are "cultural biases against information sharing as an impediment to collaborative progress that traditionally, retailers and suppliers just don't like to share supply chain information with each other. They are more inclined to guard that valuable data than to give it away, even when sharing it would be in their own best interest".

Holmstrom *et al.*, (2002:136-145) suggest that "collaborative planning will only be successful if it involves very little extra work for the retailers. The goal must be solutions that enable mass collaboration in order to obtain economies of scale". While it is quite useful for a retailer to share information with its upstream suppliers, it also can be useful for a supplier to share information on availability with its downstream retailers. It also can be useful to share information when the supplier knows that a capacity shortage will not occur, thereby preventing a shortage game.

Chapter Five

Electronic Supply Chain Management (e-SCM)

5.1 Introduction

The contemporary business environment reveals that competition is "no longer between organisations, but between supply chains" (Heizer and Render, 2008; Wu and Chuang, 2010). By the same token, business organisations are increasingly learning that firms must compete, "as part of a supply chain against other supply chains", to rapidly reflect customer's changing demands (Cigolini *et al.*, 2004:32). The improvements in electronic systems facilitate the integration of business performance processes, and link it to chain networks (Zhao *et al*., 2002; Sebastian and Lambert, 2003). The coordination of information sharing on demand orders and seamless interconnectivity on order replenishment frequencies seems to have an influence on performance benefits, in terms of both total cost reduction and improved service level. In the exploratory study of factors continuity of efficient cooperative electronic supply chain relationship, and Yeh (2005:327-335) "discovers two dimensions; firstly, resource dependence, trust and relationship commitment are positively related to the continuity of the cooperative electronic relationship; and secondly, risk perception is negatively related to the continuity of the cooperative electronic relationship".

These viewpoints buoy up the willingness of suppliers to collaborate, while encouraging members in the network to invest in resourceful facilities and procedural reform, and electronic supply chain diffusion systems to enhance their competitive edge (Yeh, 2005). In the broader collaborative relationships between participants (Smith *et al.*, 2007:2595) they "uphold the degrees of communication, trust, and interdependence, which result in creating more stable transactions and reducing certain levels of uncertainty and risk in the market". According to Evans and Collier (2007:159) "Business Intelligence Systems (BIS) consolidate data from across the organisation and allows companies to integrate information into a common database for easy access and analysis". The concept of supply chain management provides effective coordination on material, subassembly, product, delivery and payment flows between enterprises and trading partners (Ruppel, 2004; van der Zee and van der Vorst, 2005; Wu and Chuang, 2010).

While supply chain information technology (IT) can be utilised as an important active communication tool to make the deployment feasible (Lin and Lin, 2006:313), firms strive to improve the flexibility and customer demand responsiveness in the dynamic market (Gunasekaran and Ngai, 2005), and a seamless integrated network of key business processes from end users should embrace e-SCM diffusion as an open collaborative system. The e-SCM diffusion "involves both internal diffusion among functional units within an organisation and external diffusion across a large number of inter-organisational trading partners" (Smith, *et al*., 2007:2595). In an operationally defined three diffusion stages, Wu and Chang (2012:476) examine "e-SCM diffusion: 1) Adoption is defined as the extent to which a decision requires being made for the use of e-SCM and a preparation needs to be initiated for the redesign of business process; 2) Internal diffusion refers to the extent to which e-SCM is used to support key internal organizational activities of the firm; 3) External diffusion indicates the extent to which the firm has integrated its trading partners by e-SCM to perform transactions with them".

In the active cooperation level of sharing mutual performance benefits, Rogers (2003) defines innovation diffusion theory (IDT), in terms of adoption and implementation, as "a theory to understand the diffusion of an innovation across time, and it is primarily to explore how a diffusion process with multiple stages is guided and affected by changes in related variables over time". Wu and Chang (2012:475) explain further that "the adoption stage describes sub-stages of knowledge acquisition, persuasion and learning, and decision, leading to the actual adoption decision. The implementation stage comprises activities of preparation of changes to task structure, task process, and technology necessary for innovation deployment".

Wu and Chuang (2009) find that "when the firms face environmental uncertainty in the market", firms will adopt e-SCM to improve information exchange and reduce uncertainty between trading partners. The design of e-SCM is "built with useful functions and a user-friendly interface", and is the most important concern for the success of initial adoption. This process of diffusion will also initiate trust and a better collaboration relationship to further build an open network in exchanging information all the time. "Greater levels of collaboration relationship significantly expose sensitive and important information to potential risk and thus suggest a greater emphasis should be placed on information security" (Wu and Chuang, 2010:112).

5.2 Electronic Supply chain portal

The electronic supply chain (e-SC) portal allows interconnectivity across the chain network with limited manual processes. Boyson *et al.*, (2003:175) interpret a portal as a gateway in a "site that serves as a starting point for accessing the web and from which the user may access many other sites". Its function is "the collecting of buyers and suppliers to make the transaction easier for the buyer and more efficient for the suppliers" (Hartman and Sifonis, 2000). In other words, it allows all the members in a supply chain network to converge for the purpose of getting quasi-real-time information to make certain decisions, in terms of suppliers giving insight into the inventory levels and customers releasing diverse information and services on secured accessible real-time information.

However, Fraser *et al*., (2000:7-14) focus on a more specific portal where archetypal electronic commerce projects will have front-end disclosure to serve their purpose, in the form of an encryption system to allow proper security performance on financial transactions with template-based capability. Boyson, *et al*., (2003:175-192) outline streamlined portal technology to promote active coordination: "Firstly, the internal operations of the firm on individual classes of internal software with enterprise transactions (represented by vendors such as SAP); secondly, new advanced planning optimisation software (represented by vendors such as 12). and thirdly, collaborative extended enterprise software (as represented by Syncra or Manugistics)". In the synchronised perspective, the portal must provide the integrated configuration in the central hub of the data warehouse, where coordinated exchange of information enhances all transactions inside the firm and across extended enterprises in real-time.

5.3 Defining Electronic supply chain management (e-SCM)

Yao *et al*., (2007:884) describe electronic supply chain management (e-SCM) systems as "one kind of inter-organisational systems (IOS) that enhance communication, coordination and collaboration between trading partners". In other words, e-SCM systems with exchanged information from central hub data warehouse allow "the integration of fragmented, silo-oriented supply chain processes with low cost and rich content" (Rai *et al.,* 2006:225). According to Wu and Chang (2012:474) e-SCM is defined as "the physical implementation of supply chain management process with a support of information technology while also attempting to make a distinction from the concept of supply chain management". "If the e-SCM diffusion between supply chain partners is complex and dynamic in nature, the benefits from e-SCM systems can be disseminated unequally and skewed in favour of members with dominance than dependence members in the chain network" (Subramani, 2004:45-74).

Ke *et al*., (2009:839) investigate "how different types of power exercised by the dominant firm affect the focal firm's e-SCM system adoption through the effects on the focal firm's trust and perceived institutional pressures. Electronically-enabled supply chain management systems allow trading partners to share real-time information on demand, such as inventory and new product ideas". The uncertainty of e-SCM system diffusion has an effect on adopting updated innovation, and the insufficiency of e-SCM system diffusion is regarded as a "major critical failure factor of supply chain management" (Wu and Chang, 2012:103-115).

Yao *et al*., (2007:884-896) survey the perceived benefits derived from electronically-enabled supply chains (e-SC) use and discover that: 1) top management support and external influences are both important determinants of e-SC use in the food industry; 2) perceived benefits to customers, perceived benefits to suppliers, and perceived internally focused benefits are all found to positively influence e-SC use; 3) distributors are more likely to perceive greater customer benefits from e-SC use than manufacturers and retailers. This means that managers involved in developing successful e-SCs should examine both internal and external performance benefits and anticipate that top management support and external pressure from customers and /or suppliers will play a key role in the use of e-SCs. Ke, *et al*., (2009:843) caution that "the exercise of power allows the dominant firm to exert influences on the target firm's decision making and behaviours, and firms use different types of power to lead the target firm to enter into cooperation ties, such as e-SCM system". However, e-SCM systems integrate trading partners at supply chain business performance levels, and enterprises can efficiently derive quasi-real-time information exchange and active coordination. Most importantly, firms collectively take decisions to respond to vacillations in the market and mitigate consumer order demand variability in the upstream supply chain network (Sucky, 2009).

The merger of the Internet and supply chain management offers supply chains an opportunity to create value for the customers. The designs of agile and flexible systems are built around dynamic, high performance networks of electronically-enabled customer and supplier partnerships and critical information flows. In a broader perspective, Ross (2003:18) defines electronic supply chain management as "a tactical and strategic management philosophy that seeks to network the collective productive capacities and resources of intersecting supply channel systems through the application of Internet technologies in the search for innovative solutions and the synchronisation of channel capabilities dedicated to the creation of unique, individualised source of customer value".

In place of a preoccupation with optimising and accelerating the flow of material and information up and downstream sites, electronic-based channel management is concerned with the creation of new forms of customer value for both the internal and external customer (Wu and Chuang, 2010). Ross (2003:19) further defines electronic-enabled supply channel as "the application of Internet technologies focused on the continuous regeneration of networks of businesses empowered to execute superlative, customer-winning value at the lowest cost through the digital, real-time synchronisation of product/service transfer, service needs and demand priorities, vital marketplace information, and logistics delivery capabilities".

In a transvaluation perspective of the tactical and strategic importance of the supply chain, Ross (2003) and Bovet and Martha (2000) describe the power of electronically-enabled supply chains where the Internet allows companies to cheaply and quickly electronically connect all facets of the businesses, from product development to order fulfillment, with every trading partner in the supply chain matrix. Electronic supply chain management (e-SCM) enables the execution of cross-enterprise business performance processes and the integration of trading partner operations (Gounaris *et al.,* 2005; Gao *et al.,* 2005; Yao *et al.,* 2007). It deems to supersede an enterprise-centric supply channel driving multiple processes to a synchronised, superior customer service-driven one by an interconnected single process, quasi-real-time and electronically-enabler, dedicated to a single objective with underlying reliability-based, trustworthy and commitment-based supply chain (Wisner and Stanley, 2008; Van Weele, 2010; Bowersox *et al.,* 2013).

5.4 Semantic Supply Chain Models

Electronic commerce and supply chain management focus on systems and processes to support the flow of information within and between organisations, however the efficiencies of supply chain management are often impaired by inconsistent exchange and sharing of knowledge semantics among supply chain partners. Yang *et al*., (2008:1250) address the problem with semantic integration by developing ontologies of supply chain management (Onto-SCM) as "a common semantic model of the supply chain management domain. The major view is that maintaining semantic consistency of shared quasi-real-time information is crucial for effective information exchange and knowledge sharing between upstream and downstream enterprises in supply chains". Such consistency means that supply chain members need to have a common understanding of the semantic model in the domain.

The semantic view of supply chain management by Russell and Taylor (2003) focuses on managing the flow of goods and services, and information through the supply chain in order to attain the level of synchronisation with an understanding that a responsive model to customer needs could lower total costs and eventually mitigate the phenomenon of bullwhip effect. Fensel *et al*., (2003) interpret the semantic web as specifically machine-readable information whose meaning is well defined by standards with interoperable infrastructure that only global standard protocols can provide.

Durgin and Sherif (2008:49-65) focus on the semantic web where “electronic supply chain management (e-SCM) consists of the same components of supply chain management. In other words, electronic supply consists of the additional networking associated with the functions of the suppliers, producers, distributors, and customers”. The authors suggest that the semantic web can promote the eventual creation of programs that collect electronic content from diverse sources, process the information and exchange the results with other programmes. Business-to-business (B2B) becomes the most important application area of semantic web technology in terms of market volume. Somendra, Sethi and Bhandari (2003:201) maintain that “electronic supply chains require large organisation-wide changes, huge commitment from suppliers and partners, and sophisticated technical infrastructure”.

The understanding is that firms are increasingly embracing integrated electronic-based supply chains because such chains are believed to enhance efficiency and competitiveness. The semantic web project, initiated by Berners-Lee (2001:1-10) the creator of the WWW, has been designed “to make web and knowledge management data more intelligent”. In other words, semantic web searches allow the supply chain partners to search for intelligent data with the web page or data hub that searches to three variables, “Extensible Markup Language (XML), Resource Description Framework (RDF) and universal resource identifier (URI)”.

5.5 Information Technology (IT) in Supply chain (Intranet and Internet)

In terms of electronically-enabled information sharing and data transfer technology in a supply chain network, an Intranet can be extended for use to outside users, customers, partners, suppliers or others outside the company, and is referred to as an Extranet. Greeff and Ghoshal (2004) view these communications and data transfer infrastructures as enabling technologies that allow the sharing of data with the correct interpretation, as needed by the different users in the supply chains. This could be scattered around the globe, up and down stream sites of the supply chain to work as one interconnected organisational network toward a common goal.

Schneider (2009) delineates the benefits of IT in supply chain management as "Internet where suppliers can: 1) share information about changes in customer demand; 2) updated with product design changes and adjustments and provide specifications and drawings more efficiently; 3) increase the speed of processing transactions and reduce the cost of handling transactions; 4) reduce errors in entering transactions data and share information about defect rates and types".

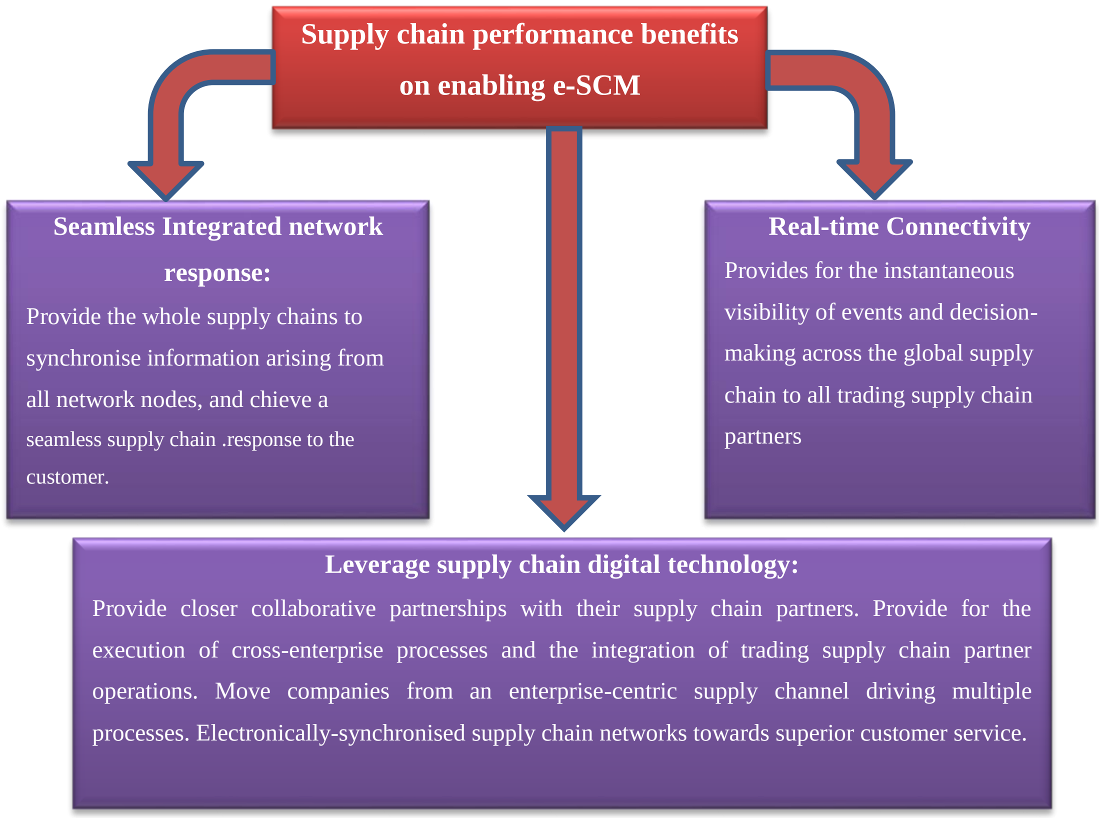
These supply chain enterprises discover opportunities to improve process clock speed, reduction on costs, and improve manufacturing lean to palliate bullwhip effect as a proactive response mechanism to market challenges in terms of quantity, supply risk and consumer demand, however a large investment in technologies and a degree of information sharing must take place across extended enterprises to promote supply alliance. Conversely, enterprises prefer a conventional disclosure process to advance economic information and often perceive that "information disclosure might hurt the firm by placing it at a competitive disadvantage" (Barratt and Oke, 2007; Schneider, 2009; Bowersox *et al*., 2013).

The long-term relationships created among participants in the supply chain are called supply alliances. These strategies will require new e-commerce channels, web-based applications to enable information sharing, and mass customisation applications, but most importantly, an effective order fulfillment process with rapid delivery. Handfield (2002) and Handfield and Nichols (2002) suggest three major developments in global markets and technologies since the information revolution, that is, the proliferation of new communications and computer technology has made real-time, online communications throughout the supply chain a reality.Each of these has fostered the emergence of an integrated supply chain management approach and an interconnected series of organisations, resources, and knowledge streams involved in the creation and delivery of value to end customers.

The ability of a company to communicate electronically will enable it to develop supply networks with traditional players, such as suppliers, manufacturers, distributors, and retailers. It manifests the new breed of dot-com intermediaries, such as virtual/contract manufacturers, service providers, fulfillment specialists, and on-line trading exchanges. Electronically connected supply chains provide the ability to enhance and coordinate supply chain management processes across trading partners. Utilisation of the Internet to realise totally new methods of selling and new sales channels provides an insight into the radical difference between e-SCM and business models.

The goal is to align the core capabilities of available channel partners with the product and service needs and priorities of customers anywhere in the supply chain (Ross, 2003). Establishing effective e-SCM in a supply channel ecosystem will require network trading partners to create channel structures, integrated planning and control, and information architectures capable of promoting continuous channel synchronisation through collaborative design (Gattorna and Berger, 2001). Electronic supply chain management requires that the companies understand the function of enabling Internet-driven information in the supply chain (Ross, 2003). The supply chain performance benefits from the effects of the enabling potential of e-SCM.

Figure 5.1: Supply chain performance benefits on e-SCM systems

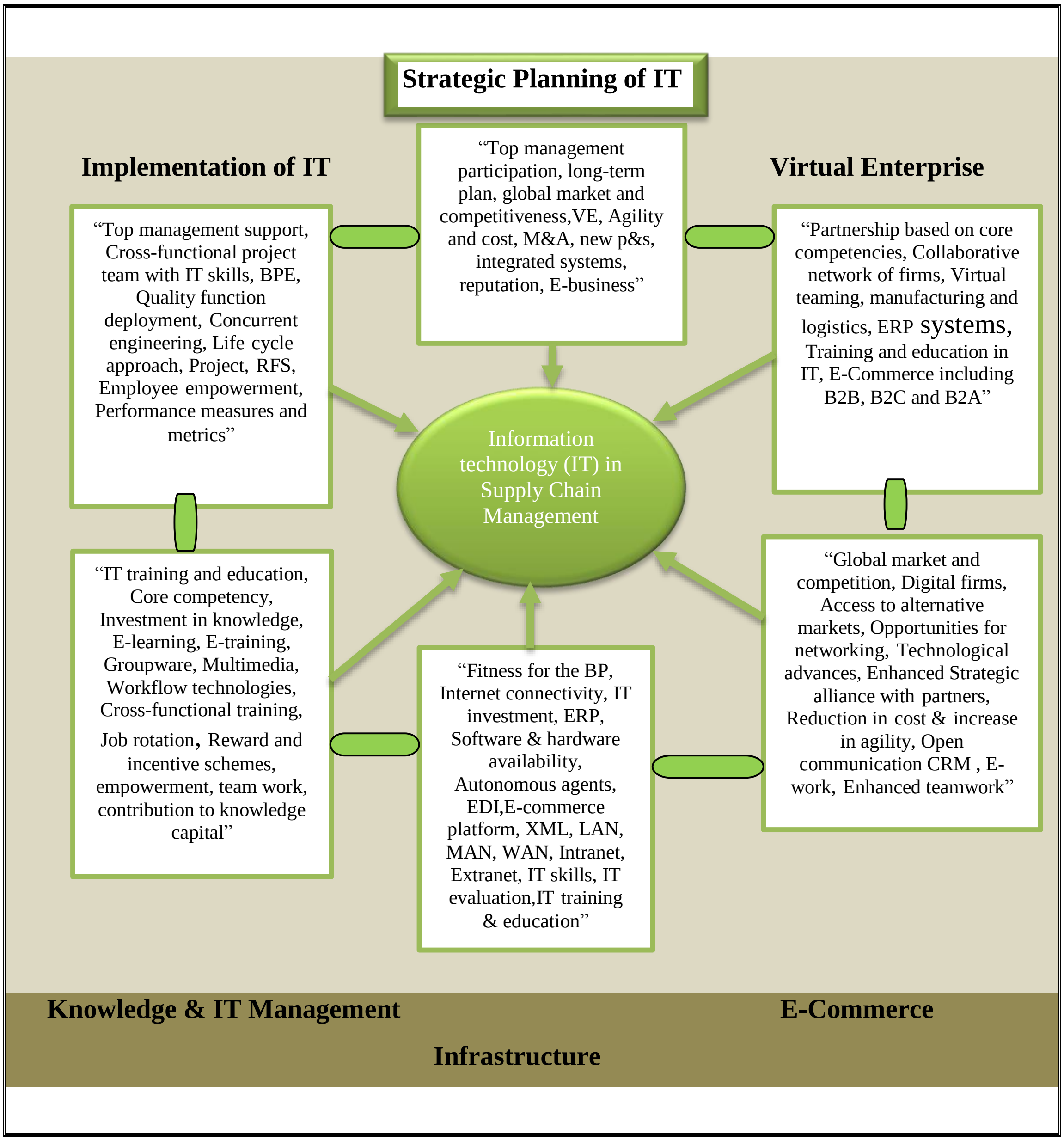


Source: Compiled by the researcher from the e-SCM perspective

Kehoe and Boughton (2001:582) alert managers that using electronic-based information transfer, located at a central hub will replace the traditional linear movement of information within supply chains, thereby, facilitating a more interactive approach to supply chain partnering. Muffatto and Payaro (2004:295-311) suggest that "e-SCM systems should provide the opportunity for visible demand data and supply capacity to all companies within a supply chain while changing the role and type of relationships between the supply chain members, creating new value networks and developing new business model". The e-SCM systems should allow in-stock availability and prices to be communicated from the wholesaler to the retailer, and orders can be placed in real-time from the retailer to the with reduced consumer demand variability.

Eventually the e-SCM should better integrate the virtual value-chain activities that focus on the consumption cycle commencing from product process design to the customer accommodation stage of logistics. Gunasekaran and Ngai (2005:423) advocate that "supply chain management emphasises the overall integration and long-term benefit of all parties on the value chain through cooperation and information sharing". These signify active supply chain communication, usefulness of e-SCM and the application of IT in supply chain management, and seemingly palliate the variability on consumer demand ordering (Yu *et al*., 2001; Barratt and Barratt, 2011).

Figure 5.2: A framework for the development of IT for effective supply chain management



Source: Gunasekaran, A. and Ngai. E.W.T (2004). 'Information systems in supply chain integration and management'. *European Journal of Operations Research*, 159(2) 269-295

Gunasekaran and Ngai (2004:269-295) classify these major components of IT-enabled supply chain management to achieve better strategic planning, successful implementation and seamless value-creating virtual enterprises. The IT-enabling SCM systems have long-term implications on the supply chain performance benefits and strategically-based on capabilities with the purpose of dealing with dynamic markets (Christiaanse and Kumar, 2000; van Hooft and Stegwee, 2001). These supply chain performance benefits and sustainable competencies should promote cross-functional cooperation as well as extended cross-enterprise integration to achieve system flexibility, responsiveness and global optimisation, to curb the amplified order variability traveling upstream the supply chain.

The virtual enterprise (VE) is closely linked with the agility system in a supply chain network, however, the prevailing challenge exists in the development of VE without IT (Black and Edwards, 2000; van Hoek, 2001; Turowski 2002). The e-SCM facilitates active inter- and intra-organisational communication by exchanging real-time consumer demand information and, in turn, reduces cycle times and develops better collaborative processes to mitigate demand order variability (Overby and Min, 2001; Emiliani and Stec, 2001; Murillo, 2001). The virtual integrated enterprise network requires "a dense networking infrastructure to support digital communications" among supply chain partners to encourage more integrated levels of e-SCM systems adoption (Au and Ho, 2002, Sharma and Gupta, 2002, Yamaya *et al*, 2002). "The knowledge and IT management further requires a systematic and innovative approaches for educating and training workers in teamwork" (Tracey and Smith-Doerflein, 2001:99).

While van Hoek (2001:21) recommends knowledge and real-time information about "market and customer expectations should be acquired with electronic-based information system to comprehend the demand order status from downstream site and production capacity from upstream site of the supply chain network". In proper implementation and planning, an electronic supply chain design will require business process reengineering (BPR) to eliminate the no-value-added activities such as the speed, information processing capabilities and interconnectivity of seamless process network increase the efficiency of business process performances and active communications in the e-SCM systems.

5.6 Electronic Supply Chain Design (e-SCD)

Information technology (IT) is linked with integration and active coordination to enhance the levels of responsiveness and flexibility while aligning diffusion with technology clock speed. Kim and Im (2002) imply that the fundamental impact of IT on supply chain performance can be achieved "when the network is evolved from a network for data exchange into knowledge sharing space". In other words, the impact of IT on supply chain is more about knowledge sharing and product development than a cost savings exercise.

The transformation of the electronic supply chain network into a proper designed "knowledge-sharing network through the information intermediation and integration effects" achieves efficient customisation and better management of suppliers (Briant, 2000), while Kim and Im (2002) describe electronic Supply Chain Design (e-SCD) as "a supply chain design to integrate and coordinate suppliers, manufacturers, logistic channels, and customers using information technology to build an electronic supply chain network (e-SCN) for transactions in virtual space". The authors conceptualise the effects of e-SCD along three dimensions:

"Firstly, linkage effect of e-SCD: once the electronic network on transaction and information sharing for business-to-business takes place, the efficiencies between manufacturers and suppliers will increase instantly. Thus the competition will press down the procurement costs of the manufacturer in the short-term, and competition among suppliers will intensify. Secondly, involvement of suppliers: customised investments of the suppliers transform the electronic supply chain network from a network for simple information exchange into a network for customised product development (Burt, Dobler and Starling, 2007). As the customised investment and suppliers' involvement increases, the electronic supply chain networks will evolve from a network for electronic data exchange into a network for knowledge sharing, information sharing and integration. Thirdly, knowledge creation: as the participants invest and involve more in the supply chain, the supply chain partners share more knowledge and coordinate more of their activities to optimise the whole supply chain".

A research study by Malone *et al.*, (1987:484-497) categorise the effects of the electronic market: 1) electronic communication effect (where IT allows faster and cheaper communication); 2) electronic brokerage effect (where electronically-connected network of many different potential suppliers quickly, while the broker reduces the need for buyers and suppliers to contact a large number of alternative partners individually); and 3) electronic effect with tighter coupling of the processes of information creation and use.

The organisations in an electronic supply chain network should therefore be able to share and create knowledge through the information exchange, brokerage, and integration cycle. Electronic supply chain design builds the high-speed communication infrastructure among companies inside the supply chain based on the information technology and the shared information (Kim *et al*., 2002).

5.7 Electronic integrated supply chain systems

Systems integration should support the facets of organisations in terms of flexibility, agility, efficiency and quality to meet the consumer demand, shorten lead-times and provide excellent customer service by mitigating the oscillator effect. Camarinha-Matos and Afsarmanesh (2002:439) define integration as "the process through which individuals of a lower order get together to form individuals of a higher order and also, to integrate is to make it a whole, to complete". Integration implies the creation of proper conditions for various components (independently of the level of autonomy) to be able to dialogue, link, collaborate and cooperate in order to achieve the goals of the supply chain system. Although supply chain collaboration and integration were used interchangeably as "tight coupling process between supply chain partners" (Cao and Zhang, 2011:163-180), supply chain integration means "the unified control (or ownership) of several successive or similar process formerly carried on independently" (Flynn *et al*., 2010:58-71). Yu *et al*., (2010:2891) stress that the "effective supply chain management is not achievable by any single enterprise, but instead requires a virtual entity by faithfully integrating all involved partners, who should come up with the insightful commitment of real-time information sharing and collaborative management".

The efficiency of supply chains can generally be improved by reducing the number of manufacturing stages (Turban, McLean and Wetherbe, 2004). Normally, the challenging problem in a chain network is still bullwhip effect, even "small fluctuations in consumer demand or inventory levels of the final company in the chain are propagated and enlarged throughout the chain" (Forrester, 1961; Holweg and Bicheno, 2002; Jacobs and Chase, 2008; Simchi-Levi *et al*., 2008). However, systems integration is a complex process facing a number of obstacles (Camarinha-Matos *et al*., 2002), such as heterogeneity (dimension/scope, abstraction levels, and supporting technologies), distribution (physical/geographical), autonomy (legacy systems without global optimisation/systems or sociable), continuous and rapid technology evolution and multi-disciplinarity.

Arguably, the diffusion of the "Internet by itself demonstrates no benefits in terms of reduced transaction cost or improved supply chain efficiency" (Wagner, Fillis and Johnasson, 2003), and has "not led to a decrease in the inventory level" (Trkman, 2000), unless supply chain activities are coordinated and integrated (Disney, Naim and Potter, 2004). Bowersox *et al.*, 2013:359) describe supply chain integration in terms of customers, internal processes functionality and suppliers as "a demonstration of strong commitment to the supportive capabilities of segmentation, relevancy, responsiveness and flexibility. Customer integration develops intimacy with competency to build lasting competitive advantage while competency in supplier integration results from performing the capabilities seamlessly in internal work processes and blending operating processes and activities with those of supply chain partners to meet increasingly broad and demanding customer expectations".

According to the Global Supply Chain Forum, "supply chain management is the integration of key business processes from end user through original suppliers that provide products, services and information that add value for customer and other stakeholder" (Chan and Qi, 2003:209). The effective supply chain management should demonstrate a proactive collaboration between buyer-supplier relationships while integrating the strategic vision and tactical delivery network across the whole supply chain, not just first-tier suppliers (Phipps, 2000; Cox, 2004). The core concept of successful supply chain management is efficient information transfer/ sharing with integrated systems (Simchi-Levi *et al.,* 2008; Wisner and Stanley, 2008), although the maximum efficiency of each chain does not necessarily lead to global optimisation (Gunasekaran, 2004; Simchi-Levi *et al.,* 2008). In the context of local optimisation to serve modern enterprise (Sawhney, 2001; Simchi-Levi *et al.,* 2008) , Pan and Lee (2003) argue that "the functional orientation has tended to reinforce departmental silos within the organisations, resulting in "disparate islands of applications" in which individual systems remained disconnected in supply chain such as e-business, supply chain management and customer relationship management which require close integration of information and process across different parts of the organization". According to Lam (2005:149-157) "the sheer scale of integrating so many different systems also adds to the complexity of the project with the required skills and expertise in integration may also prove to be problematic".

Table 5.1: Dynamics with Integrated systems

Systems	Integrating Dynamics
Vinoski (1997): Common Object Request Broker Architecture (CORBA) provided an open standard for distributed systems to communicate.	CORBA projects were perceived as technically very complex, requiring significant development effort (Henning, 2006).
Davenport (1998): Enterprise Resource Planning (ERP) which involves the replacement of existing systems with a suite of interconnected modular systems from a single vendor, was seen as the solution to the problem of systems integration.	ERP systems tend to coerce organisations into adopting standardised business processes, often resulting in organisational misalignment in which the business rewards of ERP have failed to materialise (Soh, Kien, Boh and Tang, 2003; Ross and Vitale, 2000)
McKeen and Smith (2002): Enterprise Application Integration (EAI) holistically as the plans, methods, and tools aimed at modernising, consolidating, integration and coordinating the computer applications within an enterprise. EAI tools have three main components and Lam (2007) summarises the components as an integration broker, adapters and an underlying to communication infrastructure.	Linthicum (2001) most EAI tools employ a hub-and-spoke or bus arrangement because each system need only be integrated with the integration broker one. EAI significantly reduces the overall number of interfaces that need to be built and maintained, thus avoiding the problem called spaghetti integration.

Source: Compiled by the Researcher from the listed literature review.

5.8 Electronic Business and IT systems in SCM

Complex business networks working together along the value chain are defined by their ability to get products to market with the widest range of consumers at the cheapest cost and fastest speed. According to Burn, Marshall and Barnett (2002:5) “this, in turn, has led to a completely different set of problems for the management of such structures with complex interrelationships, changing paradigms for intermediation, and an emphasis on collaborative competition.” Chen (2004:2) defines electronic business (e-business) as “the conduct of business on the Internet, not only buying and selling but also servicing customers and collaborating with business partners.” Many supply chain partners engage in information sharing so that manufacturers are able to use retailers’ up-to-date sales data to better predict demand and reduce lead times. Simchi-Levi *et al.*, (2008:9) provide distinction between “e-business as a collection models and processes motivated by Internet technology and focusing on improvement of extended enterprise performance, and e-commerce as the ability to perform major commerce transactions electronically, as part of e-business”. In other words, electronic commerce involves the electronic exchange of information or digital content between two or more parties, which results in a monetary exchange (Chen, 2005).

5.8.1 Electronic Data Interchange

An electronic format of order transmission from downstream to the upstream site can be executed by replenishment systems like electronic data interchange (EDI). The National Institute of Standards and Technology (1996) describes the electronic data interchange as "the computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments". It implies that a sequence of formatted messages between supply chain partners, may be transmitted from originator to recipient via telecommunications or physically transported on electronic storage media. According to Mossinkoff and Stockert (2007:90-104) EDI in the context of supply chain management is basically "a tool that allows automated information exchange between supply chain members in the supply (or demand) chain". EDI as an enabling technology, allows different chain tiers to connect information systems in order to achieve a certain level of seamless electronic integration of processes. In supply chains where the participants make use of electronic data interchange (EDI), information sharing is relatively simple in principle, however, the challenge is to achieve the necessary degree of partnering to make it happen (Hopp and Spearman, 2008).

EDI is necessary for a range of industry-initiatives that rely on sharing electronic point-of-sale data with upstream suppliers to increase efficiency by coordinating their production capacity and schedules with the seamless cross-enterprise integrated network. Simchi-Levi *et al*., (2008) note that the food industry introduced a similar initiative called efficient consumer response (ECR) that strives for efficient and responsive replenishments with computer-to-computer exchange of point-of-sale data. Wisner and Stanley (2008:212) advocate that the FMCG industry enhances the efforts to increase efficiency in promotion, new product introductions, and store assortment by, 1) utilising supply chain management to meet ever-increasing uncertainty and complexity of the marketplace, and 2) reducing inventory vacillations throughout the supply chain network to abate the phenomenon of bullwhip effect. The main reasons for successful implementation of electronically-integrated data interchange repose in the echelon-channel leadership position on the supply chain network together with managerial commitment, and the level of engagement on active collaborative replenishment and forecasting, whereas technological responsive readiness seems to be the biggest hurdle to overcome (Quoc and Lawrie, 2005; Mossinkoff and Stockert, 2007). According to Webster (2008) and Wisner and Stanley (2008) "firms are embracing EDI to reduce information lead time cycle times and variable demand order processing cost" as the magnitude of the bullwhip effect is mitigated.

Electronic information integration and bundling allows the flow of information to run parallel to the flow of goods leading to enhanced transparency (availability of electronic point-of-sale (e-POS) data for retailers) and flexibility in the design of supply chains, thereby providing cost absorption and value-added advantages for all involved supply chain partners (Christiaanse and Kumar, 2000; Mossinkoff and Stockert, 2007) in taming bullwhip effect. Electronic integration in some companies goes beyond a mere reduction of administrative costs to include reduction of coordination costs. In other words, operating an EDI programme is becoming increasingly complex in terms of adapting to different protocols to reduce administrative and coordination costs as companies face a wider range of requirements for industry-wide standardisation of communication data and increased planning and exception management capabilities from trading partners in the industry (Mossinkoff and Stockert, 2007; Webster, 2008).

5.8.2 Radio Frequency Identification (RFID)

Electronically-enabled supply chain management is an integrative approach to manage the overall flow of products on frequencies of order replenishment rates, quasi-real-time information sharing and finance on transactional committed orders from the supplier's supplier to the customer's customer to enhance integrated supply chain coordination, and thus reduce the bullwhip effect (Folinas *et al.,* 2004; Chae *et al*., 2005; Miao and Chen, 2005). In dealing with the Forrester effect (1958; 1961), the integration of clockspeed-based flow in a given chain network involves activities such as "the sharing of information about production, inventory level, delivery, shipment, capacity, sales and performance with firms and between supply chain members" (Patnayakuni and Rai, 2002; Li and Lin, 2006).

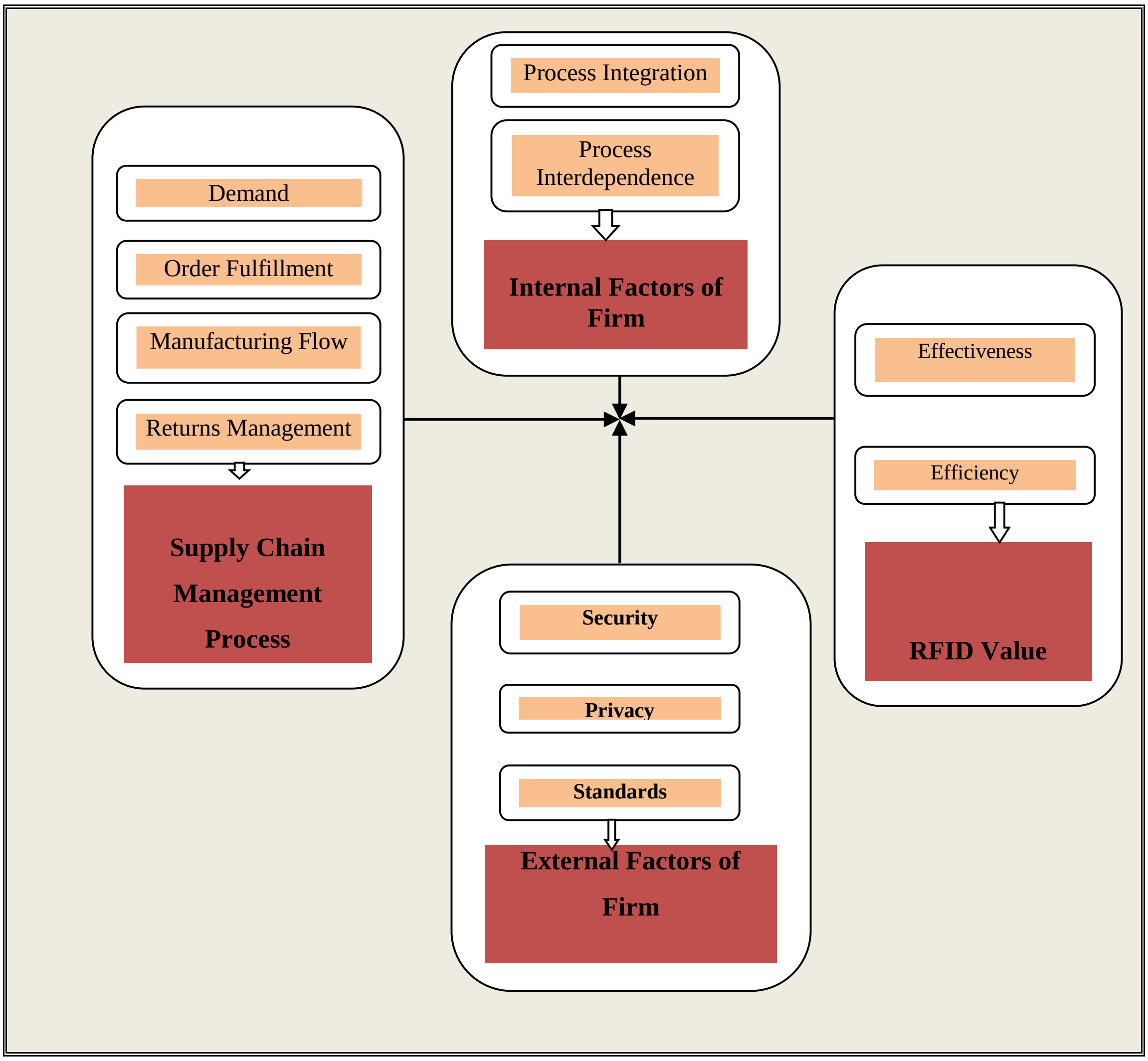
The electronic integrated systems facilitate the exchanging and sharing of information in terms of order information, operation information, strategic information, and strategic and competition information in an inter- and intra-organisational-configured supply chain network (Seidmann and Sundarajan, 1997; Daniel *et al*., 2002). Radio Frequency Identification (RFID) is "a technology that uses waves to automatically identify individual items or products in real time in a given supply chain" (Poirier and McCollum, 2006). As with wireless and mobile technologies, it incorporates an electronic microchip within a tag or label that can be subsequently attached to, or embedded in, a physical object (Leong *et al*., 2005; Sellitto *et al.*, 2007). The information at different organisational levels (at the gates, shelves and point-of-sale) and types (backlog, inventory level and forecast) can be distributed in real timer, eliminating the delay in information sharing.

According to Verma and Boyer (2010:176) “RFID utilises an integrated circuit and a tag antenna printed on a tag to transmit and record information on the product with an ability to capture more information on a product in a faster, cheaper manner offers supply chain partners a chance to exchange more information across the supply chain and improve overall forecasting accuracy”. The power of RFID microchips is their ability to contain uniquely identifying information through an electronic product code (EPC) that can be apportioned to individual products, in a similar manner that barcodes are now commercially used. The EPC network facilitates an open-loop standards-based environment, enabling end-to-end EPC information exchange by “offering an intelligent infrastructure capable of linking objects, information, computers and people within a supply chain” (Shih *et al*., 2005; Leong *et al*., 2005).

Rundh (2007:97-114) alludes to information networks with RFID providing, “more accurate information about changes in demand stream management to be in a better position for making quicker and more efficient decisions about stock levels”. RFID needs to address data synchronisation and information sharing as elements of supply chain together with order fulfillment, demand management, and manufacturing flow management (Sabbaghi and Vaidyanathan, 2008; Wamba and Boeck, 2008). Soon and Gutierrez (2008:81) argue that “the use of mandates seems to imply a dominance position of the retailers over their suppliers” that further increases the magnitude of bullwhip effect. Both the downstream and upstream sites are expected to benefits on diffusion of RFID supply chain system as the enabling technology to mitigate the phenomenon of bullwhip effect.

Figure 4.2 illustrates the challenges and values of RFID in the supply chains of firms whereby internal process integration and interdependence in firms as well as external variables such as security, privacy, and standards play a vital role in moderating the effectiveness and efficiency of RFID. Seemingly, RFID offers significant strategic value-added potential for firms in developing an integrated model of supply and demand chain while driving the revenues and innovation to gain competitive advantage, and leveraging the data collected for better conversion into value benefit of information and intelligence.

Figure 5.3: RFID value in Supply Chain Management



Source: Sabbaghi, A. and Vaidyanathan, P.J. (2008) 'Effectiveness and Efficiency of RFID technology in supply chain management: Strategic values and challenges', *Journal of Theoretical and Applied Electronic Commerce Research*, 3(2)71-81.

Organisational and legal obstacles, Swedberg (2009:1-2) reports "on the tags that utilise the global cellular network to transmit a container's identification number and location, as well as the cargo's environmental condition and status". Business performance outcomes of RFID implementation "will not arrive without incentives for manufacturers and retailers to adopt the technology" (Attaran, 2007:16). If RFID implementation improves accuracy (efficient scanning and tracking processes) and speed (improved inventory performance processes) of data collection, Simchi-Levi *et al.*, 2008:453) indicate that "retailers expect benefits from reduced inventory, labour and stockout while manufacturers improve inventory visibility, labour efficiency and order fulfillment from product traceability with long-term benefit" from a significant reduction in the bullwhip effect.

5.8.3 Enterprise Resource Planning (ERP) Systems

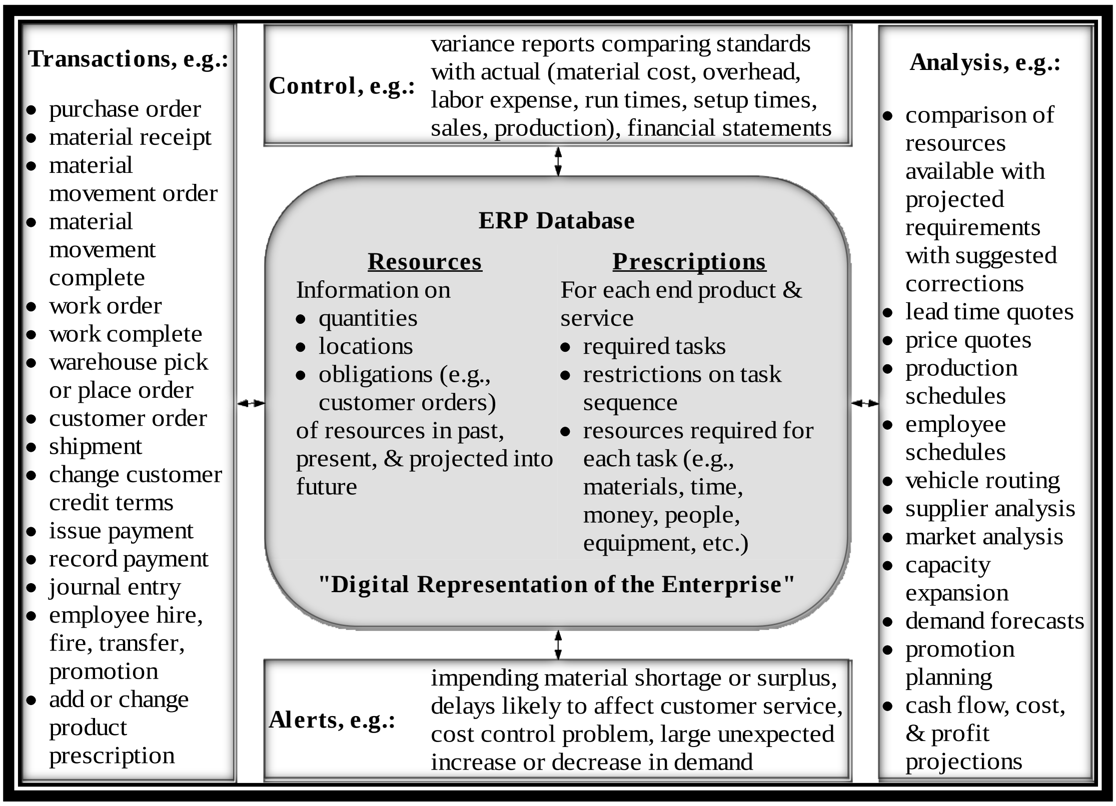
Information technology is progressively advancing value-creating opportunities for supply chain improvement and performance benefits on the understanding of a minefield of potential risks. The electronic information systems integrate information flows across all business functions and enterprises from both downstream demand site and upstream supply site in the optimal supply chain network. A research review on the functionalities of ERP systems (Biehl and Kim, 2003; Biehl, 2005) reveals that most packages offer a full set of supply chain capabilities. According to Evans and Collier (2007:178) ERP systems are vital for linking operations and other components of the value chain together in quasi-real-time and continuously updated information processing.

David *et al*., (2006:2-15) define the ERP system as "a company-wide computer software system use to globally manage and effectively coordinate all the resources, information, and functions of a business from shared data stores". The system integrates a variety of specialised software applications, such as production and inventory planning, purchasing, logistics, human resources, finance, accounting, customer relationship, and supplier relationship management using a common, shared centralised database hub (Ellen and Brett, 2006; Wisner and Stanley, 2008).

Shapiro 92007:30) describes the ERP system as "software and hardware that facilitate the creation of transactional data in a company relating to manufacturing, logistics, finance, sales and human resources. All business applications of the company are integrated in a uniform system environment that accesses a centralised database residing on a common platform including common and compatible data fields and formats across the enterprise". ERP systems are used to integrate strategic plans, effect control measures and consistently record the day-to-day compatible transactions, while providing quasi-real-time information accessibility in a consistent manner throughout the organisation and supply chain network (Webster, 2008; Bowersox *et al*., 2010). An ERP system could potentially enhance visibility and transparency across the supply chain by eliminating information distortions and increase information velocity by reducing information delays (Akkermans *et al*., 2002; Sheu *et al*., 2004). As the system facilitates the integration of information flow, the information about the supply and demand of products and services are instantaneously shared in an accurate and homogeneous manner among a set of suppliers, distributors and retailers without geographic restrictions (Soh and Tay-Yap, 2000; Chen and Popovich, 2003; Kumar and Hillegersberg, 2000).

The ERP systems and supply chain management are the basis for a better organisational performance and ongoing competitive advantage (Bergstrom and Stehn, 2005:172). Supply chain management provides organisations with efficient tools to fulfill suppliers and clients' needs and achieve a better organisational performance facing competitors and technology pressures (Gunasekaran and Ngai, 2005).

Figure 5.4: Enterprise Resource Planning Systems Database.



Source: Webster, S. (2008). ***Principles and tools for supply chain management*****. Boston: McGraw-Hill, pp.15**

The ERP modular systems are confined to transaction-based activities with control measures whereas SCA applications deal more with analysis and alerts. Figure 5.3 (Webster, 2008:14) describes "the combination of available resources with detailed descriptions of how resources are used on a digital representation of the firm to support planning control, and early identification of problems and opportunities. In the wide scope of applications and broader network processes, the length of time to implement an ERP system eventually depends on the size of the business, the number of modules, the extent of customisation, the scope of the change and the willingness of the customer to take ownership for the project". These cross-functional and enterprise processes are adapted to standardised network processes as opposed to adapting the ERP package to the existing processes.

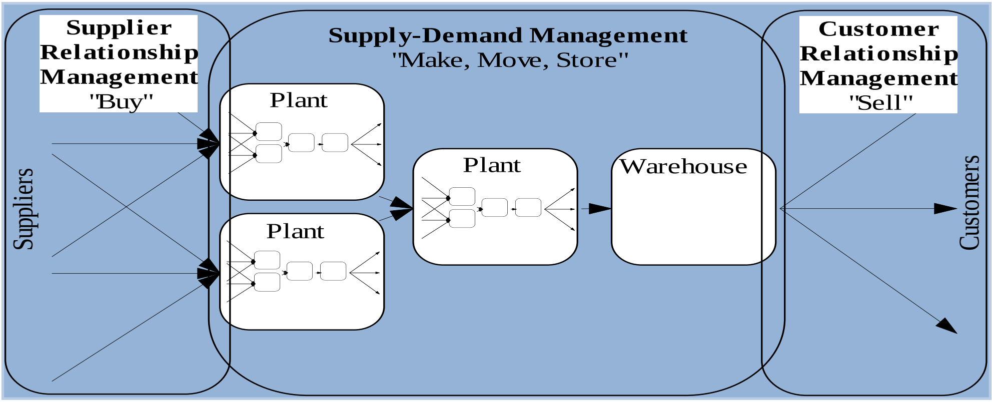
ERP implementation is considerably more difficult in organisations structured into nearly independent business units, each being responsible for their own profit and loss. These firms will each have different processes, business rules, data semantics, authorisation hierarchies and decision centres.

5.8.4 Supply Chain Analytics Systems (SCA)

An ERP database is "a digital representation of the firm that contains information on resources, customer and supplier order histories". It also provides optimum opportunities for procurement, in-house processes (makes) and product/service delivery in conjunction with envisaged costs and time on their sequential steps. Interestingly, supply chain analytics systems (SCA) use this information as a key input to assist discovering complexities and optimising planning decisions for procurement, operations, logistical transport and pricing. SCA is developed to address complexities from ERP such as the limited customisation of the ERP software, rigidity and difficulty to adapt to the specific workflow and business processes of some companies. Webster (2008:16) observes that SCA systems, which are frequently linked to ERP systems, support the detailed planning and control of material, money, and information flow through supply chains.

According to Shapiro (2007:36) analytical IT evaluates supply chain planning problems using: 1) descriptive models such as demand forecasting and management accounting, describe how supply chain activities, costs, constraints and requirements may vary in the future; 2) optimisation models such as linear programming model for capacity, planning, describe the space of supply chain options over which supply chain managers wish to optimise their decisions. Analytical IT picks up where transactional IT (acquiring, managing and communicating raw data about an enterprise's supply chain) leaves off by extrapolating data into the future and analysing one or more scenarios to identify effective decisions.

Figure 5.5: Three categories of supply chain analytics software.



Source: Webster, S. (2008). *Principles and Tools of Supply Chain Management*. Boston: McGraw-Hill, pp.17

These systems are useful to analyse and comprehensively transmit a plethora of erratic dynamic data to mitigate bullwhip effect. The focus of SCA systems is on decision support activities, and Webster (2008:16-17) identifies three main categories of SCA software (figure 5.4):

“Firstly, Supplier relationship management (SRM) software helps to analyse and manage the “buy” side of the business. In the analytical approach to bullwhip effect, the system poses a question on how have suppliers been performing in terms of pricing, quality, speed of delivery, on-time delivery, and ability to respond to emergency requests.

Secondly, Supply-demand management (SDM) software assists to analyse and manage the “make, move, and store” side of the business. The questions for analysis: What, where, when and how much should be ordered, produced, and shipped? What are the forecasts for future material requirements, and how accurate are these forecasts?

Thirdly, Customer relationship management (CRM) software helps analyse and manage the “sell” side of the business. The questions for analysis: What do one knows the dynamics of the customer on lifestyle, past purchase and other interactions with my company and on products and services that might complement or replace the current order”. SCA systems underpin the innovation of digital paradigm shifts towards new global-optimised electronic business enterprises, that is, “an intelligent digital representation of an organisation into the future”.

Lengnick-Halla and Abdinnour-Helmb (2004:307-330) describe the system as "a technology that enables companies to build and to develop their intellectual value". According to Webster (2008:21) "ERP and SCA systems provide the infrastructure for e-commerce activities such as targeted promotions, and customer order tracking and automatic customer notification of changes in delivery times". The benefits of ERP systems are potentially enormous by coordinating process and information, reducing carrying costs, decreasing cycle times and improving responsiveness to customer needs (Bowersox *et al.*, 2010).

5.8.5 Systems, Applications and Products in Data Processing (SAP) with SCM

Brief history

SAP was founded in 1972 as System Analysis and Program Development by five former IBM engineers in Mannheim, Baden-Wurttemberg (Dietmar Hopp, Hans-Werner Hecto, Hasso Plattner, Klaus E. Tschira, and Claus Wellenreuther). The acronym (SAP) was later changed to stand for Systems, Applications and Products in Data Processing. SAP provides enterprise software applications and support to businesses of all sizes globally. Headquartered in Walldorf, Germany, with regional offices around the world, SAP is the largest software enterprise in Europe and the fourth largest software enterprise in the world (Alcatel-Lucent, 2008).

The company's best known product is its SAP Enterprise Resource Planning (SAP ERP) software. SAP has evolved from a small, regional enterprise into a world-class international company as the global market leader in collaboration and inter-enterprise business solutions. SAP applications, built around their latest R/3 system, provide the capability to manage financial, asset, and cost accounting, production operations and materials, personnel, plants, and archived documents. The R/3 system (where 'R' stands for real-time data processing) runs on a number of platforms and uses the client/server model, which can be aligned with their vision: to develop standard application software for real-time business processing.

The latest version of R/3 includes a comprehensive Internet-enabled package. SAP R/3 is a multilayer Internet architecture with an open three-tier approach: presentation, application, and database layers. As the client-server concept, uniform appearance of graphical interface, consistent use of relational database, and the ability to run on computers from different vendors meets with overwhelming approval. SAP has recently recast its product offerings under a comprehensive Web interface, called mySAP.com, and added new electronic business (e-business) applications, including customer relationship management (CRM) and supply chain management (SCM), while a recent R/3 version was provided for IBM's AS/400.

The development of SAP's Internet strategy with mySAP.com redesigned the concept of business processes, that is, integration via Internet. SAP focuses on six industry sectors: processes industries, discrete industries, consumer industries, service industries, financial services, and public services. SAP offers more than 25 industry solution portfolios for large enterprise and more than 550 micro-vertical solutions for midsize companies and small businesses (Alcatel-Lucent, 20087). The real-time data from multiple sources such as point-of-sale signals, Internet and telephone orders, and RFID have challenges in terms of addressing the lack of visibility into supply chain operations across the network and an inadequate view of supply chain material flow and inventory that impede forecasting and inventory planning (Hert, 2009).

The mySAP supply chain management (mySAP SCM) solution, and in particular, its powerful supply chain execution capabilities, can help firms meet these challenges and turn their supply chain into a strategic asset. mySAP SCM is powered by the SAP NetWeaver platform, the open integration and application platform that enables change, helps companies align IT with their business, allows companies to obtain more business value from existing IT investments and to deploy a service-oriented architecture, and reduces total cost of ownership and complexity across the entire IT landscape. The mySAP SCM allows firms to adapt to an ever-changing competitive environment. It transforms traditional supply chains from linear, sequential processes into an adaptive network in which communities of customer-centric, demand-driven companies share knowledge, intelligently adapt to changing market conditions, and proactively respond to shorter, less predictable life cycle (Hert, 2009).

The supply chain execution capabilities of mySAP SCM allows firms to adapt to a dynamic, constantly changing marketplace with visibility into the operational status of the entire supply chain. These instantly sense deviations and respond with corrective actions based on real-time demand and supply signals monitored on a 24/7 basis. New sensory technologies, such as RFID, are an important aspect of such a solution, giving companies real-time information and connectivity with sensor networks for real-world awareness, insights, and visibility. These insights must align business strategy with tactics through a seamless integration of analytical, transactional, and collaborative processes. Responsive supply networks seek to combine the sharing information, and mostly importantly knowledge, seize optimal global-based opportunities, and responsively align shorter product cycles with clockspeed while adjusting to the dynamics of erratic market-based changes. The activities and benefits of SAP SCM are presented below.

5.8.6 SAP with ERP in SCM

SAP Enterprise Resource Planning (SAP ERP) provides features and functions for operational analysis to help firms optimise their entire supply chain, improve revenues, and increase customer satisfaction. Firms are concentrating mostly on the leagility system and logistical clockspeed to best serve customers. "The efficiency of the entire operational chain impacts an organisation's ability to serve its customers well. Operational excellence is the ability of an organisation to achieve a high level of customer service, while reducing operating costs. The SAP ERP Operations solutions have become the software backbone that contributes to excellent performance supporting end-to-end operational processes in all key areas: procurement and logistics execution, product development and manufacturing, and sales and service. With SAP ERP Operation, the firms can: Firstly, automate and streamline operational processes with greater adaptability. Secondly, increase productivity in their operations with a role-based solution and centralised information. Thirdly, extend collaboration to all value chain partners. Lastly, improve operations performance with strategic business insight. SAP ERP presents the solution such as features and functions that support these business activities" (Hert, 2009).

