A Mixed-Method Longitudinal Exploratory Conceptualization of E-Supply Chain Management

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Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no materials previously published or written by neither another person, nor materials which have been submitted for the award of any other degree or diploma of a university or other institution of higher learning. Where other people's work or ideas have been used, they have been appropriately referenced and acknowledged. All views expressed in this research therefore, are solely my own construct and do not necessarily reflect the views of any other individual or organization".

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ABSTRACT

This research details a mixed methods study of e-supply chain management. The research employs a quantitative study to derive descriptive statistics and network relationships of the concept during 1998-2009 from the Social Science Citation Index, through bibliometrics. A further qualitative study developed the identical sample through a three phase analysis to triangulate and corroborate a conceptual framework of e-SCM; thus achieving significant enhancement. The research finds that e-SCM refers to the use of e-technology, particular internet and web technologies, to design or configure e-supply chains for greater efficiency and productivity through e-integration, e-collaboration and e-information sharing. The study also developed a classification of e-supply chain designs.

Keywords: e-supply chains, e-supply chain management, e-supply design, supply strategy, mixed methods research, bibliometrics, e-integration, e-collaboration, e-information sharing, conventional content analysis, theme analysis, typology development, conceptual framework.

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CHAPTER ONE

1.1 Background

Supply chain management (SCM) is a wide and constantly developing domain. Traditionally the SCM area of the business manages the inputs into the organization and one would generally refer to 'good practice' as buying the correct goods and services for the organization, at the right price, right quality and on time. Although many definitions of the concept exist, a supply chain (SC) was viewed traditionally as a system where raw materials and associated information flow go in at one end and finished products come out at the other end; from source to the final consumer. Each of the members maintained an independent unit with little or no integration, direct information or relationship. Figure 1 shows a simplified supply chain of this process, in which the main firm completes all five portions of the supply network; this is known as vertical integration. This sees the main firm involved in raw materials production, the manufacturing of products and services, in-house assembly stages, owns retail outlets and also involved in customer service and beyond. Nevertheless, it is almost impossible to find firms that complete all stages of the supply network process, in practical terms. For instance, in the oil and gas industry, a single firm can control the entire supply chain, from the exploration and production of crude oil, and the refining and manufacturing of petro-chemicals, to the transportation and sale of end product such as diesel or petrol.

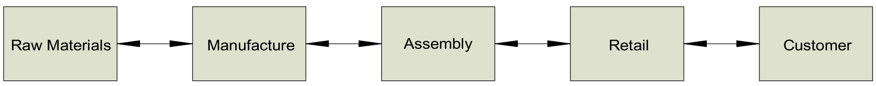

Figure 1 A vertical integrated SC

One of the most important decisions underlining SCM that makes it impossible for firms to be involved in all stages of the supply chain is the 'make or buy decision'. Very few organisations have all the skills and resources required to design and manufacture entire products or offer a full-range of services in-house. These individual 'make or buy' decisions define the scope of each stage in the supply network. For example, Figure 2 shows a five-stage supply chain from raw materials to customers in which the main firm buys raw materials and performs manufacturing in-house while the rest of the processes are completed by external suppliers. This is known as vertical disintegration.

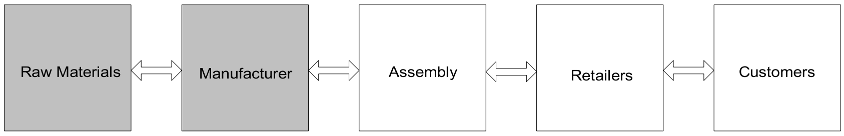

Figure 2: A vertical disintegrated SC

There are many benefits that could be attributed to an efficient and effective supply chain and firms usually get involved in designing and implementing good SCM practices for various reasons. For example, a logistics provider might see the benefits of SCM in the reduced costs of transferring fixed administration and management to a purchased service based on throughput in greater reliability of standardized processes which decrease variability, and in exceptional management and increased control as a result of monitoring management's performance with clear targets and accurate metrics. More generally, SCM practices can streamline and simplify processes, eliminate waste, increase productivity, improve quality and reduce errors, control and guide processes, provide flexibility, provide customer satisfaction, cost savings and provide an environmentally friendly recycle or end-of-life service efficiently (this is not an exhaustive list).

With time, firms begin to realise that they cannot compete in isolation of their suppliers or other sectors in their supply chain. Any gains or value made by the efficient management of each chain member is passed-on in some form or the other to the next chain member, through to ultimate value-creation for the end customer. For example, the efficient management of raw materials may lead to low-cost but high-quality raw materials for the manufacturer. Firms realise that whenever a chain member deals with another chain member which performs a phase in the supply network, both stand to benefit from the other's success. As this relates to each chain in the network, it became not only an economic importance but also a strategic one, to manage the entire network of suppliers in order to optimise or improve overall performance. One recent move to achieve this, has been the adoption of electronic technologies, in particularly, internet and web technologies, which help firms to manage the flow of materials and the parallel flow of information, and to collaborate with other chain members in an integrated network, for greater productivity and efficiency. This is generally known as internet and web supply chain management or more commonly as e-supply chain management (e-SCM). The ‘e’ signifying that it is an electronic or digital form, through internet and web technology. Firms have realized that internet and web technologies can be used to integrate all the parties and processes in SCM into seamless efficiency for greater productivity.

1.2 Introduction

Over the last decade, academic literature has reflected an increased interest in the use of electronic technology (e-technology), particularly internet and web technologies, for supply chain management. This emergent field, generally referred to as e-supply chain management (e-SCM), is discussed in high ranking journals in areas such as supply chain management, operations management, information systems and transportation research, among others. At the same time, there has also been renewed interest in the history and coverage of the use of technology in SCM. This research focusses therefore, on developments in e-SCM during the period 1998-2009.

The use of internet and web technologies for supply chain management is transforming the way business is carried out even within electronic or digital domain. The use of electronic telecommunication systems for trade is not new in itself. Some of its first applications involved the transfer of funds (between financial institutions via telecommunications networks) in the financial sector in the early 1970s. In the 1980s, electronic data interchange heralded the electronic movement of standard documents such as purchase orders, bills and confirmations between business partners. The use of internet and web technologies has had a transformative effect on SCM thinking, to become a truly global force for change. However, the concept is still in its teething stage and poses many questions and challenges.

One particular challenge is that there is no conceptual framework of e-SCM. The use of internet and web technologies has emerged principally from the utilization of technology in SCM to improve the effectiveness and efficiency of supply chain systems and processes. Its rapid adoption and development has been facilitated by the use of inter-organizational systems to collaborate, integrate, and to improve the flow of information between organizations.

Academic understanding of e-SCM has sometimes suffered from lack of conceptual clarity because of the speed of these developments, the multidimensional and the cross-disciplinary nature of supply chain management. In the same vein, the use of the pre-fix ‘e’ (relating to the internet) has become almost a cliché, which denotes the various areas in which the internet can be applied (e.g. e-learning). This can give rise to conceptual difficulty which can make it very difficult to understand the specific nature of e-supply chain management.

Although emerging studies are beginning to examine the different facets and themes of this phenomenon, an updated academic consolidation of research in this field has thus far been lacking. The increasing interest in e-supply chain management research and practice clearly highlight the need for an integrated conceptualization of this phenomenon which takes into account all its various manifestations. These concerns have made it important to develop a conceptual framework that will provide better insight and understanding of the concept and its use in practice.

This has prompted a call from the academic community for further research into the concept and practice of e-supply chain management to better understand its underlying dimensions. It is argued that conceptual clarity about the nature of e-SCM is essential for better insight and understanding of its nature, its growth and consequently, the advancement of knowledge in this area.

1.3 Research Aim and Objectives

This study aims, therefore, to develop a conceptual framework of e-supply chain management. This will extend e-supply chain management research by providing better insight and understanding of the concept, in the interest of academia and as a contribution to knowledge. Such a conceptual framework will, among other things, aid analysis and provide more insight on how organizations arrange and conduct themselves within modern economic environments, using internet and web technologies in SCM. As such, this research heeds the call from the academic community for further research into the concept and practice of e-supply chain management to better understand its underlying dimensions. To this end, the main objectives of the research are:

1. To gain insight into the direction, trends and current status of e-SCM
2. To discover a structure or components of e-SCM that will aid the creation and development of a conceptual framework.
3. To identify different types of e-supply chains.

1.4 Structure of the thesis

The remainder of the thesis is organized as follows: - Chapter two consists of a secondary analysis of previous work relevant to the research aims and objectives, in order to establish the research agenda and guide the subsequent study. Chapter three has an explanation of our research methodology, data collection methods and the approaches taken for the analysis of the data. Chapter four discusses the results, their interpretation, and research legitimation issues arising from mixed methods. Finally, chapter five discusses the conclusions of the research, with an eye on possible directions for further research.

CHAPTER TWO

A secondary analysis of e-supply chain management (1998-2009)

2.1 Introduction

This chapter consolidated and classified the literature of e-SCM from articles published in the Social Science Citation Index, over the period 1998-2009, in order to develop a conceptual framework of e-SCM. This period was deemed appropriate because of our intention to capture long-term trends, which could be used to address gaps in the literature, in order to provide better insight and understanding of e-SCM, including, a contribution to the intellectual structure of concept. Further references to papers published in other journals are included where appropriate. The review identified two main components of e-SCM, from which a conceptual framework was proposed, as well as a classification scheme for e-supply chains. The framework denotes that the use of e-technology, particularly internet and web technologies, to design or configure e-supply chains, can provide greater efficiency and productivity, through e-integration, e-collaboration and e-information sharing.

It is perhaps evident that the concept e-supply chain management is part of the wider and controversial domain of supply chain management (Croom et al. 2000). As such, SCM is seen to be very important in understanding the concept, 'e-supply chain management'. Supply chain management originated in the early 1980s, focusing on the potential benefits of integrating the internal business functions of purchasing, manufacturing, sales and distribution (Harland, (b) 1996). Though its evolution has been subsumed under a constellation of events, the domain is now being catapulted into worldwide prominence through the inception and use of internet and web technologies in supply chain practice.

The first of these milestone events took place during the 1990s, when manufacturers and service providers sought to collaborate with their suppliers to upgrade purchasing and supply management functions from a clerical role to an integral part of their systems. Correspondingly, many wholesalers and retailers also sought to integrate physical distribution and logistics functions into transportation and logistics perspective of supply chain management in order to enhance competitive advantage.

Over the years, these two traditional supporting functions of corporate strategy evolved along separate paths and eventually merged into a holistic and strategic approach to operations, materials and logistics management, to be commonly referred to as, supply chain management (Tan, 2001). The phrase has become popular overtime albeit with little consistency in its use and with little evidence of clarity of meaning (Harland, (b) 1996).

Lee and Billington, (1992) for example, described SCM as the coordination of the manufacturing, logistics and materials management functions within an organisation. Harland, (b) (1996) described SCM as managing business activities and relationships (1) internally within an organisation, (2) with immediate suppliers, (3) with first and second-tier suppliers and customers along the supply chain and (4) with the entire supply chain. Cooper et al. (1997) described SCM as the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers. SCM is the chain linking each element of the manufacturing and supply process from raw materials through to the end user, encompassing various organisational boundaries (Scott and Westbrook, 1991 and New and Payne, 1995).

Baatz, (1995) further expanded on this definition to include recycling or re-use of products and materials (Tan, 2001). Successive frameworks to define the domain has sought to better integrate the differing views of SCM related issues, from the belief that there is no common understanding on what the term SCM actually means (Mills et al. 2004). Decades on, a bibliometric study mapping the intellectual structure of SCM, confirms that these definitional standpoints, approaches and associated bodies of knowledge, still remain multidimensional (Charvet et al. 2008). These various descriptions echo New's, (a) (1997) critique that there is no explicit description of SCM or its activities in the literature.

Secondly, a controversy over the status of SCM as an emerging academic discipline has been brought into question. Half a decade or more ago, a special issue of the *International Journal of Operations and Production Management (IJOPM)* which focused on the question: 'Is SCM an emerging academic discipline'?, pronounced among other things, that although the field of SCM has continued to grow in prominence within the field of operations management, within the broader discipline of management and from increased attention from scholars in a variety of disciplines, and even from an international perspective, SCM is still not regarded as sufficiently significant, to be a discipline (Cousins et al. (a) 2006). Burgess et al. (2006) for example, found that SCM not only lacks a consensus of definition of key terms within the field but also that several disciplines are attempting to claim ownership of the field. 'SCM lacks coherence, quality, impact and debate to claim its own right as a discipline' (Harland et al. (c) 2006). While it is still developing, SCM still has some way to progress in order to be a strategic value-adding element of the business (Storey et al. 2006).

Similarly, the domain has been hit by related events and dominant business trends over the last two to three decades, which has revealed the emergence of a more holistic and integrated trend towards globalisation in co-operatives and inter-organisation networks. The first of these events catalogued by Harland et al. (d) (1999) is the increasingly emergent business context within which organizations must compete - marked by globalisation of competition, that requires global co-operation and global co-operative networks Decisions taken in such networks have not been driven by management theory, but instead by a case of academic understanding, playing catch-up with business practice.

The second event is the expanding academic subject boundaries of a broad range of traditional business subject areas, notably operations management, purchasing and supply, logistics, service management, materials management and industrial marketing. This reflects the integration within and across businesses that has been identified within business strategy as occurring in the changing global business context.

This precipitated the expansion and internationalisation of operations management and its externalisation beyond the firm boundary, the relevance of lean operations and lean supply, the shift in thinking of purchasing and supply management, the work of the Industrial Marketing and Purchasing (IMP) group in relationship marketing including networks, the birth of logistics and the attempt to integrate operations management with marketing, particularly to services, from proponents of service management, which led to the birth of the concept of ‘supply strategy’ (Harland et al. (d) 1999).

The concept of ‘supply strategy’ integrates many aspects and approaches within various subject areas to add a new overarching and differentiating logic. The integration of various bodies of knowledge and concepts forms a holistic and strategic perspective of management that stretches across organizational boundaries. Therefore, no other business subject can claim to have provided an integrated and holistic concept that joins what are essentially, bodies of work, relating to the operating parts of business that is conducted in inter-firm, co-operatives and global networks, whether in manufacturing, supply, distribution or in providing a service. Supply strategy then, relates to the integration of activities within firms, in dyadic relationships, in chains of firms and in inter-organisational networks, which even though are expressed as different systems or levels of supply, they have a common flow of supply activities and decisions associated with that flow (Harland et al. 1999).

The same has argued that a rational, normative approach to supply strategy is feasible and evident in business practice and proposed therefore that supply strategy can build on and externalise the rational operations strategy approaches, to extend them to inter-organisational networks. Their concept of supply has been summarised therefore as a holistic approach to managing operations within collaborative inter-organisational networks, allowing the formulation and implementation of rational strategies for creating, stimulating, capturing and satisfying end customer demand through innovation of products, services, supply network structures and infrastructures, in a global dynamic environment.

