CHALLENGING BULLWHIP EFFECT DYNAMICS WITH ELECTRONICALLY ENABLED-SUPPLY CHAIN MANAGEMENT SYSTEMS

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Abstract

The bullwhip effect shows the dynamics of accumulating order rate that exceeds the tentatively stable actual demand rate. This paper aimed to assess the relative role of e-SCM systems as consumer demand orders cascading upstream supply chain network. The study's population, consisting of the managers (senior and functional levels) including supervisory level (non-managerial) from retail sales, logistics, warehousing, marketing, manufacturing and IT hubs organisations, comprised of 460 respondents. In order to achieve the paper's objective, the researcher developed and distributed a survey questionnaire and collected and analysed the data using Statistical Package for the Social Sciences (SPSS). The empirical results from the study reveal that business-to-business information technology (B2BIT) diffusion frequencies have an effect on supply chain performance and e-SCM implementation promotes connectivity among supply chain partners to entrench commitment of the exchanged demand order information to mitigate the bullwhip effect.

Keywords: Business-to-Business IT, Electronic Integrated Supply Chain Systems, FMCG Industry, Information Technology, Integrated Supply Chain

1. INTRODUCTION

An integrated manufacturing procedure with highly linked facilities and distribution channels that function together to acquire raw materials, transform raw materials into intermediate and final products, and deliver final products to retailers, is referred to as a supply chain network Fu et al. (2014). Such a supply chain can be represented by a directed graph composed of nodes and arrows. According to Fu et al. (2014) supply chain management (SCM), or supply chain optimization (SCO), is a set of methods used to efficiently integrate suppliers, manufacturers, distributors and retailers, so that goods are produced and distributed in the right quantities, to the right locations, and at the right time, in order to reduce system-wide costs while satisfying service level requirements Fu et al. (2014). Lately it is gradually becoming hard for corporations to compete on a world-wide scale with only heuristic decisions on basic illustrations. In several corporations, management has reached the conclusion that optimizing the product flows cannot be attained without applying a systematic approach to the business. More and more approaches and techniques from control engineering are now utilized to design SCM strategies for achieving various goals Fu et al. (2014).

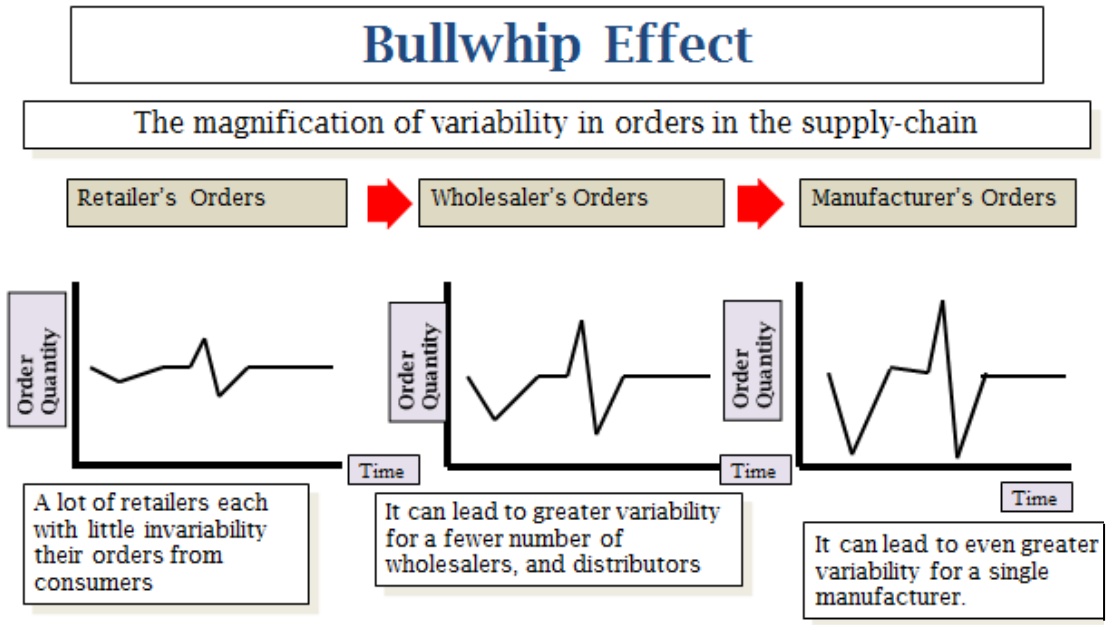
The amplitude in demand order variability (DoV) as orders surge upstream in the supply chain network epitomises a harmful effect known as the bullwhip effect. The real consumer demand orders have comparatively evinced less variability while trading supply chain members on the midstream and upstream stages experience the amplified order vacillations. The oscillator effect reveals a number of pernicious problems throughout the supply chain networks, as downstream sites include harmful bloated inventory and shortages with poor customer service (Makui and Madadi, 2007; Croson, Donohue, Katok and Sterman, 2005; Lee, Padmanabhan and Whang, 2004). The midstream and upstream sites depict the disharmonic capacity with costs and improper planning and inconsistent scheduling in production (Balan, Vrat and Kumar, 2009; Heizer and Render, 2008; Jacobs and Chase, 2008; Davis and Heineke, 2005).