Table 5.2: SAP ERP with features and functions underpinning business activities

Features and Functions –underpin business activities	
Procurement monitoring	"Monitor purchasing operations and provide a detailed analysis of purchasing activities and procurement processes".
Inventory and warehouse management	"Assess your organisation's actual stock situation based on quantity- and value-based criteria. Analyse warehouse activities, such as the physical flow of materials and workloads".
Manufacturing reporting	"Provide various standard reports and analyses detailing production-related information".
Order fulfillment analysis	"Evaluate and improve order fulfillment using key performance indicators (KPIs) for transportation and order management, strategic performance measurements or the distribution statistics needed for supply chain optimization, and operative performance measurement that capture the day-to-day information used for process optimization".
Customer service analysis	"Monitor financial trends, costs, and revenues per customer, as well as service contracts and operations. The solution also supports installed-vase analysis, and provides both customer analytics and warranty analytics.
Program and project management	Monitor and control project data, evaluate projects, and enable design-to-cost engineering to optimize product costs".
Quality management	"Plan, collect, settle, and evaluate quality-related costs. The solution includes quality management features that provides data to determine standard or user-defined quality scores".
Enterprise asset management	"Perform strategic evaluations, including mean time to repair (MTTR) and mean time between repair (MTBR) analysis".
Sales planning	Set sales targets by using multiple dimensions and key figures, integrate and consolidate sales planning with marketing or service plans, optimize your supply chain through offline account planning. The solution enables territory management according to regions, product lines, or other variables, as well as opportunity planning and analysis and partner planning".
Sales analysis	"Provide your sales organizations with an accurate overview of current sales performance and an overview of sales force effectiveness".

Source: Compiled by the researcher from the SAP ERP perspective.

Global optimisation is truly a transformational business strategy that will have a profound effect on competitive success in the entire network. It is recognised that the new economy is founded on the forces of new technologies and the increasing importance of intangible assets such as relationships and knowledge (Ireland and Crum, 2005). Companies have highly desegregated value chains, where the majority of operational efficiencies and revenue-enhancement opportunities can only come from greater visibility, integration, and synchronisation among companies in a value network. When visibility of future demand is lacking, an interesting phenomenon occurs as each partner in the supply chain tries to predict what is needed to support the end user or consumer demand (Simchi-Levi *et al.,* 2008). Demand variability amplification across the chain network, (bullwhip effect), results in serious inefficiencies across the chain.

In this regard, managers are expected to minimise this phenomenon in their chain in order to reduce costs and increase customer satisfaction by making critical decisions on electronic optimisation. Establishing effective electronic global optimisation strategy requires that channel trading partners begin by defining the objectives to be pursued. Similarly, the supply chain members must understand the function of electronic-driven information in the supply chain by each individual channel node as well as the entire supply chain acting as a unified market-satisfying force. E-SCM will enable whole supply chains to synchronise information arising from all network nodes to achieve a seamless supply chain response to the customer.

5.8.7 Electronic Procurement (e-Procurement)

Electronic procurement is used for referring the procurement processes using Internet technology. It assists to reduce the transactional costs and achieve faster, automated transactions whereby the buyer focuses more on the strategic side of procurement. Ross (2004:52) defines e-procurement "as the automation and integration of the purchasing process by the application of electronic procurement software and the growth of business-to-business trading exchanges". In the broader perspective, Min and Galle (2003:227) define "e-procurement as business-to-business purchasing practice that utilises electronic commerce to identify potential sources of supply, to purchase goods and services, to transfer payment, and to interact with suppliers". According to Kachru (2009:405) "e-procurement involves dealings with companies as mirror image of e-Commerce and the system drives implementation benefits such as time savings, more efficient and flexible, cost savings, accuracy, real-time and trackability where sellers instantly adjust to market conditions and buyers achieve flexibility due to stiff competition, fast changing customer preferences, shortening product life cycle and product variant proliferation".

Alternatively, Presutti (2003:221) defines e-procurement as "a technology solution that facilitates corporate buying using the Internet". E-procurement is part of a broader concept called information technology (IT), which the *American Heritage Dictionary* (2005) defines as the development, installation, and implementation of computer systems and applications. According to Emiliani and Stec's (2005) the value-creating chain of e-procurement is built by the exchange of information and knowledge across extended enterprises, overwhelming "silo mentality" inside the firm, while promoting global optimisation. These definitions accentuate the essence of integrated electronic processes, coordinated activities and collaborative action among trading supply chain partners and across organisational linkages.

5.8.8 Electronic Integration Systems

Supply chain integration ensures active communication interface with electronic systems to entrench better cooperation and collaboration across the extended enterprises on the value-creating chain of enterprise, electronic application, business process and data and information integration. According Li *et al*., (2009:125) relate supply chain integration to "the coordination across the network of production planning, inventory management and distribution activities" and Wong *et al*., 2011:604) stress "the urgent need to understand the conditions to maximise performance improvements on supply chain integration implementation". Patterson *et al*., (2003:95-121) suggest that "integration of supply chain activities and the technologies to accomplish efficiency and automated transactions clockspeed have become competitive necessities in most industries". The integration in supply chain management is fully understood of how the supply chain management has been conceptualised. Themistocleous and Love (2004:393) indicate that "supply chain management involves the integration of businesses, information flow, and people as key business processes from the end user through original suppliers".

These processes have provided products, services, and information that add value for customers and other stakeholders (Lambert and Cooper, 2000:66). Inter- and intra-organisational integration fundamentally excel with superior chain network performance outcomes with the view of taming the demand variability amplification from one channel node to another as orders cascade upstream the supply chain. Firms achieve internal integration by effectively coordinating across extended enterprises.

Internal integration is an exceptional “ability of distinct functions working together to create seamless interfaces across processes is fundamental to firm and supply chain success” while external integration entails “recognising suppliers as an integral part of the supply chain and engaging in collaborative information sharing efforts” to overcome the oscillation effect (Narasimhan and Kim, 2002; Gunasekaran *et al*., 2004; Pagell, 2004; Heim and Peng, 2010). In assessing the impact of supply chain integration on responsiveness, Danese *et al*., (2013:125) reveal that “in the supply networks both external and internal integration practices have a significant and positive impact on enterprise performance responsiveness”. The supply chain business performance benefits are inclusive of both upstream and downstream integration on information and material flows as an underlying integration of customer-supplier partnership, cross-organisation information sharing and extended cross-enterprise activities.

The use of IT provides the basis for intensively integrating business processed in real-time and transparently exchanging advanced economic information in the network (Cagliano *et al*., 2003:1309). Sharing advanced economic information enables multiple firms to engage in synchronous decisions inclusive of downstream and upstream sites of the chain network (Sanders, 2005:4-13). The fundamental benefits of proactive chain integration should reflect strong interaction amongst chain members (Zeng and Pathak, 2003; Power, 2005; Rai *et al.*, 2006).

The extant research findings have discovered for classification schemes or taxonomies to categorise Internet-based tools (Frohlich and Westbrook, 2002; DeBoer, Harink and Heijboer, 2002; Kehoe and Boughton 2001; Brynjolfsson and Smith 2000). This categorisation is necessary because e-procurement tools differ in many respects including costs, benefits, goals, and integrative ability. Frohlich and Westbrook (2002:729-745) categorise the respondents into four groups: firstly, Internet-enabled focus on the firms only; secondly, Internet-enabled integration between the firm and its suppliers; thirdly, Internet-enabled integration between the firm and its customers; and fourth, Internet-enabled integration between the firm, its suppliers, and its customers. Cagliano *et al*., (2003:1309-1327) categorise the firms into four clusters of respondents based on their use of Internet-based technologies: firstly, traditionalists (no Internet-based technologies); secondly, e-sellers (23% of the sample) sales customer care only); thirdly, e-purchasers (extensively making purchases from suppliers); and fourthly, e-integrators (supply chain processes).

Both studies (Frohlich *et al*., 2002 and Cagliano *et al*., 2003) propose the utilisation of less integrative e-procurement applications that will be more prevalent among the sample firms than across departments and/or forms. Power (2005) and Pearcy and Giunipero, (2008) underpin the views of impetus for optimised-integration exercises through information transfer, streamlining, and effective collaborative of extended cross-enterprises integration among chain members in an attempt to tame the oscillation effect, although Folinas *et al*., (2004:274-283) argue that "a fully integrated supply chain is characterised by extensive sharing of information and high levels of trust, which in many instances is not easily attainable, particularly when multiple suppliers and multiple customers are involved". Nevertheless e-procurement applications and business performance outcomes have been enhanced through electronically-enabled supply chain systems in palliating the phenomenon of bullwhip effect. The shared real-time order information allows the supply chain partners to efficiently respond to the increased demand order variability moving up the supply chain network.

5.8.9 Electronic Collaboration Supply Chain Systems

The supply chain performance describes how well the supply chain enterprises fulfill the supply chain financial goals compared with other primary supply chain competing enterprises as the success of virtual value-chain collaborative processes reflect on monetary matrics. Cao and Zhang (2011:167) explain collaborative supply chain performance components as "1) process efficiency as the extent to which a firm's collaboration process with supply chain partners is cost competitive among primary competitors (Bagchi and Skjoett-Larsen, 2005); 2) offering flexibility to the extent to which a firm's supply chain linkage supports changes in product or service offerings (features, volume and speed) in response to environmental changes (customer responsiveness); 3) business synergy to the extent to which supply chain partners combine complementary and related resources to achieve supernormal benefits; 4) quality to the extent to which a firm with supply chain partners offers quality product that creates higher value for customers; 5) innovation to the extent to which a firm works jointly with its supply chain partners in introducing new processes, products or services". The broader diffusion on collaborative processes require "a scientific means of assigning values to statements that indicate various levels of collaboration amongst participating members" (Barratt and Oliveira, 2001; Mentzer, Min and Zacharia, 2000). According to Ireland and Crum (2005) migrating to an anticipatory model that involves cooperation and collaboration with supply chain partners requires an investment in skills and competencies, process development, and technology.

The collaboration refers “to situations in which parties in a business relationship work together to achieve mutual goals” (Anderson and Narus, 1990; Morgan and Hunt, 1994). The approach has emerged as a key construct in the study of supply chain partnerships given its espoused benefits from the degree to which partners jointly pursue mutual goals. Additionally, Myhr and Spekman (2005:179-186) reveal that “collaborative supply chain partnerships can both achieve significant cost savings and increase the overall competitiveness of the supply chain”. Simatupang and Sridharan (2005:44) define supply chain collaboration as “two or more chain members working together to create a competitive advantage through sharing information, making joint decisions, and sharing benefits which result from greater profitability of satisfying end consumer needs than acting alone”. Contrarily, Bowersox (1990:36-43) argued that “the adoption of supply chain collaboration would increase along with effects of globalisation and information technology”. In a similar vein, Narus and Anderson (1996:112-120) stated that “supply chain collaboration becomes a central tenet in creating an adaptive supply chain”.

When key supply chain partners (either downstream or upstream) begin adopting e-SCM, other partners within the supply chain will respond to the need to adopt the innovation. It is suggested that this will enable firms to form the basis for strong collaborative relationships among the trading supply chain partners. Ovalle and Marquez (2003:151-163) advocate that “when electronic collaboration (e-collaboration) tools are implemented in the SCM, each upstream supplier could have a stable sale, and each downstream customer orders and stable amount of products in spite of the communication of information have to go through multiple intermediaries”. It means that the processes are more agile, the costs are more favourable and the service to the end customer is efficient. Although the uncertainties of the modern business environment need timely consumer demand information availability, information technology ensures visibility (transparency) of orders moving upstream in the chain.

Boyson *et al*., (2003:175) report that “electronic exchange of information leads to a reduction of errors, order variability and increased efficiency of the work processes”. Moreover, the negative effects of uncertainty and distortion in consumer demand orders can, in theory, be mitigated. Wu and Chang (2012:482) interpret “the major work of external diffusion with focuses on the use of e-SCM to integrate the firm with its trading partners in an inter-organisational basis. While other extant studies argue that collaborative used of web-based systems is more likely to improve B2B process in the areas of cost-based performance, customer service, logistics, production efficiency, inventory management and product cycle-time”.

Kachru (2009:406) provides thematic meaning of electronic collaboration (e-collaboration) as electronically-enabled data synchronisation accuracy that "uses Internet-based technologies to facilitate continuous automated exchange of information between supply chain partners on business relationships, and it requires companies to work together to integrate their operations and eliminate barriers that impact their ability to satisfy customers by including activities such as information sharing and integration, decision sharing, process sharing, and resource sharing". The author suggests that e-collaboration creates an extended enterprise in terms of 1) new product design and development in fast moving goods industry; 2) the delivery of complex technical projects and programmes; 3) improving supply chain performance outcomes on planning and forecasting in the retail sector; 4) coordinating and evaluating service delivery between multiple providers. The challenge for e-collaboration is an increase in complexity and extended enterprise of interdependent business units, partners, buyers and suppliers (Kachru, 2009:406) that create new opportunities and new challenges in aligning goals, coordinating activities and sharing quasi-real-time information across organisational supply chain cross-enterprise networks.

The collaborative principles on joint planning and decision making should depart from the centripetal theme of discreteness on underlying relational, knowledge exchange and cross-enterprise functionality. By reaching mutually satisfactory solutions, firms are motivated to continue their buyer-supplier relationship. Simatupang and Sridharan (2005:44) further introduced "three interrelated dimensions of collaboration index: firstly, information sharing as the act of capturing and disseminating timely and relevant information for decision makers to plan and control supply chain operations, secondly, decision synchronisation as joint decision-making in planning and operational contexts (The planning context integrates decisions about long-term planning and measures such facets as selecting target markets, product assortments, customer service level, promotion and forecasting. The operational context integrates order generation and delivery processes that can be in the forms of shipping schedules and frequencies of replenishment of the products in the stores), and thirdly, incentive alignment as the degree to which chain members share costs, risks, and benefits. These dimensions are important for enabling the participating members to improve the swift of flow of information, and products to the end consumers".

Table 5.3: The collaboration-performance profiles

		Collaboration Index	
		Low	***High***
Performance Index	***High***	Efficient Collaboration *(Maintain and extend)*	Synergistic Collaboration *(Harvest and sustain)*
	Low	**Underrating Collaboration** *(Develop and reengineer)*	Prospective Collaboration *(Improve and leverage)*

Source: Simatupang, T.M. and Sridharan, R. (2004). 'Benchmarking supply chain collaboration: An empirical study'. *Benchmarking International Journal.* 11(5)484

Table 5.2 indicates the supply chain collaboration index and performance index with four types of collaboration, namely synergistic, efficient, prospective and underrating. According to Simatupang and Sridharan (2004:484) this profile suggests that "a large number of companies are attempting to develop cross-enterprise collaboration relationships. Those who developed a high degree of collaboration could be successful in attaining a higher level of supply chain performance benefits". "Synergistic collaboration means these companies have adopted a range of best collaborative practices, resulting in a high level of operational performance. Efficient collaboration means these respondents will be able to move into the synergistic collaboration category with some maintenance and extensions. Prospective collaboration means that these respondents need to transfer the high level attained on the collaborative index into better operational results through learning acceleration and continuous improvement. Underrating collaboration means that these companies seem to be in an unfavourable position, but they have the potential to identify their shortcomings and develop collaborative practices to move to the category of synergistic collaboration". There are research studies on supply chain collaboration that significantly influence fulfillment, inventory and responsiveness performances.

5.8.10 Electronic Collaboration Planning Forecasting and Replenishment (e-CPFR)

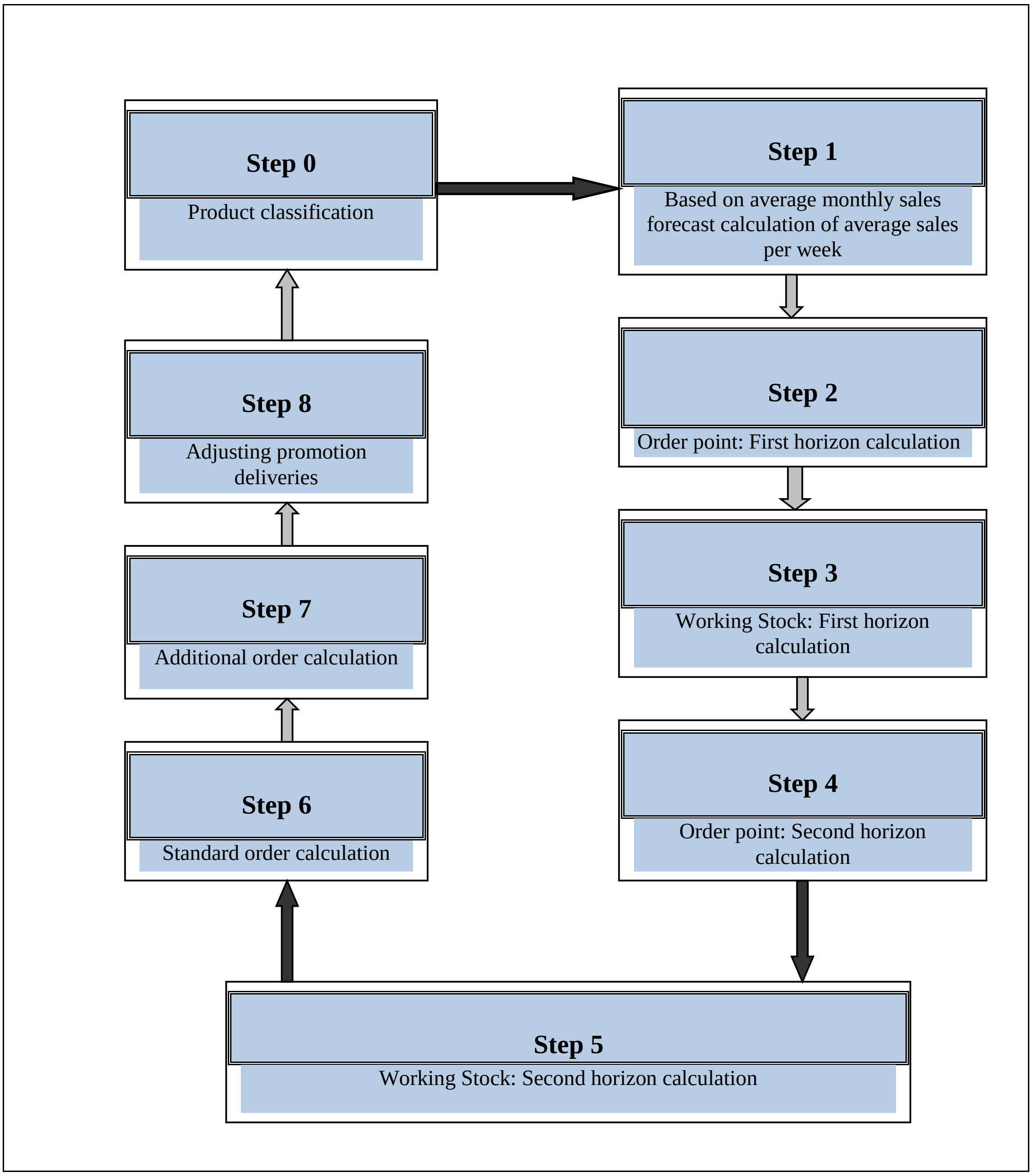
CPFR has evolved into a Web-based tool used to coordinate demand forecasting, production and purchase planning, and inventory replenishment between supply chain trading partners. It is being used as a means of integrating all members of a multi-tier supply chain, including *n*-tiers, lead suppliers, manufacturers, distributors, and retailers. According to Jacobs and Chase (2008) the ideal point of collaboration utilising CPFR is the retail-level demand forecast, which is successively used to synchronise forecasts, production, and replenishment plans upstream through the supply chain. The major objective is to exchange selected internal information on a shared Web server in order to provide for reliable, longer-term future views of demand in the supply chain (Leon, 2001:48). Grossman (2004:391) argues that "a breakthrough in thinking is clearly needed to get past the 'us versus them' mentality so common in business, and to effectively implement collaborative technologies". Smith (2000:50-64) advises that "before building the necessary collaborative and analytic capabilities, an organisation must first break through the existing cultural barriers that have been ingrained over time". Effective collaboration should imply the ability to electronically share information about business activities and interact on a quasi-real-time basis across the supply chain.

The electronically-enabled supply chain uses the mySAP supply chain management (mySAP SCM) system as a comprehensive supply chain solution that delivers a complete suite of applications for visibility, planning, execution, and collaboration. It enables a consumer goods supply chain network to anticipate consumer demand behaviour, including the impact of promotions, to forecast demand more accurately, and combine distribution and transportation capabilities. The process underpins demand-driven replenishment frequencies of finished goods in the most profitable supply chain performance outcomes. mySAP SCM collaboration capabilities help business partners work together to reduce inventory buffers, increase the velocity of raw materials and finished goods through the pipeline, improve customer service, and increase revenues (Ireland and Crum, 2005). With the CPFR capabilities within mySAP SCM, manufacturers and their trading partners can accelerate the speed and accuracy of propagating demand-influencing activities across the supply network. Ireland *et al*., (2005) suggest that CPFR with mySAP SCM provides improved visibility into demand and helps companies increase inventory turns by integrating demand and supply-side processes and flawlessly managing variability.

According to Christopher (2011:94) "CPFR is an extension of VMI that takes the idea of collaboration among supply chain partners a step further by creating an agreed framework for how information can be shared between partners and how decisions on frequency of replenishment can be taken through joint planning, forecasting and decision making. The increased joint forecast accuracy alongside supply chain collaborative long-term planning, reduces the need to build up inventories or production capacity to cover unexpected changes in demand". mySAP SCM enables supply chain partners to capture supply opportunities simultaneously and shift the supply chain network from a consumer push focus to a pull focus. In terms of disruptions in the supply chain, the system allows enterprises to react more accurately and faster to new trends in the market, new products, or special customer orders by working with integrated data (Ireland and Crum, 2005).

As a central hub, SAP Advanced Planner and Optimizer (SAP APO) provides the facilities and tools for real-time cross-enterprise process planning, optimising, and controlling. The cross-enterprises can integrate sales planning, procurement, production, delivery, and other processes into an extended supply chain network. Moreover, data is transferred between SAP APO and SAP R/3 to support the CPFR process. The CPFR process enables more efficient delivery to the distribution centres, instead of production centres pushing products to the distribution center. The processes allow products to be pulled based on forecasted demand, seasonal trends, current stock levels, and supply capacity. This integration ensures accurate and efficient transfer of sales history for statistical forecasting calculations in demand planning and conversions of plans to time-phased purchase orders to mitigate bullwhip effect (Alcatel-Lucent, 2008). Figure 5.6 presents the cycle process with an overall solution that is enabled by the supply network planning (SNP) and demand planning (DP) capabilities of SAP Advanced Planning and Optimisation (SAP APO) in mySAP SCM.

Figure 5.6: CPFR cycle



Source: www.sap.com/contactsap, mySAP supply chain management at Beiersdorf-Lechia

The process begins with product category determination, which enables the calculation of economic production lots and delivery quantities. Products are divided into three categories: A (products with high sales volume and value), B (with a high volume, but average sales value), and C (with both low sales volume and value). Production and delivery volumes are then calculated for a one-week time horizon and for a three-month horizon, based on historical sales data, information about promotions, and forecast trends.

The supply network planning capability highlights any supply surplus or shortfalls, recommending appropriate changes in production and delivery plans. The production plan on the upstream side serves as the basis for raw material suppliers that provide the components necessary for order fulfillment on the downstream side of the supply chain network. It synchronises the demand order systems with collaborative forecasting and information sharing in taming the consumer demand order variability amplified as orders travel upstream the supply chain channel. The implementation of CPFR is a way to achieve the cost reductions and customer service improvement, and mySAP SCM, as the robust demand planning and supply planning capability and the tight integration, enables the achievement of finished goods inventory reductions, a lowering of safety stock, and delivery performance improvements.

Chapter Six

Research methodology

6.1 Research design

The research design outlines a plan and structural framework of how the researcher intends to conduct the study to solve the research problems (Cooper and Schindler, 2008:140). The empirical research design constitutes the blueprint for the collection, measurement and analysis of data. This design will manifest the plan and structure of the investigation so conceived as to obtain answers to the research questions on bullwhip effect, inventory positioning, information sharing and electronically-enabled supply chain management (e-SCM) systems. Blumberg, Cooper and Schindler (2008:195) cited Kerlinger (1986:279), that "a research design expresses both the structure of the research problem and the plan of investigation used to obtain empirical evidence on relation of the problem". The structural framework of investigation interlinks with the estimable literature on an epistemological truth of research to explore, understand, explain and infer on the review (Hair et al., 2003:50). In this regard, the researcher consigns to create cohesion in data analysis by making reference to literature as a scientific paradigm. The research is grounded (grounded theory) in the data with a substantial knowledge of literature and theory to understand and explore the truth or new perspective on the phenomenon of a deleterious effect (known as bullwhip effect).

Bryman and Bell (2007:585) cited the developers of grounded theory as "theory that is derived from data, systematically gathered and analysed through the research process". In this method, data collection, analysis and eventual theory have close relationship with one another. The theory is central to two features that are concerned with the development of theory out of data (using factor analysis method) and the approach is iterative or recursive as data collection and analysis proceed in tandem, repeatedly referring back to each other (Bryman and Bell, 2007:585). This study is driven by the theory of inventory positioning from order replenishment, information sharing methods and electronic supply chain management systems, to be inducted into the language of the phenomenon - bullwhip effect. Similarly, the perspective of theory and understanding of the phenomenon identifies the gap and detour of researchable questions on empirical analysis into amplified order variability and electronic supply chain management. This study is using a quantitative approach to analyse data, and the survey instrument is used for the data collection.

6.2 Data Collection

6.2.1 Survey Instruments

A survey instrument incorporating a list of cases from bullwhip effect, inventory positioning, information sharing, electronic supply chain management and strategic global optimisation activities has been constructed based on the literature reviewed. The content validity of the instrument is established by grounding it in existing literature. The supply chain management research project concedes to the survey instrument to probe pertinent practitioners and experts in the industry, because supply chains recognise the multi-functional composition within the organisation and inter-organisational configuration. A survey instrument is designed based on the constructs of the conceptual framework using structured questionnaires to enhance research objectivities. While it could be argued that objective scales are more insightful, the study uses the subjective scales because of the multi-sectorial nature of the survey.

Sekaran and Bougie (2009:197) describe the questionnaire as an efficient data collection mechanism with a pre-formulated, written set of questions to which respondents record their answers, usually within rather closely defined alternatives. The pre-formulated thematic instrument (bullwhip effect, information sharing, inventory positioning and optimisation strategies) is grounded within the extant literature review and it was pretested using key industry practitioners and academics on discipline-based for suitability to ensure face and content validity.

The questionnaire for this study was divided into four structured sections:
Section one included typical demographic, personal profile and general information for both the company and individual respondents;

Section two included dichotomous questions (Yes or No) on general perceptions of, inventory management systems to mitigate bullwhip effect, and

Sections three, four, and five included a series of statements that covered operational supply chain networks on bullwhip effect, information sharing (especially the sharing of advanced economic information such as demand forecasting), electronic supply chain management integration and global optimisation strategies to ameliorate bullwhip effect.

Responses to each statement were on a five-point Likert scale that ranged from strongly agree to neutral to strongly disagree. Respondents indicated the degree of agreement or disagreement, where 5 represented "strongly agree" and 1 represented "strongly disagree". In other words, multi-question Likert-type five point scales were used to derive composite scores for each variable. The respondents were assured that they would receive encapsulated research findings in order to encourage or embolden completion and improve the overall response rate. The study will not disclose the names of the participating firms or individual respondents to honour the confidentiality of the participants from an ethical point of view. The anonymity of respondents tends to yield confidence and create avidity around participation in a research study.

6.3 Measurement scales

This study used categorical data that were mutually exclusive and collectively exhaustive. Nominal data allow the research to classify responses into different groupings that include the biographical like gender or situational variables like departments, part or full-time with no arithmetic value. The ordinal scale assisted beyond differentiating the categories by providing information on how respondents distinguished rank-ordering statements, although the scale did not indicate the magnitude of the differences among the ranks (Bryman and Bell, 2007:355). These data allow individuals to indicate their attitudes towards statements, and ask respondents to rank a set of attributes from the most preferred to the least preferred. Interval scale allowed the performance of certain arithmetical operations on the data collected from the respondents and assisted in overcoming the deficiencies of both nominal and ordinal scales by allowing the computation of the measures of central tendency and measures of dispersion of the responses on the variables (Cooper and Schindler, 2008:285).

Interval scaled responses have properties of an ordinal scale to incorporate two measures of central tendency (mode and median) including the arithmetic mean. The interval scale further allows measures of statistical dispersion in this exploratory study as the degree of deviation of the numbers from their mean as a central point. The ratio data represents the highest level of precision and the scale does not have a zero such as height, weight and time. According to Anderson (2009:312) the clarity about research questions and types of data collected should allow the researcher to identify the most appropriate quantitative data analysis tools to use. The following table (table 6.1) provides an indication of main option for parametric and non-parametric data (Collis and Hussey, 2009; Cooper and Schindler, 2008; Davies, 2007; Hair *et al*., 2003):

Table 6.1: Measurement data scales and options

Test Purpose	Non-parametric Data Options (Nominal & Ordinal Data)	Parametric Data Options (Interval & Ratio Data)	Types of Data	Notes
Test of Association	Cross-tabulation	Cross-tabulation	All types of data. Especially useful with nominal (category) data.	Need to report the significance of the association. Assessment of the relationship between any two variables as it is useful for nominal data.
Assessment of Significance of Association	Chi-Square (χ^2)	N/A	All types of data.	Evaluationg the probability that results in tests of association occurred through chance. χ^2 is about interaction rather than about differences between groups (ANOVA).
Test of Difference	t-test (t)	Mann-Whitney test (U)	Never for nominal data	Report probability of chance (p) result as well as the test result. Assessment of different patterns of responses within sample groups.
	One-way ANOVA (Single non-metric independent variable)	Parametric statistics te-test and ANOVA.	All types. One-way (Independent Variable – Nonmetric). N-Way ANOVA (Interval and Ratio)	One-way ANOVA uses Single nonmetric independent variable (categorical) with not extendable inferences to other levels of treatment. The independent variable in ANOVA must be categorical (either nominal or ordinal) and the dependent variable must be scale (either interval or ratio).
Test of Correlation	Spearman's rho (r_s)	Pearson's Correlation (r)	Never for Nominal Data	Report probability of chance (p) result as well as the test result. Measurement of the strength and direction of association between different variables. Calculation of a correlation of coefficient that ranges between -1 and +1.
Principal Component/Factor Analysis	Principal Component/Factor Analysis	Principal Component/Factor Analysis	Never for Nominal Data	Assessment whether there are key variables in the data or whether some variables can be grouped, reduced or clustered together to form a coherent (multidimensional) composite variable.
Relationships (Measuring Linear Relationship)	Non metric dependent variable [Logistic Regression]	Metric dependent and independent variables [Multiple Regression]	Multiple Regression (Interval & Ratio). Logistic Regression (Nominal Data).	Assessing relationships and the likelihoods. NB: Multivariate must have dependent variable as metric.

The Principles on Independent variable and Dependent variable on Measurement Scales (Babbie and Mouton, 2001:601)

If Independent Variable is measured at the:	And Dependent Variable is measured at the:	Then use the:
Nominal/Ordinal level	Nominal/Ordinal level	Chi-square test
Nominal/Ordinal level (Dichotomy#)	Interval/Ratio level (Scale*)	T-test
Nominal/Ordinal level (No dichotomy)	Interval/Ratio level (Scale*)	One-way ANOVA (F-test)
Interval/Ratio level (Scale*)	Interval/Ratio level (Scale*)	Correlation coefficient

 # A dichotomy implies a variable with two categories only, such as gender or pass/fail or yes/no.
***SPSS does not distinguish between variables on an interval or ratio level but defines both as scale variables.**

Source: Designed by the researcher from the literature (Collis and Hussey, 2009; Cooper and Schindler, 2008; Davies, 2007; Hair *et al*., 2003; Babbie and Mouton, 2001:601).

6.4 Sampling Techniques

The managers (senior and functional levels) including supervisory level (nonmanagerial) in retail sales, logistics, warehousing, marketing, manufacturing and information technology hubs are considered for this study. The higher-ranking informants generally provide more reliable information than their lower-ranking counterparts (Hiller and Roth, 1994). Although the supervisory positions, known as nonmanagerial category, have been considered for their comprehensive understanding of individual retail outlets as well as warehousing systems, senior executives were ideal participants for this study. Nevertheless, it is crucially important for this study to make inferences with thoughtful, intelligibly expressive, rational and, above all, cooperative attitudes on the research and development of new knowledge and solution based activities. Retailers (downstream supply chain) and capacitated suppliers (midstream and upstream supply chain) in the selected FMCG industry constitute the population within five major retail chain stores in South Africa and selective suppliers for these retail groups in food (dairy, frozen, canned and general) and beverages (hot and cold), and personal health care category were considered for this empirical research study.

6.4.1 Sampling types and size

A nonprobability sample that conforms to this study's criteria with purposive sampling is called judgment sampling. This sampling occurs when a researcher selects sample members to conform to some criterion (Cooper and Schindler, 2008:397). The rational behind a nonprobability sampling technique was that the respondents in management positions are difficult to identify and contact. This sample should be composed of elements that contain the most characteristic, representative or typical attributes of the population. Normally, the research projects in supply chain management make use of snowball sampling to establish relevant type of sample and to target respondents that will enhance epistemological dimensionality of theoretical, representativeness and validity-related quality. The inclusion of supervisory level in this study emanated from the referral sampling that proved to be the most efficient and effective approach in producing the sufficient sampling frame. In approaching few individual gatekeepers from the relevant population, these key individuals identified other members from the same population for inclusion in the sample (Welman, Kruger and Mitchell, 2005:69). In the context of the snowball sampling as a form of convenience sample (Bryman and Bell, 2007:200) was used in the preliminary phase of this study (pretesting the survey instrument and securing permission to conduct research) to allow initial contact with a small group of individual gatekeepers. These managers were relevant to this supply chain research theme in reviewing the content, scope and purpose of the items to ensure the content validity of the survey instrument. The individual gatekeepers from these selected FMCG companies do not solely represent the population but they have enhanced the extent of the potential population from which the sample frame would have to be drawn from each eminently encroached domain.

The sample size of 456 (260 retailers and 196 suppliers) is considered where Sekaran (2003:295) alludes to the fact that sample sizes of larger than 30 and less than 500 are appropriate for most research on population-to-sample size table. According to Sekaran (2003:294) and Bartlett, Kotrlik and Higgins (2001:48) the representative population size of 800 (retailers) and 300 (suppliers) in determining minimum returned sample size (table format – table 6.1) is 260 and 196 sample size respectively with an alpha of 0.05 and a degree of accuracy of 0.05. The alpha value or level of significance (0.05) will become enshrined as the threshold value for declaring statistical significance in this study. This study has produced a sample size of 448 respondents with return rate of 98% [(448/456) 100]. According to Krejcie and Morgan (1970) researchers typically set a sample size level of about 500 to optimally estimate a single population parameter, in turn, this will construct a 95% confidence interval with a margin of error of about ± 4.4 % for large populations. Regarding an inverse relationship between sample size and the margin of error, smaller sample sizes will yield larger margins of error. Larger sample size generally leads to increased precision when estimating unknown parameters (Cooper and Schindler, 2008; Babbie and Mouton, 2001; Krejcie and Morgan, 1970).

Nonprobability sampling has some compelling practical advantages to meet the sampling objectives of the study (Blumberg, Cooper and Schindler, 2008:235). This study intends to deal with intelligibly expressive managers and supervisors that are clearly atypical to the contextual level of approach. Executives, functional managers and nonmanagerial supervisory staff seem to provide responses at the personal and business levels with proviso of assurance for anonymity and confidentiality. According to Planet Retail (2006) there are five major retail chains (Shoprite, Pick n Pay, Woolworths, SPAR, and Massmart) with sizeable market share and average sales in South Africa. The following table indicates the computation of sample size from the population.

6.4.2 Administering Survey

It is always crucial to maximise the responses, as far as possible, by ensuring that the survey reaches all those in the sample and further miximising the chance (highest percentage of return rate) that the respondents answer the questions and return the completed questionnaire. The method of distributing the questionnaire was self-administered through scheduled delivery and collection of questionnaires within the agreed time intervals to enhance the return rate. The questionnaires were delivered to individual gatekeepers to administer the survey within their domain and most questionnaires were personally administered by the researcher within the eThekwini Metro, South Africa. The relevant letters (gatekeeper's letter, ethical clearance certificate, and consent letter to ensure confidentiality and anonymity) were constantly depicted to the gatekeepers where the researcher was given a permission to enchroach their domain.

Table 6.2: Number of Stores and Market share in South African FMCG industry

Share of modern Grocery distribution in South Africa

Stores	Number of Stores (South Africa)	Market share (2011) (Among 5 stores)
Shoprite Group	926	34.1%
Pick n Pay Group	465	24.1%
SPAR Group	846	24.9%
Massmart Group	119	10.5%
Woolworths Holdings	400	6.4%
Total	**2756**	**100%**

Table (Sekaran, 2003:294 and Bartlett *at al.*, 2001)

<u>Population</u>	<u>Sample Size</u>	
800	260	The selected stores did not divulge the number of the positions at executive, managerial and supervisory levels within their stores. The mathematical model was used to estimate proportion of executives, managers and supervisors to determine the percentage sample frame to the number of stores within the eThekwini Metro.
300	196	

Total number of stores (RSA) = 2756 multiplied by estimated eThekwini **Metro population.**

= 2756 x 29.03% = 800 retail stores

<u>Note</u>: This number (800) will represent the proportionate representative population of managers and supervisors as well as nonmanagerial positions in the retail sector around eThekwini Metro. The sample size (260) is determined through the table (Sekaran (2000) and Bartlett et al., (2001).

Capacitated suppliers *(Note: The big brand names are dominated by few suppliers in the shelf space for these five major retailers). Approximately 5000 suppliers nation-wide are supplying these retailers.*

= 5000 x 21.3% KZN population = 1056 x 29.03% eThekwini Metro population = 309 representative population that is slightly above 300, and 400 population will considered. The table indicates 196 sample size. The overall sample size = 456

Shoprite Group	Shoprite supermarket, Checkers, Checkers Hyper, Usave, OK (Food, Grocer, Value, Mini Market, Sentra and Enjoy)
Pick n Pay	Pick n Pay supermarket, Hyper, Express, Boxer, and Punch
Massmart	Makro, Game and Cambridge
SPAR	SuperSPAR, SPAR, KwikSPAR.
Woolworths Holdings	Woolworths (Pty) LTD
Suppliers	Food (dairy, frozen, canned and general) and Beverage (hot and cold); Personal and Health Care

<u>Appendix C</u>: Estimated population for KZN and eThekwini Metro 2010.

KwaZulu Natal (KZN) Population 2010 = 10 645 400 **eThekwini Population 2010 =** 3 090 139

Estimated percentage = $\frac{3\,090\,139}{10645400} \times \frac{100}{1} = 29.03\%$

The estimated percentage of population assists in determining the appropriate proportion of representative population of executives, managers and supervisors in the retail sector within eThekwini Metro. It process derived the tentatively justifiable representative population to determine the appropriate sample frame in this study.

Source: Compiled by the researcher (Business Times, 2011; Business Day, 2010; Stats SA, 2007; Sekaran, 2003; Bartlett *et al.*, 2001).

6.5 Methods

6.5.1 Univariate

The summarised univariate technique examined the distribution of cases on one variable at a time namely: biographical data, factual aspects of general experience on bullwhip effect, inventory positioning, information exchange, electronic supply chain management, strategic global optimisation tools, and general information on grocery industry. In this regard, the measures of central tendency will enable a researcher to encapsulate and condense information using mean (Cooper, 2001), and mode to locate the centre of the distribution. The measures of dispersion that describe the tendency for responses to depart from the central tendency like mean, were measured using variance, standard deviation, sigma, minimum and maximum, and Cronbach's Alpha as measure of internal consistency of reliability. The frequency distribution graphs were used to present data in the pie charts and bar charts. The usage of interval data can absorb the deficiency and shortcomings form the nominal and ordinal data to allow more measurement that would have been prohibited by limitations of the non parametric data.

6.5.2 Bivariate technique

6.5.2.1 Cross-tabulation and Chi-square

Cross-tabulation is a technique for comparing two classification variables (Cooper *et al.,* 2008:457). This technique uses tables with rows and columns that correspond to the levels or values of each variable's categories to compare two classification variables (Cooper *et al.*, 2008). Chi-square statistic tested the statistical significance between the frequency distribution of two or more groups (Hair, Babin, Money and Samouel, 2003:262). It intends to test the "goodness of fit" of the observed distribution with the expected distribution (Sekaran, 2006). These techniques hypothetically attempt to answer the following questions that are linked to research objectives as analysis of challenges in bullwhip effect from the perspective of electronically-enabled supply chain management, inventory positioning and information sharing:

- Which echelon category prefers the electronic supply chain management systems as the mitigation tools for bullwhip effect?
- How do the managerial levels rank the negative factors that influence information sharing?
- How do the managerial levels rank the positive factors that influence information sharing?

- Do organisations constantly adopt collaboration models to position their inventory levels?

These test procedures consist of four steps: - 1) State the hypotheses; 2) Formulate an analysis plan; 3) Analyse sample data; and 4) Interpret the results. In terms of *p*-values for hypothesis testing, the *p*- value is the smallest observed level of significance (0.05) at which the null hypothesis can be rejected for a given set of data. The degrees of freedom are calculated by equation, degree of freedom = number of classes – 1. It means that H_0 is rejected if the *p*-value is less than the significance level. The statistical hypothesis as an assumption about a population parameter has two types of statistical hypothesis: 1) Null hypothesis (H_0); and 2) Alternative hypothesis (H_A).

6.5.2.2 Non-parametric Statistics

Non-parametric techniques are ideal for when the researcher has data that are measured on nominal (categorical) and ordinal (ranked) scales. According to Pallant (2006: 286) "non-parametric (no parameter or characteristic of a population) techniques do not have stringent requirements and do not make assumptions about the underlying population distribution and these tests are referred to as distribution-free tests". Two non-parametric tests will be used including:

Firstly, a Wilcoxon signed ranked test will determine both direction and magnitude of difference between carefully matched pairs of collaboration models and B2B IT systems for the last five years.

Secondly, the Friedman test is an alternative to the one-way repeated measures analysis of variance. This test looks at significant differences on mean ranking mitigation factors on three dimensions and global optimisation strategies.

6.5.2.3 Correlations Analysis

This study will explore the relationships of the variables being used in this research, and a Pearson correlation matrix is seen as good indicator of direction and strength in bivariate relationships. The correlation coefficient, r (also called Pearson's product moment correlation after Karl Pearson, March 27, 1857 – April 27, 1936) is a bivariate analysis that measures the strength of association between two variables. In other words, it is widely used in statistics to measure the degree of the relationship between the linear related variables. Pearson's r is a useful descriptor of the degree of linear association between two variables within the properties of magnitude and direction (Cooper and Schindler, 2008 and Pallant, 2006). When it is near zero, there is no correlation, but as it approaches -1 or +1 there is a strong negative or positive relationship between the variables respectively. While the square of the coefficient (r^2) is equal to the percent of the variation in one variable that is related to the variation in the other.

The study has a tentative prior theory to suggest whether the relationship between variables would be positive or negative. In this regard, the two-tailed test is used with the common significance level of alpha, 0.5 with degree of freedom (N-2). The Pearson correlation will be instituted before the multiple regression on silo-oriented approach of three major dimensions (information sharing, E-SCM systems and inventory positioning).

6.5.3 Multivariate Analysis

The multivariate analysis as statistical technique is organised around a scheme that divides into interdependence (factor analysis) and dependence (regression analysis) procedures. The objective is to develop models and dimensions that best describe the population as a whole. The role of multivariate analysis in this study as statistical techniques will assist a focus on, and bring out in bold relief, the structure of simultaneous relationships among more phenomena. According to Hair *et al.,* (2003) multivariate analysis is referred to all statistical methods that simultaneously analyse multiple measurements of each individual or object under investigation. Any simultaneous analysis of more than two variables can be loosely considered multivariate analysis, and it ensures that it is representative of the population as a whole. Both interdependence and dependence procedures are interlinked where by the highly loaded factor items or retained items (equal or greater than 60%) in factor analysis method will be subjected to dependence procedure (multiple regression).

6.5.3.1 Factor Analysis

Factor analysis helps to reduce a vast number of variables to a meaningful, interpretable and manageable set of factors (Sekaran, 2003). In other words, factor analysis is a procedure that takes a large number of variables or objects and searches to see whether these variables have a small number of factors in common which account for their intercorrelation (Bryman and Bell, 2007). Factor analysis as a multivariate technique addressed the problem of analysing the structure of the interrelationships (inter-correlations) among a large number of variables by defining a set of common underlying dimensions, known as factors (Hair, *et al.,* 1995).
The interpretation of factor analysis is inclined to an underlying view of – how strongly each variable is loaded with each other's variables with an attempt to identify clusters of variables and/or search for structure among a set of variables. Rugg (2007) reports that within each

cluster, the variables will all correlate fairly strongly with each other on presumption for being variants on a single theme.

The overriding application of factor analysis in the study is to understand the complex relationships of scores (multidimensional statistics) on bullwhip effect and electronically-enabled supply chain management dynamics for each underlying dimension and substituting them for the original variables. Cooper and Schindler (2008:547) clarify that the predictor-criterion relationship is replaced by a matrix of intercorrelations among several variables, none of which is viewed as being dependent on another, but rather interdependent.

In terms of principal component analysis (PCA), it is used to reduce input variables complexity when one has a huge volume of information and one wants to have a better interpretation of variables (Camdevyren, Demyr, Kanik and Keskyn, 2005). By using this method, input variable change into principal components that are independent and linear compound of input variables (Lu, Wang, Wang, Xu and Leugn, 2003). In this study, principal component analysis transforms constructs and also extracts loadings with eigenvalues. The method intends to find a set of factors that are formed as a linear combination of the variables in the correlation matrix. The principal component methods of factor extraction and varimax methods of rotation generate factors that account for the variance. Similarly, it extracts factors with eigenvalues greater than one (Podsakoff and Organ, 1986), while varimax rotation facilitates interpretation of the factor matrix. Factor analysis in this study aims to develop conceptual framework of dimensions for aligning the strategic variables and structural formulation of supply chain management.

6.5.3.2 Multiple Regression Analysis

According to Nusair and Hua (2010:314-324) multiple regression "evolved to a sophisticated and versatile tool for various kinds of data analyses, particularly powerful when samples exhibit distinctive characteristics, and research questions are tailored to address probability related issues". The model prediction accuracy is usually measured by adjusted R^2, and the closer the adjusted R^2 is to 1 the better the accuracy of model prediction. The parameters of factor analysis model will be estimated using multivariate regression analysis. Multiple regression analysis is an analytical tool designed to explore all types of dependence relationships. Cooper and Schindler (2008:546) describe this dependency technique as a tool to develop a self-weighting estimating equation by which to predict values for a criterion variable (dependent variable) from the values for several predictor variables (independent variables). Sekaran (2003) defines multiple regression as an analysis where more than one predictor is jointly regressed against the criterion variables.

In general, multiple regression indicates a three-step process analysis (Schumacker and Lomax, 2004):
"Firstly, model specification which involves finding relevant theory and prior research to formulate a theoretical regression model; Secondly, model identification which refers to deciding whether a set of unique parameter estimates can be estimated for the regression analysis; and Thirdly, model estimation which involves estimating the parameters in the regression mode by computing the sample regression weights for the independent variables".
The results of multiple regression show the overall explanatory power of all predictor variables with measures of R^2 or adjusted R^2 along with "the relative importance of individual predictors after calculating the β coefficients" (Nusair and Hua, 2010). The relationships between independent variables and dependent variable from interval scale using r, R-square, *F* statistic and significance level is interpreted to understand how much of the variance in the dependent variable in explained by a set of predictors.

The tolerance value and variance inflation factor will be pertinent measures available for testing the degree and impact of multicollinearity. The sequential search method will select variables that maximise the prediction with the smallest number of variables employed. Stepwise estimation as sequential method allows examination of the contribution of each independent variable to the regression model. Babin, *et al*., (2003:307) refer to stepwise as "a sequential approach in which the regression equation is estimated with a set of independent variables that are selectively added or deleted from the model". The approach will be used where each independent variable is considered for inclusion in the regression prior to developing the equation. Multiple regression has correlation assumptions including "linearity of relationships, the same level of relationships throughout the range of the independent variable (homoscedasticity), interval or near-interval data, absence of outliers, and data whose range is not truncated". This study uses the stepwise estimate (forward approach) to examine the contribution of each independent variable to the regression model. The stepwise forward approach assists to develop the regression equation after thorough cogitation of independent variables without multicollinearity.

6.5.3.3 Logistic Regression Analysis

Logistic regression analysis is described as an approach that is similar to that of multiple linear regression except that the dependent variable is taken into account as categorical. Logistic regressions seem to find a relationship between the independent variables and a function of the probability of occurrence. In addition, logistic regression offers a new way of interpreting relationships by examining the relationships between a set of conditions and the probability of an event occurring (Garson, 2012).

Logistic regressions predict likelihoods, measured by probabilities (ratio of the number of occurrences to the total number of probabilities – probabilities range from 0 to 1), log-odds, or odds (ration of the number of occurrences to the number of non-occurrences – odds range from 0 to infinity) (Tabachnick and Fidell, 2007: 439). In this study, logistic regression allowed the researcher to predict a discrete outcome from a set of variables such as inventory position, inventory policy, information sharing, e-SCM systems, Third party IT system and In-house IT, that are dichotomously designed (Yes or No).

6.6 Methods of assessment

6.6.1. Reliability

Reliability relates to the consistency of the measurement as Hair *et al.,* (1998) define reliability as "a measure of internal consistency of the construct indicators, depicting the degree of which they indicate the common latent construct". Reliability is assessed at two levels (Fornell and Larcker, 1981; Hair *et al.,* 1998): "Firstly, item reliability – it indicates the amount of variance in an item due, to underlying construct rather than to error, and can be obtained by squaring the factory loadings. An item reliability greater than 0.50 (roughly corresponds to standardised loading of 0.7) is considered evidence of reliability (Chau, 1997:324). In congruence, Chin (1998) indicates that the standardised loading for each item should be greater than 0.7 to demonstrate reliability but a value of 0.5 is still acceptable. Secondly, construct reliability – refers to the degree to which an observed instrument reflects an underlying factor. A construct reliability value of at least 0.7 is usually required".

Although the reliability of the instrument is operationalised using the internal consistency method following a rule of thumb, it aims to confirm the reliability of the instrument, as factor analysis is used to reduce the total number of items to manageable factors (Bryman and Bell, 2007). Tabachnick and Fidell (2001) concede that a smaller sample size of cases should be sufficient despite the comforting cases for factor analysis, and solutions should have high loading marker variables. The reliability of factor structures and the sample size requirements should be congruent with factor loading above at least 0.80 (Cooper and Schindler, 2008). According to Dancey and Reidy (2002) at least 100 participants allow the performing of the factor analysis as underlying criterion in the study.

Cronbach's Alpha coefficient (named after Lee Cronbach in 1951) is widely used for assessing the internal consistency and reliability of a measure. Cronbach's Alpha values show that the constructs are measured with sufficient reliability (Cronbach, 1951; Nunnaly, 1978).

Cronbach's Alpha is defined as: Alpha = $[(k/k\text{-}1)] / [1\text{-}(\sum_{i=1}^{2} \sigma^2_{yi} / \sigma^2_x)]$

The alpha coefficient ranges from 0 to1 and it has a common value for efficient internal reliability of 0.70 and 0.80 denoting acceptable level of internal reliability. However, a value below 0.70 has been deemed acceptable if the research is an exploratory nature (Hair *et al.*, 1995). It provides a measure of the internal consistency and homogeneity of the items comprising of scale (Churchill, 1979).

Hair *et al.,* (1995) provide the following calculation:

$$\frac{(\Sigma \text{ factory loading})^2}{(\Sigma \text{ factor loading})^2 + (\Sigma \text{ error variance})}$$

All constructs must display composite reliabilities in excess of the 0.60 recommended value for exploratory study (Churchill, 1979). The statistical measures will assist to assess the factorability of the data with Bartlett's test of sphericity (Bartlett, 1954), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974). The Bartlett's test of sphericity is significant at 5% for the factor analysis to be considered appropriate.

6.6.2 Validity

Several procedures are recommended to assess validity of a measurement. Bryman and Bell (2007) reported that there is a number of ways to investigate the merit of measures (validity and reliability), which are devised to represent social scientific concepts. The researcher intended to identify theoretically supported relationships from prior research or accepted principles and then assess whether the scale had corresponding relationships. Anderson (2009:155) stresses that the value and credibility of an investigative enquiry can be assessed by considering issues such as the validity, credibility, reliability and trustworthiness of the data on which the inferences and conclusions are tentatively based. Construct validity assesses the quality of correspondence between a theoretical construct and its operational measures. The study tends to deduce research questions from a theory that is relevant to the concept. Content validity represents how will the content of the constructs is captured by the study's measures of the construct. As long as the results are as expected, they are considered valid on their face (Whicker and Sigelman, 1991).

Nomological validity will assist to determine if the scale demonstrates the relationships shown to exist based on theory and/or prior research in the multiple regression technique and factor analysis. Convergent validity as "a set of alternative measures accurately represents the construct of interest" (Churchill, 1979), this validity will assess the level of significance for the factor loadings. In other words, Nusair and Hua (2010:314) assesse "the degree to which dimensional measures of the same concept are correlated, as a result, the high correlations indicate that the scale instrument is measuring its intended construct". If all the individual item's factor loadings are significant, then the indicators are effectively converging to measure the same construct (Anderson and Gerbing, 1988).

Thus, items of the scale instrument should load strongly on their common construct (Byrene, 1994; Fornell and Larcker, 1981). "Higher variance extracted values denote that the indicators are truly representative of the latent construct" (Nusair and Hua, 2010). The rationale for consistency tests is demonstrated by showing that directional changes in input values are followed by changes in output values in the anticipated way. The study will assess whether there is any major departure from expectations of results or to unusual output by using multicollinearity, normality, Bartlett test, Cronbach's Alpha and eigenvalues.

6.7 Assumptions on Multivariate Analysis

6.7.1 Dimensionality

The dimensionality on an itemised set determines the list of factors and individual variable loadings on the underlying for treatment of factor loading in the factor analysis. The test of unidimensionality is that each summated scale should consist of items loading highly on a single factor. It means that the strongly itemised association with each other would constitute the one-fold concept. Exploratory factor analysis in this study will produce multiple dimensions, while each dimension can reflect a separate factor (that is, factor 1 to 10) and ultimately naming or labeling those factors.

6.7.2 Normality

Normality refers "to the shape of the data distribution for an individual metric variable and its correspondence to the normal distribution, the benchmark for statistical methods" (Welman *et al.,* 2005:234). Multivariate normality is the assumption that each variable and all linear combinations of the variables are normally distributed (Tabachnich and Fidell, 2007: 125). When the assumption is met, the residuals (left-overs → segments of scores not accounted for by the multivariate analysis as errors between predicted and obtained scores) of analysis are also normally distributed and independent.

The equation of kurtosis gives a value of 3 when the distribution is normal, but all of the statistical packages subtract 3 before printing kurtosis so that the expected value is zero. Both univariate and multivariate statistical methods will be based on the assumption of univariate normality. A rule of thumb will be based on the skewness and kurtosis values as part of the basic descriptive statistics for a variable computed by the statistical programme (SPSS). The statistic value (Z) will be calculated for kurtosis and skewness values. The critical value is from a Z scores distribution and the significance level is weighed on 0.05 (error level).

6.7.3 Homoscedasticity and Heteroscedasticity

The assumption of homoscedasticity is that the variability in scores for one continuous variable is roughly the same at all values of another continuous variable. It is related to the assumption of normality because when the assumption of multivariate normality is met, the relationships between variables are homoscedastic (Tabachnick, *et al.,* 2007:125). The assumption of homoscedasticity is the assumption that the standard deviation of errors of prediction are approximately equal for all predicted dependent variable scores while heteroscedasticity can occur when some of the variables are skewed and others are not (Tabachnick and Fidell, 2007; Fox, 1991). Heteroscedasticity can manifest from interaction of an independent variable with another variable that is not part of the regression equation (Freud and Wilson, 1998; Fox, 1991).

In terms of an assumption related primarily to dependence relationships between variables, Homoscedasticity is interpreted as the assumption that dependent variable(s) exhibit equal levels of variance (or equal spread) across the range of predictor variable(s) while heteroscedasticity is "when the error terms have increasing or modulating variance" (or unequal spread) (Hair *et al.,* 1998If the sample is heterogeneous with regard to at least one subset of the variables, then the first factors will represent those variables that are more homogeneous across the entire sample in the factor analysis (Tabachnick and Fidell, 2007).

The higher loadings and rotation of the factors will improve interpretation and naming of factors (Garson, 2012).

6.7.4 Multicollinearity

The assumption of linearity is that there is a straight line relationship between two variables (where one or both of the variables can be combinations of several variables). It assumes that errors of prediction are normally distributed around each and every predicted dependent variable. Linearity between two variables is assessed roughly by inspection of bivariate scatterplots. According to Tabachnick and Fidell (2007:127) "the residuals scatterplot should reveal a pileup of residuals in the center of the plot at each value of predicted score and a normal distribution of residuals trailing off symmetrically from the center". Multicollinearity is interpreted as a problem in multiple regression because it reduces the predictive power of an independent / exogenous variable. A high degree of multicollinearity can lead to regression estimates being estimated incorrectly and even to showing wrong signs. The distortion of the results can substantially make the results quite unstable and thus not generalisable. Blumberg, Cooper and Schidler (2005:746) define multicollinearity as "the situation where two or more of the independent variables are highly correlated".

The study will assign to a general rule of thumb that a sample correlation coefficient between two independent variables greater that +0.70 or less than -.70 will be an apparent of potential problems with multicollinearity. Multicollinearity arises because one or more of the regressors are exact or approximately linear combinations of the other regressors (Gujarati, 2003). It is necessary that the independent variables have not high relativity and the attempt should be made to remove the multicollinearity between independent variables. The variance inflated factor (VIF) criterion is usually applied to check the results and the ideal value for VIF is one. The higher values, the more multicolinearity between independent variables exist.

6.7.4.1 The tools of Multicollinearity

The tolerance value and variance inflation factor are two pertinent measures available for testing the degree and impact of multicollinearity. These measures describe the degree to which each independent variable is explained by the other independent variable. The measurements of how much the variance of the regression coefficients is inflated by multicollinearity problems (that is, VIF) present possible remedy. VIF equals 0 = no correlation, VIF measure of 1 = an indication of some association between predictor variables and VIF value of 5.0 as maximum acceptable value; anything higher indicates a problem with multicollinearity.

The VIF must present less serious multicollinearity among independent variables in the model. The model must be reliable at *p*-value for F < 0.01 and adequate with adjusted R-square.The amount of variance in an independent variable that is not explained by the other independent variables (tolerance) also presents possible solutions. Hair, Jr (1998:193) defines tolerance as "the amount of variability and the selected independent variable not explained by other independent variables". The minimum cut off value for tolerance is typically .10, that is, the tolerance value must be smaller than .10 to indicate a problem of multicollinearity. It means that small values for tolerance indicate problems of multicollinearity.