Supply strategy describes sets of supply chains, their flow of goods and services from original source to end-customer and the incorporation of the term ‘network’ signifies an attempt to make the concept wider and more strategic for harnessing resource potential in a more effective and efficient way. Supply networks denotes not only an ‘upstream’ network of suppliers but also a ‘downstream’ network of distributors and customers; hence, the much popular thesis (Cunningham, 1990) that ‘networks compete with networks' rather than simply 'firms against firms' (Lamming et al. 2000). Some of Harland et al.'s (d) 1999 assumptions and implications for the future of supply that paved the way for the study of e-supply management are summarised below:

- A prediction that globalization, as a trend, will be facilitated by the internet.
- The incidence of global inter-organization networks would be long-term with key players.
- Firms would be dynamic – as changing sets of competencies and knowledge rather than fixed functional structures.
- Supply chains would be very innovative with each link adding value, the management of which, would be comprehensive and competitive in response to market forces with value finding its way to end-customers through 'the line of least resistance'.
- And the demand for a far greater range of customized new products and services, leading to the creation of new supply systems within dynamically changing supply networks.

However, although supply strategy can accommodate and explain the commercial and market complexity associated with the delivery of goods and services from source to destination and beyond, it still appears inadequate for managers facing the practical problems of creating and operating supply networks on a daily basis (Lamming et al. 2000 and Harland et al. (d) 1999). Nonetheless, the above discussion not only represents the increasing scope of work on supply and the value chain that mirrors work in this area overtime, but it also serves as a stepping stone upon which to base the study of e-SCM.

2.2 Dimensions of E-Supply Chain Management

There has been an increasingly growing interest in the use of internet and web technologies for supply chain management (e-SCM). Over the years, various authors have indicated that e-supply chain management has allowed firms and industries to gain considerable access to their operations more effectively and efficiently (Du, 2007 and Pavic et al. 2007) so as to enable SCM to evolve from its early practice of concentrating on internal processes to the use of internet and web linking of supply chain partners. Since then, the literature is extolling the importance of e-SCM for the competitiveness of industries and economic actors (Lancaster et al. 2006). Nevertheless, research on e-SCM is in its infancy however its practice seems to be expanding as organizations and industry embrace the concept in a bid to compete in the current turbulent digital environment.

The e-SCM literature has recorded different disciplines' interest and influence in e-SCM. Further research referred to the concept and practice as an *operational strategy* (Lawson, 2000), *e-business* (Barnes et al. 2003 and 2004; Croom, 2005; Pavic et al. 2007; Caskey et al. 2001 and Wall et al. 2007), *virtual organisation* (Ho et al. 2003; Graham and Hardaker, 2000; Davidrajuh, 2003 and Gunasekaran and Ngai, (d) 2004) and *supply networks* (Kehoe and Boughton, (b) 2002; Sherer, 2005; Lamming et al. 2000).

There is already indication that those who practice e-supply chain management are improving productivity and efficiency thereby gaining competitive advantage (Du, 2007). In addition, much of the literature surrounding e-SCM is myriad with various definitions, frustrating attempts to a universal definition (Lancaster et al. 2006 and Sammon and Hanley, 2007). Another debilitating aspect of this phenomenon is the various overlapping and at times confusing terminologies and interpretations in the literature. The most colourful includes: *a tsunami of change, digital age, information economy, network capitalism* and many more (Lankford, 2004; Graham and Hardaker, 2000; Auramo et al. 2005; Lancioni et al. (a) 2005; Sammon and Hanley, 2007 and Humphreys et al. (b) 2006).

Moreover, it seems apparent that its impact is not confined to any one particular area or business practice. Its subsequent analysis and development will determine future economic growth (Del-Aquila et al. 2003) and possibly the re-thinking or re-emphasis of management thinking itself (Lang, 2001 and Ho et al. 2003). This generalization and seemingly multidimensionality of e-SCM, coupled with the cross-disciplinary nature of SCM can pose significant conceptual difficulty. Therefore, although emerging studies are beginning to examine different facets of this phenomenon (Liu et al. 2010; Mukhtar et al. 2009; Sambasivan et al. 2009 and others), a gap still exists in the e-SCM literature with regards to its conceptual development (Bi et al. 2010), which is the main aim of this study.

As such, every effort should be made by the academic community to help understand the nature and structure of this complex phenomenon in order to resolve its conceptual difficulty and subsequent empirical validation. Similarly, there should concern over the lack of an integrated perspective, which combines and examine, the different variables that have been identified in the literature, in a single study. Therefore, the onus of this study is to develop a conceptual framework of e-SCM that will provide better insight and understanding of the concept in the interest of academia and as a contribution to knowledge. Our review of e-SCM identified two main components associated with e-SCM, as depicted in Figure 3. These are (1) e-technology and (2) e-supply chain design.

Figure 3: The two main components of e-SCM

2.3 **E-technology**

E-SCM is a young, developing and exploding field that, among other things, analyses the role played by e-technology, particularly the internet and web technologies, to manage supply chain networks. E-SCM has led to the emergence of new academic research areas that builds on existing research in a host of disciplines such as information systems, business strategy, engineering and economics, to name a few (Zhao et al. 2008). Our literature review further identified four sub-categories of e-technology.

The first sub-category of e-technology is centred on technology's use in SCM, hence, we have named this sub-category 'use of technology in SCM' or "Technology" for simplicity. This sub-category includes different types of research on technologies that are used in SCM, including internet and web technologies (see appendix 5). The main themes or achievements that these technologies seem to present in supply chains are (a) better information exchange and sharing (b) integration and (c) collaboration. The second sub-category deals with research on the use of internet and web technologies to achieve integration in supply chains. This sub-category is called “e-integration”. The third sub-category deals with research on the use of internet and web technologies to achieve information sharing in supply chains. This sub-category is called “e-information sharing” and the fourth sub-category deals with research on the use of internet and web technologies to achieve collaboration in supply chains. This sub-category is called “e-collaboration”. Further review of the literature supports these views.

2.4 Technology

Since the work of Kaufman, (1966) and others in inter-organizational systems, there has been a massive development in the range of Information Technology (IT) utilization in SCM (Craighead and Laforge, 2003), as well as a virtual explosion of literature reporting their use in various academic journals and outlets (Zhao et al. 2008 and Auramo et al. 2005). Rapid technological revolution and increasing competition in the global market has forced companies to reduce cost, time to market and to speed up innovation for products and services. Consequently, firms use technology to connect and support tasks, processes and functions internally, with other companies or in their supply chain network, in order to improve efficiency and increase productivity (Furst and Schmidt, 2001).

While the technology perspective covers a broad range of traditional interest in the utilization of different technologies in supply chains, such as investment, diffusion or performance queries (Gonzalez-Benito, 2007; Khouja and Kumar, 2002; Shah and Shin, 2007; Melville and Ramirez, 2008; Wu et al. 2006), three main themes that seem to unite technology’s use in SCM is that they represent the utilization of different technologies, including electronic or digital technology in SCM in order to achieve different levels or dimensions of (1) integration (2) collaboration and (3) information sharing. This view is amply supported by the SCM literature.

2.5 Supply chain integration

SCM literature has long reported the importance and criticality of the integration dimension for efficiency, effectiveness and success in traditional supply chain management (Wall et al. 2007). Supply chain integration of all the parties is an important part of SCM (Nurmilaasko, 2007). Craighead et al. (a) (2007) for instance, agrees that a key goal of SCM is the integration of participant's efforts, activities, capabilities and resources. They asserted that the realization of this integration is clearly enabled by different kinds of technologies, particularly technologies that span the boundaries of supply chain participants, to link trading partners in a supply chain. These systems among other things; lower costs, increase information speed and reduce information errors, which in turn may enabled the effective and efficient product flow among participants. Their particular focus details the strategic and operational benefits of inter-organizational systems or supply chain management system (SCMS).

Paterson et al. (a) (2003) noted that the use of technology to accomplish supply chain integration has become a competitive necessity in most industries, "organizations need to adopt and synchronize supply chain technologies in order to protect market share and improve market penetration". They considered the extent to which US firms adopted and integrated SC technologies (including software tools) into major areas of their supply chain and reported that all these technologies were concerned with information exchange within and between organizations and/or, in managing supply chain related data activities (Paterson et al. (b) 2004).

2.6 Information sharing in supply chains

Supply chain management is about information sharing within and between organizations because it aims to ease and improve the flow of information and communication between all parties in the supply chain (Paterson et al. (b) 2004 and Numilaakso, 2007). Therefore, the use of technology for information sharing in supply chains signifies the importance that is centred on its achievement for SCM. For example, Childerhouse et al. (a) (2003) outlined the pressures surrounding automotive first-tier suppliers; discussed in terms of the 'three top pains' facing a typical major 'player'. They noted in particular, that the 'lack of information pain' is when information is withheld, masked, distorted or just missing, in real-world supply chains. This, they claimed, can lead not only to panic, confusion, excessive or unnecessary costs, but also, to lack of reliable information, which in turn is related to poor performance and a fragmented approach to supply chain design and operations. An excess cost relating to the ‘bullwhip effect’, was one such phenomenon observed under these circumstances. This situation could be resolved by implementing a holistic and seamless supply chain through BPR (Business Process Re-engineering) programmes, in order to obtain greater market share that will benefit entire supply chains if they ‘think and act as one’. They stressed that timely and high fidelity information flow (an essential feature of supply chains) is needed to compete in uncertain environments.

Similarly, in order to improve information flow in automotive supply chains, order generation and order fulfilment were identified as two ‘performance pains’ which are crucial to effective supply chain performance. These processes should be made ‘pure’ and ‘transparent’ throughout the chain, as part of ‘capturing the moments of information’ (Childerhouse et al. (b) 2003). These studies were somewhat supported by Lin et al. (a) (2002) and aims to analyse the impact of information sharing on SC performance in e-commerce. Lin’s results indicate, among other things, that the more detailed information shared between firms, the higher the order fulfilment rate will be, together with shorter order cycle time.

According to their discussion, higher levels of information sharing will guarantee competitive advantage not only in the supplier’s own industry but also outside the supplier’s industry. Technology can facilitate real-time information sharing not only with downstream firms but also with upstream firms collaboratively through EDI or the internet (Lin et al. (a) 2002). Effective information sharing significantly enhances supply chain practice and the effective coordination of chain members’ activities. Furthermore, to sustain successful partnership, information sharing between partners should be frequent and none-coercive. Supply chains that often undertake active information sharing initiatives to coordinate various activities, gain a competitive advantage over others (Benton and Zhou, 2007).

2.7 Supply chain collaboration

Collaboration is considered a critical element of SCM. SCM practices encompass a spectrum of activities both internal and external to the organisation, with the primary goal of creating value to the end customer (Handfield and Nicols, 1999). This is best accomplished when there are coordination of activities between linked members in the supply chain which should result in reduced costs due to the elimination of operational duplication and resource waste. Two types of collaboration have been identified; intra and inter-collaboration.

Intra-collaboration directly impacts inter-collaboration, which in turn directly impacts organizational performance. Intra-collaboration is defined as an effective, mutually shared process where two or more departments work together, have mutual understanding, have a common vision, share resources and achieve collective goals. This requires, among other things, cross-functional planning, coordination and sharing of integrated databases. The focus of inter-collaboration is on two or more organizations. Inter-collaboration requires sharing of information across the full range of supply participants as well as sharing of internal cross-functional processes (Sanders, (a) 2007). For example, supply chain initiatives such as Customer Relationship Programme and Vendor-Managed Inventory (CRP and VMI) provides closer collaboration through information sharing between manufacturers, retailers and have been shown to provide benefits and competitive advantage (Yao and Dresner, 2008). Most authors seem to agree that the concept of supply chain collaboration is well established.

2.8 *The importance of technology in SCM*

Technology's capability has been positively linked to increased performance and the potential to provide significant competitive advantage (Sanders, (b) 2008). Similarly, since the inception of the use of internet and web technologies in SCM, the traditional view of IT as an enabler to businesses seems to be eroding as internet and web technologies are not subject to the same restrictions as traditional IT, but rather, has evolved to a strategic role, powering supply chains to support new business strategies (Power and Simon, 2005). Numerous studies in the review indicate that the ability to leverage technology can form a profitable resource coalition for distinctive competency in the digital environment.

Some of these new technologies include software-tools to support business processes; computer-aided design (CAD) to model physical systems on computers; product data management (PDM) to support product design processes and manage all relevant construction data such as product structure effectiveness and different versions of documents and product views; enterprise resource planning (ERP) to automate finance, human resources and to help manufacturers handle jobs such as order processing and production scheduling; customer relationship management (CRM) to support sales, marketing, customer service, analysis and management reporting; SCM tools that deals with the management of materials, distributors and customers; simulation tools for manufacturing facilities to optimize part handling, transport length, buffers and stocks; simulation enterprise to support enterprise strategic planning and virtual enterprises to build business models that are complex for high-technological products and services (Furst and Schmidt, 2001).

Notwithstanding, there have been some detractors in the literature concerning technology's ascendance (Subramani, 2004 and Wu et al. 2006). Of note in Soto-Acosta and Merono-Cerdan, 2008, is Carr's assertion that 'IT doesn't matter'. His argument is that because every firm can purchase technologies in the marketplace, all companies can easily copy and/or freely use or obtain them, thus, it ceases to be a differentiating factor in organizational performance. He also questioned technology's basis for sustaining competitive advantage; pointing out that scarcity not ubiquity is the true capacity for sustained competitive advantage. However, most management information systems expert disagrees with his assertions.

In all, a greater number of authors see the growth and development of technology and its impact on SCM as changing the face of business to enable real-time collaboration, integration and to speed up information flow and sharing between supply chain partners (Sanders, 2007 and Lancaster et al. 2006). The entire sub-category therefore perceives the use of technology in supply chains, including internet and web technologies, to be important in SCM, for the achievement of efficiency and productivity either in the form of collaboration, integration, information sharing or a combination of these three achievements.

2.9 *Defining technology*

(1) Technology has been noted to provide integration between supply chain firms and a direct integrative link for supply chain coordination, (Sanders, (b) 2008). (2) In addition to integrating systems, technology has since been viewed as a backbone of SCM as it is used to acquire process, transmit and improve information sharing among supply chains to enable activities and for effective decision making. (3) Similarly, it has been tirelessly reported that the philosophy of SCM is founded on collaboration between supply chain partners. This collaboration however is facilitated by an effective and efficient technology system.

Overtime, technologies have automated many supply activities, support and have enabled a truly interacting 'added value-chain', not only to suppliers and trading partners but also to customers. An integrated "high level of technology capability can provide a clear competitive advantage....and a differentiating factor....in performance", (Sanders and Premus, (c) 2002). Since then, among other things, technology has been identified as the most common factor associated with the advancement of SCM and also regarded as the firm's most strategic tool. Therefore, companies have invested millions in technological capabilities (Sanders and Premus, (C) 2002 and Sanders, (b) 2008).