These empirical revelations exhort the supply chain trading partners to exert efforts on maximizing profits through optimisation of the product flows and availability as the operational imperative underpinned by electronically-enabled supply chain management (e-SCM) systems. Electronically-enabled supply chain management has tentatively integrative prospects 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 on reduced oscillator effect (Folinas *et al.,* 2004; Chae *et al.*, 2005; Miao and Chen, 2005). 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; Lin and Lin, 2006).

The synthesis of the above revelations informs the thematic configuration of this study from the

custodian of information to the lead suppliers in the industry. This study investigates the selected fast moving consumer goods (FMCG) industry on the amplified consumer DoV as orders cascade from downstream (retailers) to the midstream and upstream (distribution centres, manufacturers as capacitated suppliers, and lead suppliers and *n*-tiers) sites of the supply chain network. The authors synopsis of the consumption cycle of the end product as stable while the orders for raw material are highly variable, increasing costs and making it difficult for supply to match demand (Chopra and Meindl, 2007; Cachon and Terwiesch, 2009). The magnitude of consumer DoV is presented in the figure below where the amplification of demand orders moves all echelon parties in the supply chain away from the efficient frontier with diminishing customer service levels.

Figure 1. 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*

Figure 1 indicates 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. 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). Although Cachon and Terwiesch,(2009) and Sucky (2009) argue on demand volatility as one moves 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. 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 objectives of this study include to:

- Analyse the challenges of e-SCM systems from the perspective of the bullwhip effect on the selected FMCG industry.
- Assess the relative role of e-SCM as consumer demand orders cascading upstream supply chain network in the FMCG industry.
- Understand the relationship of the extent to which the phenomenon of the bullwhip effect can be explained by e-SCM systems.

2. LITERATURE REVIEW

Supply Chain Management and Information Technology (IT)

Information technology and internet have had a remarkable impact on the way corporations function today. This technology has developed rapidly over the past few years that it is hard to speculate what the future holds. Globalization, Internet and hyper competition give a new dimension to the market and operation. All three forces emphasize the pressure to decrease prices. The reasons should be sought in

the rising interest in electronic commerce. Trends towards globalization, logistics and the development of ICT, including e-commerce, are uniting to restructure the world's trading patterns and subsequently physical trade flows. Online commercial services and e-commerce capabilities is the reason why internet technology is quickly becoming a powerful business tool. The net is prepared to become a medium by which corporations trade, make contracts, exchange data and information, discuss designs and locate components Temjanovski (2014).

The effective supply chain management seems to rely on high levels of mutual trust, business process co-operation 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 Council of Supply Chain Management Professionals (CSCMP) 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" (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 a 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 a portion of the supply chain from which products originate (upstream site) and the demand end (downstream site)".

These definitions dovetail the elements of internal and external integrated processes in the supply chain networks, 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. The use of supply chain information technology (IT) to share and integrate data between buyers and suppliers is value-creating a virtual supply chain as information-based rather than inventory-based. The effective supply chain management should epitomise the design and reflect sound management of seamless, value-added processes across extended enterprises to meet the real needs of the end customer. Christopher (2011:103) stresses that "supply chain partners can only make full use of quasi-real-time shared information through process alignment, collaborative work between buyers and suppliers, joint product development, common systems and shared information". The integration of IT allows for the efficient transmission of information throughout the supply chain which in-turn facilitates supply chain integration for amelioration of bullwhip effect. The underpinning view of an extended enterprise stresses a higher level of collaboration and synchronization on the underlying agile network. In modern economies, the supply chains compete with supply chains on distinct and hard to replicate capabilities to maintain the competitive essence on new revenue opportunities. The supply chain IT portrays as an essential impetus tool for global supply chain competitiveness to enable a high degree of visibility, connectivity, responsiveness and flexibility in supply chain configurations.

Electronically-enabled Supply Chain Management (e-SCM)

According to Lin (2013) electronic supply chain management system (e-SCM) is a form of Internet-based interorganizational system (IIOS) that provide companies with a platform to improve communication, coordination, and collaboration across organizational boundaries. It is therefore important to increase competitiveness. Compared to early forms of IIOS, such as internet-based electronic data interchange (EDI), e-SCM depends greatly on socio-technical interactions (e.g., shared database and joint decision making support) to allow the integration of fragmented, silo-oriented supply chain procedures with low cost and rich content. E-SCM has been discussed in recent literatures as a technology that can offer adopters with numerous operational and strategicbenefits. Whereas the short-term, operational objective of e-SCM is to increase productivity and decrease inventory and cycle time, and the long-term objective focuses on the development and innovation of the end-to-end processes between companies, their customer, and suppliers. Although e-SCM efforts sometimes fail to reach forecasted results, e-SCM is now a Strategic management system to improve competitive position and a major concern for top-level managers. Therefore, identifying and understanding the factors influencing the e-SCM adoption decision is one of the fundamental requisites for development of e-SCM solutions Lin (2013).