6.8 Outliers of Multivariate Analysis

6.8.1 Distance Measures

Outliers are cases with such extreme values on one variable or a combination of variables that they distort statistic. Garson (2012) and Tabachnick and Fidell (2007) contribute to perspective of the distance measures on the following:

Firstly, Mahalanobis distance is the distance of a case from the centroid of the remaining cases where the centroid is the point created by the means of all the variable (Tabachnick and Fidell, 2007:166). A very conservative probability estimate for a case being an outlier, $p < 0.001$, is appropriate with Mahalanolis distance. Mahalanobis (1936) indicates the equation:

$$\text{Mahalanobis distance} = (N-1)\, h_{ii} - 1/N)$$

The higher the Mahalanobis distance for a case, the more that case's values of independent variables diverge from average values.

Secondly, centered leverage statistic, *h* (hat-value) identifies cases which influence regression coefficient more than others. A rule of thumb is that cases with leverage under 0.2 are not a problem, but if a case has leverage over 0.5, the case has undue leverage (Tabachnick *et al.*, 2007). The case should be examined for possibility of measurement error or the need to model such cases separately. The leverage statistic varies from 0 (no influence on the model) to almost 1(completely determines the model).

Thirdly, Cook's distance, D measures the effect of the residuals for all other observations of deleting a given observation. Fox (1991: 34) advocates "a cut-off for deleting influential cases, values of D greater than 4/(N-k-1), where N is sample size and k is the number of independents".

Fourthly, graphical method with "data labels reflects influential cases with high leverage that can be spotted graphically". Outliers can be flagged by use of residuals, influence statistics, and distance measures and these outliers are a form of violation of homoscedasticity and affect regression coefficients substantially (Garson, 2012). In the assumption of homoscedasticity, the histogram of standardise residuals should show a roughly normal curve and the P-P plot should show only minimal departure from normality under normal distribution.

While the plot of the dependent on the x-axis for the homoscadasticity assumption, 1) against standardised predicted values on the y-axis, the observation should be spread about the regression line similarly for the entire x-axis; and 2) against standardised residuals on the y-axis, the trend line should be horizontal at the y, 0 point. Lastly, the plot of standardised estimates of the dependent 'on the x-axis against' standardised residuals 'on the y-axis' should have a homoscedasticity model displaying a cloud of dots.

6.8.2 Residuals Analysis

Residuals show the difference between predicted and obtained y-values, identify outliers in the solution and are available in raw or standardised form with or without the outlying case deleted (Tabachnick and Fidell, 2007: 124). A graphical method based on residuals uses leverage on the x-axis and residuals on the y-axis. The statistical criterion for identifying an outlier in the solution depends on the sample size with larger sample more likely that more residuals will be discrepant (Garson, 2012, Tabachnick and Fidell, 2007 and Pallant, 2005). A criterion of $p = 0.001$ is appropriate for $N < 1000$, defining outlying cases as those with standardised residuals in excess of about ± 3.3 (Pallant, 2005: 151). The residual analysis is used for three main purposes: 1) to spot heteroscadasticy (increasing error as the observed y-values increases); 2) to spot outliers (influential cases); and 3) to identify other patterns of error (error associated with certain ranges of X variables). Garson (2012) outlines five main types of residuals:

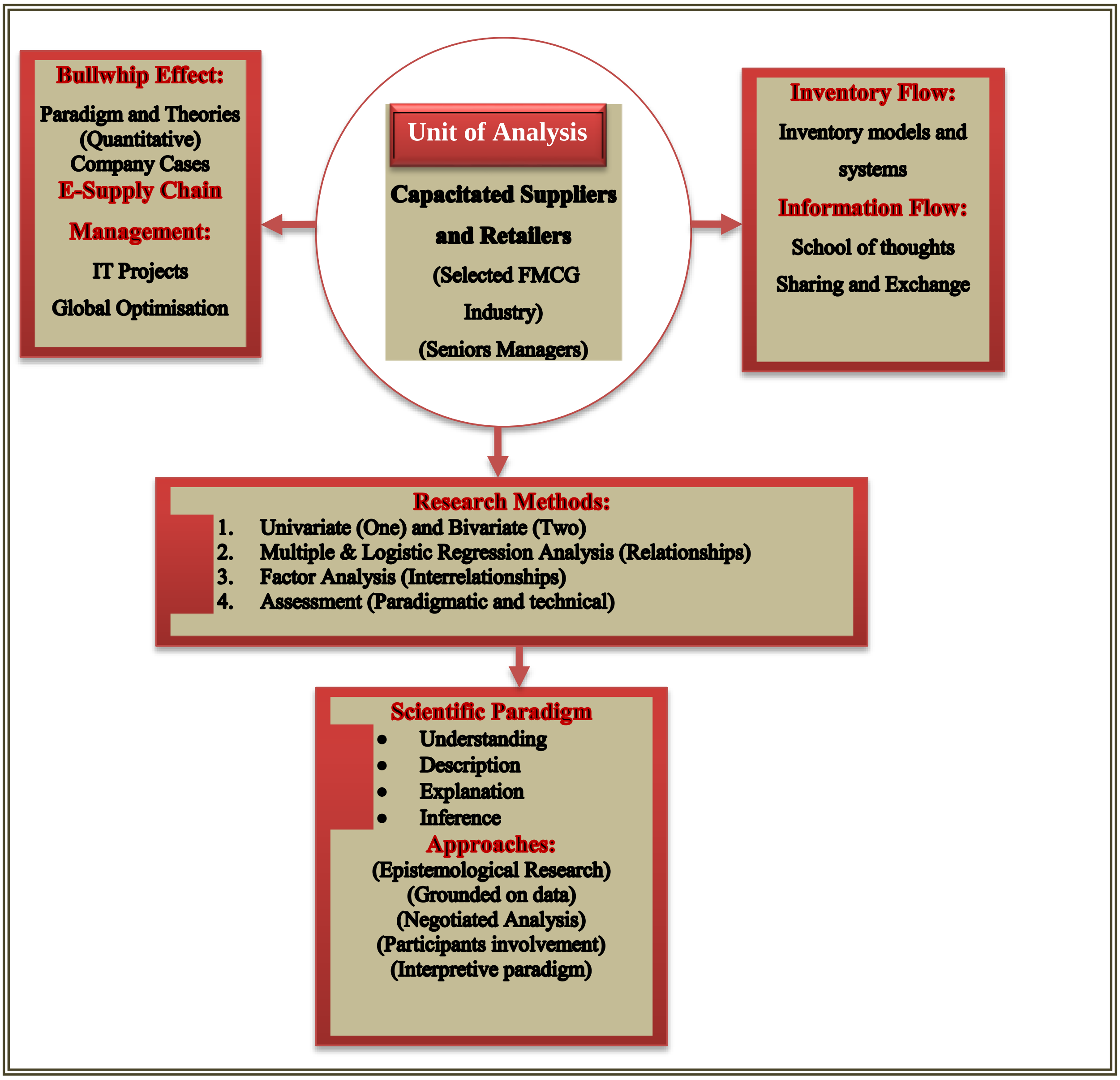
- "Unstandardised residuals that refer in a regression context to the linear difference between the location of an observation (point) and the regression line in multidimensional space.
- Standardised residuals that refer to residuals after they have been constrained to a mean of zero and a standard deviation of 1, and the rule of thumb is that outliers are points whose standardised residual is greater than ± 3.3.
- Deleted residuals compute the standard deviation omitting the given observation prior to standardising or studentising the residual.

- Studentised residuals are constrained only to have a standard deviation of 1, but are not constrained to a mean of 0.
- Studentised deleted residuals are residuals which have been constrained to have a standard deviation of 1, after the standard deviation is calculated leaving the given case out. These residuals are often used to assess the influence of a case and identify outliers. When t exceeds the critical value for a given alpha level (example, 0.05) then the case is considered an outlier".

6.9 Data analysis

The well-established statistical package SPSS (Statistical Package for Social Sciences) has been used in capturing and is capable of generating a wide range of statistical analyses. The researcher's task is the selection of relevant statistical techniques and interpreting the results. Survey data was coded using numeric and alphanumeric codes and a cross-sectional study was conducted to explore the perceptions of senior executives towards bullwhip effect and impact of electronic information exchange models. The conclusions are limited to one period of time and are subject to further tests based on data collected at other times.

Figure 6.1: Simulation diagram of research structure



Source: Developed by the Researcher

Chapter Seven

Data Analysis and Presentation of Results

7.1 Introduction

The purpose of the data analysis is to ascertain the overall perceptions of respondents towards the challenges of bullwhip effect within the context of electronically-enabled supply chain management systems, inventory positioning and information sharing. The previous chapter on research methodology and data collection suggested the univariate, bivariate and multivariate methods as most appropriate for this study after using a survey instrument (questionnaire) to solicit the data for analysis. The researcher has used the Statistical Package of Social Science (SPSS) to analyse and interpret data under univariate (descriptive statistics, frequency distribution, and pie and bar charts), bivariate (inferential statistics with hypotheses testing) and multivariate analysis (factor analysis, and multiple and logistic regression analysis).

7.2 Univariate Analysis

Univariate analysis is examining the distribution of cases on only one variable at a time for purely descriptive reasons, while bivariate analysis involves the element of relationships among variables themselves (Babbie and Mouton, 2001: 430). Exploring relationships between variables means that searching for evidence that the variation in one variable coincides with variation in another variable (Bryman and Bell, 2007:360). In terms of descriptive statistic, the analysis commences with the construction of the frequency distribution and eventually analyses sample data to measure central location, variability, and skewness and kurtosis.

The purposes of descriptive analysis in this univariate method are outlined as to: 1) provide preliminary insights into the nature of the responses obtained as reflected in the distribution of the values for each variable; 2) provide a means of presenting the data in a transparent manner with tables and graphs; and 3) provide an early opportunity for evaluating whether the distributional assumptions of subsequent statistical tests under bivariate and multivariate analysis are likely to be appropriate and satisfactory. The construction of tables and presentation of graphs in either absolute terms or percentages show how often the different values of the variable are encountered in the sample.

7.2.1 Frequency distribution: Pie and Bar charts

Frequency distribution indicates how the different values of the variable are among the units of analysis by representing the data graphically. Frequency distributions are used to describe the responses to a particular variable by displaying the counts and percentages both before and after adjustment for non-responses, and determine the amount of non-response, if any (Hair, Babin, Money and Samouel, 2003: 233). These summary measures allow the researcher to capture the essential characteristics of different distributions, condense information in the individual values and making the interpretation of data more manageable. This distribution shows the number of cases having each of the attributes of a given variable on either pie graphs or bar graphs in this study.

Figure 7.1: Departments

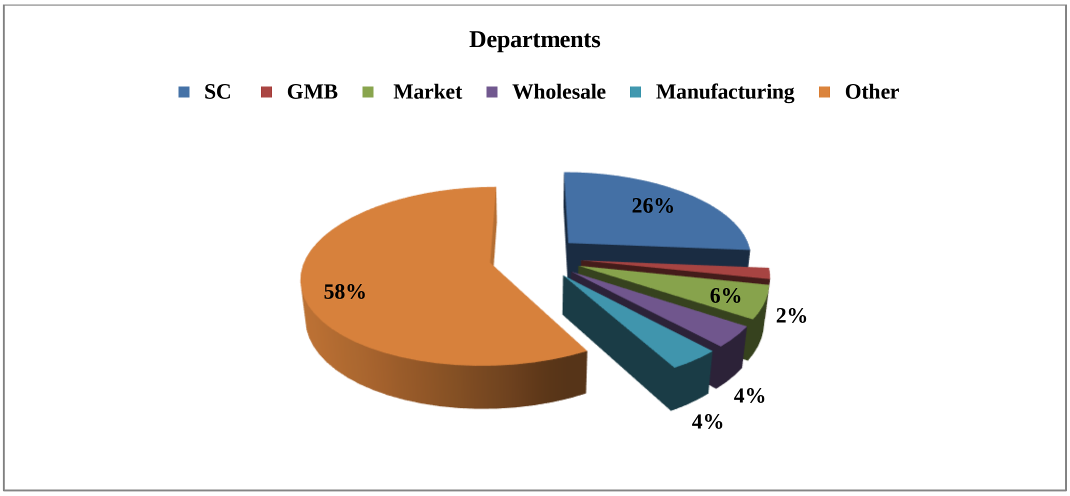
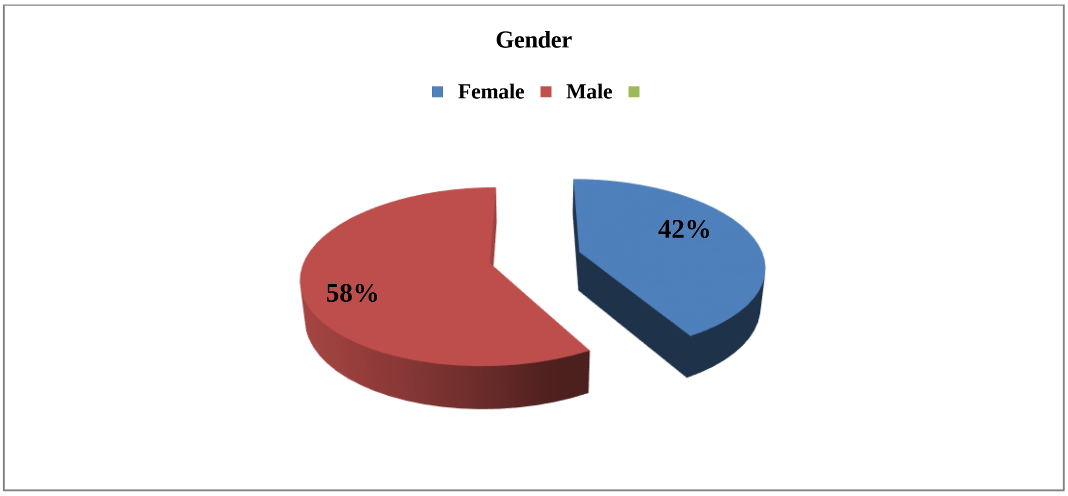


Figure 7.1 shows the percentage of respondents affiliated to various organisational departments. The supply chain department (Operations, Purchasing and Logistics) represents 26% of the respondents in this study while the other departments indicate most representation of 58% among the listed departments. The remainder of percentages, 2%, 6%, 4% and 4% represents the management, marketing, wholesale and manufacturing respectively.

Figure 7.2: Gender



A fairly representative statistical revelation between female and male participants (figure 7.2) indicates 42% and 58% respectively. These figures reflect the inequitable realities of South African workplace composite, although their points of view on subject matter are both meritoriously acceptable.

Figure 7.3: Number of years working in this organisation

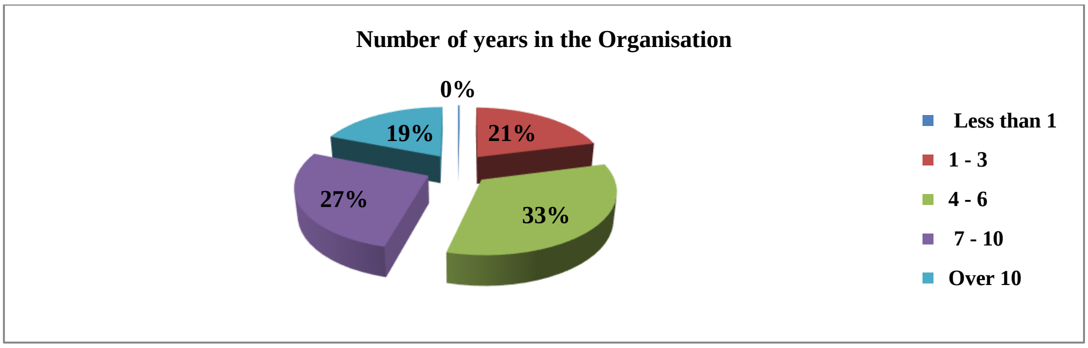
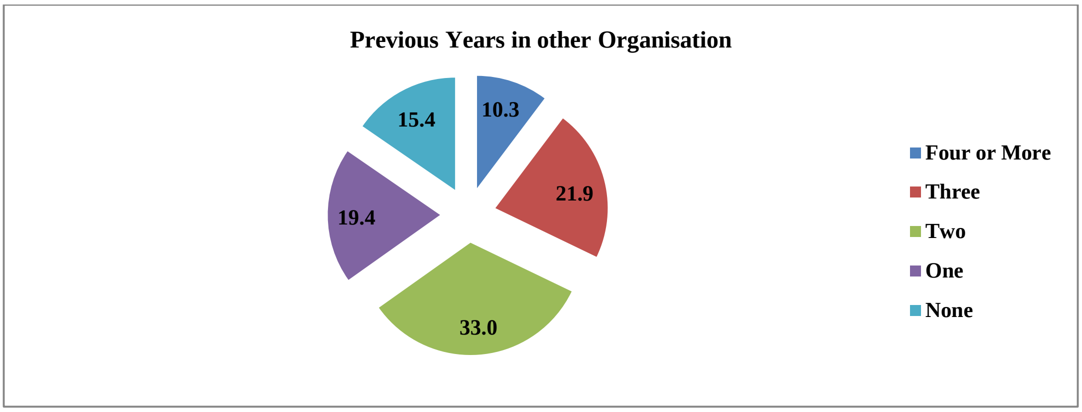


Figure 7.3 indicates the overwhelming majority of experienced respondents (79%) worked in the same organisation for between four and 10. Although the people who participated in this study had a thorough idea and immense knowledge of the industry, a considerable percentage of respondents (21%) had been with various organisations for less than three years. The public-private recruitment programmes (Setas) and graduate recruitment initiates have the propensity to elevate this number of inexperienced group of respondents. It is noted that less experienced participants had an estimable theoretical and ruminative contextual understanding of the subject matter.

Figure 7.4: Previous years worked in other organisation



The respondents with previous years from other organisations had the propensity to add value to this study, and the overwhelming majority between two and beyond five years previous experience indicates 65.2%. Hence the considerable percentage (figure 7.4) shows 34.8% respondents who had one year or no previous experience from other organisations. It is not known whether these respondents were working in the same sector or currently pursuing the same career path within the same sector.

Figure 7.5: Job status of the participants on managerial levels

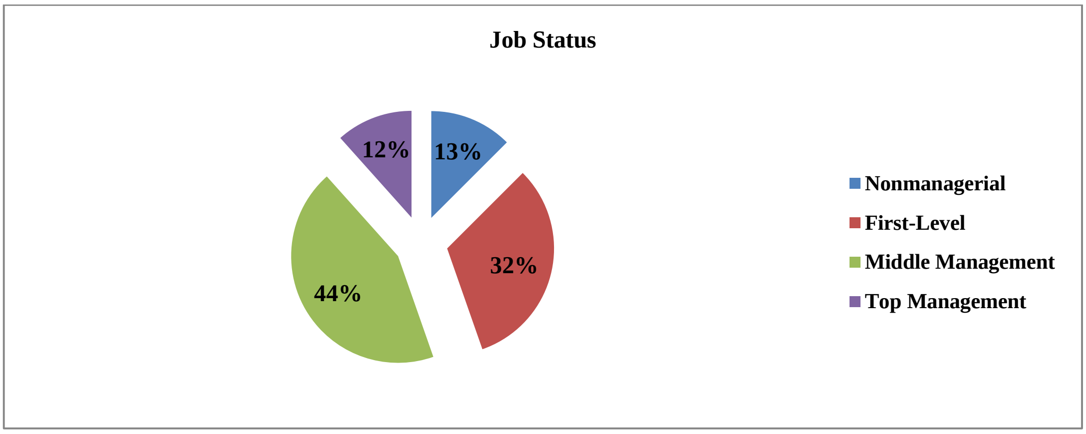
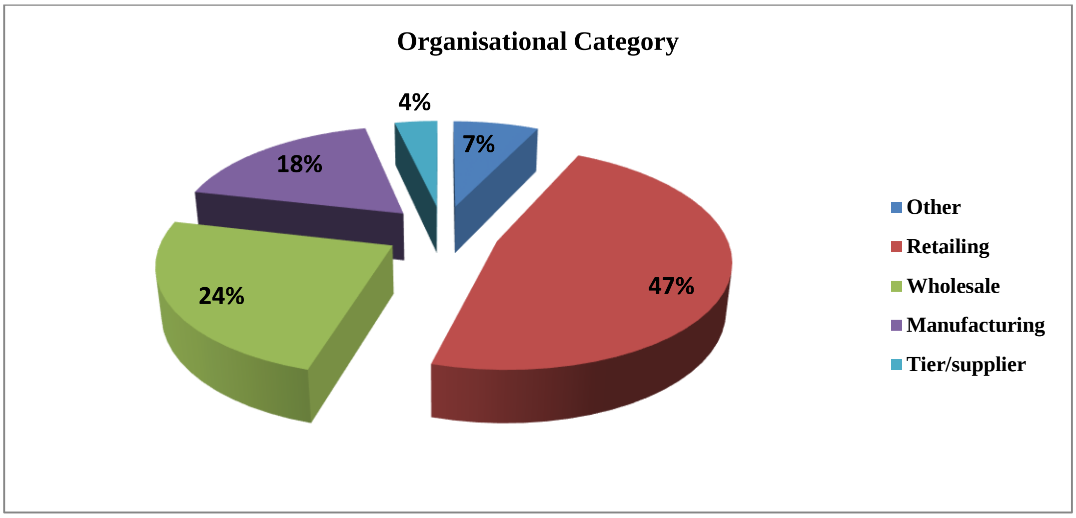


Figure 7.5 indicates the job status of the participants, and the majority of respondents (79%) between the first level and middle management aspires heretical insight and ingenuous responses in this study. In terms of pinnacle and nascent levels, the top management and non-managerial levels were 12% and 13% respectively. It was understandable difficult to pin down respondents in the vertex level of the organisations and conscientious entrust the responses from non-managerial participants for this profound study.

Figure 7.6: Characterised organisational category



In the collaborative view of a supply chain, the desegregated value chains in the process cycles have to display greater visibility and integration among multiple organisational echelon categories. On the upstream site of the supply chain network, the capacitated suppliers provided balanced representative responses whereby suppliers/tiers, manufacturing and wholesale as independent distributor or manufacture-owned distributor show 4%, 18% and 24% respectively. In the viewpoint of supply chain as a sequence of processes and flows that take place within and between different stages, retailing on the downstream site with influence in greater magnitude of uncertainty and dynamics within a supply chain indicates 47% of respondents in figure 7.6. The retailer's orders to the other echelon stages exhibit more variability than the actual demands from the customers.

Figure 7.7: Number of upstream and downstream trading supply chain partners in the network

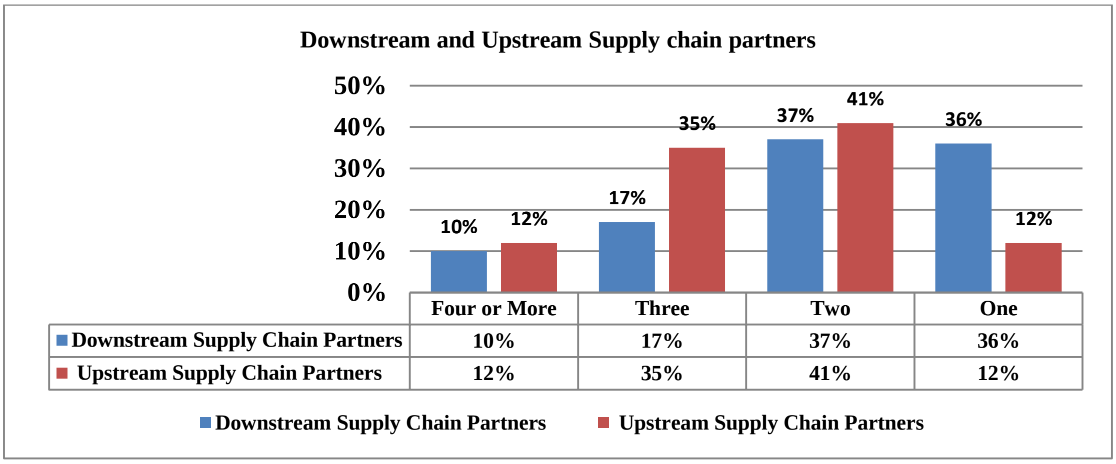
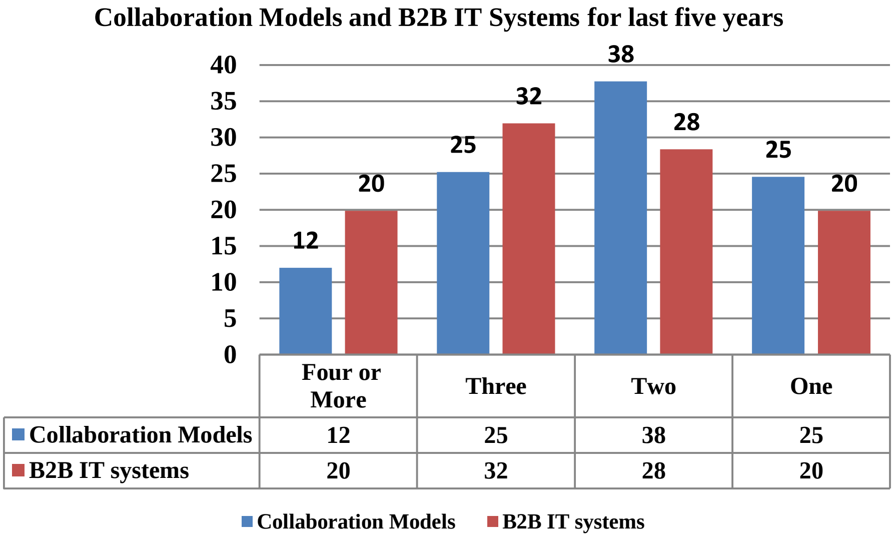


Figure 7.7 shows a realistic discernment on the downstream supply chain site where a consumption cycle of the end product presides the retail stage and the supply chain trading partners between two and one indicate 73% agreement on the number of supply chain partners below the echelon. The structural supply chain design below the retail stage (supermarkets) illustrates the consumer cycle while the retail cash discounters allow small and medium-sized supply chain traders the opportunity to procure in bulk the finished products for reselling. The combined 27% of the respondents has three or more than four supply chain partners on their downstream site. Certain retailers have comprehensive programmes that incorporate more supply chain traders especially small and medium-sized enterprises (SMEs) for Broader Based Black Economic Empowerment (BBBEE) framework.

The distinctive yet interrelated supply chain network flows are significant "in establishing a desired level of customer service in the downstream supply chain and ultimately satisfying customer's requirements". Figure 7.7 further indicates 53% of the respondents with two or less upstream supply chain partners circumscribed goal-oriented integration that focuses on inventory aggregation as a strategic approach. It can be achieved by centrally holding the slow moving items and decentralising fast moving items to attenuate the cascading phenomenon. Normally, "a multi-echelon serial supply chain consists of a retailer, wholesaler, distributor and manufacturer", and the capacitated suppliers with three and four or more members indicate 35% supply chain partners and 12% supply chain partners on the upstream site respectively. This study has noted that more than four supply chain partners on the upstream might make a concession on consolidating the forecast data and actual consumer demand information from trading supply chain partners. According to Simchi-Levi, *et al.*, (2008) the effective supply chain paradigm of networks seeks to entrench an organised and coordinated global optimised value-creating enterprise.

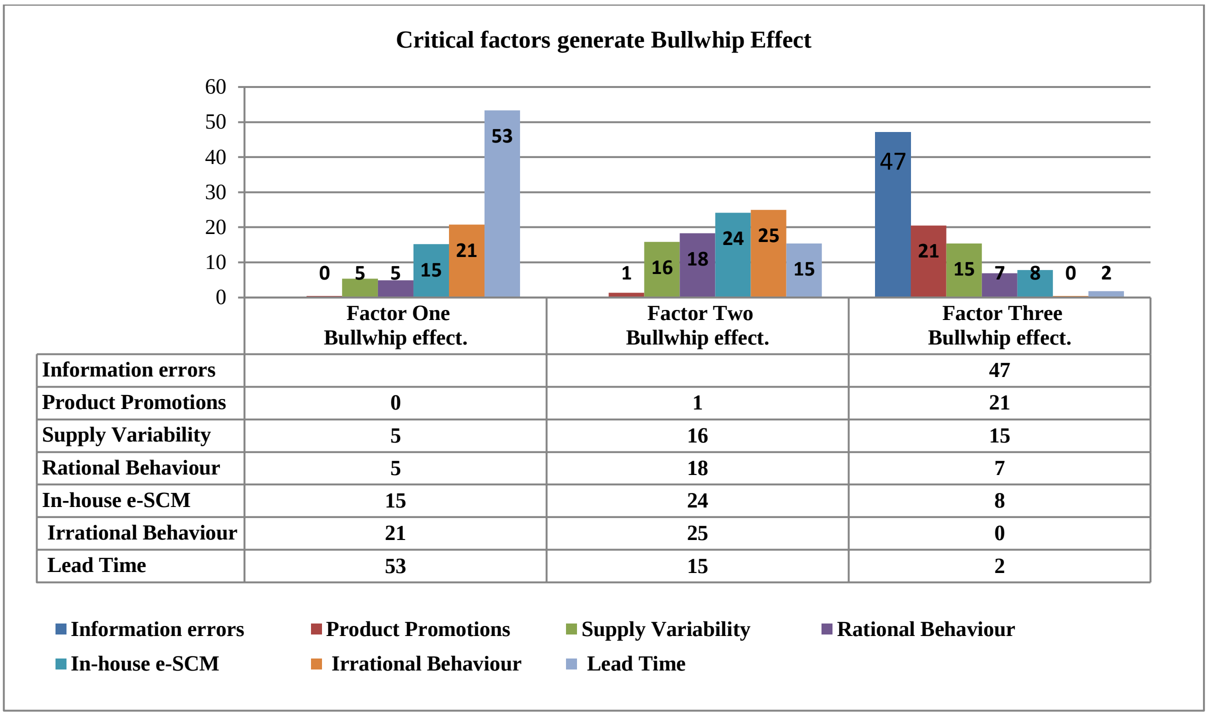
Figure 7.8: Number of Business-to-business IT systems and strategic collaboration models adopted for last five years



	Four or More	Three	Two	One
Collaboration Models	12	25	38	25
B2B IT systems	20	32	28	20

The supply chain structure reflects a group of semi-independent partners that collaborate in ever-changing business processes and models to serve dynamic markets through integrated supply chain activities. The values in the tables (figure 7.8 to figure 7.19) are in percentages although the percentage sign (%) is not attached on each value. Figure 7.8 assesses the clock speed on new models over the last five years, the supply chain paradigm with two or less that instituted models has 63% and 48% for collaboration models, and business to business information technology (B2BIT) systems respectively. In terms of technology clockspeed, 52% of respondents agree on the speed by which technology changes by implementing three or more systems for last five years while 37% represents strategic business collaboration models that have been used by organisations for global adaptability. Although an extensive education and training of workers to implement IT-enabled supply chain and adaptability of strategic business collaboration models, both systems enhance the knowledge about the real time web-based market information and customer expectations on order requisitions. The supply chain agility to meet the changing market environment and to overcome challenging technology clockspeed requires flexible and responsive strategic business collaboration and global technology optimisation. In terms of introducing more than three systems within the short space of time, this study acknowledges supply chain agility as an operational strategy that focuses on inducing velocity and flexibility into the supply chain environment.

Figure 7.9: Critical factors that tend to generate Bullwhip Effect

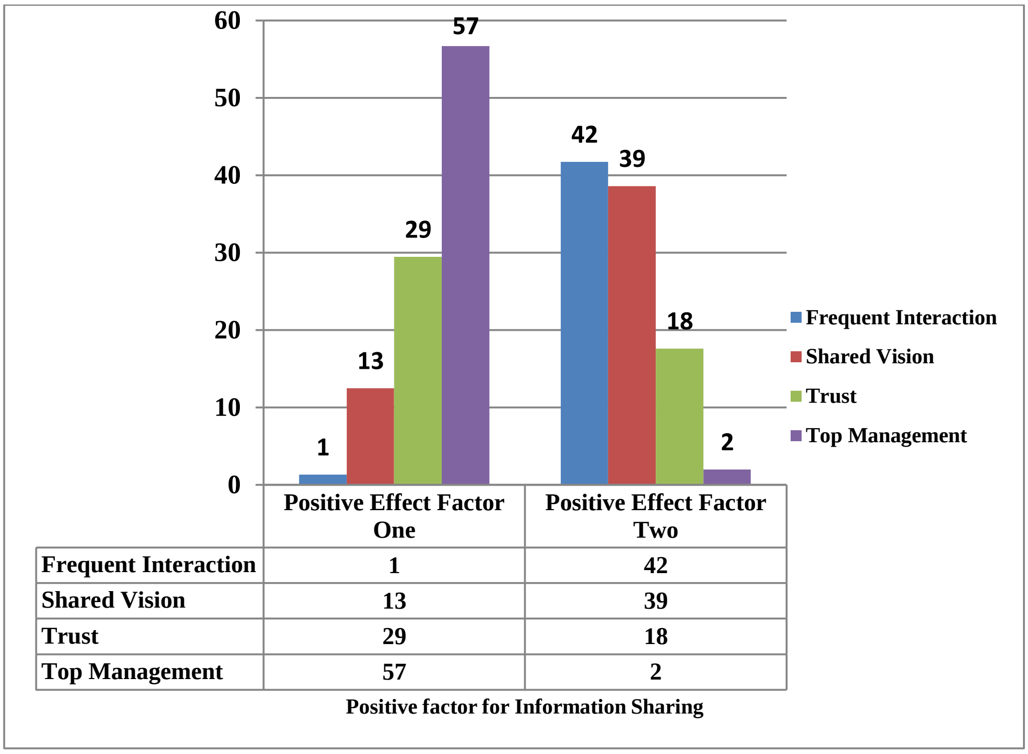


	Factor One Bullwhip effect.	Factor Two Bullwhip effect.	Factor Three Bullwhip effect.
Information errors			47
Product Promotions	0	1	21
Supply Variability	5	16	15
Rational Behaviour	5	18	7
In-house e-SCM	15	24	8
Irrational Behaviour	21	25	0
Lead Time	53	15	2

Figure 7.9 ranks one critical supply chain factor from each category of phases that tend to generate bullwhip effect in relation to various operational organisation perspectives. These highly ranked pernicious factors from each phase explicitly impact upstream site on magnified consumer demand order variability and indirectly affect downstream site on coping with less reliable order replenishment from upstream stages in the supply chain. The respondents on phase one of selection rank lead time (53%) as the factor that implodes the order replenishment processing in the supply chain. The irrational behavior patterns on decision making among supply chain members was ranked highly on phase two at second place, about 25% of the respondents while in-house e-SCM depicting 24% in the same phase.

In terms of distorted information to other supply chain partners, 47% of the respondents place information errors in phase three as the factor to affect demand order transmission along the series of trading supply chain partners. The time lags create the oscillation effect in inventory stocks as the coefficient of variation in the supplier's demand (the sum of the retailer's orders) becomes greater than the coefficient of variation of the retailer's total demand. In other words, "the variance of the orders placed by a given stage of a supply chain is an increasing function of the total lead time between that stage and the retailer" (Chen *et al.*, 2000:436). These phases produced their highly ranked individual factors and this study requires three critical factors that generate bullwhip effect. In the descending order fro each represented phase (one, two or three), the lead time (53%), information errors (47%) and irrational behavior (25%) respectively represent the order of critical importance.

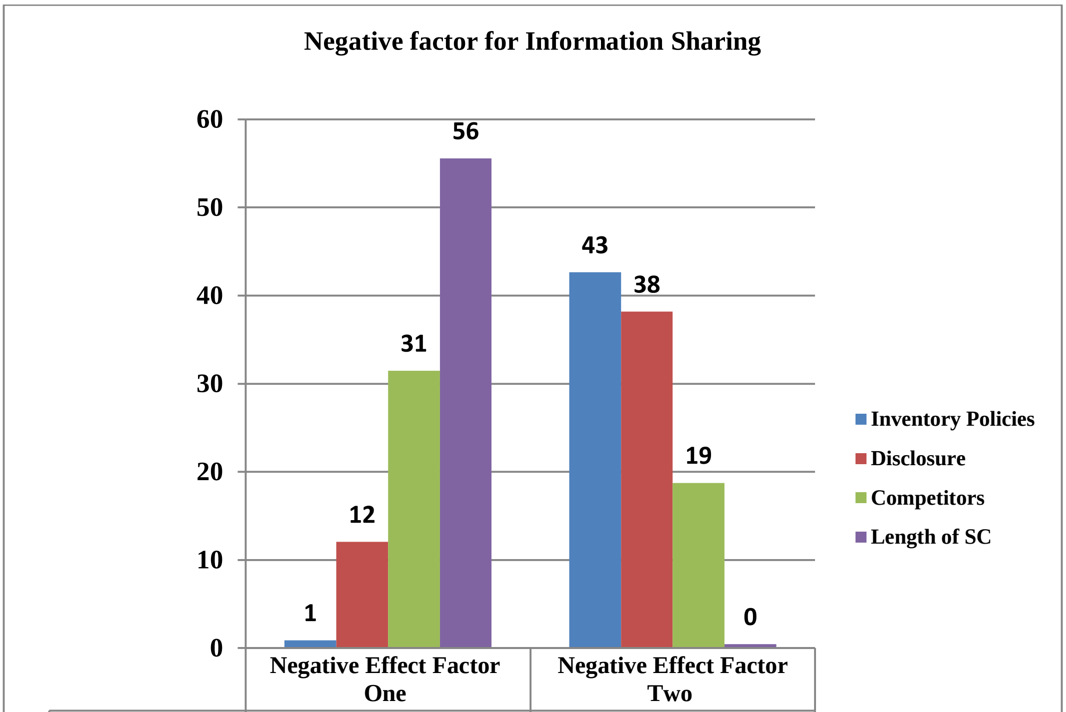
Figure 7.10: Positive factors that influence information sharing



	Positive Effect Factor One	Positive Effect Factor Two
Frequent Interaction	1	42
Shared Vision	13	39
Trust	29	18
Top Management	57	2

The value of information sharing is considered to be a reciprocal independence between the downstream and upstream sites in the supply chain. However, the rational and self-optimising behaviour by each of supply chain stages can hinder the sharing of demand order information. Among the four positive factors (top management, trust, shared vision and frequent interaction), the respondents were asked to rank two positive factors that influence information sharing. The respondents indicate 57% for top management support and 42% for frequent interaction from each phase of selection as most critical factors that positively influence information sharing as an intuitive step towards mitigating bullwhip effect. Figure 7.10 further acknowledges trust among supply chain partners (phase one) and shared vision (phase two) as important positive factors to decelerate the bullwhip effect as orders moving up the supply chain network.

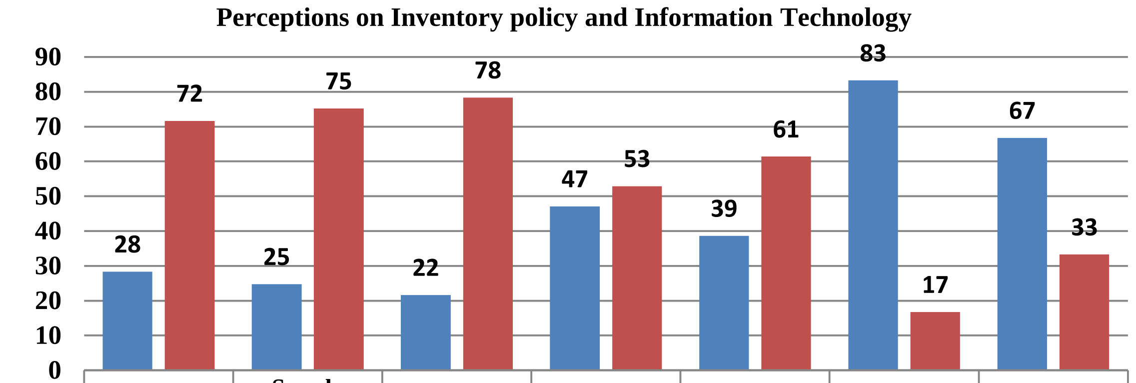
Figure 7.11: Negative factors that influence information sharing



	Negative Effect Factor One	Negative Effect Factor Two
Inventory Policies	1	43
Disclosure	12	38
Competitors	31	19
Length of SC	56	0

Figure 7.11 shows the phase one of selection with 56% of the respondents that ponders the length of the supply chain network as a negative factor influencing integrated information sharing. The second phase indicates the difference in inventory control policies (43%) as negative influence on both internal and external information flows throughout the supply chain. Regarding the information visibility as a mitigating factor to make consumer demand data available throughout the chain, 31% of the respondents argues that information sharing can regrettably reach rival competitors and 38% fear loss of power in disclosing information amongst the supply chain trading partners. This study acknowledges that the length of the supply chain echelons is the first factor to influence negatively the information sharing and secondly, the difference in inventory control policies hampers the effective sharing of information.

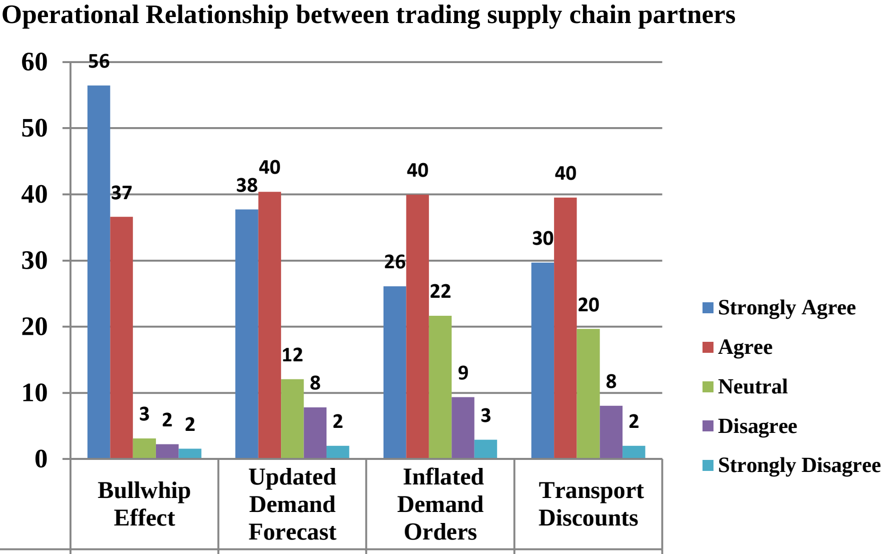
Figure 7.12: Perception on inventory policy and information technology



	Inventory Control Policy.	Supply Chain Information sharing.	E-SCM Systems	Third party IT system.	In-house IT Dept.	Performance Targets	Inventory Position
No	28	25	22	47	39	83	67
Yes	72	75	78	53	61	17	33

Figure 7.12 indicates general perceptions on inventory policy and effects of information technology where 72% of the respondents agrees that inventory control policy at retail level often propagate customer demand variability towards upstream site. Supply chain information sharing (75%) and electronic supply chain management systems (78%) are considered by the overwhelming majority of the respondents to promote and enhance communication performance to mitigate bullwhip effect. It is puzzling to discover that the demand order variability does not influence the business performance targets and customer service levels. Surprisingly, 67% of the respondents indicate channel alignment in supply chain as hindrance to coordinate inventory positioning. A high percentage (61%) of the respondents indicates that their organisations are currently having in-house information technology departments, and 53% of the respondents only gather and manage their inventory using third party information technology system.

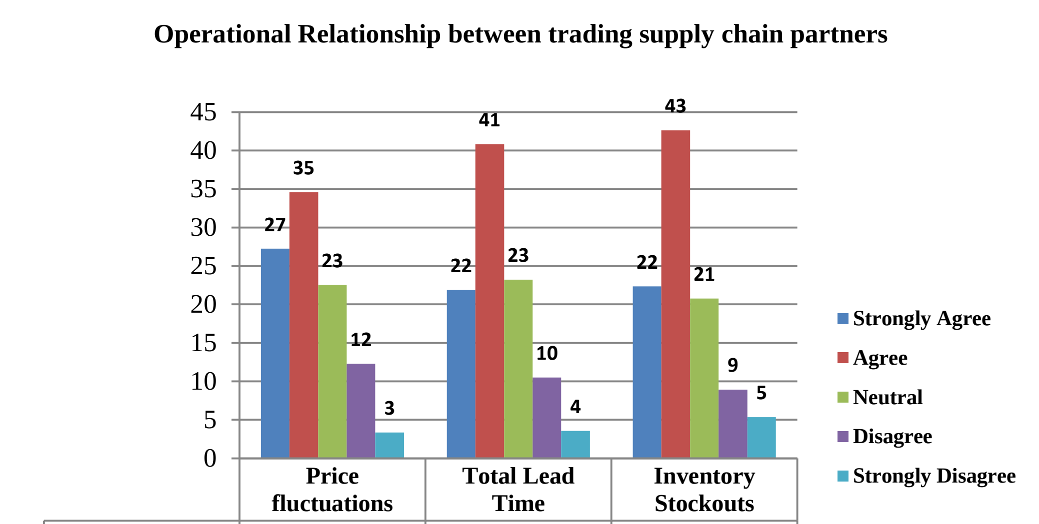
Figure 7.13: Operational relations between trading supply chain partners on causes and mitigations of bullwhip effect (four factors)



	Bullwhip Effect	Updated Demand Forecast	Inflated Demand Orders	Transport Discounts
Strongly Agree	56	38	26	30
Agree	37	40	40	40
Neutral	3	12	22	20
Disagree	2	8	9	8
Strongly Disagree	2	2	3	2

Figure 7.13 reveals the magnitudes of agreement among the respondents in relation to the operational partnerships. In terms of the phenomenon of bullwhip effect, 93% irrepressible majority of the respondents agreed that demand order variability has harmful effects in the fast moving consumer goods industry. The tendency of variability of order rates increases as orders pass through the echelons of a supply chain despite a concerted participation in updating the demand forecast (78%) across the stream sites of supply chain. Interestingly, most respondents (70%) agreed that organisations tend to order large quantities to take advantage of transport discount. While 66% of the respondents agreed on placing inflated orders during shortage periods to contribute towards cascading effect. The rationing and the shortage gaming tend to increase the safety stock target that further distorts the demand signal.

Figure 7.14: Operational relations between trading supply chain partners on causes and mitigations of bullwhip effect (three factors)



	Price fluctuations	Total Lead Time	Inventory Stockouts
Strongly Agree	27	22	22
Agree	35	41	43
Neutral	23	23	21
Disagree	12	10	9
Strongly Disagree	3	4	5

Figure 7.14 indicates that 62% of the respondents agree with the statement that price fluctuation encourages the organisations to purchase in large quantities during promotions. This disclosure is underscored by 65% of the respondents in the supply chain where organisations often set desired service coverage by holding a large inventory to prevent stockouts. Despite these practices, 63% of the respondents agree that supply chain trading members are constantly trying to reduce total lead time in terms of material, information and delivery lead times and delays. It is worth noting the minimal indifference of 23%, 23% and 21% for price fluctuation, lead time and inventory stock outs respectively.

Figure 7.15: Experience and Perception of participants on three critical variables

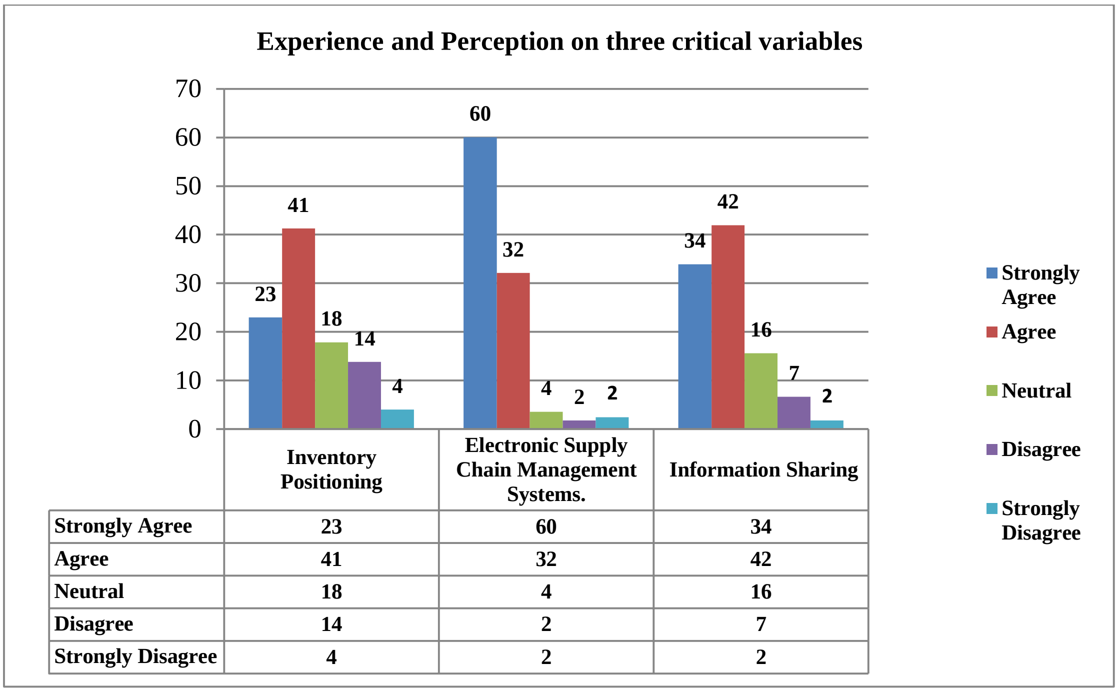
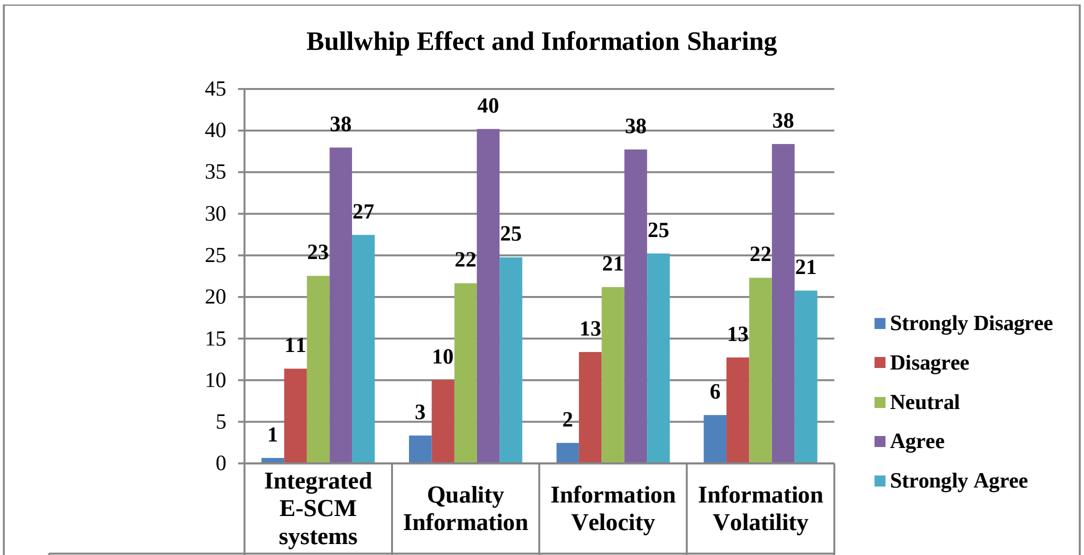


Figure 7.15 shows three critical variables (inventory positioning, e-SCM systems and information sharing) on the experience and perceptions of the particints. The degree of agreement on the statements indicates that 92% insuppressible majority of the respondents agrees that e-SCM systems mitigate consumer demand order variability in the supply chain network, and further enhance the optimal inventory positioning (64%), and achieves better coordination on information sharing (76%). These key theoretical components of this study give considerable understanding on the role of electronically enabled-SCM system and possible mitigation mechanism for consumer demand order variability. The electronic linkage for supply-side and demand-side partners indicates a better information sharing communication on inventory positioning to achieve integrated supply chain management processes. The e-SCM systems have the ability to rapidly respond to demand variability and supply changes to reduce supply chain costs and opportunity cost of lost sales.

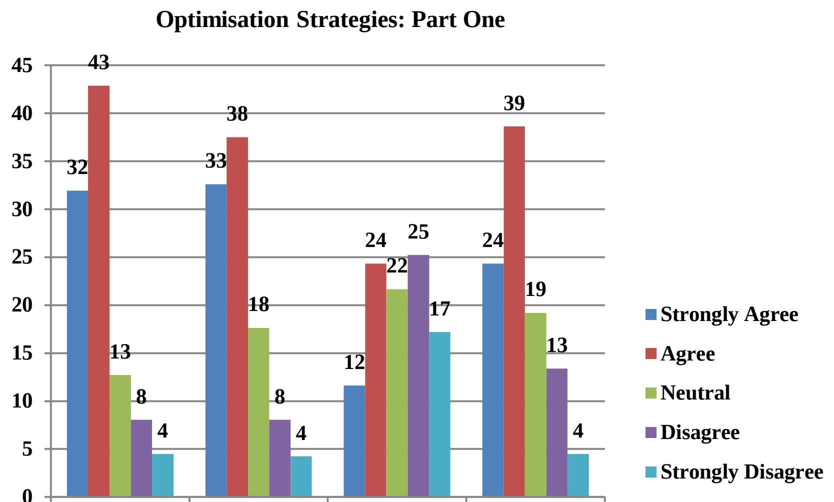
Figure 7.16: Integrated electronic supply chain management systems and information sharing on bullwhip effect.



	Integrated E-SCM systems	Quality Information	Information Velocity	Information Volatility
Strongly Disagree	1	3	2	6
Disagree	11	10	13	13
Neutral	23	22	21	22
Agree	38	40	38	38
Strongly Agree	27	25	25	21

Although 65% of the respondents agree that integrated e-SCM systems improve information sharing, information sharing is confronted by "certain level of environmental uncertainty, embattled top management support", and embroiled on incompatible information technology enablers. Fifty nine percent of the respondents concur that information volatility creates unstable demand, supply uncertainty with information content, format and timing. The successful relationships for better information sharing have attributes of trust, frequency interaction and commitment. By the same token, 65% of the respondents uphold information quality while 63% of the respondents agree that velocity of information sharing contributes positively to higher order fulfillment rate and shorter order cycle time from the strength of ingenuous trust and inexorable commitment.

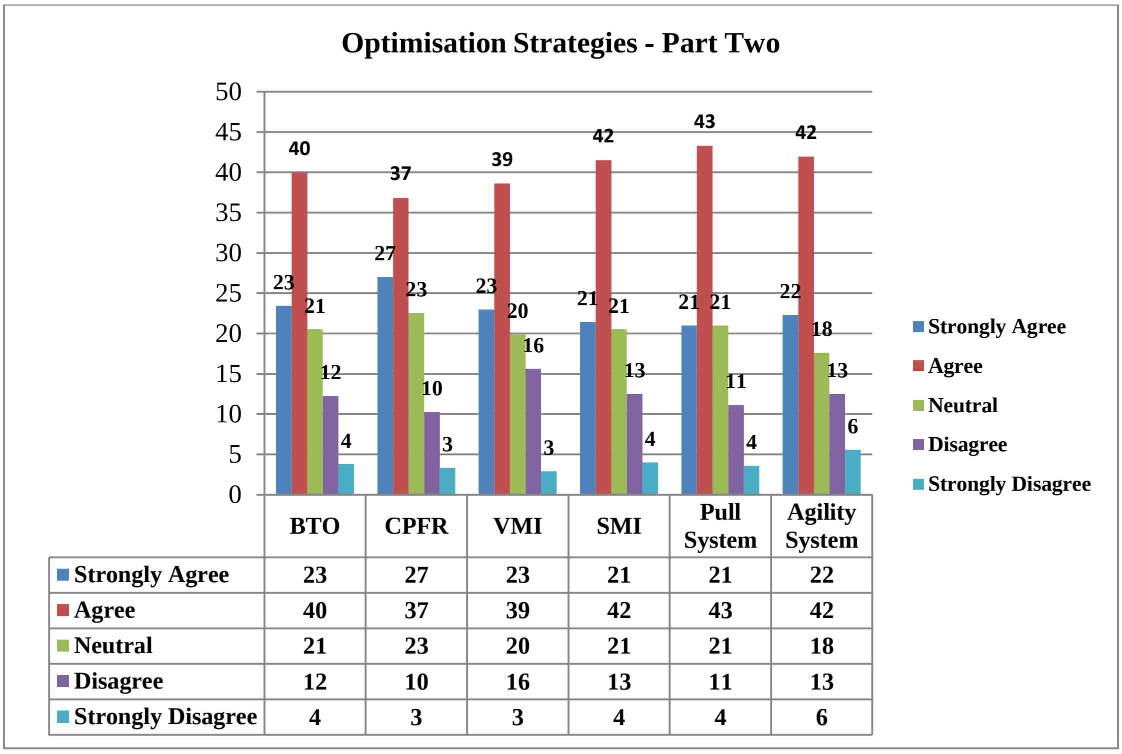
Figure 7.17: Global optimisation strategies on bullwhip effect – Part One



	Risk Pooling	CscD System	DscD System	Forecast Model
Strongly Agree	32	33	12	24
Agree	43	38	24	39
Neutral	13	18	22	19
Disagree	8	8	25	13
Strongly Disagree	4	4	17	4

According to Cai and Du (2009:709) "the strategy of risk pooling is designed to bring about demand aggregation across locations and time in order to reduce the demand order variability". Seventy five percent overwhelming majority of the respondents agree that the pooling and sharing of resources in the supply chain by modeling central supply chain distribution (CscD) system (71%) avert the risks in supply disruptions. By the same token, risk pooling and CscD system guard against stock outs and reduce the consumer order variability by aggregating demand across locations. Although the South African FMCG industry espouses the customer-supplier duality through modeled CscD system, a considerable percent (36%) of the respondents believe that decentralised supply chain distribution (DscD) system keeps the optimal stock level. The retail store chains seem to converge towards the shared business solutions of CscD system as consolidated hub systems that service a number of retail consumers. The CscD system seems to display the potential to allow upstream partners (suppliers or manufacturers) to plan their capacity and demand forecast, and sixty three percent of the respondents agree that accurate forecasting models interlink the inventory positioning and order replenishment decisions among supply chain members. However, it is noted that around 42% of the respondents did not affirm that DscD system retains an optimal stock level to circumvent the phenomenon of bullwhip effect while 22% of the respondents shows neutrality to a less consolidated system.

Figure7.18: Global optimisation strategies on bullwhip effect – Part Two



	BTO	CPFR	VMI	SMI	Pull System	Agility System
Strongly Agree	23	27	23	21	21	22
Agree	40	37	39	42	43	42
Neutral	21	23	20	21	21	18
Disagree	12	10	16	13	11	13
Strongly Disagree	4	3	3	4	4	6

Figure 7.18 indicates the combined presentation of items on global optimisation strategies and each individual item was subjected to five-point Likert type scales to determine the magnitude of agreement from each statement. The respondents agree that a vendor managed inventory model (62%) allows the manufacturer to control demand order replenishment over the entire supply chain to mitigate bullwhip effect while the CPFR model (64%) is recommended to provide unlimited access to the retail store's replenishment system. Sixty three percent of the respondents underpinned a build-to-order (BTO) system on order replenishment flexibility and responsiveness, and sixty four percent of the respondents believed that an agile supply chain further induces velocity and flexibility in a supply chain. A demand-driven strategy (pull-based supply chain) is supported by 64% of the respondents as the production and distribution coordination improvement mechanism. Sixty three percent of the respondents found supplier managed inventory system as "a shift of responsibility for inventory planning from manufacturer to supplier" as an attempt to mitigate demand order variability.