Moreover, our analyses of the 'technology' sub-category indicate that the use of technologies in SCM enables the achievement of three main themes: integration, collaboration and information sharing (see appendix 5). Lancaster et al. (2006) also confirmed that integration of technology speeds up information flow and collaboration in supply chains for e-business. For the above reasons, technology is seen to play a critical role and an essential enabler of SCM. In the above context therefore, we have accordingly defined IT as '*the use of technology to achieve integration, collaboration and information sharing in supply chains' for greater efficiency and productivity'*. Although there have been different definitions of IT (Sanders and Premus, (c) 2002), our theme-achievements definition is deemed appropriate for the study of e-SCM because of its significance to the wider study of SCM.

2.1.0 E-integration

The themes of integration and strategy seem to be interwoven at different levels around the deployment and development of internet-based activities. Therefore, it is important to understand how e-integration strategies can contribute to the achievement of e-SCM. The literature on e-integration traced the history of the interest in inter-organizational systems for supply chain integration (Siau, 2003). Several other authors looked at the use, impact and evolution of inter-organizational systems (IOS) for integration (Kurnia and Johnston, 2000; Saeed et al. 2005; Siau, 2003; Alt and Fleisch, 2000; Chi et al. 2007; Han et al. 2008; Da Silveira and Cagliano, 2006 and Lin, 2006).

Researchers have long advocated the need for a closely integrated relationship between supply chain members (see Lambert et al. 1998; Armistead and Mapes, 1993). Although we have known about the theoretical benefits of supply chain integration for years, making it work in practice has been difficult. For instance, the use of electronic supply through EDI allowed expensive but limited content with a few remote partners, while Kanban provided low cost yet rich connections with many nearby customers or suppliers.

In order to improve the effectiveness of SCM and compete in today's dynamic global markets, it is not only sufficient to have only effective integrated processes; a synchronized operation of all partners in the supply chain is required. The concept of gaining competitive advantage by linking information systems across organizations (supply chain integration) has taken on a whole new meaning. The growing importance and easy accessibility of the internet have propelled IOS to new heights. Such e-linkages known as inter-organizational information systems or e-information systems are adopted as a routine platform, and now have greater impact on organizational performance and industry structure (Siau, 2003 and Williamson, 2004).

Only recently has the internet resolved this problem and now all supply chain partners can effectively be integrated (Flynn et al. 2010). The internet can foster the integration of business processes and relationships across the supply chain and support market mechanism to generate sustainable competitive advantage (Garcia-Dastugue and Lambert, 2003). Frohlich, (2002) for example, has shown that e-integration permits strong supplier and customer integration. Customer integration involves core competences derived from coordination with critical customers while supplier integration involves core competences related to coordination of critical suppliers (Devaraj et al. 2007; Frohlich and Westbrook 2002). Customer and supplier integration are commonly referred to as external integration, which is the degree to which a firm partners with its external partners to structure inter-organizational strategies, practices and processes into collaborative and synchronised processes.

Similarly, there has also been a lot of support in the literature for e-integration of internal processes and systems. Internal integration is the degree to which a firm structures its own internal organisational strategies, practices and processes, into synchronized processes, in order to fulfil its customers' requirements and to efficiently interact with its suppliers. Just as internal fit indicates consistency among structural characteristics within an organization; it recognizes that the departments and functions within a firm should function as part of an integrated process (Kambil and Short, 1994; Flynn et al. 2010).

In addition, several other studies have argued the importance of internal integration including Harland's famous levels of integration studies and Team's 1999 technology paths to an integrated enterprise in (Wall et al. 2007). According to the work of stage theorists, internal integration is seen as a prerequisite for external integration (Flynn et al. 2010). Kim and Park, (2008) further pointed out that close strategic alignment and coordination with supply chain partners is indispensable for linking supply chain practices and competitive capability which also requires internal cross-functional integration within a firm and external integration with suppliers and other stakeholders in order to be successful. In today's global environment, businesses must be agile and responsive in order to be competitive. We are therefore in agreement that e-integration requires both internal and external integration.

E-integration requires a greater degree of synchronization of the entire supply chain that will necessitate greater coordination among participating members and stronger alliances that can improve inter-firm communication. Giassi and Spera, (2007) agreed that an essential ingredient for success is the complete integration of all the components of the supply chain; leveraging the internet as 'an interactive global nervous system' or 'supply web' in which business can employ and deploy integrated, interoperable, scalable and web-centric solutions that are requires for real-time decisions and intelligence to operations. Such e-integrative linkages are now adopted as routine platforms (Siau, 2003 and Williams, 2004) and now have greater impact on organizational performance, industry structure and competitive advantage. This sub-category discussed different focuses of internet and web integration strategies in supply chains. In line with this thinking, e-integration will be defined as '*the use of internet and web technologies for supply chain integration in order to achieve greater efficiency and productivity'*.

Pavic et al. (2007) for example, stated that the use of the internet and other information and communication technologies increase business performance, however, it is the inter-connectivity and systems integration dimension that has the most important function in e-SCM. Similarly, Kim and Park, (2006) reported that the potential benefit of integrated e-SCs will be realized only if the connections and inter-relationships among different parts of the supply chain are recognized. In line with this thinking, e-SCM ensures the coordination and integration of all activities into a seamless process to strengthen supply chain relations and create network efficiency for complete synchronization and integration of the entire supply chain (Vokurka et al. 2002 and Kehoe and Boughton, (b) 2001).

Research in this sub-category contains a large variety of initiative ranging from simple supply chain integration (e-integration) between organizational units within the same company (e.g. through intranet) to complex e-integration between different companies in an e-SC network (e.g. e-marketplace). For example, Lequizamo et al. (2004) discussed how an integrated database system can provide real-time response, heterogeneity, satisfaction, flexibility and adaptation to changing requirement. Van der Aalst and Kumar, (2003) discussed an XML system for seamless e-data transfer that supports flexible routing of documents. Davis and O'Sullivan, (2003) designed an IOS for extended enterprises. Both Lin et al. (2006) and Soliman and Janz, (2004) designed internet inter-organizational information systems, based on a portfolio of systems that integrate organizational and inter-organizational processes, to assist firms in realizing their objectives and (Lee et al. 2008) discussed e-vendor managed inventory and other lean systems in the service industry.

Other studies from this perspective include; the integration of EDI and the internet (Witte et al. 2003); the integration of short-term supply chain networks (Karkkainen et al. 2003); use of agents to integrate a scenario-driven supply chain (Cho et al. 2004); supply chain and process integration in Bose Corporation (Segars et al. 2001); Lyon's (2004) architecture for customer driven supply operations; Paik and Park's (2005) software component architecture for information integration to support innovative product design; integrating EDI legacy system with an e-SCM system (Wang and Zhang, 2005); Mondal and Tiwari's (2003) use of mobile agents for integration; Sadeh et al.'s (1998) blackboard architecture for integrating process planning and production scheduling and Chow et al.'s (2007) use of web and RFID, for visualizing logistics operations.

The e-integration classification also discussed relevant key strategic issues including adoption, design, implementation, impact, barriers and benefits of e-integration strategies. These underlying issues might depend, among other things, on the nature and type of linkages, complexity, partnership and co-operation, ownership and investment and interaction with other business processes. In addition to this, some of the competitive advantages stemming from different value creation factors from e-integration were identified. Some of these include improved communication, competitiveness and profit, real-time response to changing requirements, seamless data transfer and workflow process, efficient and effective global quality management, customer responsiveness, flexibility of ubiquitous change, global visibility, quality process improvements, lead-time performance and leagility. This sub-category has discussed the different focus of internet and web integration strategies (or e-integration) in supply chains.

2.1.1 E-collaboration

Another dimension of e-SCM that has received attention in the literature is its impact on collaborative relationships and partnership structures. E-SCM could be the catalyst for some powerful strategic partnerships (Fulconis and Pache, 2005) through a change in strategic alliances and partnership structures into relationships that are based on productivity and cooperative partnerships (Vokurka et al. 2002) rather than on long-term partnership relationships favoured by traditional supply chains (Williams et al. 2002). However, it is the strategic focus of firms that will influence the nature, collaborative and business type (Cousins, 2005).

Internet and web collaboration has emerged as one of the core components driving e-supply chain management in order to meet the ever changing market environment in the new economy, where global markets are subject to global standards. According to Jagdev and Thoben, (2001), there can be almost infinite variations in the range and scope of collaborations within an enterprise network along a continuum. However, they also noted that e-supply chains between the collaborating enterprises have to be set-up before any sophisticated manifestations of supply chain collaboration develop. Collaborative technologies have enhanced supply chain visibility and made distribution of products and services efficient, improved customer relations, supplier relationships and marketing strategies (Boone and Ganeshan, 2007). A thorough account of the characteristics of these different continuums of collaboration can be found in Jagdev and Thoben, 2001.

The use of e-technologies, specifically internet and web technologies in supply chains can enable real-time collaboration between partners in supply chains. Collaboration is considered a critical element of SCM practices and encompasses a spectrum of activities both internal and external to the organisation with the primary goal of creating value to the end customer. This is best accomplished where there is coordination of activities between linked members in the supply chain and should result in reduced costs due to elimination of operational duplication and resource waste (Sanders, (d) 2007).

E-collaboration involves both internal and external business processes and activities for customers and suppliers. For example, intra-collaboration directly impacts inter-collaboration, which in turn directly impacts organizational performance. Intra-collaboration is defined as an effective, mutually shared process where two or more departments work together, have mutual understanding, a common vision, share resources and achieve collective goals. It also requires cross-functional planning, coordination and sharing of integrated data bases. Inter-collaboration on the other hand is similar to intra-collaboration although its focus is between two or more organisations. Inter-collaboration requires information sharing across the full range of supply chain participants as well as sharing of internal cross-functional processes (Sanders, (d) 2007).

Consequently, collaboration can be easily and directly enabled by e-technologies for e-supply chains. Therefore, increasing attention is being paid to understanding details of its mechanisms and processes. Through e-collaboration for example, supply chain partners can coordinate, enabling real-time communication to travel immediately up and down the supply chain to coordinate movements of inventories. This has enabled products to be delivered quickly and reliably when and where they are needed, provide high responsiveness to short lead times, eliminate the bullwhip effect and to improve firm performance both internally among departments and among external operations with suppliers. Accessing real-time demand information was virtually impossible prior to the internet. Today e-collaboration through the internet has enabled supply chains to be powerful strategic weapons due to their use for unparalleled collaboration among partners with relatively low transaction costs (Sanders, (d) 2007).

According to Johnson and Whang, (2002), e-collaboration is defined as *'business-to-business interactions facilitated by the internet'* while Rosenzweig, (2009) considers '*e-collaboration to facilitate coordination of various decisions and activities beyond transactions among the supply chain partners.....over the internet/web technologies'*. Nevertheless, as the entire sub-category involves research on the use of the internet and web technologies for collaboration (e-collaboration) in supply chains in order to achieve greater productivity and efficiency, we have therefore accordingly defined e-collaboration as '*the use of internet and web technologies to collaborate in supply chains in order to achieve greater efficiency and productivity'*.

Most authors seem to agree however, that although the concept of collaboration in supply chains has been well established, it is the development and use of IT and communication technologies in e-supply chains that has expedited the nature and scope of collaboration to new and higher heights (Lancaster et al. 2006; Jagdev and Thoben, 2001 and Sanders, (d) 2007). Without appropriate e-technology approaches and infrastructures, effective cooperative relationships between enterprises would not be possible. Others believe that collaboration is the mediating variable between the critical role of SCM and e-business as it can be directly enabled through the use of technology. These collaborative technologies are now a prerequisite for the current new global economy. Therefore, it is believed that, since collaboration can be directly enabled through technology, e-collaboration is the critical mediating variable between SCM and e-technologies (Frohlich and Westbrook, 2002 and Sanders, (a) 2007).

For example, an internet collaborative platform was implemented to address the strategic issue of increasing shelf availability and customer service in grocery retailing. This initiative used an e-collaborative platform to enable real-time information sharing between Veropoulos Spar (a Greek retailer) and her suppliers (Procter and Gamble, Unilever and Elgeka), to address and support daily ordering and store replenishment processes with the objective of maintaining optimum levels of stock and to avoid out-of-stock or out-of-shelf situations (Pramatari and Miliotis, (a) 2008). The prior initiative was limited to collaboration through central-warehouse replenishment.

Some other examples of e-collaboration from this review includes Tolone's, (2000) agile virtual situation rooms, which connect people across enterprises; Shen et al.'s (2003) collaborative agent-based infrastructure for internet collaboration; Shirodkar and Kempf's, (2006) supply chain collaborative model to share capacity; Woo's, (2007) e-collaborative distributed process planning for manufacturers; Yang et al.'s (2006) internet collaborative product development chain for networked product development; El-Diraby's, (2006) web services environment for collaborative management of product life-cycle costs; Liu et al.'s, (2006) networked engineering portal to support distributed supply chain partnership; Howard et al.'s 2006 automotive e-hubs; Shao et al.'s (2006) web-enabled collaborative quality management system and Tseng et al.'s (2008) conceptual model of a web-based integrated design system.

Another remarkable example of this edgeless, permeable and continuously changing collaboration is what Nucciarelli and Gastaldi, (2008) refered to as ‘strategic actions and grand strategies’ in the aviation industry, where collaboration has become the core aspect driving e-supply chain management. They explained how internet web collaboration (e-collaboration) is generating competitive advantage through progressive decrease of entry barriers, more efficient and reliable relationships with different suppliers and easier access to channels of distribution.

Airlines have strongly invested in both ICT and computer reservation systems (CRS) since the fifties, which have become the central planning and commerce platform for full-blown worldwide service carriers. These have gradually evolved over the years into more sophisticated global distribution systems that can process large amounts of data and connect several industry stakeholders. Nucciarelli and Gastaldi, (2008) agree that e-collaboration, through e-marketplaces, has further broadened and increased the value chain efficiency, sustaining the creation of IT-enabled competitive advantage that has led to the achievement of industry-wide standards and supply chain integration. E-supply chains from the e-aviation industry that uses collaboration as core competence include, Aeroxchange, Exostar, Partbase, LastMinuteTravel.com, Priceline.com and Travelocity.

2.1.2 E-information sharing

One of the most important dimensions of e-SCM deliberated by a wide range of works is the importance, visibility and speed of information flows across participants through the use of e-technology (Melville and Ramirez, 2008; Kelepouris et al. 2007; Rafaeli and Ravid, 2003; Lin et al. 2005; Yao and Dresner, 2008; Chan and Chan, 2009; Rabinovich, 2007; Guide et al. 2005; Hosoda et al. 2008 Fairchild, 2005; Stefansson, 2002 and Gunasekaran and Ngai, 2007). Others have identified the dynamism of e-information sharing to be critical in building viable e-supply chains, or as they put it, ‘a multitude of firms co-operating in a multi-directional web-linked environment’, from the speed and growth of e-technology (Graham and Hadaker, 2000; Van Hoek, 2001 and Wagner et al. 2003). The internet can provide real-time collaboration and an information and communication-based network for businesses to operate through e-supply chains (Lancaster et al. 2007).