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. The rationale dictates that IT should be interlinked 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 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 IT and the shared information (Kim and Im, 2002). Ngai, Chau and Chan (2011:246) discovered that "a 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 themselves ahead of others in their territory through constant innovative business models. 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 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).

Essentially, the visibility of information flow through the RFID system (figure1) 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 the bullwhip effect). This means that the retail store outlets are highly restricted on in-house systems 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 IT from both figures (figures 1 and 2) 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 IT. 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 timelessness 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. Generally, the nature of SCIT systems with exchanged information from a central hub data warehouse allow the integration of fragmented, silo-oriented supply chain processes with low cost and rich content. 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".

Strategic nature of Electronically-enabled Supply Chain Management (e-SCM)

The inter-connectivity nature of modern supply chains are 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. The insights into e-SCM systems diffusion uphold the importance of electronic intra-and inter-organisational systems that enhance communication, coordination and collaboration between supply chain partners.

The contemporary business environment reveals that competition is "no longer between organisations, but between supply chains" (Heizer and Render, 2008; Wu and Chuang, 2012), 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 Chuang (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 processes; 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". Wu and Chuang (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". According to Wu and Chuang (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 Chuang, 2012:103-115).

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 "a 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 "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 challenging problem in a chain network is still the 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). In the same token, the systems integration is also a complex process facing a number of obstacles (Camarinha-Matos and Afsarmanesh, 2002), such as heterogeneity, distribution (physical/geographical), legacy systems without global optimisation/systems or sociable, and continuous and rapid technology evolution, unless the 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.

These statements denote that the e-business, supply chain management, and customer relationship management require close integration of information and process across different parts of the organisation on electronic integrated supply chain systems. Furthermore, Lam (2005:149-157) challenges the sheer scale of integrating so many different systems that it adds to the complexity of the project with the required skills and expertise in integration may also prove to be problematic. The electronic integrated supply chain systems should, therefore, entrench the alignment of core capabilities of available channel partners with the product and service needs and priorities of customers anywhere in the supply chain. The e-SCM systems should also 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).

3. RESEARCH METHODOLOGY

Research design

The research design outlined a plan and structural framework of how the researcher intended to conduct the study to solve the research problems (Cooper and Schindler, 2008:140). The overall research design was an exploratory survey on the empirical research design framework that constituted the blueprint for the data sources, data collection, data sampling methods and measurement, and statistical analysis of data. This design manifested the plan and structure of the investigation so conceived as to obtain answers to the research questions of the bullwhip effect, and electronically-enabled supply chain management (e-SCM) systems. Blumberg, Cooper and Schindler (2008:195) cited Kerlinger (1986:279) who stated 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". This study used a cross-sectional quantitative approach (that is, measurements were taken at one point in time on numerical exploration) to analyse data, and the self-administered questionnaire survey instrument was used for the data collection.

Data Sources

The organisations in retail sales, logistics, warehousing, marketing, manufacturing and IT hubs

were the units of analysis in this study, as such the managers (senior and functional levels) including supervisory level (non-managerial) are the subjects within the organisations. Although the supervisory positions, known as the non-managerial category, have been considered for their reliable information and comprehensive understanding of individual retail outlets as well as retail warehousing systems, the senior executives were ideal participants for this study. Nevertheless, it is crucially important for this study to make inferences with intelligible thoughts, sound rational and, above all, cooperative attitudes to produce integrated research on new knowledge and solution-based findings.

Data Collection

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. A self-developed survey instrument was 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-sectional 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) was grounded within the extant literature review and it was pre-tested using key industry practitioners and academics on a discipline based for suitability to enhance face and content validity. The survey questionnaire was structured into five sections where section one included typical demographics, personal profiles and general information for both the company and individual respondents; representing nominal data (mutually exclusive and collectively exhaustive) and rank-ordered statements (ordinal data). Section two included dichotomous questions (Yes or No) on general perceptions of, inventory management systems to mitigate bullwhip effect, representing nominal data. Sections three and four included interval data with a series of statements that covered operational supply chain networks on bullwhip effect, information sharing, electronic supply chain management integration and global optimisation strategies to ameliorate bullwhip effect. 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 on the main underlying option for parametric and/or non-parametric data (Collis and Hussey, 2009; Cooper and Schindler, 2008; Davies, 2007; Hair *et al.*, 2003). The last section enlisted numerous e-SCM systems that were being used or to an extent recommended by the respondents.

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 ranged from strongly agree to neutral to strongly disagree. Sections three and four were used to derive composite scores of data for each variable as representative of interval data. The respondents were assured that the researcher would 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. The extensive organizational levels question on executives, functional managers and non-managerial supervisory staff seem to provide responses at the personal and business levels with proviso of assurance for anonymity and confidentiality.