Figure 7.19: Electronic information systems used by companies to ameliorate Bullwhip Effect

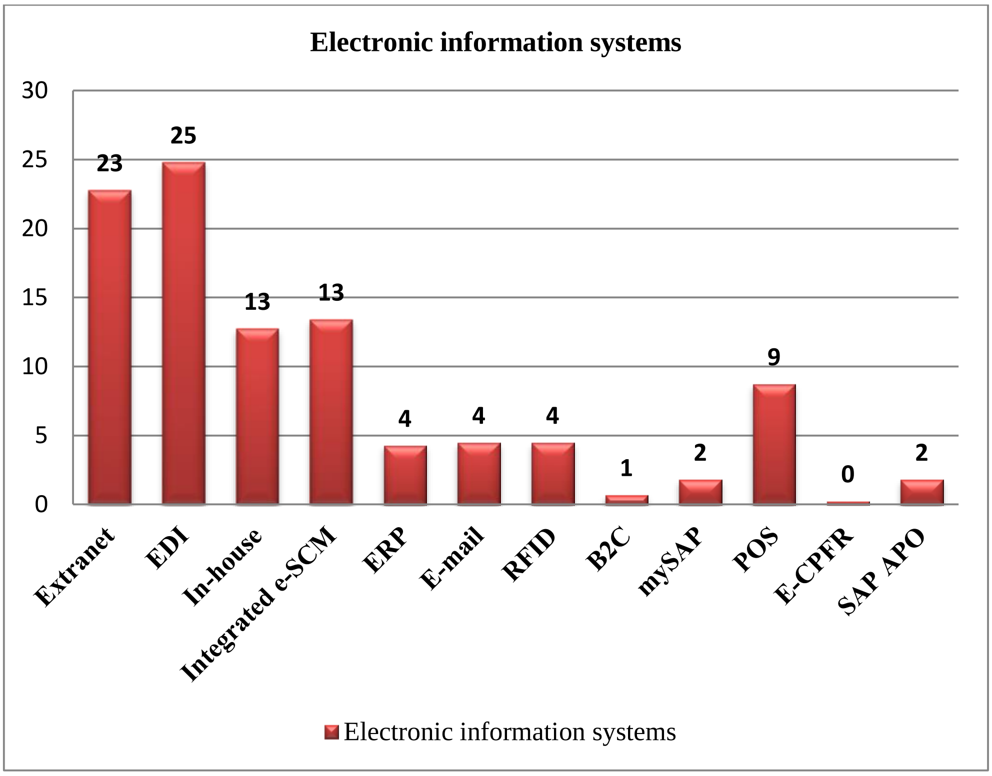


Figure 7.19 shows the percentages of the electronic information systems that the organisations use to ameliorate the phenomenon of bullwhip effect. The EDI (25%) and Extranet (23%) are mostly adopted systems. While in-house system (13%) is still used by the organisations, there is a similar use of integrated e-SCM systems (13%) for better coordination in the supply chain network. The advancement in technology is expected to enhance the adoption of integrated e-SCM systems in the near future.

7.2.2 Descriptive statistics

Measures of dispersion and central tendency give a summary indication of the distribution of cases and an average value by describing single variable within the exploratory study.

Table 7.1: Descriptive Statistics on information sharing and electronic supply chain management

Items	N	Mode	Minimum	Maximum	Mean	Median
Electronic S C M Systems.	448	4.00	1.00	5.00	4.4554	4.57
Updated Demand Forecast	448	4.00	1.00	5.00	4.0402	4.20
Information Sharing	448	4.00	1.00	5.00	3.9955	4.13
Information Sharing (I&F)	448	4.00	1.00	5.00	3.9241	4.13
Strategic Communication	448	4.00	1.00	5.00	3.8772	4.05
Transport Discounts	448	4.00	1.00	5.00	3.8460	3.98
Integrated E-SCM systems	448	4.00	1.00	5.00	3.8013	3.88
Inflated Demand Orders	448	4.00	1.00	5.00	3.7701	3.87
Lead Times	448	4.00	1.00	5.00	3.7455	3.85
Quality Information	448	4.00	1.00	5.00	3.7299	3.83
Price fluctuations	448	4.00	1.00	5.00	3.7009	3.81
Information Velocity.	448	4.00	1.00	5.00	3.6987	3.80
Inventory Stockouts	448	4.00	1.00	5.00	3.6763	3.80
Total Lead Time	448	4.00	1.00	5.00	3.6696	3.76
Economic Information.	448	4.00	1.00	5.00	3.6585	3.79
Inventory Positioning	448	4.00	1.00	5.00	3.6540	3.78
Mutual dependency.	448	4.00	1.00	5.00	3.6250	3.72
Profitability Level.	448	4.00	1.00	5.00	3.6116	3.71
Flexible Response	448	4.00	1.00	5.00	3.6071	3.76
Confidential Information	448	4.00	1.00	5.00	3.6049	3.71
Information Volatility	448	4.00	1.00	5.00	3.5558	3.67
Valid Total	**448**				**79.2478**	

Source: Compiled by the researcher from SPSS statistical results

This section of the study advocates that e-SCM systems (M = 4.46) has the highest mean score value in this exploratory study. These systems seem to create agility and high flexibility that rapidly respond to changing market requirements from diverse customers by quickly delivering the right products and services through effective integration. The respondents scored the e-SCM system as “a mechanism to integrate trading supply chain partners at technical, operational and business level with efficient real-time information sharing and active coordination” to mitigate bullwhip effect (Ke *et al.*, 2009:839).

The semantic view of electronically-enabled supply chain management underpins the effective updated demand forecast (M = 4.04) wherein the organisations jointly participate in updating the demand forecast across the stream sites of supply chain. The electronically-enabled supply chain management systems are preferably significant to improve flexibility through informal and formal information sharing (M = 3.92) in the dynamic market. The future strategic communication (M = 3.88) and information exchange (M = 4.00) are further associated with high order fulfillment rate and the shorter order cycle time that enhance supply chain performance targets in the FMCG industry. The respondents agree that information volatility (M = 3.56) creates unstable demand and supply uncertainty with information content, format and timing. Only the quality of information (M = 3.73) and the magnitude of information velocity (M = 3.70) enable organisations to produce dependable delivery and contribute positively to customer satisfaction and service level of supply chain performance.

The integrated e-SCM systems (M = 3.80) provide flexibility to respond (M = 3.61) to emergency demand order changes despite the frequent practice that the organisations constantly hold a large inventory to avert inventory stock outs (M = 3.68). The respondents agree that electronically-enabled supply chain system has significant role (highly ranked M = 4.46) to improve willingness to share sensitive and confidential information (M = 3.60) based on trust, to offer greater control and access to advanced economic information (M = 3.66). Additionally, the system will enhance profitability level (M = 3.70) and establish common goals and mutual dependency (M = 3.63) between collaborating supply chain partners to further optimise inventory positioning (M = 3.65) with significant reduction in lead times (M = 3.75). Organisations tend to order large quantities to take advantage of transport discount (M = 3.85) despite a concerted effort to reduce total lead time (M = 3.67) in terms of material, information and delivery lead times and delays. The respondents agree that price fluctuations (M = 3.70) tend to inflate demand orders (M = 3.77) during promotions and shortage periods. Normally, the mean seems to encounter / cross words with outliers (force the value on the mean upward or downward), but the median seems to comprise acceptable values in relation to mean values.

Apparently, the median is the most appropriate locator of center for ordinal data and has resistance of extreme scores (Cooper and Schindler, 2008: 438). This study shows the frequency of the data for e-SCM system with the value of 4.57 median, and updated demand forecast with 4.20 median. The figures (table 7.1) denote the mean being equivalent with the median.

The symmetric data with the same shape on either side of the middle indicates the same mean, mode and median. In rounding off the mean values of the individual variables, the symmetrical distribution is reflected in the same location between the mean, median and mode (4.00) with the exception of e-SCM system has slightly greater median (4.57 or 5.00). The symmetric location on same centre point of the average response, the middle value when the distribution is sorted from lowest to highest (median) and most frequently occurring value have distribution scores that cluster heavily or pile up in the centre with overall alpha values (0.840) on 448 sample size. The symmetrical distribution of all items is reflected in the same centre point (4.00) with the exception of e-SCM systems (5.00), and transport discounts and inflated demand orders are statistically significant to cause bullwhip effect.

In the same statistical approach, the majority of the respondents agree that e-SCM system, updated demand forecast, information sharing, strategic communication, integrated e-SCM systems, inventory positioning and flexible response are the most important variables to ameliorate bullwhip effect. Descriptive statistics relating to the research findings are presented in this table (7.2) to assess each of the strategic optimisation items in an attempt to manage the phenomenon of bullwhip effect.

Table 7.2: Descriptive Statistics on Strategic Optimisation items

Items	N	Mode	Minimum	Maximum	Mean	Med
Risk Pooling	448	4.00	1.00	5.00	3.8973	4.09
CscD System	448	4.00	1.00	5.00	3.8616	4.04
CPFR Model	448	4.00	1.00	5.00	3.7388	3.85
BTO- SCM Model	448	4.00	1.00	5.00	3.6696	3.78
Pull-based System	448	4.00	1.00	5.00	3.6696	3.77
Forecasting Models	448	4.00	1.00	5.00	3.6496	3.78
SMI System	448	4.00	1.00	5.00	3.6384	3.75
VMI System	448	4.00	1.00	5.00	3.6317	3.74
Agility SC System	448	4.00	1.00	5.00	3.6295	3.78
DscD System	448	2.00	1.00	5.00	2.8795	2.86
Valid Total	**448**				**36.2656**	

Source: Compiled by the researcher from SPSS statistical results

The average response of this study indicates that risk pooling (M = 3.90) has scored highest mean value as the global optimising and cost-effective strategy to reduce the consumer order variability by aggregating demand across locations. The consolidated distribution strategy for either lead time pooling or location pooling keeps inventory close to customers while hedging against certain form of uncertainty. The central inventory location within supply chain can exploit lead time pooling to provide some of the benefits of location pooling without moving inventory far away from customers. The respondents underpin the central supply chain distribution system (M = 3.86) as global optimisation model to suit the individual retail facility and enhances the integration of stock ordering, buying systems and store replenishment systems. This collaborative supply chain system focuses on directly involving suppliers in its initiative to realise high levels of product availability, service levels and stock runs. Interestingly, collaboration, planning, forecasting and replenishment (CPFR) model (M = 3.74) being perceived as the most important model to provide unlimited access to the retail store's replenishment system to ameliorate and manage demand order variability.

This model is most suitable for the build-to-order supply chain (BTOSC) system (M = 3.67) to allow the creation of the greatest degree of order replenishment flexibility and responsiveness on the bases of market sensitivity, leveraged information technology and tactical postponement agility. The BTOSC system requires the decoupling point (boundary) to describe forecast-driven and demand-driven elements with real-time information flow to achieve the whole system optimisation.The demand-driven strategy, also known as pull-based supply chain (M = 3.67) is the better ranked strategy to improve production leagility and distribution coordination with the customer demand. The system optimises the processes and customer demand-driven for enrichment of customer with clear understanding of demand order variation and oscillation. The forecast-driven model with accurate forecasting (M = 3.65) is supported by the respondents to control bullwhip effect in linking the inventory positioning and order replenishment decisions among supply chain trading members. The order replenishment decisions allow supplier managed inventory (SMI) system (M = 3.64) "to shift responsibility for inventory planning from manufacturer to supplier" with oriented paradigm on customer services and proximity to the downstream customers.

In tracking the supply chain downstream, the retailer seems to be the sole custodian of information about the consumer demand. Normally, the retailer found better positioned to control the replenishment decision with real-time information in the supply chain network. The respondents also agreed that vendor managed inventory (VMI) system (M = 3.63) allows real-time inventory level information. Wherein, the manufacturer seems to control demand order replenishment over the entire supply chain to deal with bullwhip effect. Interestingly, the manufacturer is found to be better positioned with real-time information to control the replenishment decisions, and the vendor managed replenishment (VMR) would require a certain degree of supply chain agility (M = 3.63). The leagility system provides a level of order replenishment responsiveness and flexibility and decentralised supply chain distribution (DscD) system (M = 2.88) seems "to keep the optimal stocked level to avoid bullwhip effect". The symmetric data with the same shape on either side of the middle indicates the same mean, mode and median by rounding off mean and median values. All variables with the exception of the DscD system (M = 3.00, mode = 2.00 and median = 3.00) are symmetrical located on same centre point (4.00), and the distributions have scores that cluster heavily in the centre.

7.3 Bivariate

Inferential statistics are used to estimate the generalisability of findings arrived at through the analysis of a sample to the larger population from which the sample has been selected (Babbie and Mouton, 2001: 486). This section focuses on cross tabulation and chi-square to estimate characteristics and relationships between variables respectively. Cross tabulation compares the incidence of one characteristic against another, and these contingency tables provide a wealth of information about the relationship between the variables. The chi-square (χ^2) statistic is used as the means of testing, or determining if the relationship is statistically significant. The researcher applies stringent criteria (0.05) for declaring significance level.

The chi-square (χ^2) test as measure of the alignment between two sets of frequency measures uses the following formula:

$$\text{Chi-square } (\chi^2) = \Sigma\ [(E-O)^2/E]$$

(Where Σ= sigma, O = observed frequency, E = expected frequency)

This test (χ^2) will be based on the assumption (H_0) that there is no relationship or association between the two variables in the total population. It means that after tabulating the responses for each of the groups and comparing them, the chi-square (χ^2) test examines whether there are any statistical significance between the groups.

7.3.1 Cross tabulation echelon category and e-SCM systems

Table 7.3: Echelon category and Electronic supply chain management (e-SCM) system

Which echelon category prefers the e-SCM system as the mitigation tool for bullwhip effect?			Electronic Supply Chain Management System					
			Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Total**
Category	**Other**	Count	2	1	1	10	18	32
		% of Total	.4%	.2%	.2%	2.2%	4.0%	7.1%
	Retailing	Count	2	0	7	64	139	212
		% of Total	.4%	.0%	1.6%	14.3%	31.0%	47.3%
	Wholesale	Count	2	4	3	43	56	108
		% of Total	.4%	.9%	.7%	9.6%	12.5%	24.1%
	Manufacturing	Count	4	1	5	22	48	80
		% of Total	.9%	.2%	1.1%	4.9%	10.7%	17.9%
	Tier/supplier	Count	1	2	0	5	8	16
		% of Total	.2%	.4%	.0%	1.1%	1.8%	3.6%
Total		Count	11	8	16	144	269	448
		% of Total	2.5%	1.8%	3.6%	32.1%	60.0%	100%

Table 7.3 shows that 92% overwhelming majority of the respondents (413 of 448 sample respondents) link the operational performance targets and outcomes after implementing electronic supply chain management (e-SCM) systems integration in the network. The retailers in the downstream site (203 of 212) agree that the e-SCM systems mitigate the consumer demand order variability as the oscillation amplifies upstream in the supply chain. There must be a relationship between echelon categories of the supply chain stream sites and e-SCM systems.

Table 7.4: Managerial level and negative factors in information sharing

How do the managerial levels rank the negative factors that influence information sharing?			Negative factors in information sharing				
			Length of SC	**Competitors**	**Disclosure**	**Inventory Policy**	**Total**
Job Status	**Top Management**	Count	26	21	5	0	52
		% of Total	5.8%	4.7%	1.1%	0%	11.6%
	Middle Management	Count	123	44	28	1	196
		% of Total	27.5%	9.8%	16.3%	.2%	43.8%
	First level	Count	74	52	15	3	144
		% of Total	16.5%	11.2%	3.3%	.7%	32.1%
	Nonmanagerial	Count	26	24	6	0	56
		% of Total	5.8%	5.4%	1.3%	.0%	12.5%
Total		Count	249	141	54	4	448
		% of Total	55.6%	31.5%	12.1%	.9%	100%

Table 7.4 reveals the first and middle levels of management that indicate the length of supply chain channel network coupled with the loss of power in disclosing advanced economic information impedes the degree of willingness to exchange data. The difference in inventory control policies creates a time-lag on order replenishment process and the first level management associates the policy differentiation as negative effect towards real-time information sharing.

Table 7.5: Managerial level and positive factors in information sharing

How do the managerial levels rank the positive factors that influence information sharing?			Positive factors in information sharing				
			Top Management support	Trust	Shared Vision	Frequent Interaction	Total
Job Status	**Top Management**	Count	0	6	17	29	52
		% of Total	.0%	1.3%	3.8%	6.5%	11.6%
	Middle Management	Count	0	36	78	82	196
		% of Total	.0%	8.0%	17.4%	18.3%	43.8%
	First level	Count	6	23	57	58	144
		% of Total	1.3%	5.1%	12.7%	12.9%	32.1%
	Nonmanagerial	Count	3	14	21	18	56
		% of Total	.7%	3.1%	4.7%	4.0%	12.5%
Total		Count	9	79	173	187	448
		% of Total	2.0%	17.6%	38.6%	41.7%	100%

Table 7.5 depicts differences in opinion by management levels about critical factors that positively influence the information sharing among the organisations. The table indicates combined 76% of the middle and first level sample respondents and this overwhelming majority asserts that the shared vision and frequent interaction between supply chain partners positively influence information sharing. Although the top management underpins the frequent interaction with 29 counts, the nonmanagerial level (14) and middle level (36) recommend trust among supply chain partners as a critical factor to influence either emphatic or advanced economic information sharing. In the parlance of hypothetical assessment as the integral observation on these counts, there is a relationship between levels of management expert opinions and positive factors of information sharing.

Table 7.6: Collaboration models for last five years and inventory position

Do organizations constantly adopt collaboration models to position their inventory levels?			Inventory Position		Total
			Yes	No	
Collaboration Models for last five years	One	Count	66	44	110
		Expected Count	73.4	36.6	110.0
		% within Collaboration Models	60.0%	40.0%	100.0%
		% within Inventory Position	22.1%	29.5%	24.6%
		% of Total	14.7%	9.8%	24.6%
	Two	Count	125	44	169
		Expected Count	112.8	56.2	169.0
		% within Collaboration Models	74.0%	26.0%	100.0%
		% within Inventory Position	41.8%	29.5%	37.7%
		% of Total	27.9%	9.8%	37.7%
	Three	Count	77	36	113
		Expected Count	75.4	37.6	113.0
		% within Collaboration Models	68.1%	31.9%	100.0%
		% within Inventory Position	25.8%	24.2%	25.2%
		% of Total	17.2%	8.0%	25.2%
	Four or More	Count	31	25	56
		Expected Count	37.4	18.6	56.0
		% within Collaboration Models	55.4%	44.6%	100.0%
		% within Inventory Position	10.4%	16.8%	12.5%
		% of Total	6.9%	5.6%	12.5%
Total		Count	299	149	448
		Expected Count	299.0	149.0	448.0
		% within Collaboration Models	66.7%	33.3%	100.0%
		% within Inventory Position	100.0%	100.0%	100.0%
		% of Total	66.7%	33.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.594[a]	3	.022
Likelihood Ratio	9.554	3	.023
Linear-by-Linear Association	.152	1	.697
N of Valid Cases	448		

Table 7.6 indicates 75% of the respondents that adopted two to four or more number of strategic collaboration models for the last five years in ensuring better coordination of inventory position along the supply chain. The organisations that introduced one strategic collaboration model in the last five years have the lowest count on dichotomy rating (Yes = 66 or No = 44, out of 448 samp le size) coordinated inventory positioning through channel alignment. The table further shows the highest count (125 of 299) that channel alignment assists to coordinate inventory positioning in supply chain if two strategic collaboration models are adopted within the period of five years. Therefore, it is tentatively inferred that there is a statistically significant association between the channel alignment to coordinate inventory positioning and frequent diffusion of strategic collaboration model. The underlying statistics indicate the value of chi-square (9.594) with a degree of freedom (3), $p = 0.022$ which is less than 0.05 significant level of confidence.

7.3.2 Nonparametric Tests

The nonparametric tests compare three or more groups when the data are categorised. It means that variability among the values can be partitioned into variability among group means and variability within the groups (Cooper and Schindler, 2008; Pallant, 2005). Variability within is quantified as the sum of squares of the differences between each value and its group mean. These inferential statistical tests allow the execution of tests if any of several means are significantly different from each other. The nonparametric test used the Wilcoxon signed ranked test (determining both direction and magnitude of difference between carefully matched pairs of collaboration models and B2B IT systems for the last five years); Friedman test on mean ranking mitigation factors (looking at significant differences on mean ranking mitigation factors on three dimensions and global optimisation strategies) and general linear model (examining the ranking scores of factors that tend to generate bullwhip effect over the three ranking structure) on bullwhip effect factors by echelon category.

Table 7.7: Wilcoxon Signed Ranked Test

Ranks for information sharing positive and negative factors		**Z Scores**	**Sig. (2-tailed)**
Information sharing	Negative effect (Factor one and two)	-17.567	.000
	Positive effect (Factor one and two)	-18.204	.000
Collaboration models and B2B IT systems		-6.513	.000

The Wilcoxon signed rank test is designed for use with repeated measures when the subjects are measured on two occasions or under two different conditions (Pallant, 2005). The variables involved are scores at positive effect factor one and two, and scores of business-to-business information technology (B2B IT) and collaboration models. Table 7.7 indicates a Z score for positive effect factor one and two (-17.567), a negative effect factor one and two (-18.204) and both positive and negative information sharing factors present statistical significance between scores with a similar significance level, p = .000 less than 0.05. The statistic test when pairing collaboration models and B2B IT systems for last five years has *Z*-value equal to -6.513, p = 0.000. Therefore, the difference between the two scores is statistically significant.

Table 7.8: Friedman Test on mean ranking mitigation factors

What is the change in bullwhip effect scores across three dimensions of mitigation factors?					
Three dimensional mitigation factors of bullwhip effect	**N**	**Mean Rank**	**Chi-square**	**Df**	**Sig**
Information Sharing	448	2.15	27.907	2	0.000
Integrated electronic supply chain management (E-SCM)	448	1.99			
Inventory positioning	448	1.89			
What is the change in bullwhip effect scores across global optimisation strategies?					
Global optimisation strategies	**N**	**Mean Rank**	**Chi-square**	**Df**	**Sig**
Risk pooling	448	5.06	190.253	7	0.000
Central supply chain distribution system	448	4.96			
Build-to-order supply chain management system	448	4.48			
Agility supply chain system	448	4.50			
Decentralised supply chain distribution system	448	3.30			
Accurate forecasting model	448	4.51			
Collaboration Planning Forecasting and Replenishment model	448	4.62			
Pull-based supply chain system	448	4.56			

Table 7.8 shows that there are significant differences in the bullwhip effect scores across the three mitigation factors with chi-square value (27.907), degree of freedom (2) at *p*-value (0.000) less than 0.05. The results further suggest that there are significant differences in the bullwhip effect scores across the seven global optimisation strategies (chi-square = 190.253, *p* = 0.000 and degree of freedom = 7). The highest ranking is present on risk pooling (5.06) followed by CscD system (4.96), CPFR (4.62), pull system (4.56), accurate forecasting (4.51), agility system (4.50), BTO system (4.48) and lastly DscD system (3.30).

7.3.3. General Linear Model

Table 7.9: General Linear Model - Bullwhip Effect factor one, two and three by echelon category

Does the test produce the same change in scores over ranked factors for the five organisational categories?

Part A: Between-Subjects Factors

Category	**Value Label**	**N**
1	Tier / Supplier	16
2	Manufacturing	80
3	Wholesale	108
4	Retailing	212
5	Other	32

Multivariate Test[c]

Effect	**Tests**	**Value**	**F**	**Hypothesis df**	**Error df**	**Sig**	**Partial Eta Squared**
Bullwhip effect Factor	Pillai's Trace	.705	529.047[a]	2.000	442.000	0.000	0.705
	Wilks' Lambda	.295	529.047[a]	2.000	442.000	0.000	0.705
	Hotelling's Trace	2.394	529.047[a]	2.000	442.000	0.000	0.705
	Roy's Largest Root	2.394	529.047[a]	2.000	442.000	0.000	0.705
				2.000	442.000	0.000	0.705
Bullwhip Factor *Category	Pillai's Trace	.033	1.847	8.000	886.000	0.065	0.016
	Wilks' Lambda	.967	1.846[a]	8.000	886.000	0.065	0.016
	Hotelling's Trace	.033	1.845	8.000	886.000	0.065	0.016
	Roy's Largest Root	.025	2.727[b]	8.000	886.000	0.065	0.016
				4.000	443.000	0.029	0.024

[a].Exact statistic; b.The statistic is an upper bound on F that yields a lower bound on the significance level; c.Design: Intercept+Category within Subjects Desing: Bullwhip Factor

Tests of Between-Subjects Effects

(Measure: Measure_1, Transformed Variable: Average)

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Intercept	9425.940	1	9425.940	3117.857	.000	.876
Category	25.860	4	6.465	2.138	.075	.019
Error	1339.283	443	3.023			

Part B: Within-Subjects Effects

Multivariate Tests[c]

Effect	**Tests**	**Value**	**F**	**Hypothesis df**	**Error df**	**Sig**	**Partial Eta Squared**
Bullwhip effect Factor	Pillai's Trace	.705	529.047[a]	2.000	442.000	0.000	0.705
	Wilks' Lambda	**.295**	**529.047[a]**	**2.000**	**442.000**	**0.000**	**0.705**
	Hotelling's Trace	2.394	529.047[a]	2.000	442.000	0.000	0.705
	Roy's Largest Root	2.394	529.047[a]	2.000	442.000	0.000	0.705
			529.047[a]	2.000	442.000	0.000	0.705

Mauchly's Test of Sphericity[b]

Within Subjects Effect	**Mauchly's W**	**Approx. Chi-square**	**df**	**Sig.**	**Epsilon[a]**		
					Greenhouse-Geisser	**Huynh-Feldt**	**Lower-bound**
Bullwhip effect Factor	.791	103.898	2	.000	.827	.837	.500

Tests of Within-Subjects Effects

Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**	**Partial Eta Squared**
Bullwhip Effect Factor	Sphericity Assumed	1534.389	2	767.195	679.548	.000	.605
	Greenhouse-Geisser	1534.389	1.654	927.906	679.548	.000	.605
	Huynh-Feldt	1534.389	1.674	916.600	679.548	.000	.605
	Lower-bound	1534.389	1.000	1534.389	679.548	.000	.605
Error (Bullwhip Effect)	Sphericity Assumed	1000.275	886	1.129			
	Greenhouse-Geisser	1000.275	732.547	1.365			
	Huynh-Feldt	1000.275	741.583	1.349			
	Lower-bound	1000.275	443.000	2.258			

Part A: Between-Subjects Effects

These tests indicate whether there are main effects for each of the independent variables, and whether the interaction between the two variables is significant. This analysis examines the ranking scores of factors that tend to generate bullwhip effect over the three ranking structure (Bullwhip Factor 1, Bullwhip Factor 2 and Bullwhip Factor 3) and further compare among five organisational categories (Tier/supplier, Manufacturing, Wholesale, Retailing and Other) the amplified oscillation travelling upstream the supply chain. This study carries out a one-way ANOVA on the data to understand if the change in bullwhip effect factors is significant across the organisational categories with different ranking of factors generating demand order variability on upstream site.

Table 7.9 (Part A) shows multivariate tests (Bullwhip effect * Category) with Wilks' Lambda and the associated probability value for significance level. Although all of the multivariate tests give the same results except Roy's Largest Root (0.029), the interaction effect is not statistically significant considering Wilks' Lambda significant level, $p = 0.065$ which is greater than the alpha level of 0.05. Nevertheless, the value for Wilks' Lambda for bullwhip effect factors (0.295) reveals a statistically significant effect for bullwhip effect factors with probability value of 0.000 less than *p*-value (0.05). There is a change in bullwhip effect factors scores across the five different organisational categories. The main effects for bullwhip effect factors are significant while the effect size of this result is presented by Partial Eta Squared (0.705) with moderate effect. Cohen (1988) proposes guideline on small effect (0.01), moderate effect (0.06) and large effect (0.14). Tests of between-subjects effects give no significant difference with significance value 0.075 greater than 0.05 while the effect size of the between-subject effect has partial eta squared value with small effect (0.014). This technique indicates the interaction effect and main effects for each independent variable and associated effect size.

Part B: Within-Subjects Effects

The tests of the within subjects effects have the same *F*s and are significant. Table 7.9 (Part B) presents the tests of the within-subjects effect whether the three factors are rated equally. Wilk's Lambda indicates $F\ (2{,}442) = 529.047$, $p < 0.05$, however, if epsilons are high, indicating that one is close to achieving sphericity, the test may be less powerful (less likely to indicate statistical significance) than the corrected univariate repeated-measures ANOVA. The Mauchly statistic is significant and, thus the assumption is violated. This is shown by the significance *p*-value of 0.000 is less than the a priori alpha level of significance (0.05).

The epsilons, which are measures of degree of sphericity, are less than 1.0, indicating that the sphericity assumption is violated (Tabachnick *et al.*, 2007). The lower-bound (.500) indicates the lowest value that epsilon could be where the highest epsilon possible is always 1.0. When sphericity is violated, Pallant (2005) recommends that epsilons less than .75 use the Greenhouse-Geisser or Huynh-Feldt if epsilons are greater than .75. Table 7.9 (Part B) notes that 2 and 886 would be the degree of freedoms to use as the sphericity has been violated. This study uses the Huynh-Feldt correction, which multiplies 2 and 886 by epsilon, which in this case is 0.837, yielding degrees of freedom (dfs) of 1.674 and 741.583. These corrections reduce the degrees of freedom by multiplying them by epsilon. It means that 2 x 0.837 = 1.674 and 886 x .837 = 741.582. The within-subjects effects adjustment of factors is significant, F (1.674, 741.583) = 679.548, $p < 0.05$. Therefore, the ratings of the three factors are significantly different. However, the omnibus (factors) F does not tell which pairs of factors have significantly different means. The overall effect (measure of association) for this analysis (using the Partial Eta-Squared) is 0.605, which indicates that approximately 60.5% of the total variance in the dependent variable is accounted for by the variance in the independent variable.

7.4 Multivariate Analysis

7.4.1 Factor Analysis

The purpose of factor analysis is to discover discrete dimensions in the pattern of relationships among the variables in the survey instrument. This study provides ten reduced number of different factors that are explaining the pattern of relationships among the variables. Helizer *et al.,* (2010:224) further stress the nature of the factors, the relationships between the fit of the factors to the observed data, and the amount of random or unique variance of each observed variable. This statistical technique intends to identify a relatively small number of individual factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1993). Nevertheless, its major objective is to reduce a number of observed variables into small number of underlying grouped factors in order to enhance interpretability and detect hidden structures in the data (Treiblmaier and Filzmoser, 2010:198).

In this regard, the dispersed mass information and variables from original data will be reduced into an economic description about phenomenon without loss of information. Basically, this study attempts to group variables with similar characteristics together into a smaller number of factors which is capable of explaining the observed variance in the larger number of variables. Costello and Osborne (2005:2) allude that factor analysis should reveal any latent variables that cause the manifest variables to covary with underlying structure on only shared variance in the solution. According to De Coster (1998:1) factor analysis is “a collection of methods used to examine how underlying constructs influence the responses on a number of measured variables”. This study uses exploratory factor analysis as an attempt to discover the nature of the constructs influencing a set of responses on the basis of a common factor model. This model proposes that each observed response is influenced partially by underlying common factors and partially by underlying unique factors. It is the form of data-driven analysis that uses factor loadings to intuit (different meanings ascribe to the factors depending on rotation) the factor structure of the data with no prior theory (Garson, 2012). The purpose of principal component analysis (PCA) will be useful to derive a relatively small number of components that can account for a variability found in a relatively large number of measures (De Coster, 1998:3). This study uses principal components analysis with varimax rotation as the method for data analysis and Kaiser criterion to decide on all factors with eigenvalues greater than one to be retained for rotation.

Table 7.10: Factor analysis on KMO and Bartlett's test, rotated components and Alpha

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.832
Bartlett's Test of Sphericity	Approx. Chi-Square	3662.946
	Df	465
	Sig.	.000

Rotated Component Matrix[a]

	Factor Loading	Eigenvalue	% of Variance	Cumulative %	Communalities Extraction
Factor 1: Supply Chain integration system					
Economic Information.	.756	6.532	21.071	21.071	.651
Flexible Response	.751				.668
Confidential Information	.665				.652
Profitability Level.	.631				.592
Factor 2: Demand-driven supply chain system					
Pull-based System.	.781	1.942	6.265	27.336	.660
Supplier Managed Inventory (SMI)	.747				.642
Agility Supply Chain System	.709				.628
Factor 3: Electronic supply chain information exchange					
Integrated e-SCM systems.	.702	1.715	5.533	32.869	.576
Quality Information	.662				.608
Information Velocity.	.553				.643
Factor 4: Supply chain lead time cycle					
Reduce Lead Times	.762	1.587	5.448	37.987	.647
Mutual dependency.	.724				.656
Inventory Positioning	.698				.603
Factor 5: Supply chain knowledge-driven system					
Collaboration (CPFR)	.723	1.409	4.544	42.532	.713
Build-to-Order System (BTO SCM)	.679				.578
Accurate Forecasting Models	.658				.669
Factor 6: Supply chain inventory variability					
Total Lead Time	.769	1.342	4.328	46.860	.659
Inventory Stockouts	.722				.666
Price fluctuations	.573				.537
Factor 7: Central risk pooling system					
Risk Pooling .	.810	1.274	4.110	50.970	.736
CscD System	.805				.766
Factor 8: Supply chain demand order quantity					
Transport Discounts	.723	1.167	3.763	54.733	.617
Inflated Demand Orders	.671				.596
Factor 9: Electronic supply chain communication system					
Strategic Communication	.613	1.136	3.665	58.399	.608
e-SCM Systems.	.599				.441
Informal and Formal Sharing.	.589				.524
Factor 10: Decentralised supply chain system					
DscD System	.768	1.034	3.336	61.735	.658

"Extraction Method: Principal Component Analysis., Rotation Method: Varimax with Kaiser Normalization., a. Rotation converged in 22 iterations.

Reliability Statistics: Overall Cronbach's Alpha = .842, and Number of items = 31".

Source: Compiled by the researcher from the SPSS statistical results.

The tests of appropriateness of factor analysis for the factor extraction include the 'Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's test of sphericity' for the extraction factors (Paulraj *et al*., 2007). The KMO value of this study is 0.832, which indicates a meritorious degree of common variance above the normally acceptable threshold of 0.50 for a satisfactory factor analysis to persist with analysis. Kaiser (1970) further stresses that a cut-off value is 0.50 and a desirable value of 0.80 is meritorious in order to proceed with a factor analysis (Hair, Anderson, Tatham and Black, 1998:99). According to Field (2000:446) all elements on the diagonal of the matrix should be greater than 0.50 if the sample is adequate. Norusis (1993) describes KMO statistic ranges from 0 and 1 and shows that a value of 0 implies that the sum of partial correlations is large relative to the sum of correlations indicating diffusion in the pattern of correlations. Conversely, a value close to 1 suggests that patterns of correlations are relatively compact and factor analysis would give distinct and reliable individual factors. The value of the test of statistic for Barlett's sphericity is large (3662.946) and the associated significance level is small (*p*-value = 0.000), suggesting that the data matrix has sufficient correlation to factor analysis.

The component analysis was used to extract factors, and varimax rotation method was used for simplicity. This method seeks values of the loadings that bring the estimate of the total communality as close as possible to the total of the observed variances. The varimax method encourages the detection of factors each of which is related to few variables while discouraging the detection of factors influencing all variables. The purpose is to seek the rotated loadings that maximise the variance of the squared loadings for each, with the goal of making some of these loadings as large as possible, and the rest as small as possible in absolute value (Garson, 2012; Costello and Osborne, 2005). A varimax solution yields results which make it as easy as possible to identify each variable with a single factor as an orthogonal rotation of the factor axes. Eigenvalues (characteristic roots) measure the amount of variation in the total sample accounted for by each factor. Kaiser rule (Kaiser, 1970) recommends a drop of all components with eigenvalues under 1.0. In the extraction sums of squared loadings (table 7.10), the first eigenvalue is equal to 6.532 and corresponds to 21.071% as the highest loading while the last (tenth) eigenvalue equal to 1.034 (lowest value) is associated with 3.336% of the variance in the original data. In the cumulative percentage, the ten factors together explain 61.735% of the variance in the original data. An eigenvalue is met to indicate how much of the total variance of all variables is covered by the factor.

7.4.1.1 Rotated Component Matrix

The factor analytic procedure has the primary goal of minimising the complexity of the factors by making the factor loadings more clearly defined, understandable and interpretable. By the same token, the item loading equal or greater than 0.55 (cut-off) were considered to factor loadings as these values are close to 0.60, if rounded off. According to Garson (2012) the loadings of Likert scales with 0.60 might be required to be considered "high". When loadings less than 0.55 were excluded, the analysis yielded a ten-factor solution with the simple structural patterns in the pattern of relationships among the variables. Hair *et al.*, (1998) call loadings above 0.6 "high" and those below 0.4 "low", although one rule of thumb for loadings suggests 0.7 or higher to confirm that independent variables identified *á priori* are represented by a particular factor (Garson, 2012). The option blank (≤ 0.55 from SPSS not to print) was used to make the output easier to read by removing the clutter of lower correlations that are probably less meaningful.

7.4.1.2 Interpretation and labeling of factors

The goal of rotation is to simply and clarify the data structure (Costello and Osborne, 2005:3). This study uses factor loadings as the basis for imputing a label to the different factors wherein the researcher examines the most highly or heavily loaded indicators in each column and assigns a factor label. The factor interpretations and labels confine to the assumption of face valid imputation of factor label (face validity) that is rooted in theory.

Factor 1: Supply chain integration system

Factor 1 distinctly indicated the greatest variable loadings of the ten factors that were extracted. Consequently, the loadings of four out of twenty seven variables have the highest variance figure of 21.071%. This critical factor is comprised of advanced economic information, flexible response, shared sensitive and confidential information, and profitability level. This factor describes the greater control and access to advanced economic information over demand in the supply chain.

Factor 2: Demand-driven supply chain system

This factor was measured by asking respondents if the demand-driven strategy improves production and distribution coordination on the customer demand; if the supplier managed inventory 'shifts the responsibility for inventory planning from manufacturer to supplier'; and if agility supply chain as an operational strategy focuses on inducing velocity and flexibility in supply chains to mitigate demand variability. Tentatively, the manufacturer has limited access to real-time inventory level information, if the retailer relishes a sole custody of information about the consumer demand.

This factor describes the demand-driven, supplier managed inventory and agility supply chain systems that yield the upstream site instead of the retailer a better inventory positioning to control the demand order replenishment decision with real-time information in the supply chain. The principle of agile supply chains in particular, allow the enrichment of customers through optimum processes and customer driven-demand from pull-based supply chain as orders move upstream on real-time information sharing systems (Cachon *et al*., 2009; Simchi-Levi *et al.*, 2008; Mason-Jones *et al*., 2000).

Factor 3: Electronic supply chain information exchange

Factor 3 was measured by items that included the integrated e-SCM systems as improvement in information sharing; quality information sharing as a positive attribute towards frequencies of order replenishment rate and limited order cycle time; and information velocity to improve information flow and propensity to tame order variability. Electronically-enabled information exchange system improves the quality and velocity of information sharing on reciprocal interdependence and integrated coordination both across and within firms.

Factor 4: Supply chain lead time cycle

The supply chain lead time cycle was measured by asking the respondents if the e-SCM system contributes significantly to reduction of lead time and eventually speed up the time-to-market; if the system establishes common goals and mutual dependency between collaboration supply chain partners; and if the electronic system optimises the inventory positioning. This factor describes the lead time pooling in the supply chain management that combines the lead times for multiple inventory locations to retain inventory close to customers

Factor 5: Supply chain knowledge-driven system

While these factor items recognise the advanced collaboration that deals with synchronising the supply chain processes within forecasting, replenishment and planning, the knowledge-driven paradigm has cluster of components 'where materials and products are pulled through the system based on customer orders'. With regard to the integrated cross-enterprise model (CPFR model), responses suggested that the model provides unlimited access to the retail store's replenishment system to manage demand order variability. Apart from collaboration, planning and replenishment components of CPFR model, accurate forecasting eliminates bullwhip effect by linking the inventory positioning and order replenishment decisions among supply chain members (Simchi-Levi *et al.*, 2008).

The factor was further measured by asking the respondents if the market-driven system (Build-to-order supply chain) moves the boundary between push-based and pull-based systems close to customers, allowing order replenishment flexibility and responsiveness to reduce order variability.

Factor 6: Supply chain inventory variability

The supply chain causes of bullwhip effect were measured by asking the respondents if the supply chain trading partners are constantly trying to reduce the total lead time in terms of material, information and delivery lead times; if the firms in the supply chains are often setting desired service coverage by holding a large inventory to prevent stock outs; and if the effect of price fluctuation encourages the firms to purchase in large quantities during promotions.

Factor 7: Central supply chain pooling system

This factor describes the aggregation of demand orders across locations wherein the high demand from one customer will be offset by low demand from another customer. The higher the coefficient of variation, the greater the benefit obtained from centralised systems, that is, the greater the benefit of risk pooling.

Factor 8: Supply chain demand order quantity

Factor 8 consists of two items that focus primarily on transportation discounts and inflated demand orders in the supply chain. This factor implies that the downstream supply chain inflates order quantity to cover the additional future demand and/or orchestrate the shortage game to take advantage of transport discounts. If the variability is measured with the coefficient of variation in the supplier’s demand between the variability of demand at one level of supply and the next lower level, the supply chain demand order quantity from inflated orders and emulated transport discounts will indicate bullwhip effect in supply chain.

Factor 9: Electronic supply chain communication system

This factor was measured by asking the respondents if the e-SCM system communicates the firm’s future strategic needs throughout entire supply chain network and eventually mitigates consumer demand order variability; and if the e-SCM capabilities appear as a crucial factor for collaborative relationships and strategic communication tool.

Factor 10: Supply chain decentralised system

Demand forecasting is essential for inventory planning, especially when the demand environment is highly dynamic and the procurement lead times are long. How to adjust the inventory planning decisions according to demand forecasting updates is of great interest to managers. A decentralised supply chain allows the manufacturer to have "better demand information because of proximity to consumers" (Simchi-Levi *et al*., 2008). Cachon *et al.*, (2009) and Schroeder (2008) stress that self-interest and decentralised decision making do not lead to supply chain efficiency without integrated electronically-enabled supply chain management systems and profound reciprocal interdependence among echelon stream sites.

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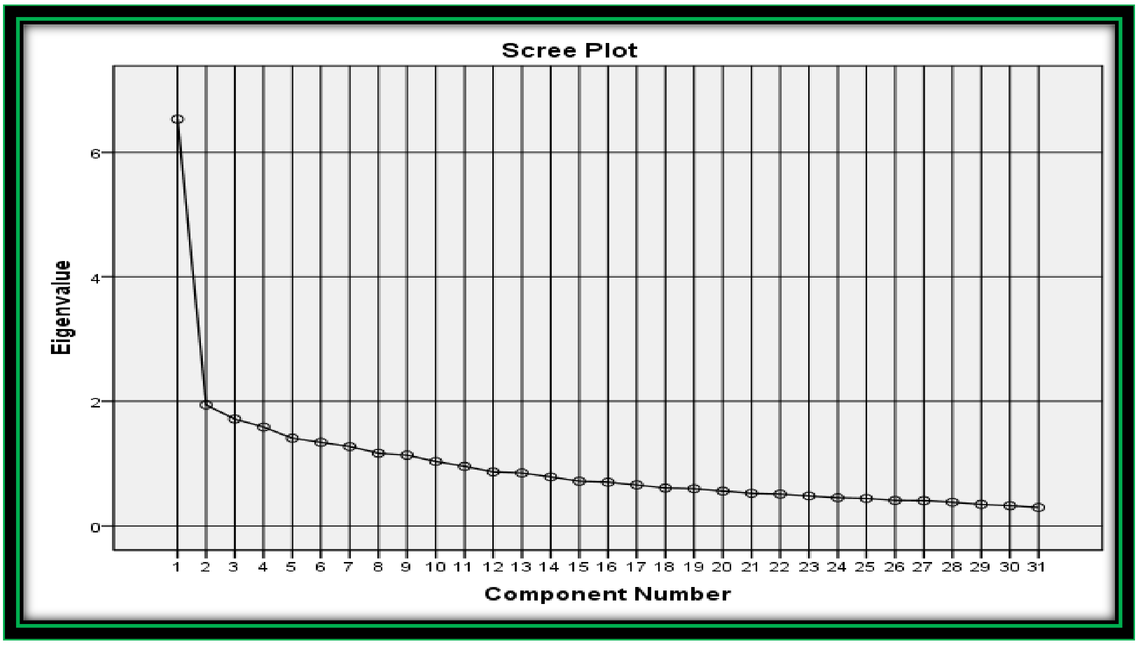
7.4.1.3 Communalities values

The proposition of each variance that can be explained by the factors is noted as h^2, and Tabachnick and Fidell (2007:621) define communality (h^2) as "the sum of squared loadings (SSL) for a variable across factors". The initial values on the diagonal of the correlation matrix are determined by the squared multiple correlation of variable with another variables. The fascinating column (table 7.10 - extraction) indicates values with the proportion of each variable's variance that can be explained by the retained factors. Table 7.10 reveals that 65.1% of the variance in economic information is accounted for by sum of a^2, the variance with highest value 76.6% of variance in CscD system is accounted for by sum of $(a)^2$, and lowest value 44.1% of variance in e-SCM system is accounted for by sum of a^2 or (Sum (factor loadings)^2, (that is, a describes 10 factor loadings across). In this regard, variables with high values (0.766) are well represented in the common factor space with higher loading on each factor between 0.7 and 0.8, while variables with low values (0.4) are not well represented in the common factor space or not well explained by the factor model (updated demand forecast, and vendor managed inventory were excluded with less than 0.55 cut-off point factor loadings. In the real data, Costello and Osborne (2005:4) suggest that the more common magnitudes in the social sciences are low to moderate communalities of 0.40 to 0.70. According to Garson (2012:30) communality is "the sum of the square a factor loadings for all factors for a given variable (row) as the variance in that variable accounted for by all the factors". It measures the percent of variance in a given variance in a given variable explained by all factors jointly may be interpreted as the reliability of the indicator. The communalities ranged from 0.441 to 0.766 suggesting the variance of the original values was fairly explained by the common factors. Subsequent to the variance of original values, the varimax rotation provided the results of the factor analysis suggested a ten factor solution and explained more than 62% of the variance in the data with eigenvalues greater than 1.

Basically, this study reveals the values in this column that tell how under varimax each variable shared with all the other variables. Reliability analysis (Cronbach's Alpha) was also instituted to test the reliability and internal consistency of each factor. The results indicate that the overall alpha value of the ten factors was 0.842, well above the minimum of 0.50 that is considered acceptable as an indication of reliability for basic research (Nunnally, 1967). Additionally, Garson (2012) looks at internal consistency construct validity in Cronbach's Alpha, with 0.60 considered acceptable for exploratory purposes. Factor analysis as a data and variable reduction technique has attempted to partition a given set of variables into groups of maximally correlated variables (Lee *et al*., 2011:2120). Factor analysis as a statistical technique has been used to represent relationships among sets of many interrelated variables, and the overall alpha value in this study (0.701) reflects good internal consistency (reliability) in terms of the correlations amongst the ten factors and the adopted measurement scale.

Figure 7.20: Scree Plot for factor analysis



A scree test is an alternative method to the eigenvalue rule for selecting the number of factors (Darlington, 2008). The method attempts to plot successive eigenvalues, and look for a spot in the plot where it abruptly levels out (Cattell, 1952). Arguably, the scree test can lead to very different conclusions if the square roots or the logarithms of the eigenvalues are plotted instead of the eigenvalues themselves (Darlington, 2008). The scree test plots the components as the x-axis and the corresponding eigenvalues as the y-axis. This figure assist in determining how many components should be retained in order to explain a high percentage of the variation in the data, and the ten factors together explain 61.735% of the variance in the original data.

Figure 7.20 presents a plot of total variance associated with each underlying grouped factor. The scree plot graphs and the eigenvalues against the factor number with the values in the first two columns of the figure (7.20) immediately above and from the third factor on, the line is almost flat. It denotes that each successive factor is accounting for smaller and smaller amounts of the total variance, and eigenvalues are plotted from largest to smallest. According to Choi *et al.*, (2011:818) "the plot normally displays a distinct break between the steep slope of the large individual factors, and eventually shows the gradual trailing off of the rest of the points'. This gradual trailing off (scree) resembles the rubble that forms at the foot of a mountain, and it confirms that the ten factor model should be sufficient for the research.

7.4.1.4 Assumptions in Factor Analysis

Factor analysis has propensity to epitomise subjectivity in imputing factor labels from factor loadings and with absence of panel of neutral experts in imputation process, factor interpretations and labels used face validity with strong rooted theory to infer from factor loadings. In terms of moderate to moderate-high intercorrelations without multicollinearity as KMO of 0.60 or higher indicates data will factor well, there was no violation of assumption with KMO revealed 0.832 as good factorability. The assumptions of both sphericity and adequate sample size were met with Barlett's test of sphericity significant at 0.000 and more cases than factors on adequate sample size. According to Garson (2012:55) there is near universal agreement that factor analysis is inappropriate when the sample size is below 50.

However, Comrey and Lee (1992) initially postulated as a guide sample sizes of 50 as very poor, 100 as poor, 200 as fair, 300 as good, 500 as very good, and 1000 as excellent. This study agrees with the suggested general rule of thumb that recommends at least 300 cases for factor analysis (Tabachnick *et al*., 2007:613), while Sapnas and Zeller (2002) and Zeller (2005) recommend cases of 100 or even 50 under some circumstances. Normality assumption pertains to the significance testing of coefficients, and factor analysis is a correlation technique, seeking to cluster variables along dimensions (Garson, 2012:59). In this respect, normality assumption is not applicable in this study because significance testing is beside the point and there is no distributional assumption. Nonetheless, normality is not considered to be a critical assumption of factor analysis as intercorrelation methods and the next multivariate method confines to this assumption.

7.4.2 Multiple Regression Analysis

Cohen *et al.*, (2003) describe multiple regression as a flexible method of data analysis that may be appropriate whenever a quantitative criterion variable is to be examined in relationship to any other factors expressed as predictor variables. This multivariate method manifests the clarity of tests of regression coefficients, and efficiency of winnowing out uninformative predictors (less predictive power in the form of interactions) in reducing a full model to a satisfactorily reduced model. Darlington (1999) points out that the products and squares of raw / original predictors in a multiple regression analysis are often highly correlated with each other, with a propensity to exhibit multicollinearity. Multicollinearity is a statistical phenomenon in which two or more predictor variables in the multiple regression model are highly correlated and provide redundant information about the response, and as a result the standard errors of estimates of the β's increased and simultaneously indicates decreased reliability.

7.4.2.1 Multiple regression on information sharing

This study has performed a regression analysis with information sharein as dependent variable and other four subjective 5-point Likert type scales items (quality information, integrated e-SCM systems, information velocity and information volatility) as independent variables from the survey instrument. Respondents were asked to indicate the extent of their agreement with each statement, ranging from 1= strongly disagree and 5 = strongly agree. It means that the role of information sharing to mitigate bullwhip effect is assumed to be dependent on the quality of information shared to shorten cycle order time, the magnitude of integration for e-SCM sytems, the velocity of information flows and the degree of information volatility on demand and supply uncertainty.

The Pearson correlation analysis revealed a significant relationship between variables, and it is vitally important to examine how much variance in the dependent variable (information sharing) is explained by each independent variable using a multiple regression method. The stepwise procedure entered two predictors (quality information and integrated e-SCM systems) and none were removed after two models. Correlation and multiple regression analyses were conducted to examine the relationship between information sharing and various potential predictors. In synopsis, each of the predictors' scores is positively and significantly correlated with the criterion, while the multiple regression model (model 2) with two predictors (quality information and integrated e-SCM system) produced $R^2 = 0.169$, F (1; 445) 21.718, $p < 0.05$.

These results provide evidence of existence of a linear relationship between the response (information sharing) and the two explanatory variables (quality information and integrated e-SCM systems). What is the best way for predicting the phenomenon of bullwhip effect on the information sharing from the sub-dimensions of information sharing?

Table 7.11: Descriptive Statistics and Correlations

	Mean	Std. Deviation	N
Information Sharing	3.9955	.96237	448
Quality Information	3.7299	1.04734	448
Integrated e-SCM systems	3.8013	.98911	448
Information Velocity.	3.6987	1.06429	448
Information Volatility.	3.5558	1.12587	448

Correlations

		Information Sharing	Quality Information	Integrated e-SCM systems	Information Velocity.	Information Volatility
Pearson Correlation	Information Sharing	1.000	.381	.309	.123	.174
	Quality Information	.381	1.000	.451	.314	.205
	Integrated e-SCM systems	.309	.451	1.000	.323	.254
	Information Velocity.	.123	.314	.323	1.000	.527
	Information Volatility.	.174	.205	.254	.527	1.000
Sig. (1-tailed)	I Information Sharing	.	.000	.000	.005	.000
	Quality Information	.000	.	.000	.000	.000
	Integrated e-SCM systems	.000	.000	.	.000	.000
	Information Velocity.	.005	.000	.000	.	.000
	Information Volatility.	.000	.000	.000	.000	.

The Pearson correlation test has been used to describe the degree of linear association between the variables. In statistics, the value of the correlation coefficient varies between +1 and -1 with a perfect degree of association between the variables (± 1), and value towards 0 indicating weaker or no relationships (Chen and Popovich, 2002). This study presents correlation matrix to estimate the relationship between all possible pairs of variables using significance level of alpha = 0.05. The significance level shows how likely it is that the correlations reported may be due to chance in the form of random sampling error. A correlation matrix gives details of acceptable positive correlation values between each pair of variables with significance less than 0.05, and there are no strong correlations (range between 0.3 to 0.5) between the criterion and the predictor variables.

Table 7.12: Statistics on Mode, ANOVA, Coefficients, diagnostics and Residuals

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.381[a]	.145	.143	.89095	.145	75.533	1	446	.000	
2	.411[b]	.169	.165	.87947	.024	12.718	1	445	.000	1.840

a. Predictors: (Constant), Quality Information, b. Predictors: (Constant), Quality Information , Integrated e-SCM systems.; c. Dependent Variable: Information Sharing

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	59.958	1	59.958	75.533	.000[a]
	Residual	354.033	446	.794		
	Total	413.991	447			
2	Regression	69.795	2	34.897	45.118	.000[b]
	Residual	344.196	445	.773		
	Total	413.991	447			

a. Predictors: (Constant), Quality Information; b. Predictors: (Constant), Quality Information , Integrated e-SCM systems.; c. Dependent Variable: Information Sharing

Coefficients[a]

Model		Unstandardised Coefficients B	Std. Error	Standardised Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1	(Constant)	2.691	.156		17.266	.000	2.385	2.998					
	Quality Information	.350	.040	.381	8.691	.000	.271	.429	.381	.381	.381	1.000	1.000
2	(Constant)	2.320	.186		12.481	.000	1.954	2.685					
	Quality Information	.278	.045	.303	6.248	.000	.191	.366	.381	.284	.270	.796	1.256
	Integrated e-SCM systems	.168	.047	.173	3.566	.000	.075	.261	.309	.167	.154	.796	1.256

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions: (Constant)	Quality Information	Integrated e-SCM systems.
1	1	1.963	1.000	.02	.02	
	2	.037	7.268	.98	.98	
2	1	2.929	1.000	.01	.01	.01
	2	.039	8.663	.19	.99	.23
	3	.032	9.544	.80	.00	.76

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Mahal. Distance	.075	13.955	1.996	2.022	448
Cook's Distance	.000	.057	.003	.006	448
Centered Leverage Value	.000	.031	.004	.005	448

Table 7.12 discloses the model that has included only quality information accounted for 14% of the variance (adjusted R^2 = 0.143) while the second model included integrated e-SCM systems with additional 2% of the variance being explained and accounted for by 16% of the variance (adjusted R^2 = 0.165). Regarding the equations: R^2 = 1-SS (Error)/SS (Total); and

R^2_{adj} = 1-MSE/MST or $R^2_{adj} = R^2-(1-R^2)p/(n-p-1)$. In this study, R square is 0.169, adjusted R^2 = 0.165, F = 45.118 with degree of freedom (2; 45) at significance level, $p < 0.05$. All t-statistics for the coefficients are significant at $p < 0.05$. The final model emerged from the stepwise analysis with only two predictor variables showing significance in this model. The relationship between criterion and predictor variables is explained by only 16.9% of the variance in information sharing and the two dimensions, quality information ($\beta = 0.303$, $p < 0.05$) and integrated e-SCM system ($\beta = 0.173$, $p < 0.05$) were found to be considerably and statistically related with information sharing. In testing for autocorrelation with the value of Durbin-Watson, "ranges from 0 to 4, values close to 0 indicate extreme positive autocorrelation" (standard errors of the B coefficients are too small); close to 4 indicate extreme negative autocorrelation (standard errors are too large); and close to 2 indicate no serial autocorrelation (Garson, 2012).

There is no multicollinearity problem for this study, the variance inflation factors (VIF) are equal to 1 (or VIF $\leq$ 10), and tolerance scores are more than 0.20 or 0.10 (O'Brien, 2007). Nevertheless a tolerance value of 0.50 or higher is generally accepted, and the higher the tolerance value, the more useful the predictor is to the analysis as defined by $1 - R^2$ (Tabachnich and Fidell, 2007). The Durbin-Watson value is used to examine the degree of multicollinearity, and 'the values should be between 1.5 and 2.5 acceptable to indicate independence of observations' (Schroeder *et al.,* 1986). It statistic tests the presence of serial correlation among the residuals and the value of Durbin-Watson statistic ranges from 0 to 4. Model 2 indicates the value (1.840) between 1.5 and 2.5, consistent with the ideal range of values with no problems related to multicollinearity. In terms of diagnostics, the condition index is measure of tightness or dependency of one variable on the others, and Tabachnick and Fidell (2007) suggest values less than 30 and variance proportions to be less than 0.50 for each item.

Residuals Statistics

According to Garson (2012) residual analysis is used for three main purposes: 1) to spot heteroscadasticity (increasing error as the observed Y value increases); 2) to spot outliers (influential cases); and 3) to identify other patterns of error (error associated with certain ranges of X variables). The studentised residual is similar to the standardised residual in measuring outliers and influential observations. This study has standardised residual (min = 3.846 and max = 2.541) within expected interval (-3.3 or ±3) and studentised residual (min = 3.857 and max = 2.573) within 0 and ±3. The normal distribution of this model has a mean of 0 (0.000) and standard deviation closer to 1 (0.998) from standardised residuals (Tabachnick and Fidell, 2007). Cook's Distance measures how much an observation influences the overall model or predicted values as a summary measure of leverage and high residuals (D > 1 indicates a big outlier problem, that is, D > 4/N → sample size) (Baum, 2006; Stock and Watson, 2008). This study presents Cook's D for observations without outliers (min = 0.000 and max = 0.057) with value of D less than 1, 'it does not have large effect on the regression analysis'. Cook's distance, $CD_i = (p\sigma^2)^{-2}(\hat{Y}_{(i)} - \hat{Y})^T (\hat{Y}_{(i)} - \hat{Y})$. Fox (1991:34) further suggests as "a cut-off for deleting influential cases, values of D greater than4 / (N-k-1)", when N = sample size and k = number of independents.