Gunasekaran and Ngai, (d) (2004) commented on this ability of e-supply chains to reach beyond boundaries of single firms to share information among suppliers, manufacturers, distributors, retailers and stated that the success of e-supply chains hinges on the application of real-time logistics information systems to improve communication throughout the supply chain. Williams and Moore, (2007) also consider information power derived from e-supply chains to be a critical factor that can be quickly turned into knowledge and serve as competitive advantage for those who have it. They reported that, with such visibility, firms have been able to develop new customer relationships, implement and manage value-added activities in their e-SCs to operate faster, better, more flexibly and at a lower cost, thus, gaining competitive advantage. In fact, Dimitriadis and Koh, (2005) suggested that the flow of information in e-SCs might be more important than the flow of goods.

"SCM is about planning, implementing and controlling the flow of information … between suppliers and through different organizations......, of information sharing within and between companies". Establishing such e-linkages with suppliers and customers can enable firms to transmit and receive communication with much shorter lead times than previously, which gives the potential to speed up all transaction (Nurmilaakso, 2007). Information sharing is an important part of SCM; by using internet and web technologies for information sharing, this can be achieved faster, with less error, saving time and money and more efficient resource utilization and customer service (Stefansson, 2002 and Gunasekaran and Ngai, 2007). Therefore, since the entire literature of this perspective involves the use of e-technologies in supply chains for efficiency and high productivity through information sharing, we have defined e-information sharing as *'the use of internet and web technologies for information sharing in supply chains in order to achieve greater productivity and efficiency'.*

Consequently, it is the advent of internet and web technologies that speeded up this new perspective of information sharing between parties in a supply chain. E-information sharing aim to ease and improve the flow of information and communication between all organizations in the supply chain in real-time (Nurmilaakso, 2007). This potential accelerated subsequent use of internet and web technologies for business-to-business and business-to-customer communication and commercialization in e-procurement, e-logistics, e-marketplaces and e-commerce.

2.1.3 Defining e-technology

Several terms can be used to describe SCM technologies, such as 'new information technology for SCM', 'IT related resources variables', 'IS' and 'technological IT resources' (Zhao et al. 2008; Auramo et al. 2005). Nevertheless, the existing contemporary literature on technology and SCM identified the common terms used for business models using IT as 'e-commerce' and 'e-business' – the former relating to typical web-based sales and the latter to a more holistic use of technology (Power and Singh, (a) 2007). Moreover, the term 'e-business' often refers to the use of the internet…', hence, 'e-business technology' (Vakharia, 2002; Power and Singh, (a) 2007).

Accordingly, Boone and Ganeshan (2007) defined 'e-business technology' as *'the use of the internet or any digitally enabled inter-intra-organizational information technology to accomplish business processes',* whilst Sanders, (a) (2007) defined e-business technologies as "*information technology that use the internet, web and web applications*". 'E-technology' is therefore a shortened form for e-business technology with the "e" indicating electronic or digital technologies with specific reference to internet and web environments. There is ample foundation then, that the term 'e-technology' could be defined as "the use of internet and web technologies in supply chains for e-integration, e-collaboration and e-information sharing in order to achieve greater productivity and efficiency*"*. Further review of the literature supports this view.

E-technologies have facilitated the creation of an entirely new way of doing business which Wall et al. (2007) described as the '*overall strategy of redefining old business models, with the aid of technology, to maximize customer value and profits and also involves the creation of new e-business strategies or models that are based on new technology*'. For example, the use of EDI or ERP with e-technology implies redefining old business models whilst the use of e-technology to design e-supply chains would indicate models based on new models. E-technology has therefore revolutionized supply chain management (Boone and Ganeshan, 2007) and provided a major opportunity for firms to differentiate themselves on the basis of a distinctive value chain (Power et al. (b) 2010).

This new shift necessitates the effective e-integration of all supply chain partners through the internet (Frohlich, 2002 and Flynn et al. 2010), for a greater level of synchronization of the entire supply chain in order to enable e-collaboration (Johnson and Whang, 2002; Sanders, (d) 2007 and Rosenzweig, 2009) that can create significant real-time visibility and speed for effective e-information sharing to enhance and coordinate supply chain activities effectively (Nurmilaakso, 2007 and Cai et al. 2010), increase resource utilization and performance, thus reducing cost and errors and in turn, the flow of goods and services to customers and supply chain partners (Gunasekaran and Ngai, 2007; Dimitriadis and Koh, 2007 and Melville and Ramirez, 2008). The adoption and implementation of these 'advance supply chain technology strategies' by American manufacturing companies has enabled them to improve both quality of service and reduce production costs thereby gaining competitive advantage (Du, 2007).

The successful implementation of these strategies which are based around the underlying technology of the internet would not be possible prior to the recent digital technology development. Some examples include: Amazon's adoption of a '*merchant model'*, allowing Amazon to retail goods and services completely over the internet, the concept of the '*extended product'*, the '*extended dynamic network'*, Shunk's '*end-to-end synchronization concept*, Kalakota's *'extended enterprise'*, Merli's *'industry transformation concept',* Thoben's *'e-business conceptual model', 'the Rosetta net'* and the *'extended SCOR conceptual model'* (Wall et al. 2007).

Over the last decade or two, such e-technologies, particularly internet and web technologies, have revolutionized supply chain design, control and management (Boone and Ganeshan, 2007). They have enabled a paradigm shift from inventory to information, from competition to collaboration and from cost to value. E-technology has permeated every supply chain process. E-technology can create an overall strategy for competitive advantage (Hoek, 2001 and Power et al. (b) 2010).

E-technologies are based on open standards allowing for the development of non-proprietary applications. The internet uses XML applications which are standard eXtensible Mark-up Language that lets digital content be written and allows interfaces with speech and handwriting systems etc. This means content can appear in different forms to those in the past. This also provides the potential for data sharing with the use of XML application (through integration) in a way not possible prior to the development of e-technologies (Chua et al. 2003). The capability of XML application and open standards, for example, has given suppliers and manufacturers the ability to share design and engineering information over the internet in the early stages of product development (Boone and Ganeshan, 2007). Open standards have also enabled legacy systems to be linked within and across firms, which has led to the development of web services, which in turn, enables systems to communicate without human intervention (Power and Singh, (a) 2007).

The premises of such web-based collaboration is faster time to market, quicker upgrades, efficient life cycle management and the elimination of unnecessary inventory. Firms in a wide variety of industries - Lucent, Adaptec and Cisco in the hi-tech industry; Gap and Land's End in the fashion industry; and Dana Corporation in the automotive parts - already embrace web-based design collaboration or e-collaboration to accelerate product development cycles (Boone and Ganeshan, 2007).

Firms involved with e-technologies proactively pursue implementation with partners (Power and Singh, (a) 2007). For example, the airline industry has utilized e-marketplaces to further broaden and increase value-chain efficiency, sustaining the creation of competitive advantage, through e-technologies, which has led to the achievement of industry-wide standards for e-integration, e-collaboration and e-information sharing (Nucciarelli and Gastaldi, 2008). Similarly, exponential growth of e-technology's capability has provided numerous choices in technology application geared towards improving supply chain functions. Selecting appropriate e-technology application, however, is a daunting task for managers given the wide array of rapidly changing and costly technology. It is important that organizational competitive priorities drive the selection of e-technology and SCM strategy with a clear understanding of business models and desired benefits (Sanders, (a) 2007).

Although Sanders, (a) (2007) provides a fine-grain perspective of the relationship between e-technology and collaboration, and intimated the promotion of integration and information sharing in supply chains in terms of buyer-supplier benefits, there has been no research study on the components of e-supply chain management or the relationships between e-technology, e-integration, e-collaboration, e-information sharing and e-SCM. The current research, among other things, fills this void.

2.1.4 E-Supply Chain Design

Globalization and the uncertain market environment have prompted customers to look beyond cost to an ever increasing demand for value through innovation and personalization of not only products but also associated delivery of services. This has led to stunning development in technology, especially electronic digitization and its utilization to increase high productivity and efficiency for goods and services in supply chains. One need not look further for reasons why SCM became the sole arbiter for this. Following the SCM definition from the Supply Chain Council in 2002 – 'The effort involved in producing and delivering a final product from the supplier's supplier to customer's customer' – the evolution of SCM was mapped towards a strategic and dynamic network perspective which led to the creation or design of new and specialized supply chains or networks, from an array of increasing specialised firms (e.g. contract electronic manufacturers and product designers) through a combination of factors; mainly globalization, increased outsourcing and rapid technological development (Mills et al. 2004).

Consequently, through the realization that enterprises can design or configure viable supply chains from the use of internet and web technologies to meet the challenges faced by the emerging virtual enterprises, the practice of 'e-supply chains' have literally swept the academic community off its feet in a bid to establish the 'what and how' of e-supply chains (Graham and Hardaker, 2000; Caputo et al. 2004, 2005; Cagliano et al. (a and b) 2005, 2006; Kotzab et al. 2003; Ghiassi and Spera, 2003;

Swaminathan and Tayur, 2003; Jagdev and Thoben, 2001; Lancaster et al. 2006 and others).

As far back as 2001, it was reported that the pursuit of e-supply chains is '*covered in about 150 papers and articles and.....growing at the speed of computing power',* (Hoek, 2001). Subsequently, e-supply chains have become critical for achieving efficiency and effectiveness in supply chain management (Akyuz and Rehan, 2009). However, there were doubts about their continued development because of the segmented as opposed to their strategic use in supply chains. Therefore, there has been a call in the SCM literature for further research into the existence of e-supply chains in order to provide better insight and understanding of the current state of the concept and practice (Hoek, 2001). A gap in the literature therefore exists, which this research will address.

In addition, similar calls in the supply strategy and supply network literatures, respectively, have sought to better articulate the role and development of supply networks (as an extension of supply chains), that can accommodate and explain the contemporary commercial and market complexity that is associated with the creation and delivery of goods and services from source to destination and beyond (Harland et al. (d) 1999 and Lamming et al. 2000) Moreover, a time lapse exists after the publication of the earliest survey classifications dedicated to the e-SCM literature (Johnson and Whang, 2002).

Notwithstanding, research into other aspects of e-supply chains have continued overtime. For example, Sambasivan et al. (2009) developed new measures and metrics for monitoring the performance of e-supply chains while both Liu et al. (2010) and Al-Mutawah et al. (2007), identified organizational culture as an important aspect for e-supply chain management systems. Mukhtar et al. (2009) also introduced a framework for e-supply chain analysis based on contingency framework of e-business adoption. Similarly, Akyuz and Rehan, (2009) discussed the requirements for forming an e-supply chain but mainly from legacy systems, including aspects of technical requirements. Nevertheless, to date, very little research has identified the different types of e-supply chains in existence and/or how they relate to the global concept of e-SCM.

This research will therefore fill these gaps and provide insight and understanding into the direction, current status and use of the concept and practice.

2.1.5 Comparative classification of e-supply chains

Over the years, there have been a significant increase in the number and diversity of papers fragmented in various research journals on the concept 'e-supply chain management'. This has made it difficult to chart its development, intellectual structure and status. However, the survey papers of Johnson and Whang, (2002), Gunasekaran and Ngai, (2004) and Gimenez and Lourenco, (2008), documented initial developments and classification of the use of internet and web technologies and their application to supply chain management.

Firstly, Johnson and Whang, (2002) classified their paper into three categories; (1) e-commerce, (2) e-procurement and (3) e-collaboration. On the other hand, Gunasekaran and Ngai, 2004 classified their review into six components; (1) strategic planning for IT in SCM, (2) virtual enterprise and SCM, (3) e-commerce and SCM, (4) infrastructure for IT in SCM, (5) knowledge and IT management in SCM and (6) implementation of IT in SCM whilst Gimenez and Lourenco, (2008) classified their framework into a variety of topics classed under (1) enablers (a) supply chain relationships, (b) information flows (c) IS integration, (d) planning and (e) optimisation), (2) SCM processes (a) fulfilment, (b) procurement, (c) CRM, (d) returns and (3) e-SCM (a) industry structure and competitive challenges and (b) impact on performance.

There are no accepted norms in the literature for classifying e-supply chains research, nevertheless our current classification scheme for e-supply chains contains some similar and additional categorizations or classification as compared to the above previous studies but also differs in the range, design and achievements of e-supply chains. It is therefore important to catalogue the different types of e-supply chains and discuss their relationship to the global concept of e-SCM.

The seemingly increasing interest, growth and range of e-supply chains identified clearly highlights the need for consolidation of research in this field. In a similar vein, a considerable time lapse exists since the publication of the earliest e-supply chains survey classification. Therefore, this research has also attempted to fill any void that may exist in the literature. For instance, since the following e-supply chain designs (e-commerce, e-logistics and e-procurement) have already been classified or largely identified and treated in the literature, this research will only therefore focus on the additional e-supply chain designs identified in this study. We have therefore opted to name this category, ‘e-supply chain design’ because it represents specific or different types of e-supply chains, and therefore, generally more representative of e-supply chains.

The extant SCM literature amply recognized and have very well documented the existence and practices of the following e-supply chain designs: *e-commerce* (Bernstein et al. 2008; Naim, 2006; Barsauskas et al. 2008; Leonard and Cronan, (a) 2002; Tsay and Agrawal, 2004; Hovelaque et al. 2007 and others), *e-logistics* (Kumar, and Putnam, (a) 2008; Sarkis et al. (b) 2004; Kapuscinski et al. 2004; Krmac, 2007; Liu et al. 2008 and others) and *e-procurement* (Puschmann, 2005; Angeles and Nath, (a) 2007; Boyer and Olson, (a) 2002; Buyukozkan, (a) 2004; Truong, 2008 and others). This might account for their high incidence in the literature, especially with regard to e-commerce and e-procurement. Therefore this research will only concentrate on the additional, identified e-supply chain designs, which are not represented in any of the previous classifications. However, it is important to note that we have used the term ‘e-procurement’ loosely to encompass e-transactions in the e-marketspace (including e-marketplace, b2b commerce, procurement etc.).

Figure 10 below illustrates a comparative classification of the e-supply chains. Included in the classification are twenty-three additional e-supply chain designs (to the earliest studies) or newly classified e-supply chains identified from the literature. The next section begins discussion of the e-supply chain designs identified.