Data Sampling Methods and Measurement

A non-probability sample that conformed to this study's criteria with purposive sampling is called judgment sampling. Non-probability sampling has some compelling practical advantages to meet the sampling objectives of the study (Blumberg, Cooper and Schindler, 2008:235). This sampling occurs when a researcher selects sample members to conform to some criterion (Cooper and Schindler, 2008: 397). This method calls for special efforts to locate and gain access to the individuals that do have the requisite information. Convenience sampling was identified based on the design of deliberate sampling for heterogeneity, in which one defines target ranks and departmental persons, and ensures that a wide range of instances from within each echelon are represented. Sekaran and Bougie (2009:276) describe convenience sampling as perhaps the best way of collecting information quickly and efficiently from members of the population who are available to provide it. Referral sampling proved to be the most efficient and effective approach that eventually yielded the majority of the potential respondents of the sampling frame. Snowball sampling relies on approaching a few individuals from the relevant population and these individuals then act as informants and identify other members from the same population for inclusion in the sample (Welman, Kruger and Mitchell, 2005:69).

The retailers (downstream supply chain) and capacitated suppliers (mid and upstream supply chain) in the selected FMCG industry constituted the population of 800 proportionate representatives within five major retail chain stores in eThekwini Metro, South Africa and approximately 300 selective suppliers for these retail groups in food (dairy, frozen, canned and general) and beverages (hot and cold), and a personal health care category were considered for this empirical research study. The sample size of 456 (260 retailers and 196 suppliers) was 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 ratios. 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 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) would become enshrined as the threshold value for declaring statistical significance in this study. This study has produced a sample size of 448 respondents with a 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).

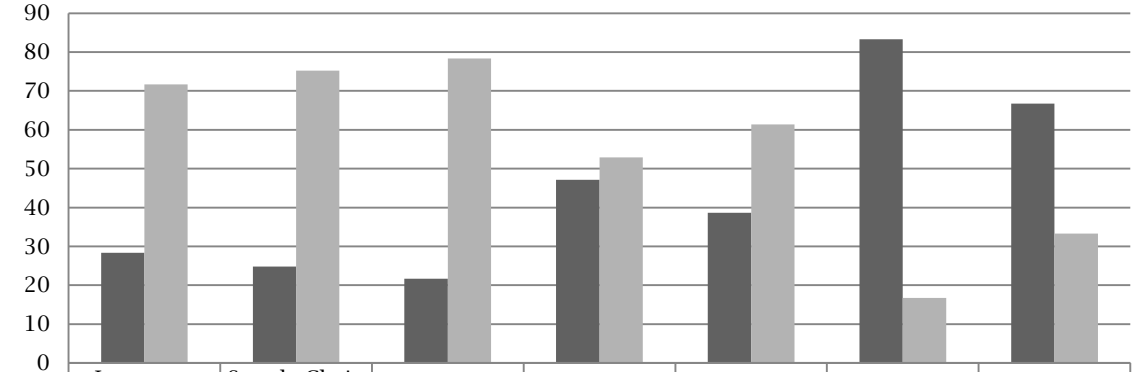
Administering the Survey

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 consistently given to the gatekeepers where the researcher was given permission to enter their domain.

4. STATISTICAL ANALYSIS OF DATA

The statistical analysis is aimed at examining the research objective for this study. The summarised uni-variate technique examined the distribution of cases on one variable at a time using descriptive statistics (mean and standard deviation) and the bi-variate technique using inferential statistics (cross-tabulation with chi-square and correlation) and non-parametric statistics. Multivariate analysis as a statistical technique is organised around a scheme of dependence (regression analysis) procedures for the underlying objective to develop models that best describe the population as a whole. Data analysis was realized using statistical methods of analysis, with computer software SPSS. The following dichotomous questions were used to assess the perception of inventory policy and IT within the challenges of the bullwhip effect.

Figure 3. Perceptions on inventory policy and IT



	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 3 indicates general perceptions on inventory policy and effects of information technology where 72% of the respondents agree 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 the bullwhip effect. It is puzzling to discover that the DoV does not influence the business performance targets and customer service levels. Surprisingly, 67% of the respondents indicate channel alignment in supply chain as a hindrance to coordinate inventory positioning. A high percentage (61%) of the respondents indicated that their organisations currently have in-house information technology departments, and 53% of the respondents only gather and manage their inventory using a third party IT system.

Descriptive Statistics

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

Table 1. Descriptive Statistics on information sharing and electronic supply chain management

Items	Mean	SD/σ	S²	Skew	Kurt	Med	Sigma BWE	Alpha
Electronic S C M Systems.	4.4554	.85020	.723	-2.164	2.487	4.57	.000	.842
Updated Demand Forecast	4.0402	.99583	.992	-1.050	.627	4.20	.000	.833
Information Sharing	3.9955	.96237	.926	-.929	.531	4.13	.000	.835
Information Sharing (I&F)	3.9241	1.10056	1.211	-1.002	.295	4.13	.623	.833
Strategic Communication	3.8772	1.08503	1.177	-.842	.040	4.05	.031	.834
Integrated E-SCM systems	3.8013	.98911	.978	-.471	-.610	3.88	.001	.834
Lead Times	3.7455	1.03300	1.067	-.698	-.021	3.85	.160	.833
Economic Information	3.6585	1.14765	1.317	-.651	-.327	3.79	.065	.831
Inventory Positioning	3.6540	1.09848	1.207	-.645	-.354	3.78	.006	.834
Mutual dependency	3.6250	1.08580	1.179	-.550	-.413	3.72	.068	.832
Profitability Level	3.6116	1.09751	1.205	-.449	-.717	3.71	.084	.833
Flexible Response	3.6071	1.17473	1.380	-.637	-.485	3.76	.006	.830
Confidential Information	3.6049	1.14406	1.309	-.471	-.707	3.71	.318	.832
Std error of Skew = 0.115 **Std error of Kur = 0.230**	SD/σ = Std deviation, S²= variance, Skew=skewness, Kurt= Kurtosis, Med= Median. M=Mean Minimum=1.00, Maximum=5.00. Mode=4.00, Sample Size=448							