Leverage measures how much an observation influences regression coefficients. A rule of thumb is that leverage goes from 0 to 1 while a value closer to 1 or 0.5 may indicate problems (Hamilton, 2006:175). Alternatively, the leverage (hat element/value) greater than 3p/n should be carefully examined as a useful rule of thumb for quickly identifying subjects which are very different from the rest of the sample on the set of predictors (Stevens, 2002). This study reveals accepted hat elements that lie between 0 (no influence on the model) and 1 (completely determines the model) (min = 0.000 and max = 0.031).Mahalanobis distance is the rescaled measure of leverage [m = leverage x (N-1)], and the higher levels indicate higher distance from average values (Baum, 2006; Hamilton, 2006). Mahalanobis distance is the distance measured by P.C. Mahalanobis as an underlying correlation between variables by which different patterns can be identified and analysed (Mahalanobis, 1936: 49-55). It looks at how far the case is from the centroid of all cases for the predictor variables. It is further associated with those points whose Cook distance are > 1 (Tabachnick and Fidell, 2007) to determine which outliers are influential data points (Cook values have min = 0.000 and max = 0.057, less than 1 and no effect on the regression analysis). The higher the Mahalanobis distance for a case, the more that case's values on independent variables diverge from average values.

Figure 7.21: Normal probability plot of Residuals on information sharing and predictor variables

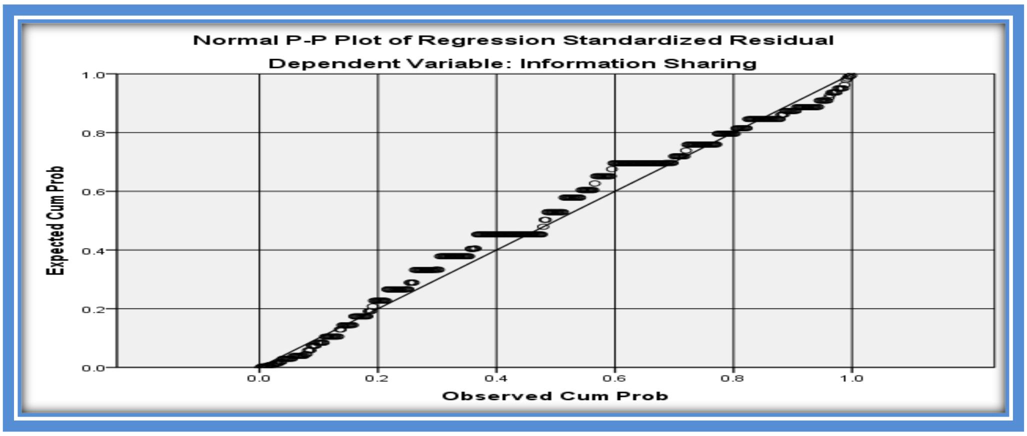


Figure 7.21 shows the normal plot of the residuals with points close to a diagonal line, thus the assumption for multiple regression analysis is met by variables.

7.4.2.2 Multiple regression analysis on electronic supply chain management systems

This study attempts to establish the correlation between variables that characterise the determinants of e-SCM systems in order to demonstrate how strong the relationship between variable is. The notations for the determinants of e-SCM systems were subjected to five-point Likert-type scales. The operational performance targets and outcomes after implementing e-SCM systems might be dependent on the enhancement of informal and formal information shared, strength to communicate strategies, willingness to share confidential and sensitive information, accessibility to advance economic information, improved flexible response, increased profitability level, mutual dependency and reduced lead times. The stepwise procedure produced two predictor variables (stratetic communication and economic information) on model 2 (table 7.14) and economic information is negatively correlated to e-SCM systems. The notation is that the greater control and accessibility to advanced economic information over demand has negative relation with the implementation of e-SCM systems.

Table 7.13: Correlation Matrix

Correlations

		e-SCM Systems	Informal and Formal	Strategic Comm	Confid Inform	Econ Inform	Flexible Response	Profit Level.	Mutual depend	Lead Times
Pearson Correlation	e-SC M Systems.	1.000	.109	.262	.038	-.021	-.004	-.016	.086	.071
	Informal and Formal.	.109	1.000	.187	.092	.039	.038	-.021	.127	
	Strategic Communication	.262	.187	1.000	.375	.266	.166	.078	.158	.162
	Confidential Information	.038	.092	.375	1.000	.476	.385	.278	.174	.108
	Economic Information.	-.021	.039	.266	.476	1.000	.549	.386	.238	.142
	Flexible Response	-.004	.038	.166	.385	.549	1.000	.523	.324	.166
	Profitability Level.	-.016	-.021	.078	.278	.386	.523	1.000	.354	.248
	Mutual dependency.	.086	.127	.158	.174	.238	.324	.354	1.000	.461
	Lead Times	.071	.104	.162	.108	.142	.166	.248	.461	1.000
Sig. (1-tailed)	Electronic SCM Systems	.	.011	.000	.210	.326	.465	.366	.034	.066
	Informal and Formal	.011	.	.000	.026	.208	.210	.326	.004	.014
	Strategic Communication	.000	.000	.	.000	.000	.000	.049	.000	.000
	Confidential Information	.210	.026	.000	.	.000	.000	.000	.000	.011
	Economic Information.	.326	.208	.000	.000	.	.000	.000	.000	.001
	Flexible Response	.465	.210	.000	.000	.000	.	.000	.000	.000
	Profitability Level.	.366	.326	.049	.000	.000	.000	.	.000	.000
	Mutual dependency.	.034	.004	.000	.000	.000	.000	.000	.	.000
	Lead Times	.066	.014	.000	.011	.001	.000	.000	.000	.
N	e- SCM Systems.	448	448	448	448	448	448	448	448	448

The correlation matrix (table 7.13) presents all possible predictor variables and the dependent measure, the e-SCM system. The eight interval level variables indicate the relationship between all possible pairs of variables using significance level of alpha = 0.05. The criterion variable is negatively correlated to advanced economic information, flexible response and profitability level with a significance level greater than 0.05, while all possible predictor variables are positively correlated with $p < 0.05$ except sensitive and confidential information and lead times. Only two predictor variables were entered into the prediction model 2 after stepwise procedure with a multiple R of 0.279 and both future strategic communication and advanced economic information are significantly entered in the regression equation.

Table 7.14: Multiple regression statistics on e-SCM systems and predictor variables

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.262[a]	.069	.067	.82141	.069	32.877	1	446	.000	
2	.279[b]	.078	.073	.81838	.009	4.315	1	445	.038	1.800

a. Predictors: (Constant), Strategic Communication; b. Predictors: (Constant), Strategic Communication, Economic Information.; c. Dependent Variable: e-SCM Systems

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22.183	1	22.183	32.877	.000[a]
	Residual	300.924	446	.675		
	Total	323.107	447			
2	Regression	25.073	2	12.536	18.718	.000[b]
	Residual	298.034	445	.670		
	Total	323.107	447			

Coefficients[a]

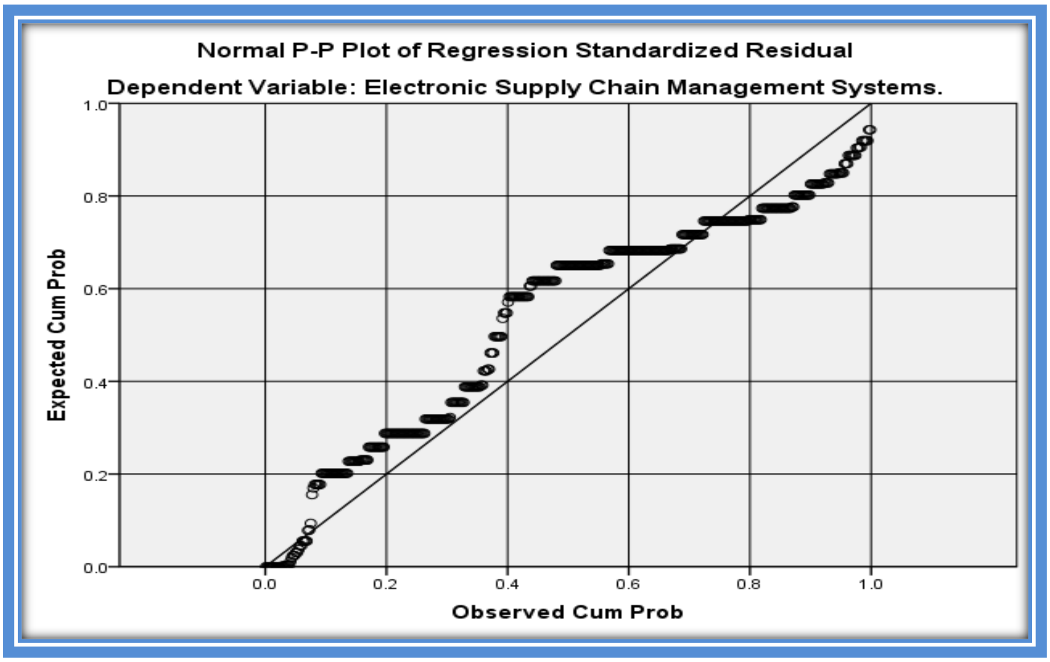
Model		Unstandardised Coefficients: B	Std. Error	Standardised Coefficients: Beta	t	Sig.	95.0% Confidence Interval for B: Lower Bound	Upper Bound	Correlations: Zero-order	Partial	Part	Collinearity Statistics: Tolerance	VIF
1	(Constant)	3.659	.144		25.385	.000	3.376	3.943					
	Strategic Communication	.205	.036	.262	5.734	.000	.135	.276	.262	.262	.262	1.000	1.000
2	(Constant)	3.846	.169		22.705	.000	3.513	4.179					
	Strategic Communication	.226	.037	.288	6.100	.000	.153	.299	.262	.278	.278	.929	1.076
	Economic Information.	-.073	.035	-.098	-2.077	.038	-.141	-.004	-.021	-.098	-.095	.929	1.076

Residuals Statistics[a]	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.7082	4.9021	4.4554	.23684	448
Std. Predicted Value	-3.155	1.886	.000	1.000	448
Standard Error of Predicted Value	.040	.133	.064	.019	448
Adjusted Predicted Value	3.6731	4.9000	4.4549	.23747	448
Residual	-3.38556	1.29179	.00000	.81654	448
Std. Residual	-4.137	1.578	.000	.998	448
Stud. Residual	-4.148	1.600	.000	1.002	448
Mahal. Distance	.090	10.816	1.996	1.947	448
Cook's Distance	.000	.076	.003	.008	448
Centered Leverage Value	.000	.024	.004	.004	448

a. Dependent Variable: e-SCMSytem Electronic Supply Chain Management Systems.

Table 7.14 indicates that the coefficient of multiple determination is 0.078, with about 7.8% of the variation in the e-SCM system being explained by future strategic communication and advanced economic information. The regression equation appears to be moderate for making predictions since the value R^2 is not close to 1. The *F* ratio is 18.718 and significant at $p = 0.000$. This provides evidence of the existence of a linear relationship between the response and the two explanatory variables (strategic communication and advanced economic information).Among all eight dimensions, future strategic communication ($\beta = 0.288$, $p < 0.05$) and advanced economic information ($\beta = -0.098$, $p = 0.05$) were found to be considerably related to the e-SCM system. In the *t*-values, these values show the importance of a variable in model 2, and the percentages are greater than 1.96 at a significance of $p < 0.05$. Apart from that, since the tolerance value was more than 0.10 and the VIF was below 10, there was no multicollinearity problem between items in the independence variables. The maximum value of Cook's distance is 0.076 under residuals, suggesting no major problem D < 1. Regarding the normal probability plot, the points (figure 7.22) are lying in a reasonably straight diagonal line from bottom left to top right with no major deviation from normality.

Figure 7.22: Normal probability plot for e-SCM systems



7.4.2.3 Multiple Regression on inventory Positioning

This study has considered inventory positioning as dependent variable and independent variables are the updated demand forecast, transport discounts, inflated demand orders, price fluctuations, total lead times and inventory stockouts. The five-point Likert type scale was used to both dependent and independent variables to assess the level of agreement. All variables were positively correlated and stepwise procedure was utilised to generate statistical results on multiple regression. Model 2 produced two independent variables and the analysis outlines that the positioning of inventory depends on order quantities that tend to take advantage of transport discounts, and the constant attempt to reduce total lead times in terms of material, information and delivery lead times and delays.

Table 7.15: Descriptive statistics and correlation matrix on Inventory positioning

Descriptive Statistics

	Mean	Std. Deviation	N
Inventory Positioning	3.6540	1.09848	448
Updated Demand Forecast	4.0402	.99583	448
Transport Discounts	3.8460	1.03666	448
Inflated Demand Orders	3.7701	1.03119	448
Price fluctuations	3.7009	1.09700	448
Total Lead Time	3.6696	1.04175	448
Inventory Stockouts	3.6763	1.08071	448

	Correlations	Inventory Position	Updated Demand Forecast	Transport Discount	Inflated Demand Orders	Price fluctuations	Total Lead Time	Inventory Stockouts
Pearson Correlation	Inventory Positioning	1.000	.174	.242	.135	.181	.172	.152
	Updated Demand Forecast	.174	1.000	.338	.253	.142	.179	.156
	Transport Discounts	.242	.338	1.000	.337	.223	.112	.129
	Inflated Demand Orders	.135	.253	.337	1.000	.301	.167	.152
	Price fluctuations	.181	.142	.223	.301	1.000	.389	.267
	Total Lead Time	.172	.179	.112	.167	.389	1.000	.447
	Inventory Stockouts	.152	.156	.129	.152	.267	.447	1.000
Sig. (1-tailed)	Inventory Positioning	.	.000	.000	.002	.000	.000	.001
	Updated Demand Forecast	.000	.	.000	.000	.001	.000	.000
	Transport Discounts	.000	.000	.	.000	.000	.009	.003
	Inflated Demand Orders	.002	.000	.000	.	.000	.000	.001
	Price fluctuations	.000	.001	.000	.000	.	.000	.000
	Total Lead Time	.000	.000	.009	.000	.000	.	.000
	Inventory Stockouts	.001	.000	.003	.001	.000	.000	.

The correlation matrix (table 7.15) presents all possible predictor variables and the dependent measure, inventory positioning. The seven interval level variables indicate the relationship between all possible pairs of variables using significance level of alpha = 0.05. The criterion variable is positively correlated to updated demand forecast, transport discounts, inflated demand orders, price fluctuations, total lead times and inventory stock outs, with significance level greater than 0.05. Only two predictor variables were entered into the prediction model 2 after stepwise procedure with a multiple R of 0.282 and both transport discounts and total lead times are significantly entered the regression equation.

Table 7.16: Regression statistics on inventory positioning

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.242[a]	.059	.056	1.06705	.059	27.718	1	446	.000	
2	.282[b]	.080	.076	1.05619	.021	10.221	1	445	.001	1.751

a. Predictors: (Constant), Transport Discounts
b. Predictors: (Constant), Transport Discounts, Total Lead Time
c. Dependent Variable: Inventory Positioning

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	31.559	1	31.559	27.718	.000[a]
	Residual	507.813	446	1.139		
	Total	539.373	447			
2	Regression	42.961	2	21.481	19.256	.000[b]
	Residual	496.411	445	1.116		
	Total	539.373	447			

Coefficients[a]

Model	Unstandardised Coefficients: B	Std. Error	Standardised Coefficients: Beta	t	Sig.	95.0% Confidence Interval for B: Lower Bound	Upper Bound	Correlations: Zero-order	Partial	Part	Collinearity Statistics: Tolerance	VIF
(Constant)	2.668	.194		13.760	.000	2.287	3.049					
Transport Discounts	.256	.049	.242	5.265	.000	.161	.352	.242	.242	.242	1.000	1.000
(Constant)	2.169	.247		8.766	.000	1.683	2.655					
Transport Discounts	.239	.048	.225	4.926	.000	.144	.334	.242	.227	.224		1.013
Total Lead Time	.154	.048	.146	3.197	.001	.059	.249	.172	.150	.145	.987	1.013

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions: (Constant)	Transport Discounts	Total Lead Time
1	1	1.966	1.000	.02	.02	
	2	.034	7.561	.98	.98	
2	1	2.910	1.000	.00	.01	.01
	2	.063	6.787	.00	.49	.62
	3	.027	10.377	.99	.50	.37

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.5622	4.1350	3.6540	.31002	448
Std. Predicted Value	-3.522	1.551	.000	1.000	448
Standard Error of Predicted Value	.053	.185	.083	.026	448
Adjusted Predicted Value	2.5484	4.1603	3.6535	.31099	448
Residual	-3.13497	2.12922	.00000	1.05382	448
Std. Residual	-2.968	2.016	.000	.998	448
Stud. Residual	-2.980	2.036	.000	1.001	448
Deleted Residual	-3.16029	2.17123	.00051	1.06122	448
Stud. Deleted Residual	-3.007	2.043	.000	1.003	448
Mahal. Distance	.113	12.684	1.996	2.081	448
Cook's Distance	.000	.027	.002	.004	448
Centered Leverage Value	.000	.028	.004	.005	448

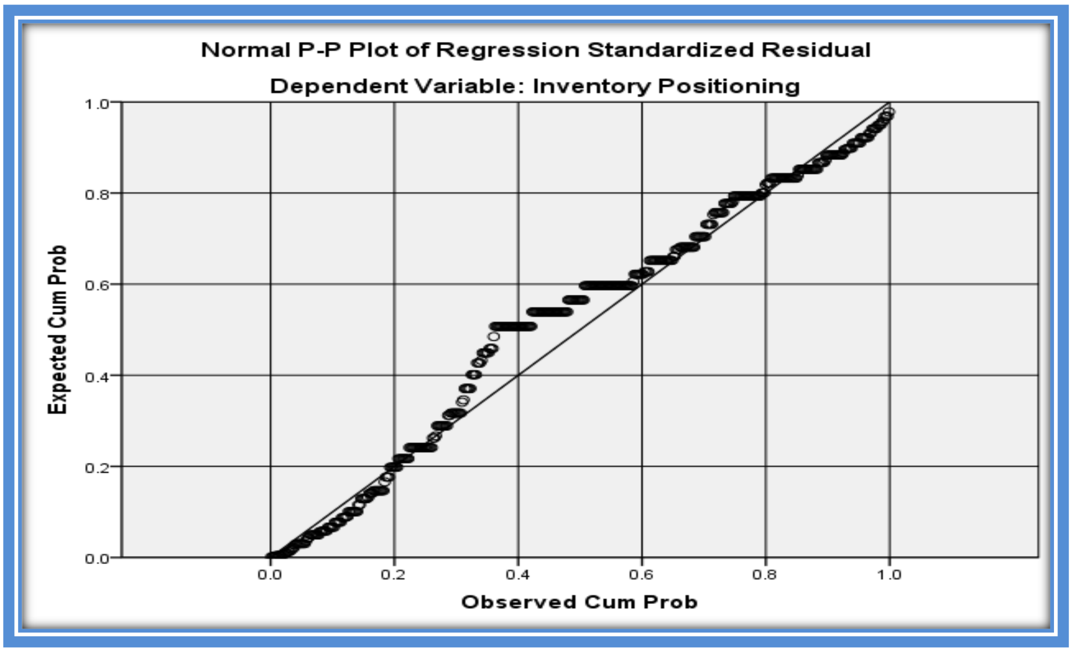
a. Dependent Variable: Optimal Inventory Positioning

Table 7.16 indicates that the coefficient of multiple determination is 0.080 with about 8% of the variation in the inventory positioning being explained by transport discounts and total lead times. The regression equation appears to be moderate for making predictions since the value R^2 is not close to 1.

The *F* ratio is 19.256 and significant at $p = 0.000$. These results provide evidence of the existence of a linear relationship between the response and the two explanatory variables (transport discounts and total lead times). Among all six dimensions, transport discounts ($\beta = 0.225$, $p < 0.05$) and total lead times ($\beta = 0.146$, $p = 0.05$) were found to be considerably related with inventory positioning. In the t-values, these values show the importance of a variable in the model 2, and the percentages are greater than 1.96 at significance of $p < 0.05$. Apart from that, since the tolerance value was more than 0.10 and the VIF was below 10, there was no multicollinearity problem between items in the independence variables. The maximum value of Cook's distance is 0.027 under residuals, suggesting no major problem D < 1. Leverage for this study reveals accepted hat elements that lie between 0 and 1 (min = 0.000 and max = 0.028).

Regarding the normal probability plot, the points (figure 7.23) are "lying in a reasonably straight diagonal line from bottom left to top right" with no major deviation from normality.

Figure 7.23: Normal probability plot on inventory positioning



7.4.2.4 Multiple Regression analysis Bullwhip effect and all predictor variables

Multiple regression analysis was conducted in order to assess how much variance in the dependent variable is explained by the independent variable. This omnibus method incorporated thirty one interval-level variables (all items on descriptive statistics, table 7.1 and 7.2) to analyse the relationship between the criterion variable of bullwhip effect and the sub-dimensions of three major possible predictor variables (e-SCM system, inventory positioning, and information sharing together with their subdimensions), and each explanatory variable from global optimisation strategies. The purpose of this method is to reveal and understand the possible predictor variables with potential contribution to the dependent variable (bullwhip effect) in the model of the study. The correlation values showed all values less than 0.7 which is less than the suggestions from (Hair *et al*., (2003) and the model in this study does not have multicollinearity problem (VIF values of more than 0.10 and Tolerance of less than 10). The results of multiple regression has relative importance of individual predictors from β coefficients that depict the omnibus explanatory power of all predictor variables with measures of R^2.

The survey instrument used a Likert scale ranging from 1 as "strongly disagree", 3 as "neutral" to 5 as "strongly agree" with section three (part one – bullwhip effect and inventory positioning and part two – information sharing) and section four (part one – e-SCM systems and part two – global optimisation strategies). The predictive model (model 7) of bullwhip effect was developed using the stepwise procedure from thirty possible explanatory variables. The empirical evidence of this study produced seven explanatory variables (updated forecast demand, transport discounts, information velocity, information sharing, risk pooling , e-SCM systems and integrated e-SCM system) from the full model with R^2 (0.023), adjusted R^2 (0.22), *F*-ratio (18.571), *df* (1;140) and $p = 0.000$. According to Nusair and Hau (2010:315) "the values of R^2 or adjusted R^2 indicate the amount of variance in the outcome explained by all predictors taken together". The tests (*t*-test, *F*-ratio and Durbin-Watson test) will allow the determination of the statistical significance of the results, both in terms of the model itself and the individual independent variables. In the same model, the major assumptions for multiple regression are described to evaluate potential problems or disclose the probable violation of assumption in the model with regard to outliers, normality, linearity, homoscedasticity and independence of residuals (Mahalanobis distances, Cook's distances and leverage *h* hat).

Table 7.17: Model Summary and ANOVA

Model Summary[h]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.328[a]	.108	.106	.75185	.108	53.742	1	446	.000	
2	.375[b]	.140	.136	.73877	.033	16.932	1	445	.000	
3	.408[c]	.167	.161	.72817	.026	14.046	1	444	.000	
4	.435[d]	.189	.182	.71907	.023	12.304	1	443	.000	
5	.454[e]	.206	.197	.71220	.017	9.591	1	442	.002	
6	.468[f]	.219	.209	.70724	.013	7.222	1	441	.007	
7	.478[g]	.228	.216	.70399	.009	5.087	1	440	.025	1.813

ANOVA[h]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30.379	1	30.379	53.742	.000[a]
	Residual	252.112	446	.565		
	Total	282.491	447			
2	Regression	39.620	2	19.810	36.297	.000[b]
	Residual	242.871	445	.546		
	Total	282.491	447			
3	Regression	47.068	3	15.689	29.589	.000[c]
	Residual	235.423	444	.530		
	Total	282.491	447			
4	Regression	53.430	4	13.357	25.833	.000[d]
	Residual	229.061	443	.517		
	Total	282.491	447			
5	Regression	58.295	5	11.659	22.985	.000[e]
	Residual	224.196	442	.507		
	Total	282.491	447			
6	Regression	61.907	6	10.318	20.628	.000[f]
	Residual	220.584	441	.500		
	Total	282.491	447			
7	Regression	64.428	7	9.204	18.571	.000[g]
	Residual	218.063	440	.496		
	Total	282.491	447			

a. Predictors: (Constant), Updated Demand Forecast
b. Predictors: (Constant), Updated Demand Forecast, Transport Discounts
c. Predictors: (Constant), Updated Demand Forecast, Transport Discounts, Information Velocity.
d. Predictors: (Constant), Updated Demand Forecast, Transport Discounts, Information Velocity, Information Sharing
e. Predictors: (Constant), Updated Demand Forecast, Transport Discounts, Information Velocity, Information Sharing, Risk Pooling
f. Predictors: (Constant), Updated Demand Forecast, Transport Discounts, Information Velocity, Information Sharing, Risk Pooling ., e-SCM System
g. Predictors: (Constant), Updated Demand Forecast, Transport Discounts, Information Velocity, Information Sharing, Risk Pooling ., e-SCM System, Integrated e-SCM systems.
h. Dependent Variable: Bullwhip Effect

Consider a random sample of *n* observations ($x_{i1}, x_{i2}, \ldots, x_{ip}, y_i$), $i = 1, 2, \ldots, n$.

The $p + 1$ random variables are assumed to satisfy the linear model

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2}, + \beta_p x_{ip} + \varepsilon_i \qquad i = 1, 2, \ldots, n$$

Where ε_i are values of an unobserved error term, ε_i, and. the unknown parameters are constants. Assumptions: The error terms ε_i are mutually independent and identically distributed, with mean = 0 and constant variances: E [ε_i] = 0 V [ε_i] = σ^2_x . This is so, because the observations y_1, y_2, . . . ,y_n are a random sample, they are mutually independent and hence the error terms are also mutually independent.

The distribution of the error term is independent of the joint distribution of x_i, x_2, . . . , x_p. The unknown parameters β_0, β_1, β_2, . . . , β_p are constants. In general, predictive models (seven models) of bullwhip effect are derived by multiple regression analysis unstandardised coefficients using the stepwise procedure for thirty possible explanatory variables as follows: (Y = Bullwhip effect –BWE from Model 1 to 7)

BWE = 3.384 + 0.262 forecast	**R^2 = 0.108**
= 3.027 + 0.210 forecast + 0.147 trans	**R^2 = 0.140**
= 3.343 + 0.229 forecast + 0.165 trans – 0.125 velocity	**R^2 = 0.167**
= 2.981 + 0.214 forecast + 0.151 trans – 0.134 velocity + 0.127 share	**R^2 = 0.189**
= 2.756 + 0.196 forecast + 0.151trans – 0.145 velocity + 0115 share + 0.100 risk	**R^2 = 0.206**
= 2.421 + 0.182 forecast + 0.146 trans – 0.143 velocity +0.105 share + 0.089 risk + 0.110 e-SCM	**R^2 = 0.219**
=2.297+ 0.177 forecast + 0.140 trans – 0.165 velocity +0.083share + 0.090 risk + 0.112 e-SCM + 0.084 I-e-SCM	**R^2 = 0.228**

The bullwhip effect is quantified as "the variance of the orders placed by stage *k*, denoted q^k, satisfies" (Chen *et al.,* 1998)

$$\mathbf{Var(Q^k) / Var(D) \geq \prod^{k}_{i+1} (1+[(2Li/p) + 2L^2 i/p^2)] \forall K}$$

In terms of demand information that is "shared with each stage of the supply chain, the increase in variability from the retailer to stage "*k* is:

$$\mathbf{Var(Q^k{}_i) / Var(D) = 1+[(2 (\sum^{k}_{(i+1)} L_i) / p) + 2 (\sum^{k}_{i+1} L_i)^2 / p^2]}$$

It is noted by Snyder and Shen (2011) and (Simchi-Levi *et al*., 2008) that for supply chains with centralised information, the increase in variability at each stage is an additive function of the lead time and the lead time squared, while for supply chains without centralised information, the lower bound on the increase in variability at each stage is multiplicative.

This implies that 'centralising customer demand information' can significantly ameliorate the bullwhip effect. Bullwhip effect measure over the entire supply chain allows one to compare different system configurations from the stability point of view.

In identifying the bullwhip occurrence at each stage of the supply chain it is proposed to compare a standard deviation of demand faced by the neighbour supply chain stages by calculate a ratio BE_i:

$$BE_i = \frac{STD\ (Q_i)}{STD(Q_{i-1})} \in (0, \infty), i = \overline{1, n};$$

If $BE_i > 1$ then the bullwhip effect exists and if $BE_i \leq 1$ then the bullwhip effect does not exist at n (number of supply chain stages). $STD\ (Q_i)$ means standard deviation of orders placed by stage i to its supplier; and $STD(Q_{i-1})$ means standard deviation of demand received by supply chain stage i. According to Simchi-Levi *et al*., (2008) the performance of the supply chain is evaluated under various factors such as end customer mean demand E(X) and its standard deviation STD(X), lead time LT, safety stock factor z and number of observation on which further demand forecast is based p implementing both decentralised and centralised information sharing strategies, although for the supply chain with centralised information sharing, the variation of placed orders travelling upstream is visibly smaller.

The validity of the final model is assessed by considering the correlation of coefficients and determination, and thoroughly examining the consistency between the model and response results through t-test, F-test and Durbin-Watson test without assuming the superiority of the model from a high value for the coefficient regression. The regression equation appears to be acceptable for making predictions with R^2 values close to 1. The correlation coefficient for model 1 appears to be low ($R^2 = 0.108$ or 0.11) while models 2 -4 are revealing values of $R^2 =$ 0.14; 0.17 and 0.19 respectively. The values of the multi-variable regression determination coefficient (R^2) for models 5 -7 are showing improvement from model 1with moderate values range ($R^2 = 0.22$ and 0.23 respectively).

The high values of R^2 wouldn't necessarily have indicated the superiority of any model without establishing the validity of models through statistical tests.This study has included updated forecast demand (forecast), transport discounts (trans), information velocity (velocity), information sharing (share), risk pooling (risk), e-SCM systems (e-SCM) and integrated e-SCM system (I-eSCM) from model 1 – 7 with adjusted R^2 values of the variance being explained and accounted for 11%, 14%, 17%, 19%, 21%, 22% and 23% respectively.

The study further indicates the final model with R square (0.23), adjusted R square (0.22), *F*-ratio = 18.571 with degree of freedom (1; 140) at significance level, p = 0.000 below confidence level (0.05). Gujarati (2006:229) recommends using adjusted R^2 across the board because it explicitly takes into account the number of variables included in the model, computed as: $R^2_{adj} = R^2 - (1-R^2)p/(n-p-1)$; or Adjusted $R^2 = 1- [(1-R^2)(N-1/N-k-1)]$.
The Durbin-Watson test discloses the consistent value (1.813) with the range of 1.5 and 2.5 and these models are not affected by problems related to multicollinearity. The *t*-test values are showing the importance of a variable in the model on the value greater than 1.96 at the significance level less than 0.05. The *t*-value of a coefficient is the coefficient divided by the standard error, and the coefficient is significantly different from zero. All *t*-test values are appropriate with *t*-significance values less than 0.05 to consider each variable significant to the valid model.

The full model (model 7) shows the proportion of variance accounted for by the model and the significance of the predictor variables (adjusted R square = 0.216, $F_{7,440}$ = 18.571, *p*-value = 0.000 less than 0.05). *F* is a function of R^2, the number of independents, and the number of cases in terms of computation of *F*-test by Larzelere and Mulaik (1977) as follows: $F = [R^2/k]/[(1-R^2)/(N-k-1)]$. The adjusted R square value of 0.216 has accounted for 22% of the variance in the criterion variables to indicate the strength of the model while *F*-ratio cites on the significance of the model with associated significant *p*-value. The regression equation appears to be useful for making predictions although the values of R^2 are not explicitly close to 1. In the model quality measure with 100 times adjusted R^2 into whole percentage terms, the accuracy for continuous dependents should be interpreted as the percent of variability in the dependent explained by predictors in the model (Norusis, 2012:278).

Table 7.18: Coefficients and Residuals statistics

Coefficients[a]													
	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Part	Part	Tol	VIF
7 (Constant)	2.297	.258		8.901	.000	1.790	2.805					
Updated Forecast	.177	.037	.222	4.780	.000	.104	.250	.328	.222	.200	.816	1.226
Transport Discounts	.140	.035	.183	4.040	.000	.072	.209	.281	.189	.169	.854	1.171
Information Velocity	-.165	.034	-.220	-4.869	.000	-.231	-.098	-.072	-.226	-.204	.856	1.168
Information Sharing	.083	.037	.100	2.213	.027	.009	.156	.213	.105	.093	.861	1.161
Risk Pooling .	.090	.032	.122	2.771	.006	.026	.153	.197	.131	.116	.912	1.096
E-SCM Systems.	.112	.041	.120	2.746	.006	.032	.192	.225	.130	.115	.920	1.087
Integrated e-SCM systems	.084	.037	.105	2.255	.025	.011	.158	.152	.107	.094	.813	1.230

Casewise Diagnostics[a]				
Case Number	Std. Residual	Bullwhip Effect	Predicted Value	Residual
12	-3.518	2.00	4.4765	-2.47654
111	-3.395	1.00	3.3902	-2.39023
116	-3.658	1.00	3.5755	-2.57549
193	-3.788	1.00	3.6669	-2.66687
222	-3.820	1.00	3.6895	-2.68948
224	-3.318	1.00	3.3355	-2.33555
272	-3.541	1.00	3.4932	-2.49315
322	-3.540	2.00	4.4921	-2.49214

Residuals Statistics[a]					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.0885	5.3055	4.4420	.37965	448
Std. Predicted Value	-3.565	2.275	.000	1.000	448
Standard Error of Predicted Value	.040	.195	.090	.028	448
Adjusted Predicted Value	3.1325	5.3139	4.4419	.37847	448
Residual	-2.68948	1.58605	.00000	.69845	448
Std. Residual	-3.820	2.253	.000	.992	448
Stud. Residual	-3.879	2.284	.000	1.005	448
Deleted Residual	-2.77299	1.63020	.00010	.71614	448
Stud. Deleted Residual	-3.943	2.295	-.001	1.010	448
Mahal. Distance	.451	33.125	6.984	5.185	448
Cook's Distance	.000	.098	.003	.010	448
Centered Leverage Value	.001	.074	.016	.012	448

a. Dependent Variable: Bullwhip Effect

The beta (β) value is a measure of how strongly each predictor variable influences the criterion variable as units measured by standard deviation. Thus, the higher the beta value the greater the impact of the predictor variable on the criterion variable. The standardised beta coefficients give a measure of the contribution of each variable to the model. The model emerged with seven positively significant predictor variables except the negative relationship between criterion variable and information velocity ($\beta = -0.220$, $p < 0.05$).

In terms of multicollinearity, the tolerance values aim to measure the correlation between the predictor variables and can vary between 0 and 1, while VIF is the reciprocal of tolerance in which a large value indicates a strong relationship between predictor variables. Since neither of the predictor variables has a variance inflation factor greater than ten (range between 1.096 and 1.230), there is no apparent multicollinearity problem. In other words, there is no variable in the model that is measuring the same relationship as is measured by group of variables with tolerance scores (0.813 and 0.920) more than 0.20 or 0.10 (O'Brien, 2007).

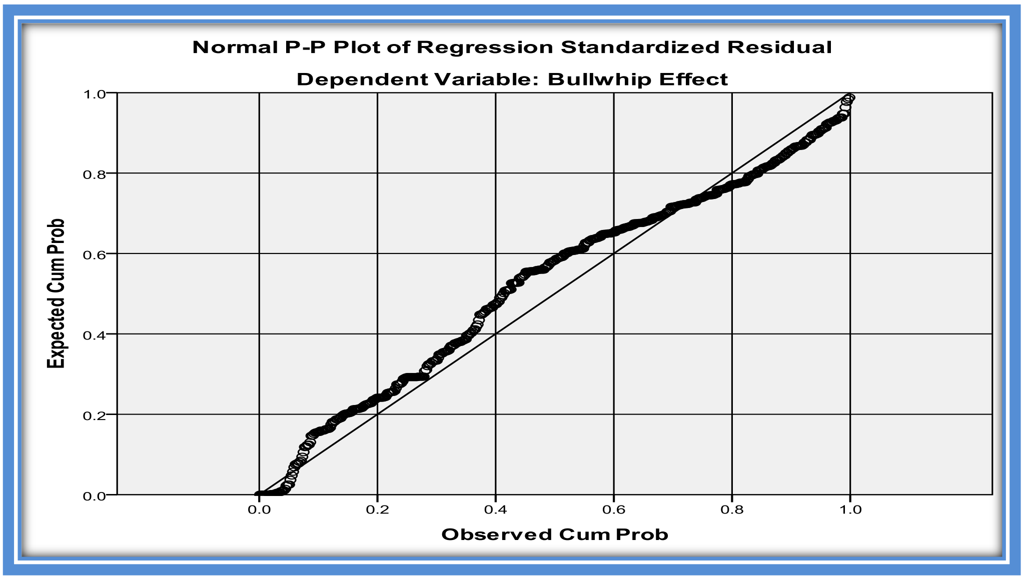
Statistics on Coefficients and Residuals

Cook's distance (D_i) captures the impact of an observation from two sources: the size of changes in the predicted values when the case is omitted (outlying studentised residuals), as well as the observation's distance from the other observations (leverage) (Hair, 1998:225). A rule of thumb is to identify observations with a Cook's distance of 1.0 or greater (Tabachnick and Fidell, 2007). Large values (usually greater than 1) indicate substantial influence by the case in affecting the estimated regression coefficients, and this study has maximum value (0.098) as measure of overall fit and suggests no problem. Leverage points are observations that are distinct from the remaining observations based on their independent variable values (Hair, 1998:185). Normally, their impact is noticeable in the estimated coefficients for one or more independent variables, and the common measure of a leverage point is the hat value. The hat value has the range of possible values between 0 and 1, and the average value is p/n, where p is the number of predictors (the number of coefficients plus one for the constant) and n is the sample size. If the p is greater than 10 (thirty for this study) and the sample size exceeds 50 (448 for this study), the rule of thumb is to select observations with a leverage value greater than twice the average ($2p/n$). This study has the threshold limits of $2p/n$ because the sample size exceeds 50 ($n = 448$) with maximum centred leverage value of 0.074. The degree of leverage is an important element in studying the effect of extreme values, wherein the diagonals of the hat matrix (h_i) are measures of leverage in the space of the independent variables. Mohalanobis distance (D^2) is the measure of the uniqueness of a single observation based on differences between the observation's values and the mean values for all other cases across all independent variables (this study reveals – minimum = 0.451 and maximum = 33.125, with mean = 6.984 and std deviation = 5.185).

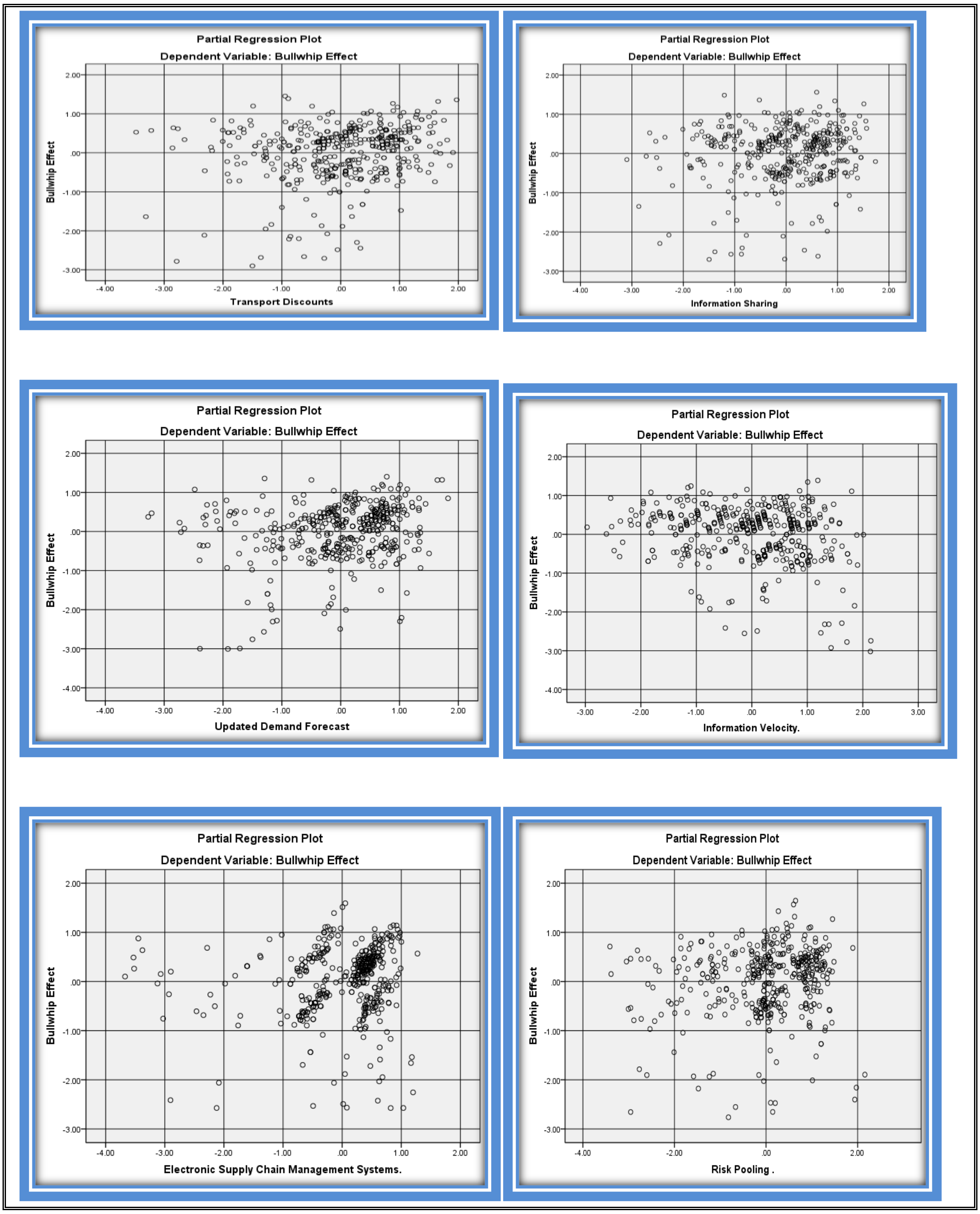
Studentised residuals are the actual residuals divided by their standard errors. In terms of values exceeding 2.5 in magnitude, these may be used to indicate outliers, and this study shows the maximum studentised residual value (2.284 less than 2.5). While standardised residuals rely on zero mean and unit standard deviation to determine the likeliness of obtaining a suspected outlier strictly by chance, residuals should reveal outliers regardless of the leverage of the observation (Freud and Wilson, 1998:125). Table 7.18 indicates the maximum standardised residual value of 2.253 with mean = 0.000 and standard deviation = 0.992. The standard error of predicted value has maximum of 0.195 as 'an estimate of the standard deviation' of the mean value of the dependent value (0.090) for cases that have the same values on the independent values.

Figure 7.24 shows a normal plot of the residuals with satisfactory points close to a diagonal line and the data is distributed uniformly. This plot suggests that the model 7 is reasonable and reliable for practical applications and it is possible to predict the phenomenon of bullwhip effect with various predictor values on model seven. Figures 7.25 indicate each of the studentised residual plots and each presentation shows acceptable random scatter of points with constant variability. According to Tabachnick and Fidell (2007:125) "the examination of residuals scatterplots provides a test of assumptions of normality, linearity and homoscadasticity between predicted dependent variables scores and errors of prediction". The assumptions of analysis are met and further screening of variables and cases is not necessary.

Figure 7.24: Normal probability plot on bullwhip effect



Figures 7.25: Studentised residual plots on bullwhip effect and predictor variables.



7.4.3 Logistic Regression Analysis

Logistic regression analysis is described as an approach that is similar to that of multiple linear regression, except that the dependent variable is taken into account as categorical. It allows one to predict a discrete outcome such as group membership from a set of variables that may be continuous, discrete, dichotomous or mix (Tabachnick and Fidell, 2007:437). According to Garson (2012) logistic regression applies maximum likelihood estimation (method used to calculate the logit coefficients) after transferring the dependent into a logit variable. A logit is the natural log of the odds of the dependent equality a certain value or not (usually 1 in binary logistic models). This means that the natural log of the odds of an event equal the natural log of the probability of the event occurring divided by the probability of the event not occurring:

$$\text{In [odds (event)] = In[prob(event/prob(nonevent)].}$$

In an equation: $z = b_0 + b_1x_1 + b_2x_2 +\ldots. b_kx_k$, where z is the log odds of the dependent variable = In[odds(event)] and z also known as logit or log odds; b_0 as constant; and b as logistic regression coefficients (or parameter estimates) with k independent (x) variables.

The objective of logistic regression analysis is to understand the strength of the relationship and likelihood of odds between the supply chain business performance targets on the proportion of consumer demand order variability outcome that is associated with set of categorised predictors.

This study uses the dichotomous (Yes or No) to find a relationship between the independent variables and a function of the probability of occurrence. The researcher aims to understand the strength of the relationship between outcome and the set of predictors in the chosen model, and further assess the proportion of variance in outcome that is associated with set of predictors. What proportion of the variability in business performance targets and customer services is accounted for by inventory positioning, inventory policy, in-house information technology, e-SCM system, information sharing and third-party information technology? In addition, logistic regression offers a new way of interpreting relationships by examining the relationships between a set of conditions and the probability of an event occurring (Garson, 2012). Multiple logistic regression output resembles that of a multiple linear regression analysis using ordinary least squares. The differences lie in the test statistic used to evaluate the significance of the coefficients. The maximum likelihood method uses the Wald Chi-square statistic rather than the t-distribution. The output also gives standardised estimates and the odds ratio.

The parameter β in equation determines the rate of increase or decrease of the curve: when $\beta > 0$, $\pi(x)$ increases as x increases; when $\beta < 0$, $\pi(x)$ decreases as x increases; and when $\beta = 0$, the curve flattens to a horizontal line (Tabachnick and Fidell, 2007). The magnitude of β determines how fast the curve increases or decreases. Logistic regressions predict likelihoods, measured by probabilities (ratio of the number of occurrences to the total number of probabilities – probabilities range from 0 to 1), log-odds, or odds (ratio of the number of occurrences to the number of non-occurrences – odds range from 0 to infinity) (Tabachnick and Fidell, 2007: 439). According to Hox (2002) maximum likelihood estimates are those parameter estimates that maximise the probability of finding the sample data that actually have been found. The model for logistic regression analysis (LRA) is a more realistic representation of the situation when an outcome variable is categorical. According to Agresti (2007: 28) the odds ratio as another measure of association for 2x2 contingency tables occurs as a parameter in the most important type of model for categorical data. It denotes that for a probability of success π, the odds of success are defined to be: odds = $\pi/(1-\pi)$ (for instance, if π (probability success) = 0.8, the probability of failure is 0.2 and the odds equal 0.8/0.2 = 4.0) while the success probability itself is the function of the odds: π = odds/(odds + 1). In terms of 2x2 tables, within row 1 the odds of success are $odds_{1} = \pi_1/(1-\pi_1)$, and within row 2 the odds of success equal $odds_{2} = \pi_2/(1-\pi_2)$. This translates to a new equation: $\theta = [odds_1/ odds_2] = [\pi_1/(1-\pi_1) / \pi_2/(1-\pi_2)]$. The test statistic uses the ratio of the maximised likelihoods:

-2log [(maximum likelihood when parameters satisfy H_0) / (maximum likelihood when parameter are unrestricted)]

When a null hypothesis is false, the ratio of maximised likelihoods tends to be far below 1, for which the logarithm is negative; then, -2 times the log ratio tends to be a large positive number, more so as the sample size increases.

Chi-squared distribution is concentrated over non-negative values. It has a mean equal to its degree of freedom (df), and its standard deviation equals $\sqrt{(2df)}$ (Agresti, 2007: 35). As the degree of freedom increases, the distribution concentrates around larger values and is more spread out. In other words, the distribution is skewed to the right, but it becomes more bell-shaped (normal) as the degree of freedom increases. The significance test for the final model chi-square (after the independent variables have been added) is the statistical evidence of the presence of a relationship between the business performance target as measuring yardstick for bullwhip effect and the combination of the major predictor variables (inventory positioning, information sharing, and e-SCM systems) and sub-dimensions of these major variables.

In this study, logistic regression tests models to predict categorical outcomes with categorical predictors or independent variables using the forced entry method or simultaneous entry as the default procedure. All predictor variables are tested in one block to examine their predictive ability, while controlling for the effects of other predictors in the model. This study demonstrates logistic regression with a dichotomous dependent variable (business performance targets). In terms of dependent variable, the respondents were asked whether demand order variability influences the business performance targets and customer service levels (Yes or No). The set of dichotomous predictors (independent variables) relate to mitigation factors that influence the performance level for the phenomenon of bullwhip effect. The set of categorical predictor variables anchored by 'yes' or 'no' includes optimal inventory positioning, coordinated inventory policy, integrated information sharing, e-SCM systems, third party IT system and in-house IT system. Each predictor variable is expected to provide indication of relative importance, and the adequacy of model by assessing 'goodness of fit'. It also allows the calculation of the sensitivity and the specificity model, and the positive and negative predictive values (Pallant, 2006: 163). On table 7.21, all predictor variables indicate higher frequency scoring values of 'yes' as an indication that the respondents concurred with the statements on improving business performance targets and customer service levels.

Green (1991) proposes a general rule of thumb for determining the minimum sample size to test the R^2 and significance tests on the regression coefficients. The author suggests that the minimum sample be greater that 50 + 8k for the former and greater than 104 + k for the latter, where k is equal to the number of independent variables. Therefore, the sample of 448 respondents exceeds the minimum requirements specified for applying regression models.

Table 7.19: Categorical Variables Codings

		Frequency	Parameter coding (1)
In-house IT	Yes	275	.000
	No	173	1.000
Inventory Policy.	Yes	321	.000
	No	127	1.000
Information sharing.	Yes	337	.000
	No	111	1.000
E-SCM systems	Yes	351	.000
	No	97	1.000
Third party IT system.	Yes	237	.000
	No	211	1.000
Inventory positioning	Yes	299	.000
	No	149	1.000

Table 7.20: Block 0: Beginning Block – Constant only

Iteration History[a,b,c]

Iteration		-2 Log likelihood	Coefficients Constant
Step 0	1	409.741	-1.330
	2	404.803	-1.582
	3	404.774	-1.604
	4	404.774	-1.604

a. Constant is included in the model.; b. Initial -2 Log Likelihood: 404.774; c. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table[a,b]

	Observed		Predicted: Business performance targets. Yes	No	Percentage Correct
Step 0	Business performance targets.	Yes	373	0	100.0
		No	75	0	.0
	Overall Percentage				83.3

a. Constant is included in the model.
b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.604	.127	160.676	1	.000	.201

Table 7.21: Block 1: Method = Enter – Full Model

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients: Constant	Inventory Position(1)	Inventory Policy(1)	Information Sharing(1)	E-SCM Systems(1)	Third Party IT(1)	In-House-IT(1)
Step 1	1	389.411	-1.794	.322	.331	.491	.297	.206	-.052
	2	378.669	-2.378	.531	.532	.727	.452	.334	-.126
	3	378.352	-2.499	.588	.582	.771	.487	.368	-.160
	4	378.351	-2.504	.591	.584	.772	.489	.369	-.162
	5	378.351	-2.504	.591	.584	.772	.489	.369	-.162

a. Method: Enter; b. Constant is included in the model.; c. Initial -2 Log Likelihood: 404.774; d. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	26.423	6	.000
	Block	26.423	6	.000
	Model	26.423	6	.000

Model Summary (Pseudo R-square)

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	378.351[a]	.057	.096

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	15.039	8	.058

Classification Table[a]

	Observed		Predicted: Business performance targets. Yes	No	Percentage Correct
Step 1	Business performance targets.	Yes	371	2	99.5
		No	69	6	8.0
	Overall Percentage				84.2

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	Inventory Position(1)	.591	.272	4.729	1	.030	1.806	1.060	3.076
	Inventory Policy(1)	.584	.276	4.470	1	.034	1.794	1.044	3.083
	Information Sharing(1)	.772	.283	7.456	1	.006	2.164	1.243	3.767
	E-SCM Systems(1)	.489	.300	2.655	1	.103	1.630	.906	2.933
	Third Party IT(1)	.369	.266	1.926	1	.165	1.447	.859	2.437
	In-House IT(1)	-.162	.280	.333	1	.564	.851	.491	1.473
	Constant	-2.504	.286	76.424	1	.000	.082		

a. Variable(s) entered on step 1: Inventory Position, Inventory Policy, Information Sharing, e-SCM Systems, Third Party IT, In-House IT.

Table 7.21 shows the set of results with highly significant $p < 0.05$ (0.000) and the chi-square value (26.423) with six degrees of freedom. The model has performed an overall indication on a ‘goodness of fit’ test over and above the Block 0 results without the predictors entered into the model. In adding new variables to the model, the -2 log likelihood (a measure of how well the model explains variations in the outcome of interest also known as deviance) has been reduced by 26.423 (chi-square value) with 6 degree of freedom. In the omnibus tests of model coefficients, the output shows that the researcher’s model is significantly better than the intercept only (Block 0) model.

According to Tabachnick and Fidell (2007:485) the chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model whereby, the reduced model is formed by omitting an effect from the final model, and hypothesised all parameters of that effect as 0.

The pseudo R-square statistics (table 7.21) suggest that between 5.7% and 9.6% of the variability is explained by the set of variables. According to Pallant (2006:167) Cox & Snell R Square and the Negelkerke R Square values (0.057 and 0.096 respectively) provide an indication of the amount of variation in the dependent variable explained by the model as from a minimum of 0 to a maximum of approximately 1. Nagelkerke R^2 attempts to quantify the proportion of explained variation in the logistic regression mode. The pseudo R square values provide information about the percentage of variance explained. The last category of test (Hosmer and Lemeshow test) is understood as the most reliable test of model fit with a different interpretation from category one (omnibus test). The Hosmer-Lemeshow's (H-L) goodness of fit test underpins the model at the chi-square value (15.039), degree of freedom (8) with a significance level of 0.058 larger than 0.05 and it implies that the model's estimates fit the data at an acceptable level.

Chan (2004:153) indicates that Hosmer-Lemeshow goodness of fit describes how closely the observed and predicted probabilities match at the expected p-value > 0.05. If the H-L goodness-of-fit test significance is higher than 0.05 (as indicated in this study, 0.058), the interpretation denotes that the researcher fails to reject the null hypothesis with manifestation of no difference between observed and model-predicted values. In other words, if the p-value is large, the model fits the data well, whereas a p-value that is smaller than alpha indicates a lack of fit. According to Hosmer and Lemeshow (2000) the well-fitting models show non-significance on the H-L goodness-of-fit test, indicating model prediction is not significantly different from observed values. The goodness of fit value measures the correspondence of the actual and predicted values of the dependent variable.

The classification section of table 7.21 is a 2x2 table which tallies correct and incorrect estimates for the full model with the independents as well as constants. The table provides an indication of how well the model is able to predict the correct category on business performance targets (yes / no) for each case through comparative analysis of Block 0 and Block 1. Initially, Block 0 (table 7.20) shows the percent of 83.3 model classification while the percentage accuracy in classification (PAC) has the binary logistic model improvement of 84.2% accuracy.

The sensitivity of the model as the percentage of the group that has the characteristic of interest has been correctly classified as 99.5% of respondents who found mitigation factors as positively influencing business performance targets except in-house IT with negative influence. In terms of specificity of the model, the percentage of the group without the characteristic interest shows 8% of respondents correctly predicting poor business performance targets from influential mitigation factors. In verifying the positive and negative predictive values, the percentages of cases that the model classifies as having and not having characteristic can be observed in this group. The positive predictive value is 84.3% (371 + 69 = 440 and 371 divided by 440 x 100 = 84.3%) while the negative predictive value is 75% (6 divided by (2 + 6) x 100 = 75%).

The section of table 7.21 (variables in the equation) indicates the important contribution of each predictor variables wherein the Wald test examines whether or not the independent variable is statistically significant in differentiating between two groups in each of the embedded binary logistic comparisons (Tabachnick and Fidell, 2007: 451). The Wald test ($\chi^2 = B^2/S.E.^2$) reveals the variables that contribute significantly to the predictive ability of the model with three significant variables for values less than 0.05 (inventory positioning, p = 0.030; inventory policy, p = 0.034; and information sharing, p = 0.006). Although e-SCM systems, third party IT and in-house IT did not contribute significantly to the model, the major mitigation factors that positively influence the business performance targets from the phenomenon of bullwhip effect are optimal inventory positioning, coordinated inventory policy among supply chain trading partners and integrated information sharing on advanced economic information.

The B values indicate a negative direction of relationship except the in-house IT independent variable score which had a positive direction. Logistic regression coefficients, in the column B in the variable in the Equation Section of table 7.20, perform the same function as regression coefficients in linear regression by indicating the direction and strength of the relationship between the independent and dependent variables. However, these logistic regression coefficients represent the influence of a one-unit change in the independent variable on the log-odds of the dependent variable. In terms of the directionality of the relationships, table 7.20 reveals positive relationships on inventory positioning (0.591), inventory policy (0.584), information sharing (0.772), and e-SCM systems (0.489), indicating that the more effective the mitigation factors are, the greater the likelihood of improving business performance targets on propensity to overcome bullwhip effect.

Positive B values suggest that a decrease in the independent variables scores will result in an increased probability of improved business performance targets. In other words, a positive sign for the logistic regression coefficient indicates that the variables are positively related to business performance targets whereas a negative sign indicates that as the variable increases, (the organisations are less likely to improve their business performance targets). In this study, the variables measuring the mitigation factors show a positive B values that the more improvement on business performance targets the less likely the business will experience the presence of bullwhip effect.

Tabachnick and Fidell (2007:462) describe odds ratios Exp (B) as "the increase (or decrease if the ratio is less than one) in odds of being in one outcome category when the value of the predictor increases by one unit". In the Exp (B) column variables in the equation, Garson (2012) states that odds ratios are effect size measures in logistic regression, with values above 1.0 reflecting positive effects and those below 1.0 reflecting negative effects. In this study, Exp(B) in the column (table 7.20) is an indicator of the change in odds resulting from a unit change in the indicator values greater than 1 indicated that as the predictor increases, the odds of the outcome occurring increase. Conversely, a value less than one indicates that as the predictor increases, the odds of this occurring decrease. This is consistent with the signs of the regression coefficients. The ratio of odds ratios greater than 1.0 is the ratio of relative importance of the independent variables which increase the odds associated with the dependent variable. Similarly, the ratio of odds ratios less than 1.0 is the same for negative effects in the measure of effect size. Although the values are having odds ratios greater than 1, the value with odd ratio less than 1 (0.851) is in-house IT from the ranges between 0.491 (lower limit) and 1.473 (upper limit) at 95 percent confident resulting in statistical insignificant at $p > 0.05$ (0.564). The value of Exp (B) is 0.851 (in-house IT) which implies for each unit increase in confidence in in-house IT the odds decreased by (0.851 – 1.0 = -0.149) 14.9% or 15%.