Johnson & Whang (2002)	Gunasekaran & Ngai (2004)	Gimenez & Lourenco (2008)	Current Study 2012
e-commerce e-procurement e-collaboration	Strategic planning for IT in SCM Virtual enterprise and SCM E-commerce and SCM Infrastructure for IT and SCM Knowledge and IT management in SCM Implementation of IT in SCM	**Enablers** Supply chain relationships Information flow IS integration Planning & optimization **Supply chain processes** Fulfilment Procurement CRM Returns **e-SCM** Industry structure & competitive challenges Impact on performance	*E-commerce* *E-procurement* E-logistics E-CRM E-optimization E-knowledge management E-Performance measurement E-manufacturing information systems E-forecasting E-scheduling E-product development E-document delivery systems E-intermediaries E-RFID E-security E-recycling E-leagile systems E-portal E-contract negotiation E-quality management E-wireless devices E-modelling of complex systems E-intelligent systems E-music Impact of e-supply chain design Adoption & implementation

Figure 4: Comparative classification of E-supply chain design

2.1.6 **E-document delivery systems**

E-document delivery (e-DD) systems refer to the use of the internet and web technologies for resource sharing, predominantly document access, delivery and management. Arte et al. 2003 presented a software architectural platform with web technology for an internet delivery document system in Italian Research Libraries. Siddiqui, (2003) examined three different e-document delivery (E-DD) systems and used a survey to investigate the availability of required hardware and software for the adoption of the internet for resource sharing in The Gulf academic libraries through document delivery.

Birch and Young, (2001) conducted an empirical evaluation of a Documents Direct project created to investigate the feasibility of offering user-initiated, unmediated request and delivery of documents, as an alternative to traditional periodic holdings and conventional Inter-Library Loan (ILL). In Mei and Dinwoodi, (2005), a survey investigated the potential for an internet based third party (IBTP) internet service provider (ISP) that offer electronic bills of lading (e-BOLs) and shipping documentation services to an international supply chain (ISC) infrastructure in China's ship industry. Burnhill and Law, (2008) investigated how to design and implement a national union catalogue database for serials which can be accessed through print via the internet. In contrast, Schulz, (2001) used a framework of the electronic resources database (ERD) of the Griffith University Library as a case study to discuss the challenges inherent in the management of electronic-journal databases and recommended solutions for their evolution.

The e-Document Delivery systems surveyed are based on the use on internet and web architectural and infrastructural decision model designs, with software and hardware platforms. Some benefits of e-document delivery supply chain design systems include: cost effective and speedier documentation processes with better information management. Unmediated and remote document ordering, for example, offers a value-added service with benefits such as linked document delivery, order monitoring, control and speed of delivery. This is cost-effective as compared to traditional ILL, in terms of staff time, overheads and the range of titles that can be accessed; demonstrating the value of access over holdings. The main themes however, seem to be increased efficiency and productivity created through the inherent integration, collaborative and information sharing nature of these systems.

2.1.7 **E-Intermediaries**

The term 'e-intermediaries' or 'cybermediaries' (internet and web-intermediaries) can be generally defined as a business organisation that occupies an intermediary position in a supply chain between a buyer and a seller and whose business is based on the use of internet-based ICT (Barnes and Hinton, 2007). Although many have come to believe that traditional intermediaries would become a thing of the past in an electronic environment, some have questioned this notion and predicted that a new age of internet-based intermediaries would emerge in a process of 're-intermediation' (Barnes and Hinton, 2007). The re-emergence has led to an increased interest and provided the impetus for supply chain management researchers to systematically examine its significance.

Barnes and Hinton, (2007) analyzed the general concept, practice and roles of *e-intermediaries*. Their findings indicated five main roles of e-intermediaries: informational, transactional, logistical, customisation and assurance. Ghose et al. (2007) conducted an analytic model of competition in a supply chain between retailers and e-institutions and assess the impact on optimal contracts among manufacturers, info-mediaries and retailers. They found out that the basic role of a *referral info-mediary* is to provide the consumer with information about prices and products by shifting much of the consumer search process from the physical platform of traditional retailers to the virtual world of the web.

Referral info-mediaries represent mid-stream players in a supply chain between a manufacturer and a dealer or between dealers and consumers. The establishment of a referral service is a strategic decision which leads to the diversion of supply chain profits from a third party info-mediary to the manufacturer. Furthermore, it enables the manufacturers to respond flexibly to an info-mediary in setting the wholesale unit fee to maximum profit level.

Tang and Cheng, (2006) simulated a model of the optimal pricing strategies of a monopolistic intermediary in a supply chain of complementary web services. Web services are 'loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard internet protocols'. *Web service intermediary* (WSI) provides both technical and aggregation services to web service supply chains and cater to the need for a practical service-oriented architecture and sought to charge optimal subscription and listing fees.

The authors indicated that the optimal strategy of WSI is to set the listing fee such that all service providers list on it. The optimal subscription fee depends on the intensity of the cross-net-work effect, consumers' valuation of value-added services and the characteristics of the web service under consideration. From a business perspective, web services enable 'just-in-time' application integration that helps to reduce software development and integration cost by allowing firms to leverage existing systems and utilize business modules developed by other companies. The scope of web services ranges from personal services (e.g. stock quotes) to enterprise-level services such as sales force automation systems.

Del Aguila-Obra et al. (2007) analysed the digital, online news industry from a value chain and value creation perspective and identified a new intermediary known as Web Content Aggregators (WCA) who are the main players in the sector. Web aggregators provide third party content to other companies and end-users and provide value by concentrating on content packaging and the distribution stages of the value chain. They aggregate the supply and demand in the industry, collect, organize and evaluate dispersed information and also provide infrastructure to other industry players. Other media and e-intermediaries in the online news industry are: Traditional Media, New Media, Alternative Media and Distribution Intermediaries. WCA facilitate creation of value through efficiency, complementarities, lock-in and novelty.

Similarly, Taylor, (2003) described the evolution of e-books and the role of the US web aggregator (OverDrive) as the market leader and the single wholesaler and distributor in the emerging e-books supply chain and its evolving role in e-brokering. The web aggregator adds value to the e-books supply chain by hosting and offering the publishers' content for resale to retailers. In addition, web aggregators can drop-ship the e-book directly to the end-customer. The retailer only takes payment and merchandize the e-books. The e-books are down-loaded direct from the aggregator's digital warehouse to the customer in just the same way that a physical book would be drop shipped from the wholesaler to the end customer, without the internet bookseller having to hold stock or handle the products.

Sarkis and Sundarraj, (2002) presented a conceptual overview of emerging issues identified in e-commerce-enabled manufacturing brokering or automated e-third party mediation mechanisms. They discussed how brokering's role and practice needs to evolve with evolving organizational forms. The authors presented supporting tools, technologies and different e-brokering mechanisms corresponding to different organizational structures and described how agent-based technology can be used to accomplish the varied brokering types.

Zsidisin et al. (2000) used a case study to analyse the role of IT, particularly the internet, in the provision of high quality service for communication channel intermediaries (CCI). As a predominantly service organization, CCIs have a dual SC with both upstream and downstream customers. They informed buyers and prospective buyers about the availability of sellers' products or services and sought to provide the best fit between downstream customers' unique needs and upstream customers' service features. What determines the service quality is the communication and information CCIs provide which is facilitated by the internet and enhanced through e-mails, telephone communication and other media. The study provides insight into how CCIs can be successful in the competitive economy.

Clott, (2000) described the new challenges and opportunities that the internet poses for non-vessel operating common carriers (NVOCC) in their role as intermediaries in the ocean freight market. The use of electronic information via the internet will make it easier for customers to interface directly with suppliers without the need for middlemen. However, specialized intermediaries can provide quality service and lowest cost for consumers. The continued existence of NVOCC requires making greater investment in IT (the internet) and other SCM tools and processes in order to raise the value of their services above that of cheaper rates. The author implied that firms such as NVOCC can provide skilled intermediation in a networked economy by creating markets and enhancing customer value through innovations within the distribution chain.

According to Ho et al. (2003), the development of virtual communities marks a structural change in the role of e-intermediaries through three related phases of intermediation, disintermediation and re-intermediation. (1) In the intermediation phase, firms pursue e-intermediation strategy to develop themselves by leveraging their middlemen position to deliver products and services that have not been available. (2) In the disintermediation phase, e-intermediaries seek to either dis-intermediate traditional middlemen to gain more market share or by acting as providers of a technological solution or an emerging IT standard (e.g. the changing role of 3PLs to that of Orchestrators). (3) In re-intermediation phase, traditional intermediaries whose interests have been hampered by e-intermediaries re-establish themselves as e-intermediaries. Virtualization has made integration of inter-organizational business processes in virtual space possible (e-integration) which enables and involves dynamic collaboration (e-collaboration). One of its rewards or achievements is that as information passes and is digitized through these systems, it can therefore be exchanged quickly to all parties via e-linkage (e-information sharing).

The reviewed papers on e-intermediaries included the changing role of e-intermediaries into virtual enterprises and value creation through e-integration, e-collaboration and e-information sharing.

2.1.8 **E-Forecasting**

Four papers contributed to e-forecasting. Bayraktar et al. (2007) analysed the impact of exponential smoothing forecast (ESF) on the bullwhip effect for e-SCM. The paper developed an e-SC simulation model to experiment the different scenarios and the right parameters needed for exponential smoothing forecasting technique on the bullwhip effect. They found that longer lead times and poor selection of forecasting parameters lead to strong bullwhip effect in e-SCs and suggested that the use of ESF can reduce lead times along e-SCs while increased seasonality would also help to reduce the bullwhip effect.

Raghaven et al. (2004) designed a web-enabled software beer-game using object oriented programming techniques that can be played online, to illustrate the bull-whip effect in supply chains. Its implementation takes into consideration demand forecasting by using both Moving Averages and Exponential Smoothing techniques of forecasting. The research showed that for the same variance of forecasting errors using both methods, the increase in variability due to exponential smoothing method is more than the increase in variability caused by the moving average method. Therefore smoother demand forecasting can reduce the bullwhip effect in supply chains.

Zhang, (2006) used a state-space model (linear dynamic system) forecast to improve demand forecasting accuracy and performance in supply chain operations in the semiconductor industry. It fully accommodates the correlation between product demand and external information (market trends and regional economic growth). The proposed state-space model leads to an expectation-maximisation algorithm that estimate model parameters and predict production demands. The findings from the study on real e-products helped to improve the production and quality of SCM, by producing more accurate predictions than other conventional approaches.

Zhang, (2007) applied a vector generalised autoregressive conditional heterosledasticity (GARCH) model to determine the optimal combinational weights of component forecasting for demand planning, where the conditional variances and correlations of forecast errors from candidate methods are represented and estimated by a maximum likelihood procedure. Combinational forecast can increase forecasting accuracy by integrating several separate forecast models when difficulties arise in identifying a single model. Its intension is to achieve an average forecast in the hope that the biases among individual models will compensate for one another. An experiment on a real time series of e-products demonstrated less predicted errors as compared to other commonly used forecasting approaches that are based on single model criteria or fixed weights.

The reviewed papers on e-forecasting, among other things, recognised demand forecasting as one of two main causes of the bullwhip effect. Owing to high transactional volume in an e-SC, demand uncertainty would cause inaccurate forecasting of information exchange in the network, which in turn, would result in the bullwhip effect (Bayraktar et al. 2008). The papers demonstrated that combinational method, particularly with the aid of the internet and web models, can produce fewer predicted errors, as compared to other traditionally used forecasting approaches that are based on single model selection criteria or fixed weights. Therefore, the use of internet and web technologies in forecast decision models can produce demand uncertainty more accurately because of visibility of information exchange in the network, which in turn, would reduce the bullwhip effect in supply chains.

2.1.9 **E-product development (e-PD)**

In the first paper on e-product design and development, Humphrey et al. (2005) proposed a prototype web-based system (WeBID) platform for evaluating supplier involvement during the design process of product development. The assessment tool included four types of indices to measure supplier involvement in design (satisfaction index, flexibility index, risk index and confidence index). The WeBID platform measures the extent to which both customer requirement and supplier capabilities correspond and therefore reflect the risk or potential of signing a project contract for future collaboration. Their analysis of a case study in the telecommunication industry indicates the method assisted in reducing product development timeframe because it automates the evaluation process and provides a flexible responsive tool for assessing prospective suppliers.

Lee et al. (2003) addressed the problem of designing an e-assembly process in an environment where materials required for assembly processes are subject to stochastic arrival times in order to maximise the probability of on-time delivery of finished products. They provided analytic results for cases that are polynomial and solvable with branch and bound heuristic algorithm for deriving optimal solution to the problem. Computational experiments show heuristic algorithms performed well.

Helender and Jaio, (a) (2002) presented a systems model of e-product development for mass customisation with a customer interface for design process. The program aimed at investigating fundamental issues and enabling techniques for applying internet to re-engineer manufacturing companies towards mass customisation. Their research applied a graph grammar formalism methodology and interactive multi-agent system platform architecture, for integrating design, manufacturing and logistics.

Jaio and Helender, (b) (2006) reported the development of an e-customized-to-order (e-CTO) platform for customised product development over the internet. It aims to integrate different web services across companies as well as various life-cycle issues of product fulfilment, into a collaborative web of interactive commerce. This generic product family master-model is proposed to support product customisation over the internet that can achieve a synergy (sales force automation, product design, manufacturing planning and SCM), within a coherent framework. The prototype e-CTO was implemented successfully. Web solutions allow firms to interactively communicate information related to product design, development, manufacturing and logistics within individual infrastructure. This offers scalability, easier implementation and compatibility across diverse information technology platforms.

In addition, e-configure-to-order product fulfilment allows firms to reduce incremental infrastructure investments and enhance collaborative customisation among partners both internally and externally. The use of the internet and web technologies for product design and development (e-PD) directly connects multiple customers and suppliers throughout the entire value chain. This alleviates much of the inefficiency in current PDD and SC practices. It integrates different facets of product design, process design, and order processing and order fulfilment in a cohesive manner (Helender and Jaio, (a) 2002). All of the papers covered collaborative decision models (through e-information sharing) and integration of different web services across companies; including design, logistics and manufacturing, life-cycle product fulfilment and automatically reconfigurable supply chain for order specification.

2.2.0 E-Leagile Supply Chain design systems

Leagile supply chain design systems are e-supply chains that use lean, agile or a combination of both lean and agile principles. Five papers contributed to this design. Bruun and Mefford, (2004) explored the effect of using internet for lean production systems in production, scheduling, inventory control, procurement, work-force and quality improvements. Case examples explored the effects on supply chains. Constraints to e-leanness are discussed and a model for lean integration was also presented. Lean integration here indicates the application of lean production principles at the factory floor level as well as in other business processes within the firm. Furthermore, the system can be extended to allow integration that bridges participating firms and production systems. The model described the framework in which the internet symbiotically supports lean principles and strengthens business processes. Its value creation elements are efficiency, lock-in, novelty and complementarities.

Although in existing literature, lean principles are generally applied to manufacturing, Buzby et al. (2002) used Cycle time and TAKT time concepts to analyse case studies and prove the application of lean principles for the administrative function of the quotation process (e-quotation). The case demonstrated that e-solutions are the best remedies for streamlining quotation processes to reduce total cycle time in order to provide competitive pricing and excellent customer service. The potential areas for streamlining cost through an e-quotation supply chain includes: reduction of paper use via electronic quotation, reduction of waiting time through electronic reminder, elimination of tasks in the quotation process, coordination with outside vendors and the collection of shop-floor data for accurate labour costing.