Source: Authors of the paper

This section of the paper advocates that e-SCM systems (M = 4.56) are the most significant systems. 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 ranked the e-SCM system with a standard deviation of 0.850 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 with 0.996 std deviation) wherein the organisations jointly participate in updating the demand forecast across the stream sites of supply chain. Although the electronically-enabled supply chain management systems are preferably significant to improve flexibility, future strategic communication (M = 3.88) and informal and formal information sharing (M = 3.92) in the dynamic market, as well as information exchange (M = 4.00), are associated with a high order fulfilment rate and a shorter order cycle time to enhance supply chain performance targets in the FMCG industry

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 systems have a significant role (highly ranked M = 4.46) to encourage 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 the 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). 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 the centre for ordinal data and has resistance to extreme scores (Cooper and Schindler, 2008: 438). This study shows the frequency of the data for e-SCM systems are (-2.164) negatively skewed and a 4.57 median, and an updated demand forecast with (-1.050), a negatively skewed distribution and 4.20 median. Nevertheless, all the individual variables with alpha values between 0.830 to 0.842, are negatively skewed as scores stretching towards the left. The variables that indicate the mean around 3.80 or below have the platykurtic distribution although the scores cluster heavily in the centre. The assumption of normality should be met with skewness values equal or below the criterion of ±3.29 (Garson, 2012; Tabachnick and Fidell, 2007). 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) and highest alpha value (0.842).

Table 2 denotes supply chain trading partners that have introduced three or more B2B IT systems in the last five years with suppliers (6), manufacturing (48), wholesale (69), retailing (91) and other (18) constituting 51.8% of the sample respondents. It was puzzling to discover that only 48.2% of the sample respondents have been cautiously and conservatively investing less on IT systems. Retailers seem to adapt well on the supply chain technological clockspeed with the value of chi-square (22.511) and the degree of freedom (12), $p<$ 0.05 (0.032). There is a statistical relationship between frequent adoption of new B2B IT systems and the echelon category stream sites of supply chain trading partners.

Table 2. Cross tabulation and Chi-square on B2B IT systems for last five years and echelon categories

How has frequent adoption of B2B IT systems influenced by echelon categories over the last five years?			Echelon Categories					Total
			Tier /Supplier	Manufacture	Wholesale	Retail	Other	
B2B IT systems for last five years.	Four or More	Count	1	19	24	36	9	89
		% of Total	.2%	4.2%	5.4%	8.0%	2.0%	19.9%
	Three	Count	5	29	45	55	9	143
		% of Total	1.1%	6.5%	10.0%	12.3%	2.0%	31.9%
	Two	Count	4	19	25	69	10	127
		% of Total	.9%	4.2%	5.6%	15.4%	2.2%	28.3%
	One	Count	6	13	14	52	4	89
		% of Total	1.3%	2.9%	3.1%	11.6%	.9%	19.9%
Total		Count	16	80	108	212	32	448
		Expected Count	16.0	80.0	108.0	212.0	32.0	448.0
		% of Total	3.6%	17.9%	24.1%	47.3%	7.1%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.511[a]	12	.032
Likelihood Ratio	22.694	12	.030
Linear-by-Linear Association	21.954	1	.344
N of Valid Cases	448		

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. Darlington (2009) 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 multi-collinearity. Multi-collinearity 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.

The correlation matrix presented all possible predictor variables and the eight interval level variables indicate the relationship between all possible pairs of variables using a 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 the 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.

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 a *t*-test, *F*-test and Durbin-Watson test without assuming the superiority of the model from a high value for the coefficient regression. The values of the multi-variable regression determination coefficient (R^2) for models 1 -2 are showing improvement with a moderate values range (R^2 = 0.069 and 0.078 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. The study further indicates the final model with R square (0.078), adjusted R square (0.073), *F*-ratio = 18.718 degree of freedom (2; 445) 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 (1.800) with the range of 1.5 and 2.5 and these models are not affected by problems related to multi-collinearity. The *t*-test values are showing the importance of a variable in the model on the value greater than 1.96 at a significance level of less than 0.05. All *t*-test values are appropriate with *t*-significance values less than 0.05 to consider each variable significant to the valid model.

The adjusted R square value of 0.073 has accounted for 7.3% of the variance in the criterion variables to indicate the strength of the model while the *F*-ratio cites on the significance of the model with an 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.