This study indicates that the odds ratios (OR) greater than 1 correspond to independent variables and increase the logit. Therefore, increase the odds of the event being predicted and odd ratio less than 1.0 correspond to a decrease in log odds of the dependent variables. This independent variable (in-house IT) does not affect the dependent variable with negative effect and no statistical significance. The odds of having the in-house IT department in these organisations are decreased by a factor of 0.851 if the organisations adopt e-SCM systems to mitigate bullwhip effect compared to the grand mean for all business performance targets.

The logistic regression solution under standard errors does not indicate multicollinearity with none of the independent variables in this analysis having a standard error larger than 2.0.

The logistic regression analysis indicates the estimated model or log-odds function from the categorical explanatory variable and eight predictor variables (log-odds create on equation very similar to the linear regression equation):

Logit Model = -2.504 + 0.591 (IP) + 0.584 (Policy) + 0.772 (IS) + 0.489 (ESCM) + 0.369 (3^{rd} PIT) - 0.162 IH IT)+ ε

These estimates report on the amount of increase (or decrease, if the sign of the coefficient is negative) in the predicted log-odds of Y = 1 would be predicted by a 1 unit increase (or decrease) in the predictor, holding all other predictors constant. The coefficients are not significantly different from 0 for the independent variables which are not significant, and the predictor variables should be taken into account when interpreting the coefficient.

Chapter Eight

Discussion of Results

8.1 Introduction

The discussion of the findings in this study is divided into four sections. Section one delineates the demographic and company profile, section two focuses on the descriptive statistics, section three examines the bivariate analysis by determining the statistical significance of associated relationships and differences between two variables, and section four investigates the interrelationships between variables and relationships and between dependent and independent variables. These sections constitute the empirical research component that was based on a judgmental and convenience sample techniques of 448 respondents. This study intended to capture pellucid insights into the phenomenon of bullwhip effect and the role of e-SCM systems in the FMCG industry. The primary objective of this study was to analyse the challenges of bullwhip effect and the role of e-SCM systems on the selected FMCG industry. The primary objective together with subsequent objectives, emanated from vignette proviso of the problem statement as the threshold to subjugate the structural framework of this study. The overall general statement of problems attempts to commingle the thematic rendition of this study to subdue any palpable mutilations that could have adulterated quintessential meaning and structure of this study. In terms of the foreground scenario of an ideal dysfunctional system in the problem statement, the bullwhip effect depicts the dynamics of accumulating order variability rate from the downstream site (normally retailers) that exceeds the tentatively stable actual demand rate as one communicates consumer demand orders to the upstream supply chain site (also known as capacitated suppliers).

The deleterious effect of this phenomenon can be ascribed to the lack of a holistic view of the supply chain processes as a cause for cascading consumer demand order variability upstream the supply chain network. Normally, supply chain partners experience the amplification in variability of orders at each stage in the supply chain with excessive swings upstream in different demand or inventory-stocking points throughout the supply chain network. The antithetical background scenario of the problem statement positively envisaged as an ideal problem-free system with optimal functionality through the role of e-SCM system, quasi-real-time information sharing and optimised inventory positioning to abate and subdue the malignant effect of bullwhip effect.

This means that the effect of electronically-enabled supply chain management systems remains the central hypothetical test and investigation for real-time information sharing and optimal inventory positioning. The e-SCM systems are envisaged to underpin the integrated supply chain processes (electronic linkage for supply- and demand-side partners) and the improved profitability through positive supply chain business performance targets and outcomes across supply chain trading partners. This problem statement was refined in the light of other extant research studies on the challenges of bullwhip effect and the effect of e-SCM systems.

In a nutshell, this particular study aims to analyse the challenges of bullwhip effect on the underlying systematic understanding of relationships with inventory positioning, information sharing, e-SCM systems and global optimisation strategies. These dimensions have served as mitigation mechanisms in managing bullwhip effect on selected FMCG industry. The literature review was structured around these constructs to identify theoretical framework that would serve as background to interpretation of the research results, while the empirical research component focused on how data could be solicited, processed, analysed and interpreted after determining appropriate research methods. This scientific research approach ensures a cogent, meaningful contribution to the body of knowledge by answering profound research questions. By the same token, the discussion of results on the underlying key findings had been circumscribed under the objectives and hypotheses of this study while the literature survey assisted in tentatively resolving certain questions posed under each research question. Initially, the researcher explicitly stated that the extant research studies had provided credible scientific findings and developed insightful literature abstracts as elucidation on key findings for this particular study. Although supply chain management is manifested as a latent and incipient discipline, the literature is credibly admissible to underpin and diametrical argue some findings in this study. The above mentioned sections (four) will be discussed from the underlying methods of univariate, bivariate and multivariate techniques within the parameters or perspective of the hypotheses and objectives of this study.

8.2 Demographic and Company profile

Section one of the survey instrument was designed to amass the demographic profile of the respondents and to measure the extent of the organisational environment in supply chain management which the respondents were experiencing. Twenty six percent of the respondents from the supply chain department validated the judgmental sampling technique with a fairly equitable statistical revelation of 42% (female) and 58% (male) representatives. The estimable value-added responses were indicated by 79% of experienced respondents with between four and 10 years experience in the same FMCG organisations.

Additionally, the insightful and substantial statistical disclosure confirmed that the overwhelming majority (65.2%) had between two and five years previous experience working in a similar industry. These majority percentages are tentatively congruent to the job status of the participants. The majority of respondents (79%) between first and middle level management were expected to overwhelm the percentages of the non-managerial level (12%) and top level management (13%). Sometimes it is difficult to entrust the non-managerial level responses with the conjectural lack of supply chain management sagacity and savvy, while the vertex level of the organisations seemingly present a challenge in terms of availability and time constraints. Although the lead suppliers/tiers, manufacturing and wholesale indicated 4%, 18% and 24% respectively on the upstream site, the retailing on the downstream site of the supply chain network depicted 47% of the respondents as a reflection of lower top level management participation. The individual retail store outlets had a limited presence of top level managers except a considerable middle level management.

This study is mainly focused on electronic information systems that the organisations can use to palliate the phenomenon of bullwhip effect. The respondents were asked to select among the options the quintessential electronic supply chain information systems that were currently being used and recommended systems to manage and control consumer demand order variability. In terms of e-SCM systems diffusion, EDI (25%) and Extranet (23%) are mostly used in the processes of supply chain management. The in-house systems (13%) are still used by the organisations although an urgent migration towards integrated e-SCM (13%) was recommended for better coordination in the supply chain network. The underpinning view (figure 7.8) indicated that the overwhelming majority (80%) of the respondents confirmed the frequent adoption and implementation of B2B information technology systems in their organisations of between two to four or more systems within the last five years. Vijayasarathy (2010:364) underpin the adoption of specific e-SCM technologies (EDI and POS systems) that these "supply chain technologies are making distinct difference in supply chain performance including buyer-supplier cooperation and collaboration, cost and cycle time reduction, better inventory control to manage variability and improved customer service, and overall supplier network performance". Interestingly, these research findings were initially emulated by Kim, Cavusgil and Calantone (2005:169-179) that the adoption B2BIT to support supply chain communication systems had a positive influence on both intra- and inter-organisational coordination, and that inter-organisational coordination has an effect on firm performance. These respondents (figure 7.12) also agreed that e-SCM systems (78%) are adjudged to promote and enhance supply chain communication performance to ameliorate bullwhip effect. Interestingly, a high percentage (61%) of the respondents indicated that their organisations currently have in-house information technology departments. Ngai *et al*., (2011:237) are convinced that the business value of supply chain IT competence is manifested in its contributions to supply chain responsiveness, connectivity and agility to enable a supply chain with a high degree of information visibility and optimal channel alignment in supply chain to coordinate inventory positioning.

This IT decision can sometimes be attributed to the lack of supply chain network trust and integration among trading supply chain partners. This study postulates that the integrated relationships on superior supply chain are built on mutual trust. It is important for any organisation to protect confidentiality and preserve trade secrets in the supply chain management network as organisations compete on supply chains in the new global paradigm. If the mutual agreement on common goals, mutual trust and compatible emulated cultures are underlying components for integrated superior supply chain and efficient supply chain performance (Heizer and Render, 2011:460), the competing supply chains should be supported by integrated e-SCM systems for effective communication and better coordination.

8.3 Descriptive Statistical Analysis

The findings of the descriptive statistical analysis indicated that a specific percentage of respondents felt that e-SCM systems (M = 4.56) were the most significant systems to create agility and high flexibility with rapid response to changing market requirements. The respondents highly ranked e-SCM systems and confirmed central point with median (4.57) and mode (4.00) closer to mean (4.45) as mechanism to integrate trading supply chain partners at technical, operational and business level. The main objective of this particular study focuses on the role of e-SCM systems to enhance the efficient real-time information sharing and active coordination of supply chain processes in managing bullwhip effect.

The organisations are jointly participating in updating the demand forecast across the stream sites of supply chains through a semantic viewpoint of highly-esteemed electronically-enabled supply chain management systems. Information sharing is an essential practice in supply chain management for forecasts, manufacturing schedules to achieve economies of scale; coordinate inventory replenishment frequencies to optimise deliveries and to produce operational and financial business benefits (Chengular-Smith, Duchessi and Gil-Garcia, 2012:60). The respondents were further asked whether information sharing achieves supply chain coordination and eventually mitigates consumer demand order variability. Information exchange (M = 4.00) was associated with high order fulfillment rate and the shorter order performance cycle time to enhance supply chain business performance targets in the FMCG industry. Contrary to the valuable business benefits on information sharing, the information volatility (M = 3.56) creates unstable demand and supply uncertainty in terms of information context, format and timing.

Nevertheless, the electronically-enabled supply chain management systems were preferably estimable in the context of real-time information exchange to optimise flexibility, strengthen future strategic communication (M = 3.88); and facilitate informal and formal information sharing (M = 3.92) in the dynamic market. These findings reflect the electronic supply chain competencies that relate to prompt decision and commitment to strategic supply chain flexible responses. According to Ngai, Chau and Chan (2011:235) cited in Shimizu and Hitt (2004), strategic flexibility is "the competence to identify changes in the environment, commit resources quickly to new courses of action in response to change, and recognise and act promptly when it is time to halt or reverse such response commitments". In the extent to which an organisation is effectively using electronic supply chain tools to manage information, the respondents agreed that quality information (M = 3.73) and the level of magnitude for information velocity (M = 3.70) enable organisations to produce dependable delivery. Thus, contribute positively to information integrity as enhancement of customer satisfaction and service level of supply chain performance cycle and product availability. However, the capabilities of supply chain functionality and information technology systems are being challenged by the magnitude of formation and linkage of supply chain network regarding inter- and intra-organisational processes.

In terms of virtual supply chain networks, the respondents further agreed that integrated e-SCM systems (M = 3.80) provided strategic flexibility to respond (M = 3.61) to emergency demand order changes in the attempts to minimise inventory stock outs (M = 3.68). The supply chain competence and degree of trustworthiness on the underlying integrated e-SCM systems subsequently galvanised the willingness to share sensitive and confidential information based on trust to access advance economic information. The afflation of mutually acceptable outcomes on established common goals and mutual dependency between collaborating supply chain partners optimises the inventory positioning (M = 3.65) with significant reduction in lead times. Despite a concerted effort to reduce total lead times in terms of material, information and delivery lead time delays, the respondents agreed that organisations tend to order large quantities to take advantage of transport discounts as either cascading demand variability or earning economies of scale. This particular study findings tentatively affirm that e-SCM systems, updated demand forecasts, information sharing, strategic communication, integrated e-SCM systems, inventory positioning and strategic flexible response are most important and statistical significant variables to palliate bullwhip effect.

The descriptive statistics (table 7.2) further examined the global optimisation strategies in an attempt to manage the phenomenon of bullwhip effect. Interestingly, risk pooling is the most significant global optimising and cost-effective strategy to abate the consumer demand order variability by aggregating demand across locations. The respondents confirmed that a central supply chain distribution system is suitable for the individual retail facility and enhances the integration of stock ordering, buying systems and store replenishment systems. The CPFR strategy seems to provide unlimited access to the retail store's replenishment system to manage demand order variability. However, it is most important to underpin the CscD system that focuses on directly involving suppliers in their initiatives to realise high levels of product availability, service levels and stock runs. In terms of supply chain order processes and suppliers involvement, the respondents felt that BTO supply chain system allows the creation of the greatest degree of order replenishment flexibility and responsiveness. The pull-based supply chain was entrusted to improve production leagility and distribution coordination with the consumer demand. The respondents also agreed that VMI allows real-time inventory level information wherein the manufacturer seems to control demand order replenishment over the entire supply chain to deal with bullwhip effect. Sometimes, the order replenishment decisions allow supplier managed inventory (SMI) system to shift responsibility for inventory planning from the manufacturer to the supplier with oriented paradigm on customer services and proximity to the downstream customers.

8.4 Inferential Statistical Analysis

Section three investigates the challenges of bullwhip effect on selected FMCG industry and attempts to understand the role of e-SCM systems, information sharing, inventory positioning and global optimisation strategies as mitigation factors. The contingency tables provided a wealth of information about the relationship between the variables while the chi-square statistic tests determined if the relationship was statistically significant. The Wilcoxon signed ranked test determined both direction and magnitude of difference between matched pairs of models. These bivariate tests were carried out using hypothetical statements and exploratory refined research questions to investigate the major research objective.

8.5 Objective One of this study: Bullwhip Effect

To analyse the challenges of bullwhip effect from the perspective of electronically-enabled supply chain management systems, information sharing and inventory positioning on selected FMCG industry.

A number of questions were developed to understand the challenges of bullwhip effect using appropriate research methods to find empirical answers.

Question One: Which echelon category prefers the electronic supply chain management systems as the mitigation tool for bullwhip effect?

The respondents were expected to characterise their organisational categories and eventually link the operational performance targets and outcomes after implementing e-SCM systems within their echelon categories. In the downstream site of the network, the retailers agreed that the e-SCM systems tentatively ameliorate the consumer demand order variability as the oscillation amplified upstream the supply chain. A greater percentage (60%) indicated that they strongly agreed that the e-SCM system has a significant role to manage and subdue the bullwhip effect. It is essential to infer that there is a statistical relationship between echelon categories of the supply chain stream sites and e-SCM systems.

Question Two: How do the managerial levels rank the negative factors that influence information sharing?

This study identified the critical factors from extant research findings and examined the positive and negative influence on information sharing in the organisational perspective. The managerial job status of the respondents was cross-tabulated against the negative factors in information sharing. There was a statistical significant association between the negative factors for information sharing travelling upstream the supply chain and the levels of managerial expert opinions. Although the first and middle levels of management indicated a combined 33.3%, an overall percentage (56%) regarded the length of supply chain channel network as an impeding factor towards sharing information among the supply chain trading partners. The additional supply chain partners beyond stream site three will pose a challenge to organised and coordinated business processes throughout information sharing value chain of multiple supply chain echelons. Figure 7.7 substantiated that the downstream site has fewer supply chain members (between one and two, 73%), while the upstream site has between two and three members (76%). If the length of supply chain network does not reflect the supply chain collaboration capabilities and optimal synchronisation, the respondents have hinted on the loss of power after disclosing advance economic information that can subsequently reach rival competitors.

Question Three: How do the managerial levels rank the positive factors that influence information sharing?

These positive factors in sharing information indicated a statistically significant relationship with the levels of management expert opinions. The respondents ranked the shared vision and frequent interaction between supply chain partners positively influence the information sharing. The element of trust among the supply chain partners had also been considered as critical factor to influence either emphatic or advanced economic information sharing. Vijayasarathy (2010:366) affirms that the level of trust in a supply chain partnership is indicative of how the member organisations perceive each other in terms of reliability and integrity to share quality information and their resolution to carry on a long-term partnership. The timely and accurate flow of data indicates necessity for successful supply chain operations with e-SCM technology facilitates the enhancement of real-time information exchange. If the top management expertise underpins supply chain capabilities, the top management role and vision should value and directly appropriate organisational response to market changes and supply chain flexibility.

Question Four: Do organisations constantly adopt collaboration models to position their inventory levels? The respondents of this study (75%) had confirmed a number of strategic collaboration models diffusion for the last five years around two to four or more models. Although there is statistical significant association between the channel alignment to coordinate inventory positioning and frequent diffusion of strategic collaboration model, the business process performance outcomes could not be attributed towards failure or successful implementation. However, the organisations that introduced one strategic collaboration model for the last five years has the lowest count on dichotomous rating between "yes" or "no" in terms of coordinated inventory positioning through channel alignment.

In collaboratively configured system of centralisation, each stage sees the actual customer demand with decentralised system in which demand information is not shared and each stage sees on the orders placed by its immediate downstream neighbour.

If L is the lead time, $\boldsymbol{i}$ number of period; and $\boldsymbol{\rho}$ as a correlation constant with $-1 < \boldsymbol{\rho} < 1$. In a centralised serial supply chain, the variance of the orders placed by stage $\boldsymbol{i}$**,** denoted $\mathbf{Q}_{\boldsymbol{i}}$**,** satisfies:

$$\frac{Var(Q_i)}{Var(D)} \geq 1 + \left(\frac{2(\sum_{i+1}^{k} L_i)}{p} + \frac{2(\sum_{i+1}^{k} L_i)^2}{p^2}\right)(1 - \rho^{p})$$

The bullwhip effect exists at reduced magnitude, if all supply chain members have visible demand information, using the same forecasting technique and same inventory policy in the centralised system.

In the decentralised serial supply chain with $\boldsymbol{\rho}$ = 0 (demands are uncorrelated across time) and $\mathbf{z}_{\alpha}$ = 0, the variance of the orders placed by stage $\boldsymbol{i}$**,** denoted $\mathbf{Q}_{i}$**,** satisfies:

$$\frac{Var(Q_i)}{Var(D)} \geq \prod_{i+1}^{k}\left(1 + \frac{2Li}{p} + \frac{2L^2 i}{p^2}\right)$$

Therefore, the increase in variability is addictive in the centralised system but multiplicative in the decentralised system (Snyder and Shen, 2011:273). Although the strategic collaboration of sharing demand information can significantly reduce the bullwhip effect in centralised system, decentralised system assumes $\boldsymbol{\rho} = \mathbf{z}_{\alpha} = \mathbf{0}$ with each stage only sees the orders placed by its downstream stage. In the world of technology-pulled innovations, the electronically-enabled supply chain management systems seem to indicate a provision of real-time information sharing capabilities.

Chengalur-Smith *et al*., (2012:58) suggest that information sharing is primarily the degree to which supply chain participants share supply chain information using integrated e-SCM systems to broaden information capabilities and underpin business functions and process performance outcomes. In leveraging the core competencies of partnering firms or supplier and information technologies under BTOSC" (Gunasekaran and Ngai, 2009:319-334), the system suggests the real-time information and flexible responsiveness among the supply chain partners that will position modular inventory at the early stage of the order processing.

8.6 Objective Two of this study: Factor Analysis and Bullwhip Effect.

To understand the discrete dimensions in the pattern of interrelationships among the bullwhip effect challenges together with mitigation strategies into reduced underlying sets of grouped dimensions.

The construct validity was evaluated using Cronbach's Alpha reliability test while the convergent validity of the instrument was assessed by examining the factor loadings. Cronbach's Alpha values range from 0.655 to 0.842, which implies reasonable reliability of the scales. This study has generated a number of larger variables into ten loaded factors with an overall value of Cronbach alpha (0.701). The purpose is to capture as much information as possible from the original data set using an interdependence tool. This omnibus alpha value reflects good internal consistency reliability in terms of the correlations amongst the ten factors and the adopted measurement scales.

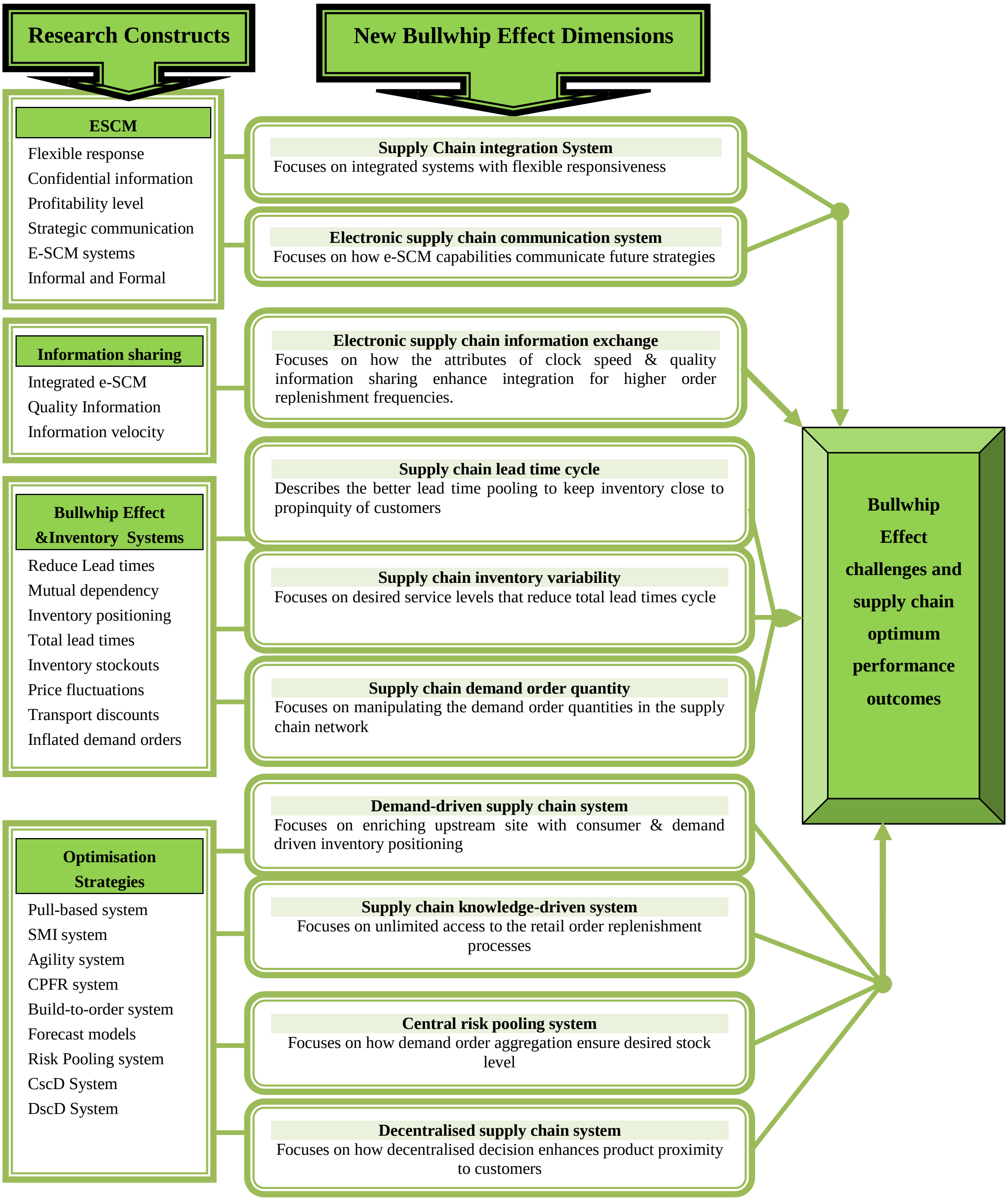
The underlying principle of factor analysis approach is to capsule information embodied in the original variables into a smaller set of underlying composite dimensions or factors with a minimum loss of information. This interdependence technique provided the basis for creating a new set of dimensions that incorporated the character and nature of the twenty seven original variables into new ten smaller composite dimensions. The statistical tests provided sufficient correlations to justify the application of factor analysis in the data matrix. Hair *et al.,* (1998:99) prescribe the critical statistical assumptions underlying factor analysis that the departures from normality, homoscedasticity, and linearity apply to the extent that diminish the observed correlations. It is essential for the interdependence performance that the data matrix has sufficient correlations.

The Bartlett test of Sphericity test indicated that correlations exist among the variables (measures of sampling adequacy of 0.832, chi-square of 3662.946, degree of freedom of 465 and significant value of 0.000). By the same token, the Kaiser-Meyer-Olkin (KMO) test provided the measure to quantify the degree of intercorrelations among the variables and the appropriateness of interdependence technique.

Exploratory factor analysis was applied to ensure the undimensionality of the scales. Both principal component analysis and varimax rotation in SPSS were chosen to identify the factors where the number of factors were not specified in advance. The variance explained by the combination of the ten dimensions is 61.735% while the "Supply chain information integration system" dimension explained the biggest part of the variance (variance = 21.071%). In an attempt to understand how much of the total variance of all variables is covered by the factor, all the ten factors have eigenvalues over 1.0 that bestowing more credibility to the factor analysis results.

This study managed to develop tacit ten constructs that can be transformed into explicit bullwhip effect challenges and optimal mitigation strategies. These dimensions reflect a new perspective in managing and controlling amplification in the consumer demand order variability (DoV) moving upstream supply chain network. This particular study achieved its objective tentatively by incisively developing bullwhip effect dimensions together with efficient optimal mitigation strategies towards ameliorating demand order variability on the selected FMCG industry. The conceptual patterns depicted relations between the extracted principal ten bullwhip effect dimensions using varimax rotation method and their respective sub-components. The following diagram (figure 8.2) illustrates the conceptual patterns of bullwhip effect challenges and supply chain optimisation business performance outcomes.

Figure 8.1: Conceptual patterns of bullwhip effect challenges and supply chain optimisation business performance outcomes.



Source: Compiled by the researcher from this empirical study

This study has developed conceptual patterns of ten key new bullwhip effect dimensions (figure 8.1) that are all related to either bullwhip effect challenges or supply chain optimisation business performance outcomes. The first dimension, **Supply chain integration system**, describes the magnitude of greater control and access to advance economic information over demand orders in the supply chain network. In sharing quality advanced economic information, Zhao *et al*., (2002); Lee and Kim (1999) and Jarrell (1998) concur that information sharing leads to high levels of supply chain integration and performance with dependable delivery and better customer service associated with higher order fulfillment rate and shorter order cycle time. Nevertheless, the system further improves willingness to share sensitive and confidential information based on trust among supply chain partners. The advanced economic information sharing induces a moderate effect on greater degree of flexibility and customer responsiveness for supply chain performance targets to entrench profitability level in the dynamic market. Although supply chain integrated network of reciprocal interdependence relationship can be developed to derive greater and mutual benefit (Choi, 2008; Chen and Paulraj, 2004; and Rinehart *et al*., 2004), the shared information asymmetries across and rational self-optimisation and opportunistic behaviours of supply chain partners impede the information sharing (Cachon *et al.*, 2009; Feldmann *et al.*, 2003). The disharmony of information exchange indicates the impact of bullwhip effect including the efficient production (production variability), exceeding suppliers (supply variability), unfavourable customer service (service variability), lead time variability and higher inventory costs.

The second dimension, **Demand-driven supply chain system**, focuses on enriching the upstream site with customer and demand-driven inventory positioning by inducing velocity and flexibility in the supply chain to ameliorate consumer demand order variability. The principle of agile supply chains in particular, allows the enrichment of customers through optimum processes and customer driven-demand from pull-based supply chain as orders move upstream on real-time information sharing systems (Cachon *et al*., 2009; Simchi-Levi *et al.,* 2008; Mason-Jones *et al*., 2000). The supplier managed inventory partnerships resemble VMI partnerships but the supplier takes responsibility for managing the supply chain inventory. In an integrated e-SCM system, the retailers transmit their point-of-sale data to the vendor's central hub of data to facilitate centralised control and management. The magnitude of collaboration between supply chain partners will allow supply chain coordination on production schedules, forecast demand and demand order replenishment frequencies to subdue the effect of bullwhip effect.

The third dimension, **Electronic supply chain information exchange**, focuses on how the attributes of clockspeed quality information sharing improve the integrated e-SCM systems for shorter order cycle times and higher order replenishment frequencies. Electronically-enabled information exchange systems improve the quality and velocity of information sharing on reciprocal interdependence and integrated coordination both across and within the firms. Chopra and Meindl (2007), and Chatfield *et al.*, (2004) suggest that information technology provides the tools to gather quality information and analyse real-time information to make optimal supply chain decisions. Although this factor is immensely underpinned by trust and shared vision between the supply chain partners, the industry type and the length of supply chain tend to impede the quality of information sharing and velocity of information flow.

The fourth dimension, **Supply chain lead time cycle**, describes the better lead time pooling in supply chain that combines the lead times from multiple inventory locations to keep inventory in propinquity to the customers. Cai and Du (2009) and Cachon *et al*., (2009) underpin that "lead time pooling and location pooling approaches create the centralised inventory location, and decrease the uncertainty with respect to the total demand in the supply chain network". Nevertheless, the congruence on goals and mutual dependency between supply chain partners consolidates distribution that enhances the optimal inventory positioning.

The fifth dimension, **Supply chain knowledge-driven system**, focuses on unlimited access to the retail store's order replenishment processes to improve forecast accuracy with supply chain integrated cross-enterprise model (purpose - overcoming discrepancies between the sales forecast and the actual demand to subdue bullwhip effect). The variables that constitute factor five focuses on the need for mass collaboration planning, accurate forecasting and strategic value chain within as 'short span of time to leverage the core competencies of partnering firms and information technologies'. Apparently, build-to-order supply chain relies on the supply chain integrated collaboration planning between upstream and downstream supply chain partners to "overcome discrepancy between the sales forecast and the actual demand" (Gunasekaran and Ngai, 2005; Chen *et al.*, 2003; Tyan *et al*., 2003). This build-to-order supply chain system "requires real-time information flow and responsiveness among partners" in order to achieve the whole system optimisation (Lyons *et al.*, 2004; Waller, 2004).

The sixth dimension, **Supply chain inventory variability**, focuses on how the desired service level in reducing the total lead time prevents stockouts and overcomes the effect of price adjustment mechanisms. Although the electronic point-of-sale data sharing system can reduce total lead times (Simchi-Levi *et al.,* 2008) by expediting purchase orders and communications, the manufacturing processes and schedules indicate difficult challenges to shorten lead times (Cachon *et al*., 2009). In this regard, the desired service level to purchase and hold a large quantity of inventory in the supply chain network is needed to prevent stock outs and to overcome the effect of price fluctuation during promotions.

The seventh dimension, **Central risk pooling system**, focuses on how demand order aggregation across locations ensures on-time delivery of customer orders at desired stock levels. In other words, the central supply chain distribution systems have the potential to allow manufacturers and suppliers to orchestrate their capacity planning and demand forecast within a central pooling location while the retailers try to ensure on-time delivery of customer orders at desirable stock level. Wanke and Saliby (2009) and Rojas (2007) consider consolidation efforts in terms of inventory centralisation, order splitting and transshipment as cornerstone tools to measure inventory costs, service levels and total costs. Risk pooling occurs because the centralised system takes advantage of the concave nature of safety stock requirements. According to Snyder and Shen (2011:146) the excess inventory at the low-demand distribution centre can be used to make up the shortfall at the high-demand distribution centre in the centralised system. If the distribution centres are consolidated into a single distribution centre that serves all of the demand as the total demand seen by this super-hub-distribution centre. Its mean ($\mu_C = \sum_{i=1}^{N} \mu_i$) and standard deviation

($\sigma_C = \sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij}}$) in centralised system show that the optimal base-stock level for the centralised system is $S_C^* = \mu_C + z_\propto \sigma_C$ with optimal expected cost

$E[C_C] = \eta\sigma_C = \eta\sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij}}$ where single distribution centre system formed by merging the distribution centres in centralised system,

$E[C_C] \leq E[C_D]$ (Snyder and Shen, 2011).

The eighth dimension, **Supply chain demand order quantity**, describes the conventional caused of bullwhip effect when the downstream supply chain inflates demand order quantities to take advantage of transport discounts. The customers tend to accumulate safety stock target with distorted demand signal, while Wisner *et al*., (2008) disquiet with suppliers that discern misconstrued demand resulting in 'unnecessary additions to production capacity, warehouse space and transport investments'. If the distorted demand order quantity for earning transport discounts does not freely allow order cancellations in a supply chain, the inflated orders and gaming behaviour strategies become major causes of bullwhip effect.

The ninth dimension, **Electronic supply chain communication system**, focuses on how e-SCM capabilities facilitate the communication of future strategic requirements in supply chain to enhance demand order replenishment frequencies. Presumably, the electronic system can enhance trust-based coordination structure, better communicate demand order replenishment requirements for consistent product availability and accelerate physical product and information flow capacity.

The tenth dimension, **Decentralised supply chain system**, focuses on how the supply chain's decentralised decision making enhances product proximity to the customer. A decentralised supply chain allows the manufacturer to have "better demand information because of proximity to consumers" (Simchi-Levi *et al*., 2008), although Cachon *et al.,* (2009) and Schroeder (2008) stress that self-interest and decentralised decision making do not lead to supply chain efficiency without integrated electronically-enabled supply chain management systems and profound reciprocal interdependence among echelon stream sites.

This particular study revealed that the pernicious effect of bullwhip effect can be managed and control with suggested dimensions. The empirical evidence in this study confirmed a number of bullwhip effect challenges and the critical role of e-SCM systems, information sharing, optimal inventory positioning and global optimisation strategies.

8.7 Objective Three of this study: Information Sharing

To examine the relative magnitude of advance economic information sharing in optimising the integrated supply chain activities in the consumer goods industry.

This objective used the multiple regression analysis to examine the relationship between information sharing (DV) and various potential predictors on the perspective of the phenomenon of bullwhip effect. Shil *et al*., (2012:72) provide challenges and distinct differences between information sharing as "the information need for supply chain efficient operation available at the right place and time to improve supply chain performance in a stable consumer demand". This information sharing indicates the challenges of bullwhip effect, multiple dyadic configurations and privacy or security across supply chains. In other distinctive type, knowledge sharing focuses on sharing tacit and explicit knowledge with a high value of information that may be useful in making decisions and prompting actions with challenges of constrained-based planning, trust and co-competition. Shil *et al*., (2012:72) further describe tacit knowledge as "extremely difficult to codify, transmit or convey with specific content and solves problems that are intractable, complex and variable. And explicit knowledge is discrete and digital, and may be easily transmitted via formal and systematic means". This study focused on the challenges of bullwhip effect with acknowledgement of both contextual information and knowledge sharing to find effective solution that promotes the efficient flow of information and using IT to streamline the supply chain information flow.

The Pearson correlation (figure 7.19) showed a significant degree of linear association between the variables. It is, therefore, acceptable to examine how much variance in the dependent variable (information sharing) is explained by each independent variable using stepwise procedure in multiple regression analysis. The final model emerged from the stepwise analysis with only two predictor variables ($R^2 = 0.169$, adjusted $R^2 = 0.165$, $F = 45.118$, $df = 2;45$, $p < 0.05$), and the relationship between criterion and predictor variables was explained by on 16.9% of the variance in information sharing. By the same token, the two dimensions as quality information ($\beta = 0.303$, $p < 0.05$) and integrated e-SCM system ($\beta = 0.173$, $p < 0.05$) were found to be considerably and statistically related with information sharing without any multicollinearity problem. The Durbin-Watson statistic value (1.840 within the consistent range of 1.5 and 2.5) produced acceptable value with no problems related to multicollinearity. In terms of residual statistics, Cook's D observations, leverage measures, and Mahalnobis distance indicated no outliers and the normal probability plot (figure 7.23) presented the normal plot of the residuals with points close to a diagonal line.

The empirical evidence in this study confirmed the moderate relationship between information sharing and predictor variables (quality information and integrated e-SCM system) in the perspective of managing bullwhip effect. In this study the quality information epitomises knowledge domain, real-time information and level of integrity on trust and commitment sometimes on constrained formal contracts, third party controlled central hub or informal willingness to share information. The quality information sharing with real-time updated content should lower levels of inventory investment and improves demand order replenishment frequencies with less information distortion. Flynn *et al*., (2010:58-71) provide clarity on the meaning of integration as "the unified central control (or ownership) of several successive or similar process formerly carried on independently, sometimes the process integration is governed by contract means". The integration of e-SCM systems either legally constrained (obligatory shared information) or proactively shared electronic information should produce real-time information content to obviate the amplification of consumer demand order variability. Underpinning supply chain integration on business performance, competitive advantage and supply chain management practices, Li *et al*., (2006); Van der Vaart and Van Donk (2008); and Flynn *et al*., (2010) provide empirical evidence on relative synergistic value creation under supply chain integration either optimal or electronic information sharing. Shil *et al*., (2012:79) recommend knowledge sharing to improve supply chain performance on respective extreme challenges rather than the researcher's challenge of bullwhip effect. Nevertheless, this study achieved its objective in identifying relative explanatory variables on information sharing.

8.8 Objective Four of this study: Electronically-enabled supply chain management systems

To assess the relative role of electronically-enabled supply chain management systems as consumer demand orders cascading upstream supply chain network in the FMCG industry.

The criterion variable (e-SCM systems) was negatively correlated to advance economic information, flexible response and profitability level with significance level greater than 0.05, while all possible predictor variables were positive to each other except confidential information and lead times. This means that the e-SCM system diffusion will dampen the willingness to share sensitive and confidential information based on trust among supply chain members. The element of trust is an underlying threshold of integrity to disclose sensitive and confidential information and avoid information reaching rival competitors.

Along the same lines, e-SCM systems adoption does not contribute to a significant reduction of lead times and speeding-up the time-to-market process in comparison to VMI and SMI, which directly execute the order replenishment frequencies. The retail stores normally use company representatives for physical monitoring and replenishing the stock on shelves. This category management approach seems to outwit the supply chain electronic communication with respect to inventory management.

Two predictor variables were entered into model 2 after stepwise procedure was executed. The variation in the e-SCM system (7.8% of coefficient of multiple determination) was explained by future strategic communication and advance economic information. Since the R^2 was not close to 1, there is moderate prediction of $F = 18.718$ and $p = 0.000$. The future strategic communication ($\beta = 0.288$, $p < 0.05$) and advance economic information ($\beta = 0.098$, $p < 0.038$) were found to be considerably related with e-SCM system diffusion with *t*-values indicating the importance of a variable in the model 2. There was no multicollinearity problem between independent variables, and the reasonably straight diagonal line (figure 7.24) had no major deviation from normality.

The empirical evidence of this study indicated the linear relationship between e-SCM system diffusion and the extent to communicate the organisation's future strategic requirements throughout the supply chain network. Communicating future strategic requirements and accessing advance economic information across the supply chain network normally depends on integrating an IT system with timely, efficient and transparent supply chain business information. The second predictor variable that should offer greater control and access to advance economic information over demand in the supply chain is negatively related to e-SCM system diffusion. Legally constrained or template-based information prohibits the level of access to advance economic information, despite the extent to which e-SCM systems are linked. Ngai *et al*., (2011:237) argue that integrated supply chain information systems enable different parties along the supply chain to access the operational information of other functions or departments.

8.9 Objective Five of this study: Inventory Positioning

To evaluate the relative optimal positioning of inventory systems and order process replenishment frequencies among the trading supply chain members.

The Pearson correlation matrix indicated an acceptable correlation between all possible pairs of variables and a significant positive correlation ($p < 0.05$) with a dependent measure (inventory positioning). There were no multicollinearity problems on items in the independent variables (tolerance value more than 0.10 and VIF below 10) and Cook's distance (0.027) under residuals less than 1. The leverage for this study revealed accepted hat elements that lie between 0 and 1, and the normal probability plot (figure 7.25) produced reasonably straight diagonal line with no major deviation from normality.

Only two predictor variables (transport discounts and total lead times) were entered into the prediction model 2 after a stepwise procedure was executed under multiple regression analysis. The coefficient of the multiple determination of variation (0.080) was very small, nevertheless the empirical evidence in this study indicated the existence of a linear relationship between the inventory positioning and two explanatory variables. This implies that the organisations tend to order large quantities to take advantage of transport discounts ($\beta = 0.0225$; $p < 0.05$) and it was found to be considerably related with inventory positioning to manage and control bullwhip effect. In the same moderate prediction with R^2 not close to 1; $F = 19.256$; $p = 0.000$, relative to inventory positioning, the organisations and supply chain members are constantly trying to reduce the total lead time in terms of material, information and delivery lead times and delays.

In this study, inventory position comprises on-hand stock (OH) plus planned receipts (OO as on-order) minus backorders (BO) wherein enough is ordered to bring that position up to the prescribed level to achieve supply chain product availability and required customer service level. Snyder and Shen (2011:35) distinguish between inventory level *(IL = OH - BO)* and inventory position *(IP = OH – BO + OO),* where inventory position (IP) is used to make ordering decision, and holding and backorder costs are assessed based on inventory level (IL).The magnitude of inventory positioning is influenced by transport discounts and replenishment lead times cycle. If the capacitated suppliers understood the behaviours of downstream and final consumer, the variability of the orders placed upstream in the supply chain will be lower than the variability of demand itself, known as Anti-Bullwhip effect. This study had relatively associated inventory positioning with supply and logistics variability, and lead time variability.

These variances without supply chain shared market demand order information involved the detrimental effects on production variability and distribution variability. If the impact of reducing total lead time and transport discounts on inventory quantities positioning are matched with acceptable frequencies of order replenishment, the pernicious effect of bullwhip effect can be managed.

8.10 Objective Six of this study: The phenomenon of Bullwhip Effect

To understand the relationship on the extent to which the phenomenon of bullwhip effect can be explained by e-SCM system diffusion, optimal inventory positioning, strategic information sharing and global optimisation strategies.

This analysis has incorporated the interval-level variable to analyse the relationship between the criterion variable of bullwhip effect and three major possible predictor variables (e-SCM system, inventory positioning and information sharing together with their subdimensions), as well as each explanatory variable from global optimisation strategies. The survey instrument used a Likert scale ranging from 1 as “strongly disagree”, 3 as “neutral” to 5 as “strongly agree” with section three (part one – bullwhip effect and inventory positioning and part two – information sharing) and section four (part one – e-SCM systems and part two – global optimisation strategies). These sections constituted the explanatory variables to explain the predictive power of relationship with the amplification of consumer demand order variability travelling upstream the supply chain network. The predictive model (model 7) of bullwhip effect was developed using the stepwise procedure from thirty possible explanatory variables. The validity of this model was assessed considering the correlation of coefficient and determination (adjusted R square = 0.0216; $F_{7,440}$ = 18.571; *p*-value = 0.000 less than 0.05) as the proportion of variance accounted for by the model. The *F*-ratio cited the significant of the model while the strength of the model accounted 22% (adjusted R^2 percentage) of the variance in the criterion variables. Durbin-Watson test disclosed a consistent value of 1.813 (ranging between the threshold of 1.5 and 2.5) indicating no problems related to multicollinearity while the *t*-values were appropriate with *t*-significance values less than 0.05 to validate the model and individual independent variables.

In terms of multiple regression assumptions, none of the assumptions were violated in the model with regard to outliers, normality (both normal plot of the residuals produced satisfactory points close to a diagonal line, and partial regression plot produced acceptable random scatter of points with constant variability) and linearity (no multicollinearity problems with VIF greater than 10 ranging between 1.096 and 1.230).

The respective statistics residuals (Mahalanobis distance, Cook's distance and leverage *h* hat) performed within their thresholds indicating no outliers.

The empirical evidence of this study produced seven explanatory variables (updated forecast demand, transport discounts, information velocity, information sharing, risk pooling , e-SCM systems and integrated e-SCM system) from the full model with R^2 (0.023), adjusted R^2 (0.22), *F*-ratio (18.571), *df* (1;140) and $p = 0.000$.

Accurate forecasting: This implies that linking the inventory positioning and order replenishment frequencies among supply chain members with accurate forecasting models reduce the pernicious effect of amplified consumer demand order variability. According to Trapero and Fildes (2012:739) forecasting accuracy is directly connected to inventory positioning and management, and lower errors result in reduced stock keeping and inventory investment without compromising the service level. This study infers that accurate forecasting models with integrated sales information from the retailer and information transparency in the supply chain enhance the degree of positioning inventory and frequencies of order replenishment rate to obviating order information distortion in the upstream site.

Transport discounts: In the elementary cause of bullwhip effect, organisations tend to order large quantities to take advantage of transport discounts. Inventory quantity decisions are impetus management of frequency and size of shipments from plants to the distribution centers (DCs) and to the retailers based on different replenishment policies. Poor integration between supply chain partners dampens the efforts of harmonising inventory cost and time-based delivery performance. The swift solution compels the supply chain members to take advantage of full load transport discount and consequently impacts the operational performance outcomes with large quantities of inventory. If the supply chain partners leverage their performance by reducing demand variability upstream, they can achieve optimal investment decision on inventory quantities rather than amplifying supply variability with transportation discounts.

Information velocity: It is puzzling to discover that information velocity does not improve information flow and does not tame order variability. If information sharing is dependent on integrated e-SCM systems, supply chain coordination data sharing and the effect of willingness would be constrained by clockspeed element to access information and degree of responsiveness to distorted information. This study tentatively suggests that the information volatility evokes a mismatch with a degree of information velocity and eventually languishes to subdue consumer demand order information distortion, also known as bullwhip effect.

Information sharing: Information sharing achieves supply chain coordination and mitigates consumer demand order variability. The level of supply chain coordination is associated with degree of uncertainty in the partnership relationship and collaborative processes from the underlying primary principle to proactively sharing supply chain demand order information. The sharing of supply chain information is normally template-based on a specified contract and described data format (Croson and Donohue, 2006) to entrench a sufficient level of coordination to share data (on consumer demand order forecasts and replenishment, sales and order status, and limited company bound information). Despite the dearth of willingness element on constrained information, the successful supply chain collaborative sharing and information under these compelling circumstances gradually builds coordination partnership, trust and commitment, and better communication. In mitigating bullwhip effect, Du *et al.*, (2012:89) provide empirical evidence that when partnerships become entrenched and coordinated, the willingness to share template-based information increases and consequently the willingness to proactively share advance economic information. This study provides empirical evidence that information sharing allows supply chain coordination-data exchange (CDE) to ameliorate the consumer demand order variability (DoV) form visible inventory level and order status.

Risk pooling: The empirical findings in this study predicted that risk pooling reduces the consumer demand order variability by aggregating demand across locations. The retail supply chain has an obligatory mandate to retail for continuously improving levels of customer service while concurrently reducing costs of inventory, distribution and transportation to maintain profit margins. As goods flow through several stages from tiers of suppliers to customers, a coordinated supply chain network should consolidate distribution locations to entrench risk pooling. Lee and Knon (2010:94) interpret a supply chain network as "the logistic network which consists of facilities, customers, products in the procedure of the planning, coordination, controlling inventory and distribution". In decelerating the pernicious effect of consumer demand variability, supply chain consolidated inventory from several locations (inventory pooling) takes advantage of the risk pooling on consumer demand orders to control variability. Eventually, this could reduce inventory costs, improve supply chain performance and enhance product availability. Underpinning the demand switching processes as inventory pooling, Hsieh (2011:137) captures the benefits of the risk pooling effect if one aggregate demand orders across product locations to reduce consumer demand order variability in the supply chain network.

E-SCM systems: This study predicted that e-SCM systems mitigate bullwhip effect in the supply chain network. Electronic systems in supply chains depicted an associative role to swiftly reflect amplified changing consumer demand orders in the supply chain network. The research results tentatively suggest that the supply chain partners can electronically integrate information flow, products and services effectively. Subsequently build business relationships that quickly and accurately respond to consumer demand variability. This study focused on both internal e-SCM diffusion among functional units within the organisation and external diffusion across inter-organisational supply chain trading partners. The literature review (chapter five) identified a number of positive and negative empirical permutations on e-SCM diffusion, however this study explores the role of e-SCM systems in retail supply chain to manage bullwhip effect. The central principle of an e-SCM diffusion is the creation of electronic flexible supply chain partnership network to facilitate a mutual decision making process across the retail supply chains partners. There are a number of challenges including partnership trust, technology compatibility, security of information flow and complexity of implementation, nonetheless this study empirically found e-SCM systems to be a key success factor in supply chain management processes to manage the phenomenon of bullwhip effect.

Integrated e-SCM systems: This explanatory variable predicted that integrated e-SCM systems improve information sharing. Sambamurthy *et al.,* (2005:237-263) support that supply chain aligned and integrated IT systems on business processes and IT activities enable supply chain agility across the supply chain network. These integrated IT processes built on underlying four strategic domains including business strategy, IT strategy, organisational infrastructure and processes, and IT infrastructure and processes (Du *et al.,* 2012). The magnitude of supply chain electronic integration and close linkage without legal constraints to hinder information velocity should be the reflection of successful information sharing and proper management of bullwhip effect. This particular study suggests improved information sharing from the underlying aligned and integrated e-SCM systems to alleviate the magnitude of bullwhip effect. Trapero and Fildes (2012:739) further propose that the electronically-enabled supply chain management techniques that permit the retailer's sales information be integrated into the supplier's planning process to alleviate supply chain demand variability amplification.

8.11 Objective Seven of this study: Supply chain performance targets and Bullwhip Effect

To establish the strength of the relationship and likelihood of odds between the supply chain business performance targets on the proportion of consumer demand order variability outcome that is associated with set of categorised predictors.

The logistic regression analysis earmarked to predict the supply chain business performance targets or benefits in the perspective of bullwhip effect from the set of categorical variables within the context of inventory positioning and information sharing. This regression method computed the logit coefficient for maximum likelihood estimation after transferring the dependent variable into a logit variable. The survey instrument (section two) was collapsed into two categories ("Yes" or "No") for the logistic regression analysis. Supply chain business performance outcomes and targets were used as a proxy for the probability to indicate mitigation yardstick for bullwhip effect. The proxy statement in this study was that demand order variability influences the business performance targets and customer service levels.

Chengalur-Smith *et al*., (2012:60) describe business performance targets (or benefits) as "the degree of operational (more efficient inventory planning policy – positioning and levels, frequencies of order replenishment and increased product and material resources availability), financial (reduced supply chain and inventory costs) and other advantages that companies realise through improved information sharing and supply chain integrated electronic business systems leveraging". This study aligned the meaning of supply chain business performance outcomes from this context particularly the operational perspective and the entire advantages, including information sharing, inventory management and e-SCM systems to examine the likelihood to control supply chain demand order variability oscillation. The supply chain business performance outcomes in this study are also associated with different competitive priorities in terms of targeting competitive price and cost efficiency (price volatility), optimum customisation and responsive flexibility (supply chain agility) for capturing the long-term behaviour of the organisation in FMCG industry.

The respondents were asked to mark on dichotomous questions ("Yes" or "No") how likely it would be that they would consider business performance targets to gauge the extent of managing and controlling bullwhip effect. These maximum likelihood methods intended to predict the proportion of variance in outcome that is associated with set of predictors. What proportion of the variability in business performance targets and customer services is accounted for by inventory position, inventory policy, in-house information technology, e-SCM system, information sharing and third-party information technology? All sets of predictor variables indicated higher frequency scoring values of "yes" against "no" from the sample of 448 respondents as an indication that the respondents concurred with the statements from categorical predictors

In the omnibus tests of model coefficients, the output depicted that the researcher's model is significantly better than the intercept (Block 0) model. The pseudo R-square statistics suggested that between 5.7% and 9.6% of the variability is explained by the set of variables. The Hosmer and Lemeshow test as most reliable test of model fit underpinned the model at the chi-square value (15.039), degree of freedom (8) with a significance level (0.058) larger than 0.05 at an acceptable level. The classification section (Block 1) indicated the slightly improved (84.2%) percentage accuracy in classification (PAC) compared to Block 0 (83.3), indicating how well the model (Block 1) had enabled to predict the correct category of business performance targets and customer services for each case. The sensitivity of the model had correctly classified 99.5% of respondents that found mitigation factors as positively influencing business performance targets, with the exception of in-house IT with a negative effect. In terms of specificity of the model, the percentage of the group without the characteristic interest showed 8% of the respondents. Nevertheless, the Wald-test revealed the variables that contributed significantly to the predictive ability of the model with three significant variables for values less than 0.05 (inventory positioning, $p = 0.030$; inventory policy, $p = 0.034$; information sharing, $p = 0.006$).

The positive B values (inventory positioning = 0.590; inventory policy = 0.584; information sharing = 0.772; e-SCM systems = 0.489) with an inverse approach suggested that a decrease in the independent value scores had resulted in an increased probability on improved business performance targets. In this study, the variables measuring predictive ability depicted the positive B values with an indication that the more improvement on business performance targets and outcomes the less likely the business will experience the pernicious presence of bullwhip effect.

In terms of effect size measures of odds ratios Exp (B) in logistic regression, the study indicated odds ratios greater than 1 corresponding to independent variables to increase the logit on the six predictor variables developed the following equation:

Logit Model = -2.504 + 0.591 (IP) + 0.584 (Policy) + 0.772 (IS) + 0.489 (e-SCM) + 0.369 (3rd PIT) - 0.162 IH IT) + Ɛ

Although log-odds equation included six prediction variables, three variables (inventory positioning, inventory policy and information sharing) contributed significantly to the predictive ability of the model with greater likelihood to improve business performance outcomes and customer services in the propensity to overcome bullwhip effect.

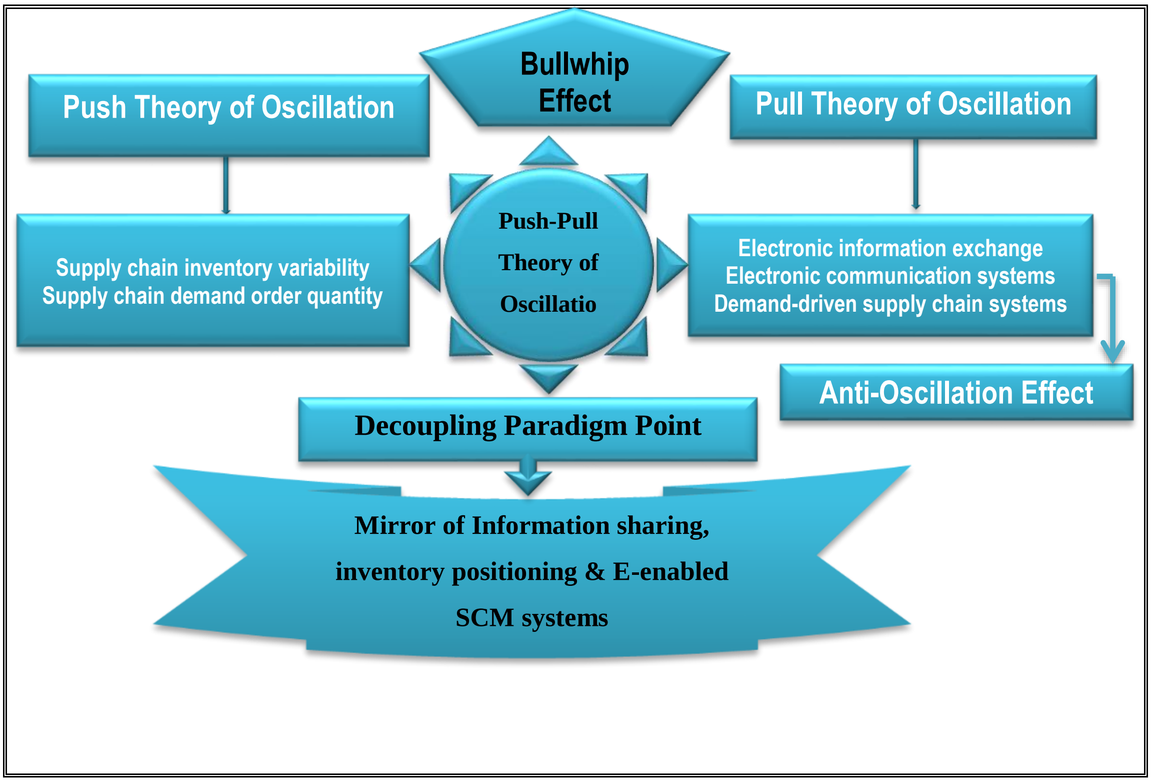
If the channel alignment in supply chain assists to coordinate inventory positioning, the supply chain business performance and customer service levels should indicate improvement as reciprocal approach towards managing demand variability. Vijayasarathy (2010:369) confirms that the quality of the supply chain channel relationship is an important determinant of supply chain business performance. In determining the business performance outcomes on the overall supply chain, the strength of channel alignment should manifest the key antecedents to successful relationships such as trust, commitment and integrity on ethical principles to tame any impetus for amplified consumer demand order variability upstream. The quality of channel alignment to sustain supply chain performance is expected to exist for long-term period on underlying reliability and integrity pillars.

If the inventory control policy at retail level is likely to propagate consumer demand variability towards the upstream sites, the odds of supply chain performance achievements are required to tame the bullwhip effect. In the supply chain operations, the timely and accurate flow of data can be necessary for successful policing inventory at retail level. The supply chain technology adoption in a more competitively stable environment is expected to benefit supply chain partners on inventory control policies throughout the supply chain network. Hong and Kim (2002:25-40) consider a leveraging approach that integrating inventory policy processes and information system output across the supply chain would improve supply chain performance. If the information sharing relates to supply chain performance targets in FMCG industry, there is probability of overcoming the bullwhip effect. Fawlett *et al*., (2008:385-368) suggest that while information sharing capability positively influenced operational performance, the impact was stronger for those businesses which reported higher levels of both connectivity and willingness to share information. It is therefore, essential to align information sharing with a degree of connectivity promotion among supply chain partners.
This process should be coupled by a strong commitment to exchange quality information to realise better supply chain business performance as management tool to ameliorate bullwhip effect. Du *et al*., (2012:89) further stress that willingness to share reflects the quality of the information shared including its timeliness, accuracy, adequacy, completeness and reliability to avoid demand order information distortion.

8.12 E-SCM systems and push-pull theory of oscillation

The key dimension of bullwhip effect focuses on how e-SCM capabilities facilitate the communication of future strategic requirements in a supply chain to enhance demand order replenishment frequencies. The electronic system can enhance a trust-based coordination structure, better communicate demand order replenishment requirements for consistent product availability and accelerate physical product and information flow capacity.