Raisingham and Meade, (2005) investigated the linkage between performance criteria, dimensions of agility, e-supply chain drivers and knowledge management using analytic network process. They developed a decision model which was presented in a case study of an e-supply chain in a telecommunications company. A knowledge management (KM) decision framework measured the relative importance of specific dimensions based on the application of concepts from information systems, management science and the digital knowledge economy literature. Findings indicated that since contextual factors play a critical role in the design of effective KM systems, technical and process solutions need to be customized to fit organizational performance criteria, dimensions of agility and SC drivers. The paper addressed the need for a strategic decision making tool to assist management in determining which KM construct is most beneficial in developing an agile supply chain based on a firm’s performance criteria, dimensions of agility and SC drivers.

Holmqvist and Pessi, (2006) examined a SC business and information systems initiative by Volvo which implementd and managed an agile aftermarket supply chain (a global web services portal platform) for selling spare parts over the internet. The effort involved direct actions to manage both the technology and the relations among the SC actors. It also indicated that continuous implementation projects can deliver innovation in new relations through new channels, particularly if they address agility from the start. The case illustrated why b2b integration required agility and how Volvo implemented it within its complex supply chain as well as the innovation that emerged in new businesses with Information Systems and Information Technology (IS/IT) models.

Herer et al. (2002) established that both agile and lean concept can be achieved through the practice of trans-shipment, to monitor stock levels and multi-location inventory systems thereby reducing cost and improving service. Faisal et al. (2006) proposed a model that is based on leagile paradigm through which suitable supply chain strategy can be selected or mapped, based on customer sensitivity and risk alleviation competency dimension. The model was tested on three Indian SMEs and Graph theoretic approach was applied to quantify these dimensions for suitable SC strategy. The model would help firms to select a suitable SC strategy based on these two dimensions and the transition required for market requirements.

E-Leagile supply chain design systems can be utilized through integration of processes, knowledge management and also in decision solutions to help firms select supply chain strategy in tune with their market requirements.

2.2.1 **E-wireless design**

According to Gehlot and Sloan, (2006), the successful creation and adoption of an international standard for wireless data network (WDN) has caused large-scale adoption and manufacturing, leading to ubiquitous deployment in academic, commercial, public, industrial and home setting. This in turn has fed rapid existing and emerging WDN innovations (Wi-Fi, Wi-Max, Bluetooth, Zigbee etc.), including in wireless medical device networks (WMDNs). However, each of these WDN have different trade-offs with regards to speed, interoperability, security, coexistence, battery life and object penetration. Their analyses of the WMDN landscape, including for both business and clinical applications, raised concern over safety and validation issues and the absence of industry standards or regulations, particularly with regard to the rapid changes in the underlying wireless network modalities in the WMDN. Based on the belief for a formal-methods approach for heterogeneous, wireless, patient-care-device networks, they proposed a prototype verification and validation tool-kit (V2T) for both clinical and business use that will ensure safe and reliable WMDN operations.

Soroor et al. (2009) devised an intelligent wireless web (IWW) model capable of high speed wireless networks that exploits advancement in internet technologies for mobile real-time supply chain coordination. The various components that enable an IWW for high speed mobile SC coordination are: mobile devices, service abstraction, semantic conformity, intelligent response, wireless communication technologies, semantic web, web services, agent based technologies and context aware computing. The system was tested and implemented in a real operational environment in a business setting. The article discussed how exploiting the convergence and synergy between different technologies has made it possible to deliver intelligent wireless web support to mobile supply chain members in real-time on a needed basis, with flexibility of use.

Marsh and Finch, (1999) explored the advantage of using portable data file technology such as high density bar coding and electronic tagging, for storing and transmitting information relating to construction materials and components. A structured methodology to aid definition of information to be encoded within labels or tags and the stages within the supply chain where such devices could be employed was presented. A case study demonstrating operational and financial feasibility in a live project was presented with recommendations for an industry wide standard, as part of a framework to promote its widespread deployment.

Wamba et al. (2008) investigated the impact of the integration of RFID with electronic product code network (EPC) on mobile b2b eCommerce (m-eCommerce). Mobile eCommerce is defined as wireless b2b and b2c exchange of operational and financial data within a SC over the complete life-cycle of a business relationship. It is an emerging phenomenon driven by rapid evolution in wireless technologies and diffusion of mobile terminals, particularly in retail SCM. The EPC information system offers real-time access to all EPC code tags through the internet. Results indicated that their integration can enable, among other things, higher levels of information sharing, synchronization between SCs and automated business processes and operations, leading to competitive advantage through cost reduction, responsiveness and performance function. Four papers contributed to this aspect. E-wireless supply chain design systems are used for electronic management of information in product's lifecycle, to access real-time information and to integrate internet technologies for real time mobile information sharing and collaboration.

2.2.2 **E-Scheduling**

Yao and Lui, (2009) contributed the first article to this section. They proposed a multi-objective optimization model for scheduling efficiency in mass customization. The solution solved contradicting problems between scaled production and customised demand in mass-customisation (MC). The paper identified two key contradicting problems in this environment: (1) To satisfy the different customised demands with scale production efficiency and (2) To enable a manufacturing supply chain system comprehensive profit maximisation based on rationally realising production efficiency of different orders. The article introduced a dynamic multi-objective mathematical optimisation model with an appropriate algorithm to solve the dominant contradictions of supply chain scheduling in mass-customisation. The model was validated through its successful implementation to improve scheduling efficiency and verify convergence character through an algorithm simulation on a numerical scheduling case.

Chua et al. (2003) presented a prototype constraint-based planning tool (an e-Integrated Production Scheduler), that enhances planning reliability while adopting lean construction principles and the theory of constraint. Unlike the critical path, it models two additional constraints related to resource supply and information exchange and employs four buffers to manage critical constraints and shield production from uncertainties. It was implemented as a distributed scheduling system using internet technologies such as java and XML and facilitated a transparent project management environment where faster communication and active collaboration among project members are achievable.

Garcia-Flores and Wang, (2002) described an e-multi-agent software system (e-MASS) that can be used to simulate the dynamic behaviour and management of chemical supply chains over the internet quantitatively. It allows distributed simulation of the chain behaviour dynamically so that compromised decisions can be rapidly and quantitatively evaluated. Because scheduling of plants often dominates chain performance in chemical supply chains, an optimal scheduling system for batch plants is integrated into e-MASS. The functions of the system are illustrated in a case study for the supply and manufacture of a multi-purpose batch plant of paints and coatings.

Sadeh et al. (2001) presented a multi-agent e-supply chain coordination tool (MASCOT), which has reconfigurable, multi-level-agent based planning and scheduling architecture and uses the internet. A key innovative element included its support of real-time mixed initiative functionalities that can enable end-users at different levels within the architecture to rapidly evaluate alternative options, associated supply chain requirements and new co-ordination protocols aimed at better exploitation of finite capacity scheduling functionalities across the supply chain. The paper presented empirical results quantifying the benefits afforded by these new protocols under different loads and supply chain configurations. MASCOT can dynamically select supply chain partners, coordinate development and manipulate planning and scheduling solutions at multiple levels of abstraction across the supply chain. Other capabilities included mixed-initiative problem solving, users who are enable to flexibly select a broad range of interactive regimes and support of workflow management capabilities that allow users to assess complex trade-offs while manipulating assumptions that often span multiple tiers across the supply chain.

The reviewed papers on e-scheduling supply chain design systems covered the use of internet and web technologies including the use of software to build infrastructure and architecture that will improve scheduling efficiency through faster communication, information sharing, active collaboration among supply chain members, through the integration of distributed and cooperative systems over the internet that can cope with uncertainty of chain dynamics.

2.2.3 **E-Manufacturing Information systems (E-MIS)**

E-Manufacturing refers to the use of internet and web technologies for global information systems infrastructure in manufacturing supply chains, driven by real-time information, visibility and connectivity. Shaw, (2000) described an emerging manufacturing technology and new business model, driven by information systems (global network infrastructure) and driven by the availability of real-time information and connectivity and also powered by the web. Information-based-manufacturing is based on using the right information to know what products to make, when to make them and then how to make them better. The key components included: sense and respond, customer interaction, supply chain coordination with enterprise operations and business processes.

The internet has the potential to enhance information-based manufacturing through information systems infrastructure. However information-based manufacturing can only be efficient when the underlying supply chain (SC) network is managed efficiently. As it is the supply chain that provides the infrastructure for directing all the activities – from receiving the raw materials to the delivery of final products. The paper illustrated how web technology can help to coordinate supply chain activities in manufacturing and the relationships between product-type, SC structures, information-sharing, coordination and the web.

Kehoe and Boughton, (2001) contributed two articles to this design. Their first article reviews current research classification of manufacturing SCs in the light of internet based applications in order to identify operations management challenges for the next generation manufacturing planning and control systems. Their paper utilized a case study of the DOMAIN project at the University of Liverpool to illustrate and develop an operations management framework for the classification and selection of an appropriate internet planning and control application. The recommended an e-supply chain resource planner (e-SRP) as an alternative to the traditional enterprise resource planning (ERP) approach. The internet facilitated SC resource planning (e-SRP) application was developed using internet based interactive planning (I-BIP) principles and it offers benefits that are associated with a more integrated approach to planning and control across the supply chain. The use of internet technologies, among other things, will enable demand and inventory data to be visible across the SC, simultaneous improvement in customer service levels and reduction in overall inventory levels, and thus, lower cost. Furthermore, it would remove the legacy systems obstacle which has persisted overtime by bringing both customer and supplier partnerships into a common systems infrastructure.

Their second paper discussed the role of the internet within manufacturing SC but focused on its impact on manufacturing planning and control operations. The paper argued for a paradigm shift to the traditional linear transfer of information within supply chains. As the internet provides opportunity for demand data and supply capacity data to be visible to all parties within the chain, firms can be in the position to anticipate demand fluctuations and respond accordingly; in contrast to the more reactive approach. Furthermore; timely information availability, not just efficient information is the key to enhance supply chain operations. They proposed the development of supply webs and a more interactive approach to supply chain partnering, and identified issues which can facilitate the development of e-manufacturing planning and control.

Coronado et al. (2004) used a case study to describe the use of a prototype (Internet-based) e-production information system, designed to assess the feasibility of driving a build-to-order (e-BTO) manufacturing configuration through a three tier high volume, high variety supply chain. The paper discussed extending the concept of customisation to manufacturing activities upstream of the final product assembly processes. This work addresses the implications of adopting information transparency in the SC that would eventually lead to the elimination and reduction of excess stock while enabling the manufacturing of goods in low volumes with high variety. The prototype system, among other things, was able to extend BTO production upstream, reduce the pipeline inventory at each tier of the chain and also a reduction in SC throughput time. The working prototype that was developed forms a foundation for operationalizing e-BTO.

Chryssolouris et al. (2004) examined problems arising from the integration of partners that utilize heterogeneous information systems to discuss the implementation of an extensible mark-up language (XML) communication system in a ‘real-world’ application in a ship repair industry. Its implementation enabled communication of heterogeneous systems, by adopting XML standard for b2b commerce. Thus, demonstrating how e-technologies through software mechanisms can support the communication of different partners and enable information sharing within the value added chain.

Lyon et al. (2004) presented a cross-supply chain information design system (CSCIS) or e-supply chain information system and provides empirical illustration of its potential in the automobile industry. The paper discussed a case study where a prototype CSCIS was tested. The CSCIS converted vehicle demand into lower tier component requirements and transmits this information via the internet across the supply chain. The case established the need for such a system by identifying the performance benefits to the SC for transparent demand information in order to improve upstream operations. This research demonstrated how information systems can be used to improve SC performance and provided further motivation for the development of more holistic SC planning information systems.

Vaaland and Heide, (2007) conducted a cross-sectional survey of Norwegian firms to find out the extent they are prepared to meet SCM challenges through the use of modern planning and control methods. Findings clearly indicated that SMEs, among other things, are less concerned with e-based solutions and give less attention to planning and control methods. The paper emphasised that the availability of the internet and associated technologies provide the opportunity to make significant and radical improvements to planning and control in manufacturing information systems. The practical implication of the paper is that horizontal cooperation can reduce the information technology gap by sharing planning and control systems through suppliers of support systems, who should consider delivering complete ‘turn-key’ solutions specifically targeted at SMEs.

Marincas, (2008) discussed the phases in the development of a supply chain management information system (process mapping, internal integration of functions, financial analysis to maximise value creation processes, collaboration, strategic cost management, information visibility) to demonstrate how an integrated information system can create a solid network of suppliers and customers and used a case study to demonstrate its implementation in a Romanian company in order to show how IT can support the development of communication, information sharing and visibility across supply chain partners in order to meet the increasing customer demand, profitability and global competition.

Azevedo et al. (2004) proposed a multi-agent internet system architecture for real-time customer-order planning in distributed manufacturing enterprises that address make-to-order requirements. It provided enhanced visibility of information, early warning of disturbances, synchronized production and collaborative planning in the SC. The system aims at responding to cooperation, integration and configurability for new powerful decision support systems needed for planning and coordination in heterogeneous environments particularly in complex and dynamic environments.

Xiong et al. (2003) described a web-based flexible available-to-promise computational system (WebATP) which provides enhanced flexibility. The paper used a dynamic bill-of-material (BOM) to simplify the BOM exploding processes. Case studies show the system can help firms to understand their capability for filling customer demands better. This web system can be accessed from any location and from any computer terminal and is also less expensive.

Stevenson and Hendry, (2007) explored the implication of enhancing existing decision support systems (DSS) based on a workload control (WLC) concept with web-functionality, in order, to improve its practical applicability as a tool for the integration of supply chain. Although the use of internet and web technologies in manufacturing planning and control systems have been embraced by large companies, SMEs are still lagging behind in its adoption. Their findings included proposals for future research in this area.

In contrast to the view of some commentators that some sectors within the manufacturing industry are reluctant of exploiting internet capabilities and that current practices that uses internet and web technologies within the manufacturing sector is piecemeal that rarely extend beyond dyadic relationships (Kehoe and Boughton, (b)

2001), the work here demonstrated various, complex and dynamic use of the internet and web technologies that provided the architecture for collaboration, information sharing and integration through the synchronization of the entire supply chain in several application areas.

2.2.4 E-Portal

An e-Portal provides a unifying infrastructure that allows a single, shared database to coordinate all transactions within the firm and its partners in real-time. Boyson et al. (2003) reported a pilot project of the US Department of Defence to create a portal for supply chain integration. The case demonstrated the feasibility of real time support for end-to-end SCM in a complex organization. A portal allows more complex and integrated decision-making than is possible with separate systems and best practice e-SC portal are designed to 'plug and play' and also supports future software changes. The system is scalable and allows more users to be connected as required. These features minimize the risk of obsolescence in system investment decisions. One of the most important functions is the collection of buyers and suppliers which enables easier transaction easier for buyers and greater efficiency for suppliers. Other benefits included improved financial performance, inventory availability and reduced life cycle costs by providing the right information to the right people to make the best decisions in real-time.