Table 3. Multiple regression statistics on e-SCM systems and predictor variables Model Summary

					R Square Change	F Change	df1	df2	Sig. F Change	
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-SC Systems

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	25.073	2	12.536	18.718	.000[b]
	Residual	298.034	445	.670		
	Total	323.107	447			

Coefficients[a]

Model		Unstandardized Coefficients		Std-Coeff	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Par-tial	Part	Tolerance	VIF
2	(Constant)	3.846	.169		22.705	.000	3.513	4.179					
	Strategic Communica-tion	.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]	Mini mum	Maximum	Mean	Std. Deviation	N
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

Source: Research Results byAuthors of the paper

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

Among all eight dimensions, future strategic communication (β = 0.288, p< 0.05) and advanced economic information (β = -0.098, p = 0.05) were found to be considerably related to the e-SCM systems. Two predictor variables were entered into model 2 (table 1.3) after the 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 (β = 0.288, p< 0.05) and advance economic information (β = 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. Apart from that, since the tolerance value was more than 0.10 and the VIF was below 10, there was not a multi-collinearity problem between items of 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 are lying in a reasonably straight diagonal line from bottom left to top right with no major deviation from normality.

5. DISCUSSION

This study found fascinating empirical research evidence on e-SCM systems that retail supply chain businesses have fastidiously adapted to technology clock-speed for the last five years. The increase in the diffusion of business-to-business information technology (B2BIT) systems for the last five years has been moderate considering the underpinning technology adaptability using the third-party IT system from industry experts. Apparently, the organisations currently have an in-house information technology department either facilitating or carrying out the required supply chain technology solution. Surprisingly, both upstream and downstream echelon categories agreed that e-SCM systems have a significant role to play in mitigating the consumer DoV in the supply chain network.

This study further discovered that the migration from in-house IT systems to integrated e-SCM systems 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 alleviate the challenges of the bullwhip effect. Distinctively, 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 the bullwhip effect.

The criterion variable (e-SCM systems) was negatively correlated to advance economic information, flexible response and profitability level with a significance level, while all possible predictor variables were positive to each other except confidential information and lead times. This infers 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.

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. This study indicates the linear relationship between e-SCM system diffusion and the extent to communicate the organisation's future strategic requirements throughout the 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. 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. In a broader empirical perspective, e-SCM systems diffusion depicted key positive associations with the challenges of the bullwhip effect and the likelihood of persuading mutual supply chain business performance targets to deal with the pernicious effect of cascading DoV in the FMCG industry. 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.

CONCLUSION

In a nutshell, the adoption of e-SCM systems has a positive influence and association with the bullwhip effect by effectively communicating and actively coordinating the real-time information exchange. Sometimes the elements of partnership trust, security of information flow and complexity of implementation can prohibit the accessibility to advance economic information. The in-house IT department 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. Nevertheless, the ability of a company to communicate electronically should enable it to develop supply networks with traditional players, such as suppliers, manufacturers, distributors, and retailers. Electronically connected supply chains provide the ability to enhance and coordinate supply chain management processes across trading partners.

RECOMMENDATIONS

The antithetical background scenario of the research statement positively envisaged as an ideal problem-free system with optimal functionality through the role of the e-SCM system, quasi-real-time information sharing and optimised inventory positioning to abate and subdue the malignant effect of the bullwhip effect. In this regard, 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. In terms of upholding the virtual supply chain networks, the integrated e-SCM systems should provide strategic flexibility to respond to emergency demand order changes in the attempt to minimise inventory stock outs from cascading demand orders upstream. In terms of the supply chain competence and degree of trustworthiness on the underlying integrated e-SCM systems, the FMCG industry should galvanise the willingness to share sensitive and confidential information based on trust and to enhance accessibility on advance economic information. These findings reflect the electronic supply chain competencies that relate to prompt decision and commitment to strategic supply chain flexible responses.

REFERENCES:

1. Anderson V 2009. Research Methods in Human Resource Management. 2nd Ed. London: Chartered Institute of Personnel Development.
2. Babbie E and Mouton J 2001. The practice of social research. Cape Town: Oxford.
3. Balan S, Vrat P and Kumar P 2009. 'Information distortion in a supply chain and its mitigation using soft computing approach'. Omega37:282-299.
4. Barratt M and Barratt R 2011. 'Exploring internal and external supply chain linkages: Evidence from the field'. Journal of Operations Management, 29:514-528.
5. Bartlett JE, II, Kotrlik JW and Higgins C 2001. 'Organisational research: Determining appropriate sample size for survey research'. Information Technology, Learning and Performance Journal, 19(1):43-50.
6. Blumberg B, Cooper DR and Schindler PS 2008. Business Research Methods. New York: McGraw-Hill International.
7. Cachon G and Terwiesch C 2009. Matching supply with Demand: An introduction to Operations Management. Boston: McGraw-Hill Irwin.
8. Camarinha-Matos LM and Afsarmanesh H 2002. 'Design of a virtual community infrastructure for elderly care'. Proceedings of PRO-VE 2002 – Collaborative Business Ecosystems and Virtual Enterprise, Kluwer Academic Publishers, Sesimbra: Portugal, 439-450, 1-3 May 2002.
9. Cao M and Zhang Q 2011. 'Supply chain collaboration: Impact on collaborative advantage and firm performance'. Journal of Operations Management, 29:163-180.
10. Chae B, Yen HR and Sheu C 2005. 'Information technology and supply chain collaboration: Moderating effects of existing relationships