Figure 8.2: Push-pull theory of oscillation



Source: Developed by the researcher for the empirical study

In the push theory of oscillation, there is an amplification of DoV from the custodians of information (downstream retailers) that generate orders with distorted demand information moving upstream. In the pull theory of oscillation, the amplification of DoV is based on reactions (which all ultimately respond directly to genuine customer demand – as Anti-Oscillation Effect) from integrated e-SCM systems and synchronised processes of decision-making responsibility across extended enterprises. The study reveals that the surfaces of bullwhip effect and maximum oscillations of inventories can emerge as the push theory of oscillation as the weight given to the history of the demand and the importance of the last incoming order. This means that the bullwhip and the maximum oscillation surfaces have a similar characteristic shape for all demand (supply chain inventory variability and demand order quantity). The push theory of oscillation is therefore, described as the oscillating DoV that originates and germinates from the operational downstream-site of demand information distortion and disintegrated order replenishment policies within supply chain networks. It is also driven by multiple causes of the bullwhip effect such as total lead times, inventory stockouts, price fluctuations, transport discounts and inflated demand orders. Contrarly, the pull theory of oscillation describes the oscillating DoV controlled and customer-to-customer driven by the innovative exploitation of integrated electronically-enabled supply chain systems, quality knowledge and information sharing, and information velocity on downstream diagnosed customer demand and upstream engineered market changes. The alleviation of DoV seems to be achievable through electronically-enabled supply chain central hubs for better integrated strategic communication using informal and formal information. This pull-based, innovative theory focuses on enriching upstream site with quasi-real-time consumer- and demand-driven inventory positioning by inducing agility within the supply chain networks. In other words, customer satisfaction is enhanced through the optimisation process and customer driven-demand from the pull-based supply chain (Simchi-Levi *et al*., 2008; Danese *et al.*, 2013), an understanding of demand variation, order oscillations and demand uncertainty (Jacobs *et al*., (2008), and the behaviour of supply chain partners as orders move upstream, and information sharing systems (Cachon *et al*., 2009; Ciancimino *et al.*, 2012

The decoupling point also acts as a strategic point for buffer stock, and its position changes depending on the variability in demand and product mix (Mason-Jones *et al*., 2000). An increase in product mix and fluctuating volume would force the decoupling point to move upstream, making the supply chain system more agile to ameliorate the magnified oscillations upstream. In this study, the decoupling paradigm point assists in ameliorating order vacillation through central consolidation and a risk pooling system. The mirror of the three dimensions of information sharing, visible inventory positions and electronically-enabled supply chain systems is utilised as the viably regionalised central hubs. The decoupling point epitomises customer-driven orders on the upstream site using positive interventions to alleviate the impact of the bullwhip effect in the FMCG industry. Customers are becoming more and more aggressive in demanding new products and services within a short period of time clockspeed. The hybrid strategy (push-pull theory) should facilitate proper understanding of the underlying causes of oscillation (the push theory of oscillation) and managing oscillation through the mirror dimensions (the pull theory of oscillation) to tame and manage consumer DoV in the supply chain. This dichotomy of oscillated demand order-push and demand order-pull has brought the juxtaposition of these two approaches to the magnitude of consumer DoV from the characteristics of supply chain networks. The demand order-pull approach requires the identification of a broader set of supply chain market features. These features include the characteristics of the end markets and the whole supply chain network economy that affects the performance of supply chain frequencies to demand order replenishment rate (Stefano *et al*., 2012:1283).

If the e-SCM systems promote and enhance the communication strategies, there is likelihood to persuade common supply chain business performance targets to mitigate bullwhip effect. Kim, Cavusgil and Calantone (2005:169-178) underpin the likelihood that the adoption of IT to support supply chain communication systems has a positive influence on both intra- and inter-organisational coordination, and internal coordination has an effect on business performance. Although Vijayasarathy (2010:369) argue that the influence of technology usage in the supply chain on performance is moderated by the environment, the quality of the channel relationship and the implementation of process innovation. Nevertheless, the well-developed supply chain communication technologies enhance decision making and seamlessly electronic and speeding up information sharing to improve supply chain business performance.

Chapter Nine

Recommendations and Conclusions

This study sought to understand the challenges of bullwhip effect and empirically examined the effects of e-SCM systems diffusion, orientated supply chain information sharing, optimised position of inventory and global optimisation strategies to ameliorate the phenomenon of bullwhip effect in the FMCG industry. This study engaged in these selected strategic dimensions from the extent to which the critical extant research attributed element of converging and practical problem-solving areas.

9.1 Objectivity and Statement of problem

The statement of problem articulated the challenges of bullwhip in the retail supply chain as the dearth of holistic view in the supply chain management processes with cascading demand order variability upstream. The excessive swings and amplification of supply chain demands indicated a propensity to be wider upstream in the supply chain as a roguish effect on likelihood of odds for supply chain business performance targets in the multiple echelon stages of supply chain network. The literature review undertook an analysis of extant research findings on challenges of bullwhip effect that partially answered certain research questions aligned to bullwhip effect, inventory positioning, information sharing and e-SCM systems. Nevertheless, this study focused mainly on the effect of e-SCM systems diffusion as a central principle for managing bullwhip effect and contextually associated the study with other dimensions including information sharing, inventory positioning and global optimisation strategies. The research objectives (seven objectives) presented the purposes of this study towards palliating the problems of cascading consumer demand order variability. The research questions appropriated the research methodology options in an attempt to answer the research questions. Hypothetically and otherwise, a number of empirical research findings indicated distinct inferences, predictions and likelihoods of odds that empirically contributing to practical solutions in FMCG industry. This study will shed light in this industry although it was constrained within the province of KwaZulu Natal.

The participants of this study were predominantly (58%) from supply chain departments (operations, purchasing and logistics) were well-experienced within FMCG organisations (79%), and an overwhelming majority (65.2%) had between two or beyond five years previous experience in the FMCG industry. The participants validated knowledge creation, organisation and sharing as high value forms of solving intractable and complex problems that may be useful in decision-making processes.

Shih *et al*., (2012:71) add that tacit and explicit knowledge sharing contributes more to efficient and effective decision-making that involve proactive knowledge management. Although the first level and middle level managements displayed amazing insight and ingenuous responses (79%) in this study, the FMCG organisations depend on these levels due to their proximity to the consumers. The frequent interaction between supply chain partners was highly ranked as the positive factor for sharing information to decelerate the bullwhip effect. In sharing information among the supply chain partners, the participants agreed (92%) that the challenges of bullwhip effect on selected FMCG industry require e-SCM systems diffusion for efficient real-time information sharing to enhance supply chain business performance outcomes. This study discovered few differences in the extent to which the impact of other strategies influences the phenomenon of bullwhip effect, however the next segments discuss the literature which supported the empirical research findings in this study and recommendations.

9.2 Electronically-enabled supply chain systems Perspective

In the fast moving consumer retail downstream site of supply chain networks, the underlying appeal depends on product availability on a broad selection of goods underpinned by frequencies of order replenishment which are, normally not susceptible to demand order variability to efficiently maximise customer service. Hugo *et al.,* (2008:275) support information distortion immunity that the comprehensive pattern of frequent replenishment fill rates enable an integrated supply chain to reliably deliver and sustain the cost-effective availability of a wide product range in different stores across broad geographic locations. While the upstream site in FMCG industry expects an acceptable degree of intelligent supply chain cooperation and coordination that enhance visibility of point-of-sales data, contribute to updated demand and supply forecasts for better capacity planning and schedules as well as earning economies of scale. These downstream and upstream sites of supply chain networks operate on the reality of the lower margins through a high volume throughput and higher overall volume of sales with cumulative profit on generally large quantities of sales. Eventually, the lapse in integrity spurs amplification of demand order rate to exceed the actual demand order rates as the manufacturer creates an ordering policy for each item. Under these circumstances, the supply chain trading partners are expected to leverage upstream and downstream relationships to create fundamental supply chain performance outcomes while integrating the resources and capabilities of supply chain members.

The interconnectivity nature of modern supply chains is embedded in highly desirable electronically-enabled supply chain management systems. These seamless linkages between supply chain partners seem to entrench velocity on real-time information flow in consumer demand and supply sides, inventory status and availability, and capacity availability. Li *et al*., (2009), and Darwish and Odah (2010) support that supply chain management technology has an ability to achieve accurate forecasts by communicating real-time data (accurate point-of-sales data) and increase in inventory visibility (access updated current retail, distribution centres and supplier inventory status) in which the costs of transacting will be reduced amongst the trading supply chain partners. Chapter five (e-SCM systems) in this study provided the insights into e-SCM systems diffusion as the important electronic intra-and inter-organisational systems that enhance communication, coordination and collaboration between supply chain partners, and underlying variety of IT systems in supply chain management (EDI, RFID, ERP, SCA, SAP with SCM and ERP). The e-SCM diffusion was generally recommended for both internal adoption among functional units within an organisation and external adoption across a large number of inter-organisational supply chain trading partners. This process of diffusion was arguably creating trust and close relationships in the multiple echelon demands, although the underlying element of electronic communication seemingly underpins supply chain information sharing under the restricted technology portals.

The literature further highlighted perceived e-SCM benefits from empirical research findings with specific electronic supply chain design (infrastructural channel structures, integrated planning and control, information orientation, synchronised information architectures and align core capabilities of available channel partners). E-SCM diffusion was hypothetically presented in the problem statement as the fundamental tool to relatively examine the challenges of bullwhip effect, and the empirical investigation was mainly confined to e-SCM adoption to mitigate the phenomenon of bullwhip effect. Camarinha-Matos and Afsarmanesh (2002:439) define integration as the process through which individuals of a lower order get together to form individuals of a higher order and also, to integrate is to make it a whole, to compete. Although supply chain collaboration and integration were used interchangeably as ‘tight coupling process between supply chain partners’ (Cao and Zhang, 2011), ‘integration means the unified control (or ownership) of several successive or similar process formerly carried on independently’ (Flynn *et al*., 2010).

The integrated systems in the context of central control and 'process integration governed by contract means' was interpreted in the literature as a complex process facing a number of obstacles such as 1) heterogeneity (dimension, scope, abstraction levels and supporting technologies); 2) autonomy (legal systems without global optimisation and contract means); and 3) continuous and rapid technology evolution and multi-disciplinary.

The element of dependence within the contract means would compel the migration from in-house IT systems to central hub or integrated e-SCM systems to exhort close integration on information exchange and processes across different parts of the organisation. Yeh (2005) further argued on two fundamental factors regarding continuity of cooperative integrated electronic supply chain relationship, firstly, positively related to resource dependence, trust and commitment; secondly, negatively related to risk perception. In this study, a number of literature studies hinted that supply chain collaboration is more attractive with "an emphasis on governance through relational means in addition to contract means". Nyaga *et al*., (2010) added that "it could capture the joint emphatic relationship between autonomous supply chain partners on the set of interconnecting dimensions such as information sharing, goal congruence, decision synchronisation, incentive alignment, resource sharing, collaborative communication and joint knowledge creation". Cao and Zhang (2011:174) confirm that "jointly creating common pace of information sharing, downstream frequencies of order replenishment and upstream supply synchronisation in a supply chain can reduce excess inventory with optimal product availability".

9.2.1 Empirical analysis on e-SCM systems diffusion

This study found the fascinating empirical research evidence on e-SCM systems that retail supply chain businesses have fastidiously adapted to technology clockspeed for the last five years. The number of business-to-business information technology (B2BIT) systems for the last five years indicated 52% between three to four or more implemented IT with 28% of organisations introducing two IT systems. A sufficient percentage of respondents (53%) underpinned this technology adaptability using their third-party IT system from industry experts, although 61% of organisations currently have an in-house information technology department either facilitating or carrying out the recquired supply chain technology solution. The majority of the respondents (92%) in both upstream and downstream echelon categories agreed that e-SCM systems have a significant role to play in mitigating the consumer demand order variability in the supply chain network.

This study further discovered that the migration from in-house IT systems to integrated e-SCM systems (65%) would entrench close integration of information exchange and processes across different parts of the organisation and inter-organisational linkage. The e-SCM systems diffusion was highly ranked among the meticulously considered variables to palliate the challenges of bullwhip effect. Furthermore, the mean dimensions of the strategic collaboration models did not match the supply chain performance of the mean dimensions of B2BIT systems in controlling the demand order variability. The mean vectors of e-SCM systems outwitted the mean vectors of information sharing capabilities by providing efficient real-time information exchange, and active communication and coordination to control bullwhip effect.

In terms of new dimensions from factor interpretation, these findings are underpinned by grouping essential interrelated variables (strategic communication, e-SCM systems, and informal and formal information sharing) together. “Electronic supply chain communication system” describes the supply chain electronic system that enhances trust-based coordination structure, better communication of demand order replenishment requirements for consistent product availability and accelerates physical product and information flow capacity. The e-SCM systems diffusion also depicted positive linear relationship to the extent to which the organisations efficiently and timely communicate the future strategic needs and demand order replenishments throughout the entire supply chain network. The access to advance economic information negatively related to e-SCM systems with the virtue of legal constraints and template-based information attachments. In a broader empirical perspective, e-SCM systems diffusion depicted key positive associations with the challenges of bullwhip effect and the likelihood of persuading mutual common supply chain business performance targets to deal with pernicious effect of cascading demand order variability in the FMCG industry.

In a nutshell, the adoption of e-SCM systems has a positive influence and association with bullwhip effect by effectively communicating and actively coordinating the real-time information exchange. Although the likelihood of odds underpinned the successful supply chain business performance outcomes, the legal constraints and template-based information presented intractable access to advance economic information due to sometimes the elements of partnership trust, security of information flow and complexity of implementation. The in-house IT department (61%) might have a roguish effect on the compatibility of technology solutions and eventually contribute towards instituting information flow security constraints and debilitating the level of trust.

9.3 Inventory Systems Perspective

The inventory policies are predominantly propulsive to control inventory investment, positioning and overall management in the FMCG industry. The inventory policy decisions have impetus formation from the desire to optimise inventory replenishment frequencies, epitomise the supply chain inventory technology diffusion and leverage inventory risk pooling from inventory capabilities of supply chain trading partners. Cachon and Terwiesch (2009) state that supply chain inventory tactics are maximising inventory flexibility and positioning by designing products specifically to support potential risk pooling and postponement. Other authors contend that the upstream site viciously endures an increase in raw material or work-in-process inventory from risk pooling and postponement, especially on the principle of BOSC system, while the downstream site relish benefits of more centralised supply chains (distribution or consolidation) and shorter consumer lead times with lower total delivery costs and better product availability (Frahn, 2003; Gerchak and He, 2003; Jacobs and Chase, 2008; Bowersox *et al*., 2010). The migration to centralised supply chain distribution system is expected to engender harmony in abating excess inventory from the upstream and grant onus to retail distribution centres to optimise inventory positioning.

This study is not necessarily analysing the incessant influx of inventory policies but it analyses the best inventory management practices that could contribute towards supporting frequencies of order replenishment, optimising inventory positioning and achieving product availability. The selected inventory systems were considered within the thematic framework and objectivity of the study in an attempt to manage the phenomenon of bullwhip effect. The build-to-order supply chain management (BOSC) system provided a substantial contribution to the underlying competitive inventory performance objectives on incisive inventory systems. Gunasekaran and Ngai (2005:425) define the system as "a value chain that focused on requirements of individual or group of customers within a short span of time by leveraging the core competencies of supply chain partnering suppliers and information technologies to integrate such a value chain". The integrated value chain captures the joint central controlled and contractually governed process of relationship between autonomous supply chain partners in the set of interconnectivity domain for joint mitigation of amplified order variability. Waller (2004) asserts that the knowledge-driven (BOSC) system requires real-time information flow and responsiveness among supply chain partners in order to achieve the coordinated system optimisation for better positioned inventory under the challenges of order oscillation.

The prognosis of these supply chain partners focuses on supply chain network development from their respective core competencies and electronic communication systems to reach the market without procrastination with right products. This propulsive network formation of relationship between the number of warehouses, inventory and customer services is described by Wisner *et al*., (2008) as risk pooling. The underlying principles of these systems are that as the number of customers served by central supply chain warehouse/system increases, the demands variability offsets each other more often, thus reducing overall demand variance and the likelihood of stockouts. The systematic design of risk pooling epitomises "demand aggregation across locations or times in order to subdue the availability measured by either the standard deviation or the coefficient of variation". This study recognised the contributions of central supply chain inventory system by consolidating distribution centres where the surplus inventory locations were deemed to supplement the deficient location to manage the demand variability. In terms of proximity to customers, Exhun *et al.,* (2003); Taylor and Plambeck (2003); and Simchi-Levi *et al*., (2008) contend that a decentralised supply chain system allows the manufacturer to have better symmetric demand information on capacity planning decisions in the upstream while the downstream synchronises consumer demand with regional factory operations or region distribution centres. In the South African retail supply chain context, the central supply chain system requires major regional central consolidating distribution centres (DCs) on each province based on centre of gravity methodology. The literature review chapter on inventory systems provided a fundamental theoretical framework on key variables and extant research findings relative to the thematic problem statement on inventory positioning.

9.3.1 Empirical analysis on Inventory Systems

The pernicious factors of bullwhip effect explicitly impact upstream sites magnified consumer demand order variability and indirectly affect downstream sites on coping with less reliable demand order replenishment from the upstream site supply chain. The respondents (53%) entangled the fallible demand order replenishment processing in the supply chain to the relatively incessant cycle of lead times. If the inventory positioning is envisaged from shared information, the respondents pondered the length of supply chain network (56%) and inventory control policies (43%) was a negative influence on effective information sharing. The extended length of supply chain network would not align echelon channels (67%) to coordinate inventory positioning as the inventory control policy (72%) at the retail side frequently propagate consumer demand variability towards upstream sites.

The fragmented position of inventory tendentiously epitomised large order quantities (70% agreement) after taking advantage of transport discounts and frequently setting desired service of holding excess inventory to forestall stockouts (65% agreement) in the supply chain. Sometimes these inventory decision-making processes are exhorted by resolutely inflated orders (66%) placed by supply chain members during shortage periods. There are instigated by wanton price fluctuations (62%) through purchases of large quantities during inchoative promotions indicating deleterious effect of bullwhip effect. Nevertheless, the respondents recommended possible global optimal inventory positioning strategies including demand aggregation across inventory locations (75%), responsive build-to-order supply chain (63%), VMI (62%), SMI (63%) and pull-based system to mitigate bullwhip effect. In the retail supply chain, the consolidated distribution strategy (71% of CscD system) for either lead time pooling, risk pooling or inventory locations pooling seemed to keep retail inventory close to customers while hedging against certain forms of uncertainty. This central supply chain system was supported by constantly adopting two to four or more collaboration models (75%) within the period of the last five years.

Ngai *et al*., (2011:237) derive the business value on supply chain IT competence that enables the supply chain an optimal inventory positioning In the nutshell, the optimal inventory positioning could be dependent to the advantage of transport discounts and reduction in total lead time cycle. While the significant likelihood of odds to improve supply chain business performance outcomes and customer services on an undertaking to manage bullwhip effect is dependent on inventory positioning, inventory control policies and information sharing.

9.4 Information Sharing Perspective

Several literature studies were embroiled on semantic between knowledge sharing (tacit with difficulty to codify, transmit or convey within a specific context and explicit with discrete and digital systematic means for decision making) and information sharing (obligatory and template-based in terms of order exchange, strategic, operational and competitive information sharing) on the same underlying improved supply chain business performance outcomes. The literature review concentrated on dimensions of information sharing such as quality, velocity, volatility and electronic integration, relative to the challenges of bullwhip effect in the FMCG industry. Information velocity is a term used to describe how fast information flows from one process to another, and information volatility describes the uncertainty associated with information content, format, or timing, that must be properly handled to add value to the supply chain. According to Li and Lin (2006:1641) quality of shared information is described as "quality of information shared among supply chain partners as this quality includes aspects such as information usefulness, information accuracy and information accessibility".

The supply chain relationships with suppliers and customers are thus impacted not only by the accuracy of information, but also its availability, velocity and volatility (Wisner *et al*., 2008). A number of authors provided empirical research revelations on the role of information sharing in consumer goods retail supply chains including the value of shared information on inventory (Cachon and Fisher, 2000) and optimal inventory holding policies (Gvirneni *et al*., 1999), and the value of centralised demand informant (Chen, 2003). These generic mitigation, simulations and modeling approaches were reconnoitered to palliate the cascading supply chain bullwhip effect from the diagnoses of Forrester (1958); Lee *et al*., 1997) and Balan *et al*., (2009). This study also investigated the challenges of bullwhip effect, and gaining supply chain information visibility (Barratt and Oke, 2007) for quality, timeliness and access improves supply chain responsiveness and frequencies of order replenishment capabilities (Mentzer *et al*., 2004; Patterson *et al*., 2004).

In the macro perspective, Barratt and Barratt (2011:514) explored the specific roles of internal and external information-based linkages in the extent of visibility across the entire retail supply chain to reduce uncertainty and demand order variability from improved operational business performance outcomes and degrees of integration. The degree to which the supply chain partners have on-hand information relative to demand and supply for planning and control management was attributed to supply chain information visibility (Barratt and Oke, 2007). While the balance between information flow on demand and supply across the network alleviate bullwhip effect (Balan *et al*., 2009), and supply chain information transparency reduces demand order uncertainties as bullwhip effect problem in the dyadic downstream and upstream relationship and organisational trust.

Wang and Wei (2007:647) contend that opportunistic behaviour that results from information asymmetry or to the extreme strengthens asymmetric relationships (visibility fails to mitigate) in terms of the scope and depth of information. Unless information visibility in retail supply chain serves as a mechanism to mitigate bullwhip effect problems. Certain extant research studies allude to the predicaments of no information availability, constrained private information and lead time information that admonish the propensity to amplification of demand order variability. Under these circumstances, the downstream sites of supply chain rely on the history of order arrivals to make replenishment decisions (Chen and Yu, 2005) while the upstream sites are obscured of product availability downstream and enjoined the silo-oriented new product roll-out strategy (Ferguson and Ketzenberg, 2006; Li and Gao, 2008).

Information sharing in a retail supply chain presents challenges of mapping information flow in terms of collection and transfer capabilities from one point to other internal and external users. The efficient mapping information flow seems to be dependent on information availability, velocity and level of volatility. This would strengthen the partnership relationships between the upstream and downstream sites of supply chain in terms of information capturing, transforming and exchanging on both internal and external supply chain users (Wisner and Stanley, 2008). The propulsion of the value of information sharing for effective mapping of internal and external information flows was exhorted through contract types, including revenue sharing contracts (Cachon and Leriviere, 2005) and quality based contract menus (Anand and Goyal, 2006; Ha and Tong, 2008). This study did not capture the extent to which the shared information under contract relates to trust among supply chain partners. Chu and Fang (2006) suggest that a firm’s trust in its supply chain partners is highly and positively related to perceived satisfaction, partner’s reputations in the market and communication.

This study inferred that the magnitude of reputations and communications indicated sufficient partners’ trustworthiness and integrity sequestered from underlying contract means. Van Weele (2010:395) add that shared information on trust from competence and trustworthiness perspective requires supply chain partners to act in a consistent and reliable manner with regard to underlying ethical principles and consistent organisational behaviour and integrity.
Although simplicity on the extent of collaboration and inevitable conflicts between supply chain partners (suppliers and retailers) (McIvor and Humphreys, 2002; Elmiliani, 2003) under certain level of trust in information sharing, trust can exhort high independence with “willingness to negotiate functional transfer, share key information and participation in joint operational planning” to subdue problems of demand variability (Shen *et al*., 2006). This study implicitly avoid being overzealous on semantics and unconditional concept of trust (Davis, 2006), and recognised trust in sharing information as a reduction of uncertainty from the incessant collaboration and integration of organisational activities.

The integrated cross-enterprise model using the electronic CPFR (e-CPFR) systems towards common goal of serving end consumers (Chang *et al*., 2007) was upheld to reduce bullwhip effect and entrenched “reputation of on-time delivery and consistent product availability” from shared information (Bowersox *et al*., 2010). In the proper management of information, Craighead *et al*., (2006:136) and Subramani (2004:46) characterise "Interorganisational System (IOS) as: 1) a class of information technologies that transcends the boundaries of firms to link with other businesses such as supply chain partners; and that, 2) generally includes EDI on value added networks and supply chain management systems".

According to Hartono *et al*., (2010:399) "the impact of the quality of shared information in IOS use on overall firm performance starts with top management support and IT infrastructure capability, and that these success factors positively impact the quality of shared information in IOS use. Moreover, the quality of shared information positively impacts operational supply chain performance, which, in turn, leads to improvements in overall firm performance". Yu *et al*., (2010:2891) stress that the "effective supply chain management is not achievable by any single enterprise, but instead requires a virtual entity by faithfully integrating all involved partners, who should come up with the insightful commitment of real-time information sharing and collaborative management". The authors caution that sharing only capacity and/or inventory information, without sharing information on demand, interferes with production at manufacturers, and causes misunderstandings, which can magnify the bullwhip effect.

9.4.1 Empirical Information Sharing Perspective

In this empirical research evidence, top management support had been considered as the most critical factor to the subsequent frequent interaction among supply chain partners as value-based information sharing capability. The other two factors (shared vision and trust) indicated an extensive desire to consider of template-based and contract means on facilitating exhorted positive influence on information sharing. These supply chain information sharing constraints are expected to improve collaboration with the underlying ethical principles of integrity. Contrary to the positively shared information factors, the length of supply chain network, and inconsistent rigid inventory control policies among the supply chain partners, were considered to be negative factors influencing value-based information sharing in the retail supply chain.

Despite channel alignment in retail supply chains, the literature findings hinted that the lengthy supply chain network and uncoordinated inventory policies would produce distorted information with subsequent loss of power from information disclosure or unnecessarily reaching rival competitors.

Nevertheless, information sharing is related to supply chain performance targets in the FMCG industry in terms of higher order fulfillment rate and achieving shorter order cycle time through integrated e-SCM systems. If the integration IT infrastructure capability and top management support (in terms of visible involvement, commitment and participation of executives and allocate required resources) are both significant antecedents of quality of shared information. Hartono *et al*., (2010:406) demonstrate that quality of shared information among supply chain partners is positively related to the supply chain's operational performance and, in turn, the overall firm performance is directly impacted by supply chain performance.

The respondents (76%) further claimed that information sharing would achieve supply chain coordination and eventually mitigate cascading consumer demand order variability. The key subdimensions of information sharing including electronic integration, quality information and velocity are fundamental mechanisms to tame demand variability despite the recurrence of demand volatility and supply uncertainty on information content, format and timing. These grouped interrelated variables in the factor analysis produced a new dimension "Supply chain information exchange". The first and middle levels of management associated information volatility to the length of supply chain channel networks coupled with the principles of information disclosure as impediments to the information sharing and relative supply chain performance targets.

The positive migration to a CscD system seemed to subdue demand variability and supply uncertainty by consolidating information pooling on content, format and timing. It should also be noted that the central supply chain system would be supported by integrated e-SCM systems to achieve supply chain performance benefits on real-time information sharing capabilities and active coordination processes. Initially, this study found that information sharing could empirically palliate cascading consumer demand order variability and seemed to be related to supply chain business performance outcomes. Its predictive ability came from integrated e-SCM systems and quality of information. It means that there is a linear relationship between information sharing and integrated e-SCM system solutions and quality of information shared in managing the challenges of bullwhip effect. The information sharing further presented the likelihood of odds of improvement in supply chain business performance outcomes as less likely that the business would experience the presence of oscillating bullwhip effect.

This study sought to analyse the challenges of bullwhip effect relative to the role of e-SCM systems and the dimensions of managing the cascading consumer demand order variability including optimal inventory positioning, effective information sharing and global optimisation strategies. The literature review explored several aspects from the evolution and causes of bullwhip effect, modeling content analysis and deliberated on mitigation factors of bullwhip effect. The empirical research examined three dimensions and their subdimensions to develop the framework in terms of average responses, description analysis, association between two variables, difference between the mean vectors, patterns of interrelationships and reduction of data and relationship between criterions and predictor variables.

In this study, the effect of lead times on order replenishment processes, irrational behavioural patterns and decision making and information errors or distorted information were perceived as three consecutive factors to generate bullwhip effect in the supply chain network. The respondents agreed (93%) that demand order variability has deleterious effects in the FMCG industry. The respondents further confirmed the conventional causes including inflated demand orders from shortage gaming (78%), transport discounts from full truck load (70%), price fluctuations from uncoordinated promotions (62%) and stock outs from orchestrated none optimal safety stock (65%), and the proposed mitigation factors such as jointly updated demand forecast (78%), and reduced total lead times (63%). The selected fundamental dimensions to analyse the challenges of bullwhip effect served the purposes of this study wherein the respondents agreed that the e-SCM systems (92%), optimal inventory positioning (64%) and effective information sharing (76%) could manage and control the phenomenon of bullwhip effect.

The extent to which the underlying challenges of bullwhip effect would be contextualised in this study, the new incisively developed dimensions should be envisaged in terms of Supply chain integration system, Supply chain electronic communication system, Supply chain information exchange, Supply chain lead time cycle, Supply chain inventory variability, Supply chain demand order quantity, Demand-driven supply chain system, Supply chain knowledge-driven system, Central risk pooling system and Decentralised supply chain system. This study further produced explanatory variables that indicated the predictive ability of relationships between bullwhip effect and seven predictors while each of the three fundamental dimensions produced their individual models relative to the challenges of bullwhip effect.

9.5 Recommendations of this study

This particular study has managed to partially answer certain research questions from the literature review, however the major findings emerged from the scientific component of this study. The following recommended findings are solely related to challenges of bullwhip effect on the extent to which this phenomenon can be palliated, decelerated, managed or controlled but not entirely exterminated:

- The accurate forecasting models are directly linked to effective positioning of inventory and frequently replenishing demand orders. The effective supply chain performance as antecedent of the phenomenon and overall firm's performance is highly dependent on integrated and transparent sales information such as electronic point-of-sale data, from the downstream site to control the deleterious cascading consumer demand order variability.

- The length of supply chain channel network impedes the sharing value chain and mapping flow of information that should reflect effective supply chain collaboration capabilities and optimum synchronisation. If the channel alignment in the supply chain assists in coordinating inventory positioning, the supply chain business performance and customer service levels should indicate improvement as a reciprocal approach towards managing demand variability.

- The supply chain network is implicitly interpreted and controlled by logistics network (3^{rd} party, 4^{th} party, retail or supplier owned distribution or retail distribution centres) that encourages supply chain members to take advantage of full-truck-load transportation discounts. This means that inventory quantity decisions are driven by frequency and size of shipments from plants to the distribution centres then individual retail stores, and supply chain partners need to leverage their operational supply chain performance outcomes: 1) Downstream site must optimise investment performance decisions on inventory quantities to reduce demand order variability; 2) Upstream site must harmonise time-based delivery performance with transportation quantity discounts to reduce supply variability. The conjoint of information sharing will include demand, capacity and inventory information requirements.

- The level of supply chain coordination is associated with degree of uncertainty in partnership-collaboration-processes (PCP) relationship on the underlying principle of proactively sharing supply chain demand order information. The template-based information sharing on specified contract and data format can gradually build active coordination partnership, trust and commitment and increased willingness to share template-based information. The integrated and constrained-based information sharing exhort proactive willingness and supply chain coordination-data exchange to subdue both demand order and supply variability.

Note:

1) E-SCM systems diffusion creates electronic flexible supply chain partnership networks to facilitate mutual decision making on partnership-collaboration-process (PCP) relationship across supply chain partners. These business relationships can quickly and accurately respond to the management of consumer demand order variability despite the challenges of trust, technology compatibility, security information flow and complexity of implementation.
2) The integrated e-SCM systems moderate trust and willingness from high independence to encourage participation in joint operational planning where retailer' sales information (POS data) is integrated with or into suppliers' planning processes.

The quality of information sharing depends on the integrated e-SCM system solutions from the highly unified independence that moderate the magnitude of trust and willingness among supply chain partners to share knowledge and information on underlying PCP relationships.

The downstream and upstream sites of supply chain network operate on the lower margins through a high volume throughput and higher overall volume of sales with cumulative profit on generally large quantities of sales. The interconnectivity nature of a modern supply chain network, although interpreted as a logistics network, is embedded in a highly desirable e-SCM system to effectively communicate and actively coordinate the real-time knowledge and information exchange. In other words, effective e-SCM systems diffusion depends on timely communication of future strategic supply chain activities including: 1) Visible real-time POS data for accurate forecasting; 2) Up-to-date demand and supply forecasts for better capacity planning and schedules; and 3) Frequencies of order replenishment requirements with product availability to proper manage bullwhip effect.

The retail supply chain migration to CscD system as the consolidated distribution strategy for either lead time pooling, risk pooling, inventory locations pooling or supply pooling brings retail inventory closer to customers with optimum position of inventory. The optimal inventory positioning depends on the advantage of transport discounts and reduction in total lead time cycle as an epitome of lower margins industry that rely on high volume throughput and high overall volume of sales. The supply chain upstream site will experience large order quantity requirements, sometimes inflated orders from shortage gaming practices, and, in turn, they can build their supply or manufacture distribution centres to consolidate inventory requirements as central supply pooling system. This initiative can focus on supply chain performance of supplier's pre-allocation cross-docking and DC's pre-merchandising system, in terms of centrally-pooled pre-packaged orders from suppliers, while the downstream site will relish the benefits of more centralised supply chain distribution or consolidation gaining shorter lead times with lower total delivery costs and engender better product availability from retail DCs. If both stream sites adopt central supply chain system, the likelihood of odds to improve operational supply chain performance would depend on real-time quality information and how inventory is optimally positioned and the inventory policies are effectively controlled to mitigate bullwhip effect.

The value of centralised information flow mapping (CIFM) on demand order informant prevails from internal and external information-based linkages. These interconnectivity activities improve velocity of information flow with better content and format as added value to the supply chain performance. The value-based information sharing depends on integrated e-SCM systems and quality of information shared to improve supply chain responsiveness and frequencies of order replenishment capabilities. This study further recommend that the quality of electronically-integrated supply chain information sharing yields the maximum likelihood of odds to an improvement of supply chain business performance as less likely that the retail supply chain could experience the presence of oscillating bullwhip effect.

The risk pooling is quintessential as global optimising and cost-effective strategy to ameliorate the demand order variability by aggregating demand across product locations pooling, lead times pooling, materials pooling and capacity pooling. The retail supply chain would need a CscD system that focuses on directly involving capacitated suppliers in their initiatives to realise high levels of customer service satisfaction. A central supply chain system indicated superiority over decentralised system in the empirical research.

The migration from a DscD system to a CscD system provides positive transformation on supply chain risk consolidating and/or pooling and business process performance in terms of: 1) Product availability from high delivery performance; 2) Reduction on inventory investment and total supply chain costs; 3) Improved demand order replenishment frequencies with shorter cycle time; 4) Gaining reliable deliveries and stock runs; and 5) Improved capacity planning and schedules from the development of production leagility and distribution coordination on the upstream site.

Note: The number of systems that supports a CscD system, such as degree of responsive order replenishment flexibility (BTOSC) and pull-based supply chain systems, are dependent on real-time inventory level information (using VMI, EDI, e-SCM) as the supply chain performance mechanism to control demand order variability and demand order replenishment frequencies over the entire supply chain network. Electronically-enabled BTOSC system provides real-time information and flexible responsiveness among the supply chain partners that position modular inventory at the early stage of the order processing.

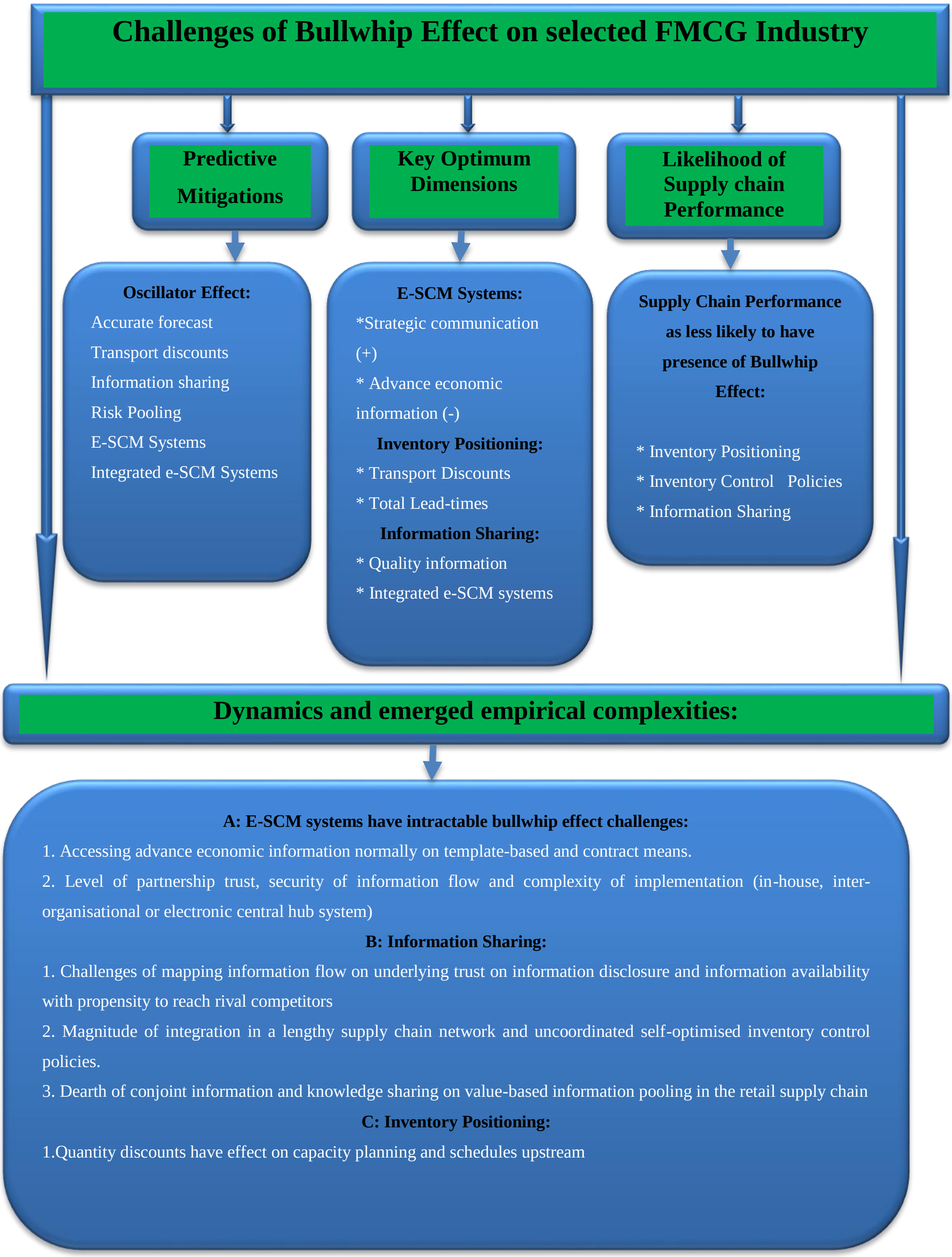
The electronically-enabled supply chain management systems improve effective communication with efficient real-time information sharing and better coordination of supply chain processes with integrated supply chain performance to mitigate bullwhip effect. The frequent adoption and implementation of B2BIT systems allows the compelling migration from in-house IT department to align technology clockspeed with central integrated hub as creation of agile and highly flexible responsive system to changing market requirements.

The tentatively recommended inferences from the newly developed dimensions on Bullwhip Effect challenges:

- The magnitude of greater controll of bullwhip effect and accessing the advance economic information over demand orders in the supply chain network is dependent on an integrated system **- Supply chain integration system.**
- The magnitude of collaboration between supply chain partners allows supply chain coordination on production schedules, forecast demand and demand order replenishment frequencies to subdue the effect of bullwhip effect. - **Demand-driven supply chain system.**
- An electronically-enabled information exchange system improves the quality and velocity of information sharing on reciprocal interdependence and integrated coordination both across and within the firms. - **Electronic supply chain information exchange.**

- The better lead time pooling in supply chain that combines the lead times from multiple inventory locations to keep inventory closer to the customers for improved product availability. If the impact of reducing total lead time and transport discounts on inventory quantities positioning are matched with acceptable frequencies of order replenishment, the pernicious effect of bullwhip effect can be managed. **- Supply chain lead time cycle**.
- A focus on unlimited access to the retail store's order replenishment processes to improve forecast accuracy with supply chain integrated cross-enterprise model (purpose - overcoming discrepancies between the sales forecast and the actual demand to subdue bullwhip effect) **- Supply chain knowledge-driven system.**
- The desired service level to purchase and hold a large quantity of inventory in supply chain network is needed to prevent stock outs and to overcome the effect of price fluctuation during promotions**- Supply chain inventory variability.**
- The central supply chain distribution systems have the potential to allow manufacturers and suppliers to orchestrate their capacity planning and demand forecast within a central pooling location while the retailers try to ensure on-time delivery of customer orders at desirable stock level **- Central risk pooling system.**
- The conventional cause of bullwhip effect when the downstream supply chain inflates demand order quantities to take advantage of transport discounts. The customers tend to accumulate safety stock target with distorted demand signal **- Supply chain demand order quantity**
- The electronic system can enhance trust-based coordination structure, better communicate demand order replenishment requirements for consistent product availability and accelerate physical product and information flow capacity. The central principle of e-SCM diffusion is the creation of an electronic flexible supply chain partnership network to facilitate mutual decision making process across the retail supply chain partners **- Supply chain electronic communication system.**
- A decentralised supply chain allows the manufacturer to have better demand information because of proximity to consumers **- Decentralised supply chain system.**

Figure 9.1: Challenges of Bullwhip Effect on key dimension.



Source: Developed by the researcher from this empirical study

9.6 Limitations and delimitations of the study

The concept of supply chain management is deemed abstractive and inchoative to the discernment of certain of potential retail supply chain respondents who participated in this study. The incisiveness of supply chain orientation, supply chain management and bullwhip effect indicated some kind of a challenge, nevertheless, the simplicity of survey instrument was designed to ease those kinds of challenges together with a judgmental sampling technique. Those organisations gathered certain groups of employees in their boardrooms to answer the questionnaires in my presence, presented an opportunity to clarify certain questions. It is not known whether all respondents understood all the questions and answered to the best of their abilities, however the study indicated consistency on the internal reliability of the instrument. The discernible limitations of this study are the sample population, which was constrained to the province of KwaZulu Natal depicting a dearth of representativeness of the population, and the cross-sectional survey of a specified industry. The FMCG industry (only major South African retail stores and suppliers) is a potential source of common method variance and basis for analysis without extensive generalisability of the survey findings. The results and limitations of this study would be a good starting point for exploring future research needs concerning the impact and quantification of bullwhip effect and the effectiveness of e-commerce and electronic supply chain implementation.

9.7 The value and future of the study

The contribution of this study to broader multi-discipline research areas can only be enhanced by future research studies by isolating the major dimensional findings. The extrapolation of these empirical results from the South African retail supply chain industry contributed hugely to the body of knowledge. These empirical results are expected to shed new perspicacious light from an electronic supply chain orientation and supply chain management perspective relative to bullwhip effect, and mitigation mechanisms including e-SCM systems, inventory positioning, information sharing and global optimisation strategies. This two dimensional study explored theoretical models and extant supply chain management-oriented literature survey, while the scientific component utilised empirical research methods to answer the proposed research questions as an attempt to contribute effectively to worthy perspective on the body of knowledge. Despite certain limitations, this study has provided additional insights into areas relating to e-SCM system solutions, optimally positioning inventory in spite of conventional large quantities inventory practices, and leveraging real-time information sharing from CscD system in the retail supply chain industry.

Based on the results, it would be fascinating to find out specifically how the combination of knowledge and information sharing can support the supply chain performance as an antecedence for overall inter- and intra-organisational supply chain performance, and eventually palliate the presence of bullwhip effect in the retail supply chains. Generally, the knowledge sharing assists in weighing the level of partnership trust and magnitude of integration beyond partnership collaboration through template-based business engagement. It would also be worthwhile to explore further how the FMCG industry enhances supply chain IT orientation, deal with complexities of e-SCM systems implementation and central integration, and monitors the degree of e-SCM investment orientation in terms of new IT solutions aligned with technology clockspeed and personnel training on IT systems. In the macro perspective, future research should look at addressing the issue of how to exterminate the phenomenon of bullwhip effect completely, rather than ameliorating the cascading consumer demand order variability in the FMCG industry.

9.8 Conclusion of the study

The findings of this study have shed light on successful global existing supply chain management practices and supply chain orientation from a literature survey perspective and provided empirical research evidence based on ranking, testing, developing patterns of interrelationships, estimating predictive ability, and estimating the maximum likelihood of odds. In this regard, the study confirmed certain challenges of bullwhip effect, hypotheses on mitigation dimensions and answering research questions. The role of e-SCM systems was found to be critically important in managing bullwhip effect, including its role on information sharing and aspects of positioning inventory in the FMCG industry. It shows that the industry has the capability to capture the magnitude of technology clockspeed for improvement of supply chain performance. This understanding is directly linked with frequent diffusion of B2BIT systems between two to four or more supply chain IT solutions within the period of five years. If the full migration to a CscD system is completed in retail supply chain network, the more integrated e-SCM systems will provide revelation and become indispensable in the FMCG industry. As the retail consumer goods industry fully concentrates on Central, West and East African countries in expanding their customer base (Pick n Pay selling their Australian operations to focus on the markets in Africa) and the world is gradually converging in Africa with an extremely successful FMCG business directly investing in Africa (Wal-Mart acquiring Massmart). These businesses are expected to bring insightful experience that is innovatively impetus of supply chain IT solutions, and the findings of this study on the role of e-SCM systems diffusion can present a strong case and be bestowed as the IT innovations are unfolding.

Beyond the context of cascading consumer demand order variability, this study found other dimensions such as information sharing and other global optimisation strategies more dependent on integrated e-SCM systems.

Generally, the number of FMCG businesses is not susceptible to IT solutions with incessantly regressive campaigns of keeping things manually simple at the expense of inconsistent poor supply chain performance and failure to leverage the diverse consumer service requirements and satisfaction. This study found that integrated e-SCM systems provide real-time information sharing on inventory status, frequencies on order replenishment fill rates, timely sharing electronic POS data with maximum likelihood of improvement in supply chain performance. Currently, all major FMCG businesses have reported migration to a CscD system with greatest manifestation of impetus e-SCM system solutions, and this study contribute in the transition with its empirical findings. These empirical results seem to be tentatively compatible and appropriate with practical suggests to the number of supply chain orientation problems. These research findings might exert pressure on the retail industry to seek supply chain business solutions from innovatively electronically-enabled supply chain management. Hypothetically, supply chain management orientation as businesses competing on supply chains and degree of integration and embedded interconnectivity can be defined by limpid sagacity of electronic supply chain IT solutions in modern supply chain networks. This statement could be the summary of this study or a prospective future hypothesis that should be tested with a clear understanding of technology clockspeed. The acknowledgment of future studies emerged from a bumpy ride and/or abrupt and rough progress and challenges with compelling set of parameters that left out certain supply chain activities although the literature survey explored a number of contributing factors.

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Appendix A: The schools of thought on developing information sharing modeling methods

	Model	Strategic approach to Information Sharing
1	**Schouten-Eijs-Heuts model (Schouten *et al.*, 1994).**	It considers a situation that the supplier produces orders in fixed production cycles. The retailers place orders independently from time to time. From a single retailer's point of view, the main uncertainty is the time period from placing an order to fulfilling the order, which is called 'virtual lead time'. Then the shared information is the supplier's production run status. The shared production run status information is used to improve the retailer's knowledge about the lead time for distribution of an order, and thus to determine different reorder points on different virtual lead time. The retailer policy (St, Q), St is reorder depending on the virtual lead time *t*.
2	**Zipkin model (Zipkin, 1995).**	It considers a centralized supplier and several retailers. The supplier can make only one unit of the product one time, other orders are put in queues. When the system is busy, two different policies in choice of which product to produce, first-come-first-serve (FCFS) and longest queue (LQ) are considered. Therefore, the retailer's inventory information is utilized through adopting the longest queue policy. The difference of the overall average costs under above two policies represents the value of shared inventory information.
3	**Bourland-Powell-Pyke model (Bourland *et al.*, 1996).**	It considers a situation that the supplier and retailer have asynchronous periodic inspection policy and investigate how to minimize their inventory cost. Consider an ordering period with total *P* days. Under the asynchronous periodic inspection policy, the supplier inspects the inventory level after *y* days from the arrival of the retailer ordering, and considers how to replenish its inventory to satisfy the retailer's next ordering. Without sharing the information of the retailer, the supplier must consider the demand fluctuation during the total order period *P*.
4	**Lee-So-Tang model (Lee *et al.*, 2000).**	It considers that, when the end demand process faced by the retailer is an auto-correlated process AR(1), whether sharing demand information can improve the supplier's performance. Without information sharing, εt (independent and identically distributed from a symmetric distribution with mean **0** and variance σ^2 can be only dealt as a random variable. Li *et al.*, (2005) further confirm that, whether knowing the value of εt for the supplier is a key factor for him/her to decide his/her optimal order-up-to level. Therefore, the supplier is able to reduce his/her inventory level and inventory costs significantly through information sharing.
5	**Graves model (Graves, 1999)**	It considers whether sharing demand information improves the supplier's performance when the end demand process faced by the retailer is an integrated moving average process (IMA). The demand process seen by the upstream is an integrated moving average process, it is thus claimed that since the forecast method use by the upstream provides an optimal estimation for future demand, the information sharing has no impact on the cost of supply chain.
6	**Chen model Chen (1998)**	It considers two different inventory policies under a serial supply chain. One is based on echelon stock, and another is based on installation stock. The former requires centralized demand information, for a given order quantity Q, the only decision variable is the reorder point. The cost difference with the two optimal solutions indicates the benefit of information sharing. Thus, the optimal reorder points for all echelons can be obtained if one know the reorder point of the first echelon Y_i, probably the retailer. In the installation inventory-based strategy, the reorder policy is determined only based on the local inventory position. Owing to the computational complexity, it first identifies the bounds of the optimal reorder points for each echelon, and then the solutions are searched out within the boundaries. Li et al., (2005) suggest that the computational results show that the information sharing value could be up to 9 percent and the average is 1.75 percent.
7	**Cachon-Fisher model Cachon and Fisher (2000)**	It consider a similar system on a periodically reviewed system with capacitated supplier and multiple identical retailers in which all the members use echelon-stock (R,nQ) policies. The supplier has information about all the retailers' inventory positions. It shows how having this information benefits the supplier's order and allocation decisions. According to Chatfield et al., 2004) the manufacturer's production capacity and cost, as well as of the retailers' order size on the benefit of information sharing are expected to be managed within the required parameters.

		The parameters have regard to cost effectiveness of echelon stock policies in systems, introduce the information pooling effect and economies of scale with full information sharing.
8	**Moinzadeh-Kapuscinski-Tayur model (same as the Lee-So-Tang model), (Gavirneni *et al*., 1999**	It assumes that there are other channels to fulfill the inventory if it is not satisfied by the supplier. Thus, the different decision only impact on the supplier's cost. In a case of no information sharing (Chen and Yu, 2005), the supplier decides the production according to the retailer's order. The supplier observes that the order demands in each period are independent identically distributed. In other case of partial information sharing, (Simchi-Levi *et al*., 2008) imply that the supplier knows the retailer's inventory policy (s,S) as well as the values of s and S. Thus, the supplier may obtain the information of the retailer about the probability of the ordering and ordering quantity distribution of ordering in the next period. In the final case of complete information sharing, the supplier knows the daily sales of the retailer. In knowing this information, the supplier then estimates the probability of retailer's next order and the ordering quantity.
9	**Gavirneni model (Gavirneni, 2001).**	It considers a supplier producing a single product for multiple retailers. Under the make-to-order strategy, the supplier does not keep inventory and therefore all the inventory costs and shortage costs occur at the retailers (Chen,2003; Miemczyk, Howard and Graves, 2004; Gunasekaran and Ngai, 2005). Since the supplier has a limited production capacity, the overall demands from retailers cannot always be satisfied. Thus, it must decide how to allocate its capacity such that the total cost of retailers can be minimized. The complete cooperation gives the lowest cost, however, with no cooperation or partial cooperation have substantial cost and retailers with larger inventories receive small shipments.
10	**Moinzadeh model (Moinzadeh, 2002).**	It focuses on the impact of the supplier using information to improve its replenishment ordering decision. By using the shared information about demand and inventory position of each retailer, the supplier has the next effective replenishment policy. The supplier does not need to obtain any shared information, but uses a classical installation policy.
11	**Kulp model (Kulp, 2000).**	It suggests that both parties have the same demand information and cooperatively select a quantity to produce and order. The supplier receives the demand signal from the retailer before the production plan is made in the VMI system. Vendor managed inventory (VMI) is one of the most important information sharing tools applied in supply chain management. In a VMI system, the retailer authorizes the supplier to replenish the inventory. The supplier, according to the on-time demand information and inventory level of the retailer, determines the time and amount of replenishment.
12	**D'Amours-Montreuil-Lefrancois-Soumis model (D'Amours *et al*., 1999).**	It considers a virtual manufacturing and logistics network with manufacturing, storage and transportation, which implements a make-to-order strategy with the lowest cost. Since the activities involved in the network are performed by different firms, the problem is choosing a proper biding protocol to ensure that capable firms join the networks, then in achieving the optimal time-cost trade off. In the bidding protocol, the invitation is represented as cost function involving the starting time of each process, duration time, and the quantities of manufacturing, storage and transportation. The bidding protocols ranging from supplying type, customizing and webbing with different solutions. The level of information sharing affects the structure of the supply network. With the same level of cost, the higher level of the information sharing is, the fewer partners are needed.
13	**Lee-Whang model (Lee and Whang, 2000).**	It proposes three system models of information sharing. Firstly, Informant Transfer Model as trading partner transfers information to another that maintains the database for decision making. It is seen as a natural evolution from the EDI-based transactional model although a company doing business with multiple partners has to provide different interfaces and support multiple standards. Secondly, Third Party Model involves a third party whose main function is to collect information and maintain it in a database for the supply chain. Thirdly, Information Hub Model is similar to Third Party Model, except that the third party is replaced by a system as an information hub.

Appendix B: Benefits of SAP SCM: Operate efficiently and profitably

SAP Supply Chain Management		
Functions	Activity	Benefit
Demand and supply planning	Demand planning and forecasting	Use state-of-the-art forecasting algorithms for product life-cycle planning and trade promotion planning.
	Safety-stock planning	Meet desired customer service levels while maintaining a minimum amount of safety stock
	Supply network planning	Simulate and implement comprehensive tactical planning and sourcing decisions based on a single, globally consistent model
	Distribution planning	Determine the best short-term strategy to meet demand and to replenish stocking locations
	Service-parts planning	Use the latest forecasting, inventory planning, and distribution models to improve service levels while reducing inventory costs.
Procurement	Strategic sourcing	Identify and evaluate potential vendors based on historical performance and other data. Create long-term plans for sourcing that take into account the company's financial and marketing strategies.
	Purchase order processing	Manage the purchasing process for direct materials, indirect materials, and services Convert demand into purchase orders or delivery schedules for a scheduling agreement
	Invoicing	Receive, enter, and check vendor invoices for correctness Use automatic workflow to ensure proper invoice circulation and automatic blocking for payments that exceed set limits
Manufacturing	Production planning and detailed scheduling	Generate optimized schedules for machine, labour and overall capacity utilization Address problems of unequal allocation of constrained materials and capacity, due-date commitments, and sequencing of incoming orders without disrupting existing plans
	Manufacturing visibility, execution, and collaboration	Meet and deliver on your production plans by managing production processes and the deployment of the workforce and resources on the shop floor Document, monitor, and dispatch inventory across the production life cycle Share information with partners to coordinate production and increase visibility and responsiveness on the shop floor
	Material requirements planning-based detailed scheduling	Create feasible production plans across different production locations (also with subcontractors) to fulfill demand to the schedule and to the standard expected by the customer Use the advantages of production planning and detailed scheduling for scheduling, simulation, and alert monitoring to optimize order sequences that can be released for production
Warehousing	Inbound processing and receipt confirmation	Receive and process externally procured goods into the warehouse with a single RF scan Capture detailed and overview information using RF identification (RFID)-enabled tools
	Outbound processing	Use a combination of RF, voice recognition, or RFID technology to manage all the steps of goods issue, including distribution and proof-of-delivery activities.
	Cross-docking	Direct inbound goods from receipt to issue without interim storage Use cross-docking, planned and opportunities, to minimize duplicate goods movements within the warehouse, optimize the flow of goods from inbound to outbound processing, and shorten routes within the warehouse
	Warehousing and storage management	Optimize internal movement and storage of goods within a warehouse Utilize task interleaving to decrease travel and improve efficiencies
	Physical inventory	Plan and execute a physical inventory or velocity-based dynamic-cycle counts
Order Fulfillment	Sales order processing	Fulfill a range of contracts or purchase orders by delivering a specific product configuration and quantity or by providing a service at a specific time
	Billing	Manage the entire billing process, from the creation and cancellation of invoices through the transfer of billing information to the accounting department
	Service-parts order fulfillment	Expand visibility into the entire service-parts supply chain, providing the ability to respond rapidly to customer and internal orders from the most appropriate locations
Transportation	Freight management	Receive, update, and confirm transportation requests Predefine a specific route through the transportation network with

		dynamic route determination
	Planning and dispatching	Optimize, create, and manage planning processes using best-in-class optimization, dynamic routing and scheduling, and continuous-move optimization
	Rating, billing, and settlement	Evaluate, calculate, and distribute transportation charges for the ordering party and the supplying party Enable financial transactions for customer billing and for supplier invoicing Use denied-party and embargo lists to ensure compliance for cross-border shipments
	Driver and asset management	Maintain vehicles, vessels, and departure schedules by considering the constraints of these resources, such as volume and weight Gain global visibility into various assets, including track and trace for container movements Maintain and ensure sufficient driver qualification during the manual assignment of drivers to assets
	Network collaboration	Forecast shipment levels, carrier capacity, and equipment allocations Determine shipment volumes by origin, generate weekly and daily forecast, and collaborate with logistics service providers Tender your offers directly into your carrier's or forwarder' system over the Internet or using XML or electronic data interchange (EDI)
Real-world awareness	Supply chain event management	Recognise and react to unplanned events in the supply chain Manage by exception rather than monitoring processes that are running smoothly Measure business partners' performance
	Auto ID/RFID and sensor integration	Integrate automatic identification technologies (barcodes, RFID, and so on) with existing SAP ERP software systems Convert raw reader data into business transactions and set up a rule-based mechanism to handle its tasks Use preconfigured processes for outbound processing, inbound processing and returnable transport item management
Supply chain visibility	Strategic supply chain design	Perform strategic and tactical business planning Test scenarios to determine how to address changes in the market, in the business, or in customer demand
	Supply chain analytics	Improve visibility across the extended supply chain Define, select, and monitor key performance indicators (KPIs) for a comprehensive view of performance Use predefined KPIs base on the supply chain operations reference (SCOR) model
	Supply chain risk management	Identify, measure, manage, and monitor risks Define risk impact and risk mitigation strategy and develop process and scenario alternatives Assign the effort of your mitigation strategy (cost impact)
	Sales and operations planning	Align your company's financial goals, marketing efforts, and inventory targets in one consolidated plan Gain access to relevant data, including aggregated, role-specific information about time, organization, product, geography, and units of measure
Supply network collaboration	Supplier collaboration	Connect to and collaborate with your suppliers by providing them easy and seamless access to supply chain information, which facilitates your ability to synchronise supply with demand
	Customer collaboration	Collaborate with your customers by providing them broad functionality for replenishment, including min/max-based vendor-managed inventory
	Outsourced manufacturing	Connect to and collaborate with your contract manufacturers by providing them easy and seamless access to supply chain information that extends visibility and collaborative processes to their manufacturing processes.
Supply chain management with Duet software	Demand planning in Microsoft Excel	Access demand plans from Microsoft Excel, analyse plans offline, and upload revised plans from Microsoft Excel into the demand planning component of the SAP Supply Chain Management application

Source: The best-run businesses run SAP, (www.sap.com/contactsap)

Appendix C: Population and Sampling

Estimation of the mid-year population

Rank	Province	Population (2010 est.)	Percentage
1	Gauteng	11,191,700	22.4
2	KwaZulu-Natal	10,645,400	21.3
3	Eastern Cape	6,743,800	13.5
4	Limpopo	5,439,600	10.9
5	Western Cape	5,223,900	10.4
6	Mpumalanga	3,617,600	7.2
7	North West	3,200,900	6.4
8	Free State	2,824,500	5.7
9	Northern Cape	1,103,900	2.2
South Africa		**49,991,300**	**100.0**

Source: ***(24 October 2007)*** *Community Survey, 2007*. ***Statistics South Africa, p. 14. (Report). Retrieved 15 January 2011.***

Since 1994 there have been two full censuses, in 1996 and 2001, as well as a "Community Survey" in 2007 which sampled approximately 2% of the population.