To effectively deal with distributed data, Rezayat, (2000) combined distributed object standards with web standards protocols to create an Object Web. Its combination with an enterprise's information authoring and management system can create an Enterprise-Web portal. This portal can provide the right information to the right person at the right time and in the right format anywhere within the extended enterprise. Using scenarios based on actual prototype implementation, E-Web can provide support for everyone associated with a product during its life cycle, thus creating a true integrated products, processes and protocols development (IP3D) environment. E-access, in order to design and manufacture information within extended enterprises must be web-based because of its universal interface, open standards, ease of use and ubiquity.

Sammon and Hanley, (2007) presented a case study and survey of Intel's pursuit to become a 100 per cent e-corporation by undertaking two web solutions known as Intel Web Suite and a system-to-system b2b known as Rosetta Net XML standards. The suite comprises of four separate applications and operates over a web portal to *transfer information* between Intel and its external suppliers. Whereas Rosetta Net is a consortium of more than 400 major IT, electronic components, semiconductor manufacturing and solution providers, working to create and implement industry-wide, open, XML *business process standards*. The paper gave a comparison between Intel's traditional supply chain, its Web-suite e-supply chain and Rosetta Net e-supply chain. Some of the benefits of the e-supply chain initiatives include, reduced inventory levels, operational efficiencies and market reach.

Portal technology allows all partners in the supply chain to log into a single system to immediately access relevant information by harnessing diverse real-time data sources to make decisions. A Portal uses internet and web technologies for a comprehensive electronic platform infrastructure built through combined filed data collection technology, ERP functions, advanced planning, collaborative planning, forecasting and real-time control panel displays that uses geographical visualization and arrays of key performance indicators.

2.2.5 **E-quality management (E-QM)**

E-quality management refers to the use of the internet and web technologies for the management of quality in supply chains. Tang and Lu, (2002) proposed a conceptual and functional model of a quality information management system based on Internet/Extranet/Intranet-Quality Information System (IEI-QIS) architecture for an extended enterprise. The system is able to integrate quality information from the enterprise, product, customers and suppliers and serve as a powerful quality management tool for modern enterprises.

Chin et al. (2006) introduced the principles, approaches, mechanisms and processes involved in global quality chain management and proposed a computer-integrated and internet architectural system called the global quality chain management system (GQCMS), with which the distributed partners in a global quality can cooperate. The paper outlined a framework and presented the results of a first-phase developmental system called QQ-Enterprise system.

Segars et al. (2001) examined how a group of middle-managers promoted and pushed through an evolutionary total quality management program at Bose. The program consisted of a five stage (exploration, discovery, formalization, process thinking and process linking) process improvement practice of functional areas, targeted at SC processes within Bose and across its supply chain. The program initially focused on six major areas (1) time-to-market processes (2) integrated SC processes (3) market-to-collection processes (4) customer service processes (5) managing results and (6) a SAP R/4 enabling infrastructure, thus, framing the network of processes that spans the operations of the firm, its customers and suppliers. The organization is hopeful that as functional areas improve their core processes, this would provide benefits through an integrated process-linking across the entire SC of the enterprise. This program of improved process management and improved response to changing demands within the component hi-fi market, maintained Bose's position in the Japanese original equipment manufacturing (OEM) segment of audio products.

Shao et al. (2006) proposed a conceptual framework for collaborative quality management and presented a tested prototype web system for life cycle collaborative quality management (CQMS). The system was implemented based on web services with ERP/SCM/CRM subsystems and provided an overall collaborative mechanism for product quality control and quality assurance within and outside an enterprise, including integration of systems. Research in this area involved the use of internet and web technologies to build global collaborative quality control infrastructures and architecture for integrated SCM of enterprises that also supports unique information sharing capabilities

2.2.6 **E-recycling**

E-recycling design systems involves the general use of internet and web technologies for different aspects of the end-of-life supply chain management of products, including product recovery, disassembling and remanufacturing, waste, recycling and spare-parts management, taking into cognizance, eco-conscious, green management and other environmentally friendly measures.

Spengler and Schroter, (2007) developed an internet information and communication platform for information management and spare-parts management in closed-loop supply chains. Using system dynamics, the authors simulated an integrated production and recovery system for supplying spare-parts to evaluate possible strategies for meeting spare-parts demand in end-of-life electronic equipment. Its implementation in a pilot-study determined how recovery components could reduce costs in spare-parts management throughout an end of life service period.

Rios and Stuart, (2004) discussed the scheduling of plastic-to-plastic recycling. Recent research has shown the feasibility of extending reverse electronic supply chain, driven primarily by remanufacturing and metals recovery, to include plastics recovery. The extended re-cycling processes added plastic cover disassembly for separation of majority of the plastics in electronics prior to bulk processing for metals separation. In anticipation of recovered plastics demand, they developed scheduling rules for plastics demand-driven disassembly processes and tested them in a discrete event-simulation model in a recycling centre. The experiments vary disassembly scheduling rules and the mix of end-of-life electronic product arrival and plastic demand. Their results demonstrated that the application of plastics demand-driven or supply-based disassembly scheduling rules perform similarly in maintaining metals and plastics throughput from consumer electronics.

Nagurney and Toyasaki, (2005) conducted a supply chain analysis and management of the collection, recycling and processing of electronic waste, which may be ultimately converted into products demanded by consumers. In particular, they proposed an integrated reverse supply chain management framework (e-cycling network equilibrium framework) that allows for the modelling, analysis, and computation of material flows as well as the prices associated with the different tiers of decision-makers in a multitiered electronic recycling SC. The analytic framework contributed to the analysis of multiple tiers of decision makers, who may compete within a tier but cooperate between tiers in order to optimize behaviour of the network equilibrium. They applied computational algorithms to numerical examples and illustrated both the model and algorithm. The model also conformed to current environmental management.

Hammond and Buellens, (2007) expanded previous work on oligopolies in closed-loop supply chains and proposed a network model which is based on recent EU directives regarding the waste of electronic and electrical equipment (WEEE). The model is based on a simulated-game of competition in the manufacturing and consumer markets. The model used extra-gradient algorithms with constant step size to solve numerical examples. Closed-loop supply chain network equilibrium occurs when all players agree on volumes shipped and prices charged.

Zikopoulos and Tagaras, (2006) examined the attractiveness of simple sorting procedures characterised by limited accuracy before disassembly and remanufacturing of used products. This type of quick sorting is made possible through simple electronic devices which record basic usage data and provide information about re-manufacturability of products without the need for disassembly. Their analyses provided a simple analytic expression that determined when operations are economically justifiable and also indicated that the economic attractiveness of the sorting procedure, based on accuracy and expected yield of returned products as oppose to the variability of yield. Moreover, their work showed that the specification of the sorting criterion may have significant impact on profitability of remanufacturing operations

Ge and Wang, (2007) proposed an activity-based modelling approach to assess key stakeholders' corporate strategy in developing eco-conscious e-products. Their work applied a quantitative assessment on case studies to evaluate effective corporate strategies and resulting environmental impact on product quality, cost and performance. Their results provided useful knowledge and guidance for selecting suitable corporation strategy in order to achieve desired eco-conscious design of e-products.

Lee and Klassen, (2008) used a case study of multiple suppliers to map factors that can initiate and improve environmental capabilities in SMEs. The authors built an integrative assessment framework for environmental management capabilities (EMCs) that can provide direction to improve environmental performance.

Zhu et al. (2008) evaluated green supply chain management (GSCM) adoption and implementation in manufacturing supply chains and assessed their contribution to closed loop supply chain (CLSC) practices from a cross-sectional survey of manufacturers in China. The paper examined four GSCM practices (internal environment management, external GSCM, investment recovery and eco design management) that can help organizations to close the SC loop and provided insight into the adoption of GSCM practices in various industries and their relationship with CLSC.

2.2.7 **E-Security**

E-Security refers to the use of the internet and web technologies for security in transaction processes of point-of-sale (POS) and web-based multi-media digital content (MMDCs). With the exponential growth of e-business in recent years, the security of e-payments which is an important part of e-SCM has become a critical issue. A large amount of payments in e-transactions are made via point of sale (POS) devices. Yang et al. (2007) investigated both hardware and design of physical security on POS devices. This included attacks, countermeasures and their practical implementation. Secure key management and security management in the manufacturing industry were also investigated and analysed to highlight security systems and approaches which can be integrated into e-manufacturing and e-supply chains for security enhancement.

Web based multimedia digital content (MMDC) has been accelerating due to the increase in the use of the internet. However, the security of its distribution systems through the web is not guaranteed, especially when supplying large amount of high quality MMDCs to users. Na et al. (2009) designed a prototype security technique (Layered web cache structure) for each group in a multi-layered structure, on a caching technique to improve user's response speed thereby guaranteeing security of digital content distribution. In addition, the system uses a layered encryption and decryption technique to improve the level of security of digital contents. Its implementation verified the performance of the system based on improvements in the level of security and execution speed.

In the same vein, Park et al. (2007) identified a comprehensive list of numerous risks in global online trading of digital goods and proposed a risk framework consisting of four factors (technological risk, environmental risk, strategic risk and operational risk) for establishing a risk management system. The paper addressed SC activities which are involved in digital goods, from production of components to final consumer stages.

2.2.8 **E-RFID**

E-RFID refers to the use of internet and web technologies with radio frequency identification (RFID) system for management of supply networks. Mehrjerdi, (2008) introduced the concept of RFID technology and reviewed an RFID internet enabled system. Bi and Lin, (2009) proposed a new taxonomy of supply networks which provided the necessary systematic framework for mapping supply networks based on the purpose and availability of information. The paper then developed an innovative methodology for using RFID technology to discover supply networks (SNs). By leveraging this technology, a firm can visualize its SN at more a detailed and also, at multiple levels, in real-time. This method can provide accurate data about product movement. This research solved a real-world SCM problem of how to identify and discover SNs.

Zhou et al. (2007) proposed an e-radio frequency identification (e-RFID) remote monitoring system that uses the internet to provide transparent and visible information flow for internal enterprise production management. RFID technology, bluetooth and internet technology are employed to form a remote monitoring system for production management. The developed system led to enterprise inventory visibility, which in turn, leads to reduced costs, improved customer service, increase of inventory accuracy and decrease of lead-time variability.

Mourtzis et al. (2008) discussed the design and implementation of an e-RFID system that can dynamically query SC partners to provide real-time or near real-time information regarding availability of parts for the production of highly customisable products. Furthermore, the study described the details of a software system for evaluating time and financial feasibility of acquiring the necessary parts for building the customised product. This SC control model used internet communication and real-time information from RFID sensors. The feasibility of this approach was implemented successfully in an automotive case. Curran and Porter, (2007) outlined a library prototype SC design system that uses RFID technology to help streamline major library processes such as stock taking and book searches. The study found that the functionality and benefits offered by the RFID match the needs and areas of improvement for libraries. This demonstrated that RFID can be successfully integrated into existing library systems to improve the efficiency and quality of the main processes and services provided.

Prater et al. (2005) examined the market drivers that could lead to RFID implementation in the grocery industry and provided a theoretical framework for future applied research on RFID implementation in the grocery industry. They discussed how the industry can utilize this technology to change the entire method of SC operation. The framework included research using modelling techniques, RFID implementation and the impact of RFID on daily operational issues. The study found that the adoption of RFID technology in SCM could be more successful than automatic replenishment programs (ARP).

Gessner et al. (2005) examined the role of RFID in e-records management (e-RM) in the US to improve supply chain operations and response to public health crises. The article illustrated the complexity, challenges and crucial role of records management in global food supply chains and the importance of being able to produce records quickly, on request, particularly in health crises situations.

2.2.9 E-optimization design

E-supply chain optimization design describes the use of the internet and web technologies for optimization of supply chains. Lin et al. (2006) presented an internet quick-response (e-QR) system, also called an efficient customer response system (ECR) framework for perishable goods supply chain and developed a dynamic frequency supply and distribution (DF-SD) algorithm to optimise supply and distribution strategy for all members in the supply chain. The algorithm is composed of a linear-programming model and an extended genetic algorithm. Simulation results indicated that the e-QR successfully out-performed the traditional six-frequency approach in terms of both solution quality as well as computational time efficiency.

Dotoli et al. (2007) proposed an IESC optimisation model using fuzzy logic. In order to rank the optimal solution, the authors proposed two fuzzy multi-criteria techniques and two fuzzification methods. The paper modeled the structure of the IESC by a digraph describing the actors, stages, materials and information links among them. An integer linear programming problem with suitable constraints was employed to formulate the IESC network design decision problem. The methodology was applied to a case study which shows the effectiveness of the method in selecting the optimal IESC configuration solution. This work was an improvement of a previous IESC network design method that selected and linked partners in the different IESC stages.

Luo et al. (2001) proposed and illustrated an integrated multi-objective mathematical e-supply chain model to design (fuzzy logic) and optimise SC performance (product cost, cycle time, quality, energy and environmental impact) in a global internet manufacturer. The e-SC is an extension of traditional SC; with distributors, suppliers and users but included end-of-life product collectors and de-manufacturers. Furthermore, it extended the performance considerations from cost and productivity to include environmental performances. Such an extension allowed for the development of e-manufacturing systems that are agile and can produce desired products with minimum environmental impact over their life cycle. It can attack typical configuration problems such as partner selection and transportation selection based on partner characteristics. This can help manufacturers to enhance their competitiveness by balancing their environmental responsibilities.

Yusecan at al. (2001) introduced a framework for combining statistical efficiency of simulation optimization techniques through Optimal Computing Budget Allocation

(OCBA) algorithm. A prototype was implemented in a web environment for low cost parallel and distributed simulation experimentation that successfully demonstrated its viability in web simulated environments. It offers an intelligent way to identify optimal systems design and demonstrated the power of web technologies for experimental design and output analysis phases of a simulation study.

Kotzab et al. (2003) examined the formulation of SC strategies in complex environments and argued that current e-SCM, as well as the use of Transaction Cost (TC) and Network and Resource Based (RB) theories, altogether, can be used to form a model for analyzing SCs with the purpose of reducing uncertainty when formulating SC strategies. They presented and validated a theoretical e-supply chain strategy optimisation model (e-SOM) in the Agric-chemical industry, to analyse SCs in a structured way with regards to strategic preferences for SC design, relations and resources, with the ultimate purpose of enabling the formulation of optimal, executable strategies for specific supply chains.

Laval et al. (2005) reported the development of a systematic way of combining expert knowledge, scenario-based modelling and optimisation (software and internet) coupled with scenario analysis, to solve complex problems in supply chain network design.

2.3.0 E-modelling of complex systems

This design involves the use of the internet and web technologies to model complex SC systems. Modelling SCs is a difficult and challenging task, particularly given the need to model stochastic operations in typical SCs based on internet technologies. This can offer the promise of connecting SC partners including customers in a seamless information network that can substantially improve decision-making and considerably improve operations.