between partners'. IEEE Transactions on Engineering Management,52(4): 440-448.
11. Chopra S and Meindl P 2007. Supply chain management: Strategy, planning and operations. 3rd Ed. New Jersey: Pearson International edition.
12. Christopher M 2011. Logistics and Supply chain management. 4th Ed. Boston: Pearson Publishing.
13. Cohen J, Cohen P, West SG and Aiken LS 2003. Applied multiple regression/correlation analysis for the behavioural sciences. 3rd Ed. New York: Lawrence Erlbaum Associates.
14. Collis J and Hussey R 2009. Business Research: A practical guide for undergraduate students. Basingstoke: Palgrave.
15. Cooper BR and Schindler PS 2008. Business Research Methods.10th Ed. New York: McGraw-Hill International.
16. Council of Supply Chain Management Professionals (CSCMP) 2011. Supply Chain Management definitions, 2011. [Online] Available: http://cscmp.org/aboutcscmp/definitions.asp. [Accessed: 03/12/2009].
17. Croson R, Donohue K, Katok E and Sterman J 2005. 'Order Instability in Supply Chains: Coordination Risk and the Role of Coordination Stock'. PSU Working Paper.
18. Daniel E, Wilson H and Myers A 2002. 'Adoption of e-commerce by SMEs in the UK, towards a stage model'. International Small Business Journal, 20(3):253-270.
19. Darlington RB 2009. Factor Analysis. Pp. 1-23, [Online] Available: http://www.psych.cornell.edu/Darlington/factor.htm. [Accessed: 14/02/2012].
20. Darwish MA and Odah OM 2010. 'Vendor managed inventory model for single vendor multi-retailer supply chains'. European Journal of Operational Research, 202:473-484.
21. Davies MB 2007. Doing a successful Research Project using Qualitative Methods. Basingstoke: Palgrave MacMillan.
22. Davis MD and Heineke J 2005. Operations Management: Integrating manufacturing and services. 5th Ed. Boston: McGraw-Hill.
23. Flynn BB, Huo B and Zhao X 2010. 'The impact of Supply chain integration on performance: A contingency and configuration approach'. Journal of Operations Management, 28(1):58-71.
24. Folinas D, Manthou V, Sigala M and Vlachopoulou M 2004. 'Modeling the e-volution of a supply chain: Cases and best practices'. Internet Research: Electronic Networking Applications and Policy, 14 (4):274-283.
25. Forrester JW 1961. Industrial dynamics. New York: MIT Press & John Wiley & Sons, Inc.
26. Fu D, Ionesco CM, Aghezzaf E and De Keyser R 2014. Decentralized and Centralized Model Predictive Control to Reduce the Bullwhip Effect in Supply Chain Management. Elsevier: Belgium.
27. Garson GD 2012. Factor Analysis. North Carolina: Statistical Associates Publishing.
28. Gunasekaran A and Ngai EWT 2005. 'Build-to-order supply chain management: a literature review and framework for development'. Journal of Operations Management, 23(5):423-451.
29. Hair Jr JF, Babin B, Money AH and Samuel P 2003. Essentials of Business Research Methods. New York: John Wiley & Sons, Inc.
30. Heizer J and Render B 2008. Principles of Operations Management. 7th Ed. New Jersey: Pearson Education.
31. Holweg M and Bicheno J 2002. 'Supply chain simulation – a tool for education, enhancement and endeavour'. International Journal of Production Economics, 78:163-175.
32. Hugo WMJ, Badenhorst-Weiss JA and Van Biljon EHB 2008. Supply chain Management: Logistics in perspective. Pretoria: Van Schaik Publishers.
33. Jacobs FR, and Chase RB 2008. Operations and Supply management: The Core. 2nd Ed. Boston: McGraw-Hill.
34. Ke W, Liu H, Wei KK, Gu J and Chen H 2009. 'How do mediated and non-mediated power effect electronic supply chain management system adoption? The mediating effects of trust and institutional pressures'. Decision Support Systems, 46:839-851.
35. Kerlinger FN 1986. Foundations of Behavioural Research. 3rd Ed. New York: Holt, Rinehart and Winston.
36. Kim KC and Im I 2002. 'The Effects of Electronic Supply Chain Design (e-SCD) on Coordination and Knowledge Sharing: An Empirical Investigation'. In Hawaii International Conference on System Sciences, Big Island, Hawaii, IEEE Computer.
37. Krejcie RV and Morgan DW 1970. 'Determining sample size for research activities.' Educational and Psychological Measurement, 30:607-610.
38. Lam W 2005. 'Exploring Success Factors in Enterprise Application Integration: A Case-Driven Analysis'. European Journal of Information Systems, 14(2):175-187.
39. Lee LH, Padmanabhan V and Whang S 2004. 'Comments on information distortion in a supply chain: the bullwhip effect'. Management Science, 15:1887-1893.
40. Li G, Yang H, Sun L and Sohal AS 2009. 'The impact of IT implementation on supply chain integration and performance'.International Journal of Production Economics, 120(1):125-138.
41. Lin FR and Lin YY 2006. 'Integrating multi-agent negotiation to resolve constraints in fulfilling supply chain orders'. Electronic Commerce Research and Applications, 5(4):313-322.
42. Lin H 2013. Understanding the determinants of electronic supply chain management system adoption: Using the technology–organization–environment framework. Taiwan: Elsevier.
43. Makui A and Madadi A 2007. 'The bullwhip effect and Lyapunov exponent'. Applied Mathematics and Computation, 189:53-70.
44. Miao L and Chen J 2005. 'Information sharing with scarce goods in cournot retailers', International Conference on Services Systems and Services Management, Proceedings of ICSSSM '05, Chonqing.
45. Ngai EWT, Chau DCK and Chan TLA 2011. 'Information technology, operational and management competencies for supply chain agility: Findings from case studies'. Journal of Strategic Information Systems, 20:232-249.
46. Patnayakuni N and Rai A 2002. 'Towards a theoretical framework of digital supply chain integration', European Conference on Information systems (ECIS), Gdansk, [Online] Available: http://is2Ise.ac.uk/asp/aspecis/20020127.pdf., [Accessed: 05/10/2011].
47. Poirier C and McCollum D 2006. RFID strategic implementation and ROI: A practical roadmap to success. New York: J. Ross Publishing.
48. Seidmann A and Sundarajan A 1997. 'Sharing logistics information across organizations: Technology, competition and contracting'. Working Papers from Rochester, Business – Operations Management, [Online] Available: http://oz.stern.nyu.edu/papers/slog.html. [Accessed: 19/08/2009].