KwaZulu-Natal: quick facts

Capital:	Pietermaritzburg
Major city:	Durban
Languages:	80.9% isiZulu, 73.6% English, 1.5% Afrikaans
Population:	9 904 698 (2006)
Share of SA population:	20.9%
Area:	94 361 square kilometres
Share of total SA area:	7.7%
Population density:	105 people per square kilometre
Gross regional product:	R206.8-billion (2003)
Share of total SA GDP:	16.7%

Although the Northern Cape is the largest province, at almost a third of South Africa's land area, it is an arid region with the smallest population – only 1.15-million people, or 2.2% of the total.

POPULATION BY PROVINCE 2010		
Province	**Population**	**% of total**
Eastern Cape	6 743 800	13.5%
Free State	2 824 500	5.7%
Gauteng	11 191 700	22.4%
KwaZulu-Natal	10 645 400	21.3%
Limpopo	5 439 600	10.9%
Mpumalanga	3 617 600	7.2%
Northern Cape	1 103 900	2.2%
North West	3 200 900	6.4%
Western Cape	5 223 900	10.4%
TOTAL	**49 991 300**	100%

Source: *Statistics South Africa*

EThekwini Municipality is the local government body responsible for governing and managing Durban. The eThekwini Municipal Area (EMA):

- Is 2297 km in size (1.4% of the province of KZN);
- Has an annual municipal budget of R12,3 billion (2004/5);
- Has 18 886 municipal employees (2005);

- Has a population of 3 million (more than one-third of the population of the entire province); The eThekwini Municipality was awarded the highest credit rating in Africa for a municipality in September 2004 by the Global Credit Rating Company. Durban has the largest and busiest port on Africa's east coast; more than 1.956 million containers were handled in 2004/5. Manufacturing (30%), tourism (24%), finance and transport are the four largest economic sectors. Tourism is concentrated along the coast, with emerging eco – and cultural tourism opportunities in the western areas; and eThekwini Municipality's Gross Value Added (GVA) comprises 66.3% of the total GVA for KwaZulu-Natal and 9.9% of the national economy.http://www.durban.gov.za/durban/government/cifal/about/durban-ethekwini.

In the case of Durban, the table of Main Places is as follows:

Name	Population	Name	Population
Durban	536644	Macala-Gwala	9359
Umlazi	388687	Mawotana	8913
Chatsworth	192166	Hambanathi	8568
Kwa-Mashu	175913	Thoyana	7886
Phoenix	169163	Roseneath	7303
Inanda	153098	Qadi	7170
Ntuzuma	114579	Mpolo	6914
Pinetown	100037	Dassenhoek Part 1	6823
Mpumalanga	99720	Luganda	6121
Sobonakhona	64162	Hillcrest	5341
Clermont	57536	Hazelmere	5128
Verulam	54645	Magabeni	4933
Kwadabeka	52617	Umgababa	4059
Iqadi	44532	Mt Edgecombe	3874
KwaMakhutha	43781	Emalangeni	3606
Tongaat	41055	Emona	3188
Mawothi	40465	Mangangeni/Vumazonke	3111
Westville	37517	Umkomaas	3027
Newlands West	37425	Assegay	2930
Kloof	35623	Ezembeni	2918
Ximba	34557	Genazano	2866
Lamontville	32991	Redcliffe	2800
KwaNdengezi	31528	Naidooville	2417
Queensburgh	29519	Elangeni	2249
Folweni	28759	La Mercy	2104
Qiniselani Manyuswa	25878	Bothas Hill	1992
Kingsburgh	23812	Drummond	1943
Unnamed rural areas	23209	Umdloti	1939
Luthuli/Umnini Trust	23008	Maphunulo	1769
Dassenhoek Part 2	22462	Mwawine	1460
Newlands East	22444	Ngqungqulu	1455
Inchanga	21987	Amalanga	1340
Ngcolosi	20166	Westbrook	1266
Malagazi	15681	Cato Ridge	1059
Umhlanga	15387	Cibane	1050
Cele/Vumengazi	15099	Amawoti	1038
Amanzimtoti	13437	Desainager	994
Molweni	12975	Oceans	823
Siyanda	12924	Tongaat Beach	735
Tshelimnyama	12731	Adams Mission	631
New Germany	12592	Gcumisa	593
Ilanga	12236	Umbumbulu	304
Klaarwater	12169	Mount Moreland	273
Amaotana	10643	Clansthal	272
Maphephetha	9814	Khabazela	250
Embo/Nksa Isimahla	9771	Ntshongweni	201
Total **(eThekwini Metro)**			**3090139**

Source: htonl (talk) 22:01, 17 September 2010 (UTC)

Appendix D: Store number - Massmart, Shoprite, Pick n Pay, Woolworths and SPar

Store number: Massmart

Number of Stores (2010)

Region	Country	Number of Stores
Africa	South Africa	275
Africa	Namibia	20
Africa	Mozambique	14
Africa	Botswana	11
Africa	Lesotho	2
Africa	Malawi	2
Africa	Uganda	2
Africa	Zimbabwe	2
Africa	Ghana	1
Africa	Mauritius	1
Africa	Nigeria	1
Africa	Swaziland	1
Africa	Tanzania	1
Africa	Zambia	1

Massmart Summary

Total Sales	Top Markets	
World Wide - USD 8.3 billion	South Africa, Botswana, Mozambique, Zimbabwe, Namibia	
South Africa - USD 7.4 billion		
CAGR	**Number of Stores**	**Website**
World Wide Sales - 10%	World Wide - 334	www.massmart.co.za
South Africa - 8%	South Africa - 275	

Number of Stores – Shoprite (2010*)*

Region	Country	Number of Stores
Africa	South Africa	1,306
Africa	Namibia	99
Africa	Botswana	38
Africa	Zambia	30
Africa	Lesotho	20
Africa	Swaziland	15
Africa	Angola	9
Africa	Mozambique	9
Africa	Madagascar	7
Africa	Malawi	6
Africa	Uganda	5
Africa	Ghana	4
Africa	Tanzania	4
Africa	Nigeria	2
Africa	Mauritius	1
Africa	Zimbabwe	1

Source: Planetretail, 2010

Appendix E: Growth in store numbers

Trading Brand		FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
Consumer Goods							
SPAR Group	KWIKSPAR	185	176	161	150	144	+2
	SPAR	475	478	477	457	462	+16
	SUPERSPAR	123	145	172	218	241	+12
Pick n Pay Group	PnP Hyper	14	14	16	18	20	-
	PnP Supers	144	149	156	155	156	+3
	PnP Family	170	190	227	266	266	+50
	PnP Express	-	-	-	-	3	+2
	Boxer Supermarkets	54	54	60	63	81	+5
	Punch Stores	-	-	-	-	1	-
Shoprite Group	Shoprite	327	348	364	373	383	+23
	Checkers	95	110	117	123	134	+13
	Usave	84	92	99	116	154	+28
	Checkers Hyper	23	24	24	24	24	+0
	Ok Franchise Division	192		204	256	226	+8
	Megasave	56	56	56	44	39	
Massmart Group	Game	61	70	82	84	87	+13
	DionWired	-	-	2	6	6	+7
	Makro	14	14	12	13	13	+3
	CBW Wholesaler	58	62	65	65	73	+1
	Jumbo	7	7	7	6	6	-
	Saverite	-	-	-	-	30	-
Woolworths Group	Woolworths Full Line	84	94	98	108	121	+9
	Woolworths Food	60	74	97	114	129	+9
	Woolworths Food Stop	5	13	24	38	40	+7

Source: Trade Intelligence (2011). Trade Profiles. *www.tradeintelligence.co.za*, ***Available:*** *http://www.tradeintelligence.co.za/TradeProfiles/sparredirect.aspx*, ***Accessed: 11/24/2011***

Appendix F: Pick n Pay: Number of stores: 28 February 2011

Format	Stores and Outlet	Outlets	Products
Hyper	**20 corporate**		**Overall**
Supermarket	**160 Corporate**	**285 Franchise**	
Express		**8 Franchise**	**Food**
Liquor	**83 Corporate**	**66 Franchise**	
Pharmacy	**1 Corp. stand-alone**	**18 Corp. in-store**	
Clothing	**47 Corporate**	**10 Franchise**	
Boxer	**93 Supermarkets**	**11 Hardware**	
	4 Liquor	**1 Punch**	
Zimbabwe - TM	**51**		

Source: Pick n Pay Integrated Annual Report (2011). [Online], Available: http://www.picknpay-ir.co.za/financials/annual_reports/2011/glance_store_formats.htm. Accessed: 11/17/2011

Appendix G: Glossary

Adoption is defined as the extent to which a decision requires being made for the use of e-SCM and a preparation needs to be initiated for the redesign of business process.

Advanced CPFR is when this collaboration deals with synchronising the dialogue between the parties. It is expanded to coordinate processes within forecasting, replenishment and planning. The approach is combined with a resource-based and competency perspective.

Adversarial collaborative relationships entail the buyer working collaboratively with the supplier at an operational level to increase value, but competing with them commercially, to appropriate for themselves as much of this value as possible.

Agile system defined as the ability of an enterprise to survive in a competitive environment with continuous and unanticipated change and to respond quickly to rapidly changing markets that are driven by the customers valuing the products and services.

Agile system interpreted as one with volatile demand, high product variety, shorter product life cycle, and availability-driven customers, while a value stream in lean depends on a customer and cost perspective, rather than the organisation's viewpoint.

Agility response defined as one with volatile demand, high product variety, shorter product life cycle, and availability-driven customers.

Amplification is when a gradual increase in variance across all the elements in the chain.

Anticipatory model involves cooperation and collaboration with supply chain partners requires an investment in skills and competence, process development, and technology.

Benchmarking described as a critical aspect of supply chain performance measurement that makes management aware of state-of-art business supply chain performance practice, it is adopted as supply chain tool to assess operations (many firms do not benchmark processes) in relation to these leading firms, both competitors and non-competitors, in related and nonrelated industries.

Benchmarking is defined as the process of analysing the best products or processes of leading competitors in the same industry or leading companies in other industries.

BOSC defined as a strategy of value chain that manufactures quality products or services based on the requirements of an individual customer or a group of customers at competitive prices, within a short span of time by leveraging the core competencies of partnering firms or suppliers and information technologies such as Internet and World Wide Web (WWW) to integrate such a value chain.

Build-to-order production systems rely strongly on the information sharing for tight integration of the upstream supplier of parts, the midstream manufacturer and assembler of components, and the downstream distributor of finished goods in the supply chain.

Bullwhip effect as the observation that the variability of orders in supply chains increases as one moves closer to the source of production.

Bullwhip effect as the phenomenon of amplified order variability as orders move upstream in the supply chain from the retailer up to the manufacturer.

Bullwhip effect defines as the phenomenon that occurs in a supply chain when order size variability is amplified as orders move upstream in the supply chain from the retailer up to the manufacturer.

Bullwhip effect refers to a phenomenon in supply chain operations where the fluctuations in the order sequence are usually greater upstream than downstream of a chain.

Business expansion refers to the business expanding its business processes, procedures and business model to markets outside the country of origin while attempting to grow the business and ultimately gaining profits and customers.

Capacity pooling as the practice of combining multiple capacities to deliver one or more products or services, it can increase sales and capacity utilization but requires flexible capacity (it is probably not free and may be quite expensive).

Centered leverage statistic, h (hat-value) identifies cases which influence regression coefficient more than others. A rule of thumb is that cases with leverage under 0.2 are not a problem, but if a case has leverage over 0.5, the case has undue leverage

Centralised supply chain distribution centre (CscDC) or warehouse in this context is the facility in the supply chain network that receives goods from the upstream side, stores them in the centre, and ships them to the downstream individual retail stores.

Centralised system is a system in which inventory is kept at a central distribution centre (DC). As the random demands are aggregated across different locations in the centralised system, it becomes more likely that high demand from one location will be offset by low demand from another.

Chain networks are complex web of interconnected nodes (representing the entities or facilities such as suppliers, distributors, factories and warehouses), and links (representing the means by which the nodes are connected on supply chain mapping flows).

Character-based is based in an organisation’s culture, leadership and philosophy considering the action’s impact on the other.

Chi-square statistic test is the statistical significance between the frequency distribution of two or more groups. It intends to test the "goodness of fit" of the observed distribution with the expected distribution.

Close relationships mean that channel participants share risks and rewards and are oriented for long-term relationship.

Coefficien of variation = Standard deviation / Average demand

Collaboration defined as diverse entities working together, sharing processes, technologies and the data to maximise value-added for the whole supply chain group and the customers they serve.

Collaboration Planning Forecasting and Replenishment (CPFR) operates described as a set of business processes in which trading partners agree to mutual business objectives and measures, develop joint sales and replenishment plans.

Collaboration refers to situations in which parties in a business relationship work together to achieve mutual goals.

Common Object Request Broker Architecture (CORBA) provides an open standard for distributed systems to communicate.

Competence trust develops when the skills needed to perform a task reside across partners, and the level of search is undertaken by one party, for those skills before selecting the right partner to enter into such a relationship.

Consolidated distribution described as a strategy that uses lead time pooling to provide some of the benefits of location pooling without moving inventory far away from customers.

Construct reliability refers to the degree to which an observed instrument reflects an underlying factor. A construct reliability value of at least 0.7 is usually required.

Construct validity assesses the quality of correspondence between a theoretical construct and its operational measures. The study tends to deduce research questions from a theory that is relevant to the concept.

Consumer buying behaviour refers to the buying behaviour of ultimate consumers, those who purchase products for personal or household use and not for business purposes.

Content validity represents how will the content of the constructs is captured by the study's measures of the construct. As long as the results are as expected, they are considered valid on their face.

Convenience sampling described as perhaps the best way of collecting information quickly and efficient from members of the population who are conveniently available to provide it.

Convergent validity defined as a set of alternative measures accurately represents the construct of interest, this validity will assess the level of significance for the factor loadings.

Cook's distance, D measures the effect of the residuals for all other observations of deleting a given observation. Fox (1991: 34) advocates "a cut-off for deleting influential cases, values of D greater than 4/(N-k-1), where N is sample size and k is the number of independents". Cook's distance (D_i) captures the impact of an observation from two sources: the size of changes in the predicted values when the case is omitted (outlying stundentised residuals) as well as the observation's distance from the other observations (leverage)

Correlation coefficient, r (also called Pearson's product moment correlation after Karl Pearson, March 27, 1857 – April 27, 1936) is a bivariate analysis that measures the strength of association between two variables. In other words, it is widely used in statistics to measure the degree of the relationship between the linear related variables. Pearson's r is a useful descriptor of the degree of linear association between two variables within the properties of magnitude and direction.

CPFR describes a framework for the sharing of data between buyers and sellers in a supply chain in support of their planning, forecasting and replenishment processes.

CPFR is an extension of VMI that takes the idea of collaboration among supply chain partners a step further by creating an agreed framework for how information can be shared between parnters and how decisions on frequency of replenishment can be taken through joint planning, forecasting and decision making.

CPFR It involves few key business processes and a limited integration with trading partners. Partners enter into collaborative relation based on exchange of stock level data.

Critical ratio defined as a ratio that is calculated by dividing the time remaining until the job's due date by the total shop time remaining for the job.

Cronbach's alpha coefficient (named after Lee Cronbach in 1951) is widely used for assessing the internal consistency and reliability of a measure. Cronbach's alpha values show that the constructs are measured with sufficient reliability.

Cross-tabulation is a technique for comparing two classification variables. This technique uses tables having rows and columns that correspond to the levels or values of each variable's categories to compare two classification variables.

Customer relationship management (CRM) software helps analyse and manage the "sell" side of the business. The questions for analysis: What do one knows the dynamics of the customer on lifestyle, past purchase and other interactions with my company and on products and services that might complement or replace the current order.

Decentralised approach is determined by the objectives of individual members of a supply chain in terms of cost structure and profitability. The resulting interaction is sub-optimal from the perspective of the entire supply chain. In contrast, in the centralised approach, decisions are based on the overall objective of the supply chain in terms of total cost / profit, where the individual members are controlled by a central decision making centre.

Decentralised system defined as a system in which a separate inventory is kept at individual territory to satisfy each source of demand and there is no reinforcement between locations, so the surplus supplied location is not allowed to supply the deficient supplied location. The system aims to keep the optimal stocked level $\mathbf{s_i}$ (the stocked level at the $_i$th location) to decrease the expected total cost $\mathbf{H_D}$ $(\mathbf{s_i})$ within this system, which is achieved by minimising the sum of the individual location costs $\mathbf{H_i}$.

Decision synchronisation defined as a joint decision making process in planning and other operational contexts or levels while incentive alignment is the extent to which demand chain members share costs, risks and benefits realised from collaborative arrangements.

Decision synchronisation described as joint decision-making in planning and operational contexts (The planning context integrates decisions about long-term planning and measures such facets as selecting target markets, product assortments, customer service level, promotion and forecasting. The operational context integrates order generation and delivery processes that can be in the forms of shipping schedules and frequencies of replenishment of the products in the stores).

Decoupling point also acts as a strategic point for buffer stock, and its position changes depending on the variability in demand and product mix.

Delayed differentiation as the analogous strategy with respect to product pooling, that is, delayed differentiation hedges the uncertainty associated with product variety without taking the variety away from customers. It requires redesigning the product/process and may introduce a slight delay to fulfill demand.

Deleted residuals compute the standard deviation omitting the given observation prior to standardising or studentising the residual.

Demand chain is the set of activities and processes associated with new product introduction that includes the product design phase with capabilities and knowledge on sourcing and production plans.

Demand chain management (DCM) defined as a set of practices aimed at managing and co-ordinating the whole demand chain, starting from the end customer and working backward to raw material supplier.

Demand chain management is the management of upstream and downstream relationships between suppliers and customers to deliver the best value to the customer at the least cost to the demand chain as a whole.

Design chain operations Reference (DCOR) model is to provide a framework that links business process, metrics, best practices, and technology features into a unified structure to support communication among design chain partners and to improve the effectiveness of the extended supply chain including the development chain.

Distribution centre described as a warehouse facility that holds inventory from manufacturers pending distribution to the appropriate individual stores.

Distribution chain system is interpreted as of quality if it's reliable and ensures availability and timely delivery of products to the consumption cycle.

Diversification relates to the organisation expanding product and service offering, for reasons of expanding what the organisation offers to customers and potential customers.

E-business is viewed as a collection models and processes motivated by Internet technology and focusing on improvement of extended enterprise performance.

e-Collaboration creates an extended enterprise in terms of 1) new product design and development in fast moving goods industry; the delivery of complex technical projects and programs; improving supply chain performance outcomes on planning and forecasting in the retail sector; and coordinating and evaluating service delivery between multiple providers.

E-commerce is defined as the ability to perform major commerce transactions electronically, as part of e-business". In other words, electronic commerce involves the electronic exchange of information or digital content between two or more parties, which results in a monetary exchange.

EDI in the context of supply chain management is basically a tool that allows automated information exchange between supply chain members in the supply (or demand) chain.

EDI indicates that orders placed with suppliers, orders received from customers, payments made to suppliers and payment received from customers, can all be transmitted through information networks.

Efficient collaboration means these respondents will be able to move into the synergistic collaboration category with some maintenance and extensions.

Eigenvalues (characteristic roots) measure the amount of variation in the total sample accounted for by each factor.

Electronic brokerage effect (where electronically-connected network of many different potential suppliers quickly, while the broker reduces the need for buyers and suppliers to contact a large number of alternative partners individually).

Electronic business (e-business) described as the conduct of business on the Internet, not only buying and selling but also servicing customers and collaborating with business partners.

Electronic collaboration (e-Collaboration) as electronically-enabled data synchronisation accuracy that uses Internet-based technologies to facilitate continuous automated exchange of information between supply chain partners on business relationships, and it requires companies to work together to integrate their operations and eliminate barriers that impact their ability to satisfy customers by including activities such as information sharing and integration, decision sharing, process sharing, and resource sharing.

Electronic communication effect (where IT allows faster and cheaper communication).

Electronic data interchange interpreted as the computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments.

Electronic information integration and bundling allow the flow of information to run parallel to the flow of goods leading to enhanced transparency (availability of electronic point-of-sale (e-POS) data for retailers) and flexibility in the design of supply chains, thereby providing cost absorption and value-added advantages for all involved supply chain partners.

Electronic integrated systems facilitate to the exchanging and sharing information in terms order information, operation information, strategic information, and strategic and competition information in an inter- and intra-orgnisational-configured supply chain network.

Electronic Supply Chain Design (e-SCD) defined as a supply chain design to integrate and coordinate suppliers, manufacturers, logistic channels, and customers using information technology to build an electronic supply chain network (e-SCN) for transactions in virtual space.

Electronic supply chain management (e-SCM) systems defined as one kind of inter-organisational systems (IOS) that enhance communication, coordination and collaboration between trading partners. In other words, e-SCM systems with exchanged information from central hub data warehouse allow “the integration of fragmented, silo-oriented supply chain processes with low cost and rich content.

Electronic supply chain management described as a tactical and strategic management philosophy that seeks to network the collective productive capacities and resources of intersecting supply channel systems through the application of Internet technologies in the search for innovative solutions and the synchronisation of channel capabilities dedicated to the creation of unique, individualised source of customer value.

Electronic supply consists of the additional networking associated with the functions of the suppliers, producers, distributors, and customers.

Electronically-enabled supply chain management (e-SCM) diffusion basically involves both internal diffusion among functional units within an organisation and external diffusion across a large number of inter-organisational trading partners.

Electronic-enabled supply channel interpreted as the application of Internet technologies focused on the continuous regeneration of networks of businesses empowered to execute superlative, customer-winning value at the lowest cost through the digital, real-time synchronisation of product/service transfer, service needs and demand priorities, vital marketplace information, and logistics delivery capabilities.

Enablers of the CPFR process involved defining the agenda for collaboration in terms of stabilising the collaborative goals, expanding the collaborative projects in terms of complexity and scope, and trust in the relationship and ensuring information sharing.

Enterprise Application Integration (EAI) holistically as the plans, methods, and tools aimed at modernising, consolidating, integration and coordinating the computer applications within an enterprise. EAI tools have three main components and the components are summerised as an integration broker, adapters and an underlying to communication infrastructure.

Enterprise Resource Planning (ERP) involves the replacement of existing systems with a suite of interconnected modular systems from a single vendor, was seen as the solution to the problem of systems integration.

EPC network facilitates an open-loop standards-based environment, enabling end-to-end EPC information exchange by offering an intelligent infrastructure capable of linking objects, information, computers and people within a supply chain.

E-procurement defined as the automation and integration of the purchasing process by the application of electronic procurement software and the growth of business-to-business trading exchanges.

E-procurement involves dealings with companies as mirror image of e-Commerce and the system drives implementation benefits such as time savings, more efficient and flexible, cost savings, accuracy, real-time and trackability where sellers instantly adjust to market conditions and buyers achieve flexibility due to stiff competition, fast changing customer preferences, shortening product life cycle and product variant prolification.

ERP database is a digital representation of the firm that contains information on resources, customer and supplier order histories.

ERP system defined as software and hardware that facilitate the creation of transactional data in a company relating to manufacturing, logistics, finance, sales and human resourses. All business applications of the company are integrated in a uniform system environment that accesses a centralised database residing on a common platform including common and compatible data fields and formats across the enterprise.

e-SCM diffusion involves both internal diffusion among functional units within an organisation and external diffusion across a large number of inter-organisational trading partners.

e-SCM is defined as the physical implementation of supply chain management process with a support of information technology while also attempting to make a distinction from the concept of supply chain management. If the e-SCM diffusion between supply chain partners is complex and dynamic in nature, the benefits from e-SCM systems can be disseminated unequally and skewed in favour of members with dominance than dependence members in the chain network.

e-SCM systems diffusion as a process form internal diffusion among functional units within an organisation to external diffusion across inter-organisational trading partners when e-SCM becomes an integral part of the value activities.

External diffusion indicates the extent to which the firm has integrated its trading partners by e-SCM to perform transactions with them.

External integration entails recognising suppliers as an integral part of the supply chain and engaging in collaborative information sharing efforts.

Factor analysis is used to reduce a vast number of variables to meaningful, interpretable and manageable set of factors. In other words, factor analysis is a procedure that takes a large number of variables or objects and searches to see whether these variables have a small number of factors in common which account for their intercorrelation. Factor analysis as a multivariate technique addressed the problem of analysing the structure of the interrelationships (inter-correlations) among a large number of variables by defining a set of common underlying dimensions, known as factors.

Factor interpretations and labels confine to the assumption of face valid imputation of factor label (face validity) that is rooted in theory.

Factor loadings as the basis for imputing a label to the different factors wherein the researcher examines the most highly or heavily loaded indicators in each column and assigns a factor label.

Flow maps serve described as a basis for analysing information needs and the services necessary to align the firm's information collection and transfer capabilities with the information needs of its internal and external users.

Frequency distribution indicates how the different values of the variable are among the units of analysis by representing the data graphically. Frequency distributions are used to describe the responses to a particular variable by displaying the counts and percentages both before and after adjustment for non-responses, and determine the amount of non-response.

Graphical method with "data labels reflects influential cases with high leverage that can be spotted graphically".

Grounded theory defined as the theory that is derived from data, systematically gathered and analysed through the research process. In this method, data collection, analysis and eventual theory stand in closely trenchant relationship to one another.

Heteroscedasticity can manifest from interaction of an independent variable with another variable that is not part of the regression equation. Homoscedasticity is interpreted as the assumption that dependent variable(s) exhibit equal levels of variance (or equal spread) across the range of predictor variable(s) while heteroscedasticity is when the error terms have increasing or modulating variance (or unequal spread).

Homoscedasticity is that the variability in scores for one continuous variable is roughly the same at all values of another continuous variable. It is related to the assumption of normality because when the assumption of multivariate normality is met, the relationships between variables are homoscedastic.

Hosmer-Lemeshow goodness of fit describes how closely the observed and predicted probabilities match at the expected p-value > 0.05. The goodness of fit value measures the correspondence of the actual and predicted values of the dependent variable.

Hotelling's T^2 is used when the independent variable has only two groups and there are several dependent variables. Hotelling's T^2 is used to understand if groups differ on the two dependent variables combined.

Incentive alignment described as the degree to which chain members share costs, risks, and benefits. These dimensions are important for enabling the participating members to improve the swift of flow of information, and products to the end consumers.

Information sharing described as the act of capturing and disseminating timely and relevant information for decision makers to plan and control supply chain operations.

Information sharing is the optimisation strategy to enhance active coordination and integration in the chain network, and it extenuates challenges from consumer order demand variability.

Information sharing paradigm described as the widespread belief should achieve a high degree of active coorperative behaviour requirements to which supply chain participants voluntarily share operating information beyond the scope of cross-enterprise collaboration and jointly plan strategies on extended enterprise integration on supply chain performance benefit, risk sharing, trust, leadership and conflict resolution.

Information technology (IT) is defined as the development, installation, and implementation of computer systems and applications.

Information technology integration includes the exchange of knowledge with partners up and down stream of the supply chain, allowing them to collaborate and to create synchronised replenishment plans.

Information velocity as a term used to describe how fast information flows from one process to another, and information volatility as the uncertainty associated with information content, format, or timing, must be handled to add value to the supply chain.

Innovation diffusion theory (IDT), in terms of adoption and implementation, described as a theory to understand the diffusion of an innovation across time, and it is primarily to explore how a diffusion process with multiple stages is guided and affected by changes in related variables over time.

Integration described as the process through which individuals of a lower order get together to form individuals of a higher order and also, to integrate is to make it a whole, to complete. It implies the creation of proper conditions for various components (independently of the level of autonomy) to be able to dialog, link, collaborate and cooperate in order to achieve the goals of the supply chain system.

Integrity is based on experience from interpersonal relationships between the trustee and the trustor and more specifically on their perceptions of each other's past behavior. Integrity is important in a supply chain because of the presence of numerous players with sometimes, conflicting goals and the existence of written and oral promises to be fulfilled.

Internal diffusion refers to the extent to which e-SCM is used to support key internal organizational activities of the firm.

Internal integration, an exceptional, the ability of distinct functions working together to create seamless interfaces across processes is fundamental to firm and supply chain success.

Internet is where suppliers can share information about changes in customer demand; updated with product design changes and adjustments and provide specifications and drawings more efficiently; increase the speed of processing transactions and reduce the cost of handling transactions; 4) reduce errors in entering transactions data and share information about defect rates and types.

Intranet can be extended for use to outside users, customers, partners, suppliers or others outside the company and it is referred to as an Extranet.

Inventory can be defined "as the goods and/or services that an organisation holds in stock while considering the different types of inventory or inventory categories.

Inventory described as the stock of products held to meet future demand while inventory management is defined as the practice of planning, organising and controlling inventory, which is the main contributor to the profitability of a business.

Inventory management can be defined as the process of efficiently controlling the constant flow of units into and out of an existing inventory

Inventory optimisation described as the discipline of continuously managing inventory policies can optimise supply chain performance against business objectives, changing market conditions, risks, and supply chain constraints.

Item reliability indicates the amount of variance in an item due, to underlying construct rather than to error, and can be obtained by squaring the factory loadings.

Knowledge creation interpreted as the participants invest and involve more in the supply chain, the supply chain partners share more knowledge and coordinate more of their activities to optimise the whole supply chain.

Lean and agile systems share some interface with several other types of performance improvement, including flexible, adaptable, and mass customisation to overcome the rippling oscillator effect in the supply chain. The leagility is described as a system in which the advantages of leanness and agility are combined, was originally developed to describe manufacturing supply chains.

Location pooling provides the retailer with a centralised location for inventory but eliminates the retail stores close to customers.

Logistic regression analysis is described as an approach that is similar to that of multiple linear regression except that the dependent variable is taken into account as categorical. Logistic regressions seem to find relationship between the independent variables and a function of the probability of occurrence.

Logit is the natural log of the odds of the dependent equality a certain value or not (usually 1 in binary logistic models). It means that the natural log of the odds of an event equal the natural log of the probability of the event occurring divided by the probability of the event not occurring.

Mahalanobis distance is the distance of a case from the centroid of the remaining cases where the centroid is the point created by the means of all the variable. Mohalanobis distance (D^2) is the measure of the uniqueness of a single observation based on differences between the observation's values and the mean values for all other cases across all independent variables.

Mapping information flows allows managers to identify how information is transmitted from one point to another both within the firm and externally, to suppliers and customers.

Maximum likelihood estimates are those parameter estimates that maximise the probability of finding the sample data that actually have been found.

Measures of central tendency will enable a researcher to encapsulate and condense information using mean and mode to locate the centre of the distribution while kurtosis and skewness can be measured with ordinal and nominal data.

Measures of dispersion that describe the tendency for responses to depart from the central tendency like mean, will be measured using variance, standard deviation, sigma, minimum, maximum and Cronbach's alpha.

Multicollinearity described as the situation where two or more of the independent variables are highly correlated". linearity is that there is a straight line relationship between two variables (where one or both of the variables can be combinations of several variables). It assumes that errors of prediction are normally distributed around each and every predicted dependent variable. Multicollinearity is interpreted as a problem in multiple regression because it reduces the predictive power of an independent / exogenous variable. A high degree of multicollinearity can lead to regression estimates being estimated incorrectly and even to showing wrong signs.

Multiple regression evolved to a sophisticated and versatile tool for various kinds of data analyses, particularly powerful when samples exhibit distinctive characteristics, and research questions are tailored to address probability related issues. Multiple regression analysis is an analytical tool designed to explore all types of dependence relationships. It describes this dependency technique as tool to develop a self-weighting estimating equation by which to predict values for a criterion variable (dependent variable) from the values for several predictor variables (independent variables).

Multiple regression indicates three-step process analysis (Schumacker and Lomax, 2004): Firstly, model specification which involves finding relevant theory and prior research to formulate a theoretical regression model; Secondly, model identification which refers to deciding whether a set of unique parameter estimates can be estimated for the regression analysis; and Thirdly, model estimation which involves estimating the parameters in the regression mode by computing the sample regression weights for the independent variables.

Multivariate analysis as statistical technique is organised around a scheme that divides into interdependence (factor analysis) and dependence (regression analysis) procedures. The objective is to develop models and dimensions that best describe the population as a whole. Multivariate analysis is referred to all statistical methods that simultaneously analyse multiple measurements of each individual or object under investigation.

Multivariate normality is the assumption that each variable and all linear combinations of the variables are normally distributed.

mySAP SCM is powered by the SAP NetWeaver platform, the open integration and application platform that enables change, helps companies align IT with their business, allows companies to obtain more business value from existing IT investments and to deploy a service-oriented architecture, and reduces total cost of ownership and complexity across the entire IT landscape. mySAP SCM allows firms to adapt to an ever-changing competitive environment. It transforms traditional supply chains from linear, sequential processes into an adaptive network in which communities of customer-centric, demand-driven companies share knowledge, intelligently adapt to changing market conditions, and proactively respond to shorter, less predictable life cycle.

mySAP supply chain management (mySAP SCM) solution, and in particular, its powerful supply chain execution capabilities, can help firms meet these challenges and turn their supply chain into a strategic asset.

Newsvendor model or the newsboy model interpreted as a single-period single-product inventory mode, which is a desirable tool for making a decision, when there is a "too much-too little" challenge.

Nomological validity determines if the scale demonstrates the relationships shown to exist based on theory and/or prior research in the multiple regression technique and factor analysis.

Non-adversarial collaborative relationships entail close operational working and the equitable sharing of value at the commercial level. This strategic integration is likely to occur in situations where the buyer and supplier are interdependent.

Normality refers to the shape of the data distribution for an individual metric variable and its correspondence to the normal distribution, the benchmark for statistical methods.

Odds ratio as another measure of association for 2x2 contingency tables occurs as a parameter in the most important type of model for categorical data.

Odds ratios Exp (B) described as the increase (or decrease if the ratio is less than one) in odds of being in one outcome category when the value of the predictor increases by one unit.

One-way ANOVA involves one independent variable (referred to as a factor), which has a number of different levels, and the levels correspond to the different groups or conditions. It uses a single-factor, fixed-effects model to compare the effects of one treatment or factor on a continuous dependent variable.

Operational excellence is the ability of an organisation to achieve a high level of customer service, while reducing operating costs.

Order splitting described as a stock keeping location that operates independently of all facilities in filling its demand, but divides its reorders (not necessarily evenly) among multiple suppliers.

Organisational learning (OL) perspective views learning that occurs at multiple level and information is processed and transformed into insights and innovative ideas by individuals first; then knowledge is shared and mutual understanding is developed among groups; and some individual or group learning further become institutionalised as organisation artifacts.

Oscillation is when orders and inventory demonstrate large amplitude-fluctuation nodes in the supply chain.

Outliers are cases with such extreme values on one variable or a combination of variables that they distort statistic.

Phase lag when after a certain delay, the peak of orders placed, which commences at the retailer, extends to the rest of the components further upstream. These phases define the magnitude of bullwhip effect.

Portal interpreted as a gateway wherein a site that serves as a starting point for accessing the web and from which the user may access many other sites.

Postponement described as the basic thesis of leagility, the delaying of operational activities in a system until customer orders are received rather than completing activities in advance and then waiting for orders. The lean processes are on the upstream side of the decoupling point, and the agile processes are on the downstream side.

Predictability reflects the trustor's belief that a trustee's actions (good or bad) are consistent enough that it can be forecasted in a given situation. It is based on the premise that organisations are consistent, stable, and predictable in relation to past patterns of behavior.

Principal component analysis (PCA), it is used to reduce input variables complexity when one has a huge volume of information and one wants to have a better interpretation of variables.

Principal component analysis transforms constructs and also extracts loadings with eigenvalues. The method intends to find set of factors that are formed as a linear combination of the variables in the correlation matrix.

Process integration defined as the coordinating and sharing information and resources to jointly manage a process. Process integration can sometimes be an extremely difficult task, because it requires proper training and preparedness; willing and competent trading partners; trust; and, potentially, a change in one or more organisational cultures.

Product pooling with a universal design is useful but might limit the functionality of the products offered.

Prospective collaboration means that these respondents need to transfer the high level attained on the collaborative index into better operational results through learning acceleration and continuous improvement.

Pseudo R square values provide information about the percentage of variance explained.

Questionnaire interpreted as an efficient data collection mechanism with a pre-formulated written set of questions to which respondents record their answers, usually within rather closely defined alternatives.

R/3 system (where 'R' stands for real-time data processing) runs on a number of platforms and uses the client/server model, which can be aligned with their vision: to develop standard application software for real-time business processing.

Radio Frequency Identification (RFID) defined as a technology that uses waves to automatically identify individual items or products in real time in a given supply chain. As the wireless and mobile technologies, it incorporates an electronic microchip within a tag or label that can be subsequently attached to, or embedded in, a physical object.

Reliability relates to the consistency of the measurement as Hair et al., (1998) define reliability as a measure of internal consistency of the construct indicators, depicting the degree of which they indicate the common latent construct.

Reliability-based trust is grounded in an organisational perception of the potential partner's actual behaviour and operating performance where the partner is willing to perform and capable of performing as promised under trustworthy relationships.

Research design expresses both the structure of the research problem and the plan of investigation used to obtain empirical evidence on relation of the problem".

Residuals show the difference between predicted and obtained y-values, identify outliers in the solution and are available in raw or standardised form with or without the outlying case deleted

Retail business model (RBM) innovation is defined as “a change beyond current practice in one or more elements of a retailing business model (retailing format, activities and governance) and their interdependencies, thereby modifying the retailer’s organising logic for value creation and appropriation.

Retailer-managed inventory (RMI) systems where the retailer places orders with the manufacturer who fulfills these orders. Retailer Managed Inventory (RMI) where supplier has the knowledge of retailers’ daily inventory status and the demand experienced by the retailers, but the retailers decide the order quantity based on the stock on-hand and order-up-to level policy.

RFID utilises an integrated circuit and a tag antenna printed on a tag to transmit and record information on the product with an ability to capture more information on a product in a faster, cheaper manner offers supply chain partners a chance to exchange more information across the supply chain and improve overall forecasting accuracy.

Risk pooling as a strategy that aims at pooling and sharing resources in a supply chain so that the risks in supply disruption like, bullwhip effect can be shared.

Risk pooling described as the relationship between the number of warehouses, inventory, and customer services. It can be explained intuitively when market demand is random, and it is very likely that higher-than-average demand from some customers will be offset by lower-than-average demand from other customers.

SAP Advanced Planner and Optimizer (SAP APO) described as a central hub, provides the facilities and tools for real-time cross-enterprise process planning, optimising, and controlling. The cross-enterprises can integrate sales planning, procurement, production, delivery, and other processes into an extended supply chain network.

SAP Enterprise Resource Planning (SAP ERP) provides features and functions for operational analysis to help firms optimise the entire supply chain, improve revenues, and increase customer satisfaction. Firms are concentrating mostly on leagility system and logistical clockspeed to best serve customers.

SAP provides enterprise software applications and support to businesses of all sizes globally. SAP applications, built around their latest R/3 system, provide the capability to manage financial, asset, and cost accounting, production operations and materials, personnel, plants, and archived documents. SAP focuses on six industry sectors: processes industries, discrete industries, consumer industries, service industries, financial services, and public services.

SAP R/3 is a multilayer Internet architecture with an open three-tier approach: presentation, application, and database layers. As the client-server concept, uniform appearance of graphical interface, consistent use of relational database, and the ability to run on computers from different vendors meets with overwhelming approval.

Scan-base trading (SBT) is the process where suppliers maintain ownership of inventory within retailers' warehouses or stores until items are scanned at the point of sale.

Semantic view of supply chain management focuses on managing the flow of goods and services, and information through the supply chain in order to attain the level of synchronization with an understanding that responsive model to customer needs could lower total costs and eventually mitigate the phenomenon of bullwhip effect.

Semantic web described as specifically machine-readable information whose meaning is well defined by standards with interoperable infrastructure that only global standard protocols can provide.

Service chain is configured for a better understanding of service chain management from the perspective of the value network composed of consumers, logistics service providers, multi-tiers of suppliers and auxiliary enablers of technologies and systems.

Service chain management (SvcCM) enables service and/or product organisations to improve customer satisfaction and reduce operational costs through intelligent and optimised forecasting, planning and scheduling of the service chain, and its associated resources such as people, networks and other assets.

Snowball sampling relies on approaching a few individuals from the relevant population and these individuals then act as informants and identifyi other members from the same population for inclusion in the sample

Standard deviation defined as the measure of how much demand tends to vary around the average, and coefficient of variation as the ratio of standard deviation to average demand, that is,

Standardised residuals that refer to residuals after they have been constrained to a mean of zero and a standard deviation of 1, and the rule of thumb is that outliers are points whose standardized residual is greater than ± 3.3.

Stepwise estimation defined as sequential method allows examination of the contribution of each independent variable to the regression model. Stepwise can be referred to as a sequential approach in which the regression equation is estimated with a set of independent variables that are selectively added or deleted from the model.

Stepwise forward approach assists to develop the regression equation after thorough cogitation of independent variables without multicollinearity.

Stock refers to all the raw materials, finished goods and those that are in the warehouse ready to be delivered to the customers or clients. It pertains to goods only, both in terms of quantity as well as its monetary value.

Strategic alliance is defined as an agreement in which, managers pool or share their organisation's resources and know-how with another organisation, and ultimately share the rewards and risks of pursuing the venture.

Studentised deleted residuals are residuals which have been constrained to have a standard deviation of 1, after the standard deviation is calculated leaving the given case out. These residuals are often used to assess the influence of a case and identify outliers. When t exceeds the critical value for a given alpha level (example, 0.05) then the case is considered an outlier".

Studentised residuals are constrained only to have a standard deviation of 1, but are not constrained to a mean of 0.

Supplier relationship management (SRM) software helps to analyse and manage the "buy" side of the business. In the analytical approach to bullwhip effect, the system poses a question on how have suppliers been performing in terms of pricing, quality, speed of delivery, on-time delivery, and ability to respond to emergency requests,

Supply chain agility as an operational strategy focuses on inducing velocity and flexibility in the supply chain.

Supply chain analytics systems (SCA) is developed to address complexities from ERP such as the limited customisation of the ERP software, rigidity and difficulty to adapt to the specific workflow and business process of some companies.

Supply chain collaboration described as two or more chain members working together to create a competitive advantage through sharing information, making joint decisions, and sharing benefits which result from greater profitability of satisfying end consumer needs than acting alone.

Supply chain integration in terms of customers, internal processes functionality and suppliers interpreted as a demonstration of strong commitment to the supportive capabilities of segmentation, relevancy, responsiveness and flexibility. Customer integration develops intimacy with competency to build lasting competitive advantage while competency in supplier integration results from performing the capabilities seamlessly in internal work processes and blending operating processes and activities with those of supply chain partners to meet increasingly broad and demanding customer expectations.

Supply chain integration means the unified control (or ownership) of several successive or similar process formerly carried on independently.

Supply chain management as the design and management of seamless, value-added processes across organisational boundaries to meet the real needs of the end customer.

Supply chain management emphasises the overall integration and long-term benefit of all parties on the value chain through cooperation and information sharing. These signify active supply chain communication, usefulness of e-SCM and the application of IT in supply chain management, and seemingly palliate the variability on consumer demand ordering.

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, it integrates supply and demand management within and across companies.

Supply chain management focuses on the flow of physical products from suppliers through manufacturing and distribution all the way to retail outlets and customers.

Supply chain management is viewed defined as a pipeline or conduit for the efficient and effective flow of products/materials, services, information and financials from the supplier's suppliers through the various intermediate organisations out to the customer's customers or the system of connected networks between original vendors and the ultimate final consumer.

Supply chain operations Reference (SCOR) includes plan, source, make, deliver and return, it goes a step further by including supply chain decisions in design phase and creating a value chain that unites the design chain and the supply chain.

Supply chain orientation defined as the recognition by an organisation of the systematic, strategic implications of the tactical activities involved in managing the various flows in a supply chain.

Supply chain visibility defined as the extent to which partners within a supply chain have access to or share information which they consider as key or useful to their supply chain operations efficiency and which they consider will be of mutual performance benefit.

Supply-demand management (SDM) software assists to analyse and manage the "make, move, and store" side of the business. The questions for analysis: What, where, when and how much should be ordered, produced, and shipped? What are the forecasts for future material requirements, and how accurate are these forecasts?

Synergistic collaboration means these companies have adopted a range of best collaborative practices, resulting in a high level of operational performance.

The Value Reference Model enables organisations to effectively develop and get knowledge of the comprehensive process architectures in their value chains

Tolerance interpreted as the amount of variability and the selected independent variable not explained by other independent variables.

Transshipment occurs when a facility satisfies every demand coming from another territory. It implies that a given proportion of demand is supplied from facilities located in different markets, regardless of whether there is sufficient inventory in the original serving facility.

Trust as a reduction of uncertainty in terms of being a useful component towards understanding collaborative relationships, but trust as an altruistic, unconditional concept is not particularly helpful in a business context.

Trust defined as a "firm's belief to another company"; the performance actions should result in positive supply chain outcomes for enterprise integrated network as well as not taking unexpected actions that result in negative supply chain outcomes.

Trust defined as a firm's belief in its partner's trustworthiness and integrity while commitment is interpreted as an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts at maintaining it by expressing an enduring desire to maintain a valued relationship.

Tukey's test is used to compare the means of every treatment to the means of every other treatment, that is, it applies simultaneously to the set of all pairwise comparisons, $\mu_i - \mu_j$. It is in conjuction with an ANOVA to find which means are significantly different from another.

Underrating collaboration means that these companies seem to be in an unfavourable position, but they have the potential to identify their shortcomings and develop collaborative practices to move to the category of synergistic collaboration.

Unidimensionality is that each summated scale should consist of items loading highly on a single factor. It means that the strongly itemised association with each other would constitute the one-fold concept.

Univariate analysis is examining the distribution of cases on only one variable at a time for purely descriptive while bivariate analysis involves the element of relationships among variable themselves.

Univariate technique will to examine the distribution of cases on one variable at a time.

Unstandardised residuals that refer in a regression context to the linear difference between the location of an observation (point) and the regression line in multidimensional space.

Varimax solution yields results which make it as easy as possible to identify each variable with a single factor as an orthogonal rotation of the factor axes.

Vendor-managed inventory (VMI) system sometimes called a Vendor-managed replenishment (VMR) system, the supplier decides on the appropriate inventory levels of each of the products (within previously agreed-upon bounds) and the appropriate inventory policies to maintain these levels.

Appendix H: Questionnaire

UNIVERSITY OF KWAZULU-NATAL

School of Management

Voluntary Questionnaire

Doctor of Philosophy (PhD) - Supply Chain Management Research Dissertation

Researcher: Mr Thokozani Patmond Mbhele 031 - 2607524 mbhelet@ukzn.ac.za

Supervisor: Dr Maxwell A. Phiri 033 - 260 5843 phirim@ukzn.ac.za

Faculty Office: Ms Christel Haddon 031- 260 1553 Haddonc@ukzn.ac.za

Research Office: Ms Phumelele Ximba 031- 260 3587 ximbap@ukzn.ac.za

Title: Electronic supply chain management systems in managing the bullwhip effect on selected fast moving consumer goods

The purpose of this survey is to solicit information from senior and functional managers regarding the pernicious effect of consumer demand order variability and the magnitude of integrated electronically-enabled supply chain management systems to mitigate the bullwhip effect. The information and ratings you provide us will go a long way in helping us identify the efficiency of integrated electronically-enabled supply chain management systems among retailers and suppliers to improve positive performance targets and outcomes that can enhance the profitability level across the supply chain trading partners. The questionnaire should only take 10-15 minutes to complete. In this questionnaire, you are asked to indicate what is true for you, so there are no “right” or “wrong” answers to any question. If you wish to make a comment, please write it directly on the booklet itself and make sure not to skip any questions. Please answer all these questions as honestly as possible.

Thank you for participating!

Section One

The questions below ask about your organization environment and your personal profile.

1. Department: ________________

2. Your Gender:

Female		Male	

3. Indicate the number of years working in this organization:

Less than 1	1- 3	4 - 6	7 - 10	Over 10

4. Indicate the number of other organizations worked for before joining this organization:

None	One	Two	Three	Four or more

5. What is your job status/level:

Top management	Middle management	First-level	Nonmagerial

6. How would you characterise your organizational category?

Tier/supplier	Manufacturing	Wholesale	Retailing	Other:

7. How many supply chain trading partners in the supply chain network according to stream sites?

Upstream	One	Two	Three	Four or more
Downstream	One	Two	Three	Four or more

8. How many business-to-business information technology systems have been implemented in your organization for last 5 years?

One	Two	Three	Four or more	Namely:

9. How many strategic business collaboration models have been used by an organization for global adaptability in the last 5 years?

One	Two	Three	Four or more	Namely:

10. Which of the following **important factors** tend to generate bullwhip effect in relation to your organization perspective? ***Please select at least THREE factors (encircle your options).***

A. Lead times in the supply chain order replenishment processing

B. Irrational behavioral patterns and decision making among supply chain members

C. In-house electronic supply chain management systems (isolate the supply chain trading partners)

D. Rational behavior under supply chain structure (intuitive or deliberate behavioural patterns)

E. Supply variability on machine reliability problems (factory level)

F. Product promotions (silo-oriented approach)

H. Information errors (distorted information to other supply chain partners)

11. Which of the following critical factors influence information sharing in your organization perspective? ***Please select TWO factors on each category.***

	Positively	**Negatively**	
	Top management support	Length of supply chain network	
	Trust among supply chain partners	Information can reach competitors	
	Shared vision between supply chain partners	Lost of power in disclosing information	
	Frequent interaction between supply chain partners	Difference in inventory control policies	

Section Two

This section aims to obtain information on dichotomous questions *(Yes or No)* with regard to general perceptions, inventory policy and impact of information technology. Please encircle or tick on the appropriate box(es) below.

General perceptions, Inventory and Information			
12	Demand order variability influences the business performance targets and customer service levels	**Yes**	**No**
13	Channel alignment in supply chain helps to coordinate inventory positioning	**Yes**	**No**
14	Inventory control policy at the retailer level often propagate customer demand variability towards upstream site	**Yes**	**No**
15	Information sharing relates to supply chain performance targets in the FMCG industry	**Yes**	**No**
16	Electronic supply chain management systems promote and enhance communication strategies to mitigate order variability	**Yes**	**No**
17	Does your organization use third party information technology system to gather and manage inventory?	**Yes**	**No**
18	Does your organization currently have an in-house information technology department?	**Yes**	**No**

<u>Section Three</u>

The following questions are related to the operational relationship between trading supply chain partners. Based on your experience and perception, please encircle or tick on the appropriate number *("1" as strongly disagree, "3" as neutral or neither agree nor disagree, "5" as strongly agree).*

19	The phenomenon of bullwhip effect (demand order variability) has harmful effects in fast moving consumer goods industry.	**5**	**4**	**3**	**2**	**1**
20	The organizations jointly participate in updating the demand forecast across the stream sites of supply chain.	**5**	**4**	**3**	**2**	**1**
21	The organizations tend to order large quantities to take advantage of transport discounts.	**5**	**4**	**3**	**2**	**1**
22	Inflated orders placed by supply chain members during shortage periods tend to magnify the bullwhip effect.	**5**	**4**	**3**	**2**	**1**
23	Price fluctuation encourages the organizations to purchase in large quantities during promotions.	**5**	**4**	**3**	**2**	**1**
24	Your organization and supply chain trading members are constantly trying to reduce in total lead time in terms of material, information and delivery lead times and delays.	**5**	**4**	**3**	**2**	**1**
25	The organizations in the supply chains are often setting desired service coverage by holding a large inventory to prevent stockouts.	**5**	**4**	**3**	**2**	**1**
Information Sharing						
26	Information sharing achieves supply chain coordination and mitigates consumer demand order variability	**5**	**4**	**3**	**2**	**1**
27	Quality information sharing contributes positively to higher order fulfillment rate and shorter order cycle time	**5**	**4**	**3**	**2**	**1**
28	Integrated electronic supply chain management systems improve information sharing	**5**	**4**	**3**	**2**	**1**
29	Information velocity improves information flow and tames order variability	**5**	**4**	**3**	**2**	**1**
30	Information volatility creates demand volatility and supply uncertainty with information content, format and timing	**5**	**4**	**3**	**2**	**1**

Section Four

The following questions relate to operational performance targets and outcomes after implementing Electronic Supply Chain Management Systems Integration in supply chain business convergence. Based on your experience and perception, please circle or tick on the appropriate number *("1" as strongly disagree, "3" as neutral or neither agree nor disagree, "5" as strongly agree).*

Electronic Supply Chain Management Systems Integration						
31	The system mitigates consumer demand order variability in the supply chain network	**5**	**4**	**3**	**2**	**1**
32	The system enhances informal and formal information sharing among trading supply chain members	**5**	**4**	**3**	**2**	**1**
33	The system communicates your firm's future strategic needs throughout entire supply chain network	**5**	**4**	**3**	**2**	**1**
34	The system improves willingness to share sensitive and confidential information based on trust among supply chain members	**5**	**4**	**3**	**2**	**1**
35	The system offers greater control and access to advanced economic information over demand in the supply chain	**5**	**4**	**3**	**2**	**1**
36	The system provides flexibility to respond to unexpected demand changes (manages emergency demand orders)	**5**	**4**	**3**	**2**	**1**
37	The system improves supply chain performance targets to enhance profitability level	**5**	**4**	**3**	**2**	**1**
38	The system establishes common goal and mutual dependency between collaboration supply chain partners	**5**	**4**	**3**	**2**	**1**
39	The system contributes to significant reducing lead times and speeding up the time-to-market	**5**	**4**	**3**	**2**	**1**
40	The system enhances the optimal inventory positioning	**5**	**4**	**3**	**2**	**1**
Global optimization Strategies						
41	Risk pooling reduces the consumer order variability by aggregating demand across locations	**5**	**4**	**3**	**2**	**1**
42	Centralised supply chain system allows pooled demand from all sources to mitigate demand order variability	**5**	**4**	**3**	**2**	**1**
43	Decentralised supply chain system keeps the optimal stocked level to avoid order variability	**5**	**4**	**3**	**2**	**1**
44	Accurate forecasting models eliminate the bullwhip effect by linking the inventory positioning and order replenishment decisions among supply chain members	**5**	**4**	**3**	**2**	**1**
45	Build-to-order supply chain management allows order replenishment	**5**	**4**	**3**	**2**	**1**

	flexibility and responsiveness to reduce order variability					
46	Collaboration Planning Forecasting and Replenishment (CPFR) provides unlimited access to the retail store's replenishment system to mitigate and manage demand order variability	**5**	**4**	**3**	**2**	**1**
47	Vendor Managed Inventory (VMI) allows the manufacturer to control demand order replenishment over the entire supply chain to mitigate bullwhip effect	**5**	**4**	**3**	**2**	**1**
48	Supplier Managed Inventory (SMI) shifts the responsibility for inventory planning from manufacturer to supplier to mitigate demand order variability	**5**	**4**	**3**	**2**	**1**
49	Pull-based supply chain as demand-driven strategy improves production and distribution coordination with the customer demand to mitigate bullwhip effect	**5**	**4**	**3**	**2**	**1**
50	Agility supply chain as an operational strategy focuses on inducing velocity and flexibility in supply chain to mitigate demand order variability	**5**	**4**	**3**	**2**	**1**

<u>Section Five</u>

51. **Which of the followings electronic information systems are used by your organization to eliminate bullwhip effect or demand variability?**

Systems:	**Using**	**Recommended**
Extranet (SAP)		
Electronic Data Interchange (EDI)		
In-house system		
Integrated Electronic Supply chain Management (e-scm)		
Enterprises Resource Planning (ERP)		
E-mail (E- fulfillment, E-Procurement)		
Radio Frequency Identification Device (RFID)		
B2C e-commerce (Customer relationship management systems)		
mySAP supply chain management		
E-Business Collaboration (Supplier relationship management systems)		
Point-of-Sale (POS)		
E-marketplace		
Electronic Collaboration Forecasting Planning and Replenishment		
Enterprise Application Integration (EAI)		
SAP Advanced Planner and Optimiser (SAP APO)		
Other:		

End of the Questionnaire

Thank you for taking the time to complete the questionnaire.

Consent:

I, ____________________________________ *(Name: Optional)* hereby confirm that I understand the content of this document and the nature of the research project, and I consent to participating in the research dissertation.

I understand that participation is voluntary and I am at liberty to withdraw from the process at any time, should I so desire.

Participant's Signature: _____________________ **Date:__________________**

Appendix I: Ethical Clearence Letter

UNIVERSITY OF KWAZULU-NATAL

RESEARCH OFFICE (GOVAN MBEKI CENTRE)
WESTVILLE CAMPUS
TELEPHONE: 031 260 3587
EMAIL: Ximbap@ukzn.ac.za

25 October 2010

Mr. TP Mbhele (9307842)
School of Management

Dear Mr. Mbhele

PROTOCOL REFERENCE NUMBER: HSS/01181/010D
PROJECT TITLE: Electronic supply chain management systems in managing the bullwhip effect on selected fast moving consumer goods.

EXPEDITED APPROVAL

This letter serves to notify you that your application in connection with the above has been granted full approval through an expedited review process.

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through the amendment /modification prior to its implementation. Please quote the above reference number for all queries relating to this study. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years

Best wishes for the successful completion of your research protocol.

Yours faithfully

....

PROFESSOR STEVEN COLLINGS (CHAIR)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

cc. Supervisor (Dr. MA Phiri)
cc. Mrs. C Haddon

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

Appendix J: Turnitin Report

ELECTRONIC SUPPLY CHAIN MANAGEMENT SYSTEMS IN MANAGING THE BULLWHIP EFFECT ON SELECTED FAST MOVING CONSUMER GOODS INDUSTRY.

By **Thokozani Patmond mbhele**

Turnitin Originality Report is divided into two – Part 1 and 2	
Part 1	**Part 2**
Turnitin Originality Report Prt1 by Tp Mbhele From Paper (Doc FR Thesis) • Processed on 30-Aug-2013 3:31 PM CAT • ID: 348033093 • Word Count: 62407 Similarity Index 2% Similarity by Source Internet Sources: 1% Publications: 1% Student Papers: 0%	Turnitin Originality Report Prt 2 by T Mbhele From Paper (Doc FR Thesis) • Processed on 30-Aug-2013 4:47 PM CAT • ID: 348040495 • Word Count: 68172 Similarity Index 1% Similarity by Source Internet Sources: 1% Publications: 0% Student Papers: 0%
sources:	**sources:**
1 1% match (Internet from 21-Mar-2013) http://front.cc.nctu.edu.tw/richfiles/20004-viewcontentservlet.pdf 1	**1** 1% match (Internet from 02-Mar-2012) http://www.nou.edu.ng/noun/NOUN_OCL/pdf/pdf2/EDU%20802%20Advanced%20Statistics%20Final%202.pdf

PO Box 68648

Bryanston

2021

27February 2014

To whom it may concern,

This letter is to confirm that I am a professional editor and proof reader and that I have edited Mr Thokozani Patmond Mbhele's dissertation (Reg.Number: 9307842).

Title: Electronic Supply Chain Management Systems in managing the Bullwhip effect on selected fast moving consumer goods.

For any queries, please contact me on jenniferrenton@live.co.za.

Yours sincerely,

Jennifer Lindsey-Renton

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