49. Sekaran U 2003. Research Methods for business: A Skill Building Approach.4th Ed. New York: John Wiley & Sons Inc.
50. Sekaran U and Bougie R 2009. Research Methods for Business: A Skill Building Approach, 5th Ed.New York: Wiley & Sons.
51. Simchi-Levi D, Kaminsky P and Simchi-Levi E 2008. Designing and Managing in supply chain: Concepts, Strategies & Case Studies. 3rd Ed. New York: McGraw-Hill/Irwin.
52. Smith GE, Watson KJ, Baker WH and Pokorski II JA 2007. 'A critical balance: Collaboration and security in the IT-enabled supply chain'. International Journal of Production Research, 45:2595-2613.
53. Snyder LV and Shen ZM 2011. Fundamentals of Supply Chain Theory. New Jersey: John Wiley & Sons, Inc.
54. Sorescu A, Frambach RT, Singh J, Rangaswamy A and Bridges C 2011. 'Innovations in Retail Business Models'. Journal of Retailing, 87S (1):S3-S16.
55. Subramani M 2004. 'How do suppliers benefit from information technology use in supply chain relationship?' MIS Quarterly, 28(1):45-74.
56. Sucky E 2009. 'The bullwhip effect in supply chains – An overestimated problem?' International Journal of Production Economics, 118:311-322.
57. Tabachnick BG and Fidell LS 2007. Using Multivariate Statistics. 5th Ed. Boston: Pearson International Edition.
58. Temjanovski R 2014. Challenges of Information Technology and Supply Chain Management in Logistic Sector: With an Overview of Quehenberger Logistics in Macedonia. Macedonia: SINTEZA.
59. Verma R and Boyer KK 2010. Operations and Supply Chain Management. International Ed., US: Cengage Learning.
60. Welman JC, Kruger SJ and Mitchell BC 2005. Research Methodology. 3rd Ed. Cape Town: Oxford University Press Southern Africa.
61. Wisner JD, Leong GK, and Tan K, 2009. Principles of Supply Chain Management: A Balanced Approach. 2nd Ed. Australia: Thomson South-Western, CENGAGE Learning.
62. Wu IL and Chuang CH 2012. 'Using the balanced scorecard in assessing the performance of e-SCM diffusion: A multi-stage perspective'. Decision Support Systems, 52: 474-485
63. Wu IL and Chuang CH 2012. 'Examining the diffusion of electronic supply chain management with external antecedents and firm performance: A multi-stage analysis'. Decision Support Systems, 50(1):103-115.
64. Yao Y, Palmer J and Dresner M 2007. 'An interorganisational perspective on the use of electronically-enabled supply chains'. Decision Support Systems, 43(3):884-896.
65. Yu M, Ting S and Chen M 2010. 'Evaluating the cross-efficiency of information sharing in supply chains'. Expert Systems with Applications, 37:2891-2897.
66. Yu Z, Yan H and Cheng TCE 2001. 'Benefits of information sharing with supply chain partnerships'. Industrial Management and Data Systems, 101(3):114-119