Blackhurst et al. (2004) proposed a network-based method to model and analyse SC systems. The method represented the operations of a SC as an abstracted network and allowed for the inclusion of stochastic variables so that uncertainty can be model. The method is then illustrated using a case study based on company data which demonstrated, among other things, that this approach can improve the operation of a supply chain.

Rabelo et al. (2006) presented a system dynamics simulation methodology that trained neural networks to make online predictions of behavioural changes, at very early decision making stages, so that an enterprise would have enough time to respond and counteract any unwanted situations. Eigenvalue analysis was used to investigate any undesired foreseen behaviour. The principles of stability and controllability are used to mitigate or study several of such decisions. A case study of an actual electronic manufacturing company was used to demonstrate the real benefits to an enterprise.

To cope with increasing complexity of managing distributed systems (dynamic SCs) across firm boundaries, Goul et al. (2005) proposed a Database Schema Design model with web-scripts as a means for pre-specifying and monitoring organisationally approved patterns of web service invocations. Challenges associated included variable quality service levels, share-ability of web-scripts between firm business processes, continuous updating of web-scripts by human or automated agents and scalability of designs to accommodate evolutionary changes. This system has implications for the strategic management of web services supply chains as a critical business process.

Nagurney and Matsypura, (2005) proposed a framework that modeled the dynamics of a global SC network during risk and uncertainty. The proposed framework allowed for the modelling and theoretical analysis of competition within a tier of decision-makers with cooperation between tiers. The paper also provided numerical examples for illustrative purposes.

Abdul-Malek et al. (2004) developed a framework to assess the performance of complex multi-layered supply chain strategies. The framework provided a datum to compare multi-layered SCs where stock, long-term partnership contract and/or competitive e-bidding strategies could be practiced. To estimate the required level of stock, the SC was modeled as a set of tandem queues and the lead-times were computed, using Markovian closed-form expressions and simulation, to estimate the annual costs of each strategy. Analysis indicated the length of lead-time; variance and inventory carrying cost are among the decisive factors against competitive bidding strategies. The result from this study provided decision makers with means for a first cut evaluation scheme to compare outsourcing strategies before implementation in a supply chain.

In order to respond to the increasingly uncertain environment, firm are using spanning flexibility (the ability to provide horizontal information connections across the value chain) to meet a variety of customer needs. Zhang, (2006) used structured interviews to collect data on spanning flexibility from manufacturing executives. Structural equation modelling was then used to test a framework that explored the relationship bwteen flexible competences (supply chain information dissemination flexibility), flexible capability (strategy flexibility) and customer satisfaction. This result indicated strong positive and direct relationships between flexible spanning competence, capability and between flexible spanning capability and customer satisfaction.

Jian et al. (2005) proposed a fuzzy enhanced high level petri net model (FEHLPN) for modelling and analysing the dynamics of supply chain networks in vague and uncertain environments for effective management of supply chains in an e-commerce environment.

2.3.1 **E-performance measurement systems (e-PM)**

E-performance measurement refers to the ability to measure the entire network performance of electronic enterprises. Straub et al. (2004) explored the dimensions of network organisational performance; as a construct, a set of measures and also, as a construct, within a nomology using game theory concepts. The research adopted the network as the primary unit of analysis, validated a set of procedures to be adopted in examining symmetry in dyadic relationships and further developed network firm performances from numbered tiered and layered perspectives. The concept of degree and symmetry were applied to all three perspectives to discover and investigate causes for variations in nominal degree and relative symmetry of performance. The results indicated that firms should expand performance analysis to encompass the three network perspectives, which will enable development of key capabilities. This paper offered a way to gather information about how partners work together in sharing strategic information about which antecedents have downstream effects and about how performance across entire networks can be measured and thereby improved.

Tang et al. (2004) developed an enterprise simulator to quantify and evaluate the impact of e-solutions across supply chains in terms of operational and financial performance measures. The simulator allowed the complete SC to be modelled across four key applications areas - control system design, virtual enterprises, pan-SC performance metrics and e-SC design methodology. This tool exploited the capabilities and business strategies offered by e-business whilst at the same time included quantitative as well as qualitative analysis of the SC design performance at each stage.

Caputo et al. (2004) proposed and tested an integrated global framework to analyse and evaluate performance of e-supply chains. The output of the model can also be used to design totally new e-SCs or to redesign existing ones, in both manufacturing and service industries. In another paper, Caputo et al. (2005) provided an integrated global framework to classify e-SNs by identifying and describing two characteristics e-SN patterns are based on (influencing factors and the types of physical and immaterial flows between actors). The framework may be used to assess the management of a specific e-SN and their coherence within their business environment. It could also provide useful guidelines for managers and practitioners involved in e-SN design.

Reiner, (2005) explained the importance of customer orientation for improvement and evaluation of supply chain performance and described how process improvements can be dynamically evaluated with consideration of customer orientation, supported by an integrated use of discrete-event simulation models and system dynamic models. The author illustrated its use in an electronic manufacturer in the telecoms industry.

Vanteddu et al. (2007) used the concept of coefficient inverse responsiveness (CIR), to facilitate efficient introduction of responsiveness related costs into the scheme of SC performance evaluation and optimisation. Their stochastic model developed the total cost expression of safety stock costs and responsiveness related costs, for a serial decentralised SC, as an aid in achieving better strategic fit between individual business units and overall SC requirements in terms of cost efficiency and responsiveness. According to the authors, both overall SC cost and responsiveness (i.e. SC lead time) are the most significant determinants of SC competitiveness; as competition between and within supply chains has shown that priority and importance should be given to the overall SC, rather than, to the goals of individual players.

Eng, (2007) conducted a study of internet coordination mechanisms and network organizational characteristics, in order to improve service responsiveness and firm performance. The main results from a survey of firms in the UK electronic manufacturing industry, suggested that, internet coordination mechanisms and network firm characteristics positively influence firm performance and service responsiveness. In addition, the results suggested that e-coordination mechanisms could provide better advantages, to support coordination through open systems and virtual channels.

Ho et al. (2005) used structural modeling to measure SC uncertainty and developed a validated scale to diagnose SC problems. The proposed uncertainty construct can be incorporated into performance evaluation, monitor and assess the effectiveness of e-commerce solutions to solve problems of inter-organizational integration. This can reduce the risk of failure by identifying uncertainties which could affect inter-firm processes and evaluate the damage they can cause. This, in turn, can enable organizations to diagnose properly and deploy e-commerce solutions, to monitor the improvement of supply chain performance.

Gulledge and Chavusholu, (2008) used supply chain operations reference (SCOR) model and Oracle E-business Suite to configure an integrated internet supply chain operations reference (iSCOR) architecture, which can provide automated data collection for supply chain performance management. Arns et al. (2002) developed a technique to measure the performance of SCs with the use of queuing networks (QNs) and Perti nets (PNs). There results indicated very high performance between a SC channel of web consumers and a manufacturer.

2.3.2 **E-contract negotiation (E-CN)**

Agricultural supply chains are strictly regulated to ensure food safety and multi-level traceability. Supply contracts in such chains need sophisticated specification and management of supply chain agents to ensure auditability. Bacarin et al. (2008) developed a framework to support and manage agent's online interaction during contract negotiations. The framework was based on three elements; contracts, coordination plans (business processes) and regulations (business rules).

Li et al. (2002) designed and implemented a set of business negotiation objects (BNOs) to support the bargaining phases of business negotiations. The objects defined the operations and information contents needed for negotiating parties, to express their requirements and constraints during a bargaining process. Their implementation was patterned after business objects documents in XML format. The use of BNOs in a bilateral bargaining protocol was also presented and validated in an integrated SC network environment, which consisted of two replicated negotiation servers, two commercial products and a university research system.

Tserng and Lin, (2002) proposed an integrated Extensible Mark-up Language (XML) subcontracting and procuring web architecture (ASAP), which uses internet and web technologies to re-engineer the subcontracting and procurement processes, to enable contractors, to accurately decide the risk and profit related to projects before they are implemented.

2.3.3 **E-intelligent agent systems (E-IA)**

E-intelligent agent systems refers to the use of software agents to integrate different information technologies through the internet, including semantic web, to enable intelligent behaviour in machine-to-machine, in order to utilize SC information for decision support capabilities and value-based relationships, thereby improving the effectiveness and efficiency of SCM. Kumar, (2003) developed an e-human capital SCM framework, with the use of intelligent agents, that facilitated search for employment. The framework enabled decision-support capability in an internet environment and provided a value-based relationship between partners. The impact of the internet on HRM and quality human resource initiatives that could link a technologically adept workforce was also analysed.

Lo et al. (2008) designed a web-based, e-fashion multi-agent SC system, which manifested intelligent behaviour. The system can integrate different information technologies, including, the semantic web and other web softeware, in order to share more useful information from customers; thereby, improving the effectiveness and efficiency of SCN. The system can also solve problems in b2b and b2c web transactions, in machine-to-machine interaction.

2.3.4 **E-CRM systems**

E-CRM refers to the use of the internet and web technologies for managing customer relationship management (CRM) in an enterprise SC network environment. Tan et al. (2002) assessed the impact of the internet on CRM in order to reveal new opportunities and challenges related to CRM in the business setting. The paper also addressed the relationship between CRM and other e-business applications, including, ERP, SCM and Data Warehousing. The authors identified different CRM programs, classification and major players in the CRM software industry and discussed elements and phases of the key characteristics of the internet for CRM implementation.

Reichmann, (2002) introduced the concept of Stakeholder Relationship Management to show how businesses use the internet to supply their stakeholder with information in CRM, Investor Relations and Public Relations.

Sheth et al. (2000) proposed a framework for analyzing customer-centric marketing (CCM), which seeks to fulfil the needs of the customer and examined its antecedents, which included, the increasing pressure on firms to improve marketing productivity, increasing market diversity in business and households and technological applicability in production, distribution and facilitation. They suggested that the shift in CCM would increase the importance of marketing as a ‘supply management’ function, with consequences for customer outsourcing, co-creation marketing, fixed-cost marketing and customer-centric organizations. Some of the supply management technologies included; computer aided design, computer aided manufacturing, databases, just-in-time flexible systems for production, electronic data inter-change (EDI) combined with forecasting tools, scanners for distribution and internet technologies that can provide the ability to store vast amounts of information, including customized information. The use of internet and web technologies can enable CCM to obtain a more intimate understanding of customers, which in turn, would enable them to realise efficiency in marketing processes.

Ross, (2005) described how the rise of internet technology has not only transformed customer relationship management but also provided many computerized toolset that have significantly expanded its traditional functions (sales, customer services and marketing) and capabilities. The study provided detailed capabilities of e-CRM for SCM. These included providing visibility to customer value capabilities, generating an integrated infrastructure and a seamless end-to-end SCM service through internet technologies. Giovanni and Franceschini, (2003) presented experimented results for a segmentation model between users and web sites, that permited the provision of specific service management for each user segment. The model supported customer relationship management and quality e-commerce web service and its implementation.

2.3.5 E-Music systems

E-music refers to the use of the internet and web technologies in music SC network environment. Hardaker and Graham, (2008) analysed the overlapping nature of consumption and production in the supply chain of the e-dance music sector in Finland. The structural formation of the industry is fractured, to the extent, that the identities of producers and consumers are blurred, by the decentralised nature of the supply chain network. This situation challenges the conventional distinction between consumers and producers of music, with the record label typically acting as mediators. The result of the study indicated that the methods of production and supply are highly integrated through the creation of peer-to-peer communities, which has resulted in the overlap of traditional cultural consumption and production, to an emergent self-organisation.

Graham et al. (2004) explored the impact of the internet on the supply chain of music. The internet, coupled with the production of music in digital format, the advent of file downloading and swapping has changed the dominance of the major labels over music

creation, distribution and consumption. More and more music is distributed electronically. Consequently, the structure of the industry's SC is changing from a relatively linear and fixed structure, to a more flexible network, where partners are likely to change more frequently. The replacement of a vertically-integrated SC with a more dynamic and flexible network structure is likely to reduce the power of the dominant players, as they will no longer be able to own and control the main distribution channels. However, the biggest threat to the dominance is internet piracy.
Lewis et al. (2005) compared pre-and-post-web music supply chains and argued that the internet is destabilizing the music industry SCs by challenging and dominating pre-web roles and by changing the primary entry barriers in the sector. The paper contributed to the understanding of the strategic responses taken by industry incumbents and presented the implications for consumer welfare.

2.3.6 **E-Knowledge Management systems**

Lin et al. (2002) examined different types of knowledge flows from recent advances in computer networks and the internet and proposed a knowledge management architecture that facilitated knowledge management in collaborative supply chains. According to the paper, e-linkages have fundamentally changed the nature of inter-organizational relationship, as firms can now tightly couple process interfaces at each stage of the value chain. Networks can redesign internal and external relationships and create knowledge networks in order to facilitate communication of data, information and knowledge, while improving coordination, decision making and planning. The paper also discussed three knowledge e-technology models to outline different industry's architectures and the knowledge flows therein. These results also indicated the different types of SC networks, the amount of transactions and the main collaborative functions in the SC that would lead to different types of knowledge flows and the tools adapted.

Cronin, (1998) described the strategic importance of information and intelligence management to socioeconomic growth and considered the implications to human and structural intellectual capital development, through demand-and-supply side analyses of knowledge and skills requirement for information professionals in the digital age. According to Cronin, in the digital age the socioeconomic wellbeing of nations and the business world depended on the ability of information professionals to access and exploit knowledge, which further depended, on the ability to link quality telecommunications infrastructure and extensive diffusion of information processing and analytic skills, throughout the workforce.

According to Marfleet and Kelly (1999), the advent of the internet has given rise to the evolution of information professionals and the need to refocus their traditional role of information retrieval to the development of core competences. The paper viewed the changing role of information professionals to that of a facilitator of quality information retrieval, which must be closely aligned to business and able to ride the change in business and technology. These changing roles should encompass, end-user relationships, training on best practice, implementing information supply strategies (IT), information management, intranet development, industry specialization and continued professional development.

Li and Chandra, (2007) discussed the challenges and requirements faced by knowledge integration in complex networks and proposed a knowledge integration framework that models various network structures and adaptively integrates knowledge based on dependency, modelling and information theory. The paper used a conceptual Bayesian model to support its application to SC risk management and computer network attack correlation. This research provided insight into systems modelling and knowledge management in response to complex network management and representd appropriate network modelling that can integrate knowledge for decision making in complex networks.

Gunasekaran and Ngai, (a) (2007) reviewed the literature on knowledge management, identified gaps between theory and practice and developed a framework for knowledge management in the emerging advanced manufacturing environment which is characterized by SCM, enterprise resource planning, virtual enterprise, outsourcing and e-commerce. The framework was based on four main dimensions which are also the key functions of manufacturing (design and engineering, production, distribution and IT systems). According to the paper, although recent developments have been driven by IT, the process of innovation heavily depended on knowledge and the management of knowledge, of which, human capital should be an essential element, in the management of any business.

Their findings suggested that manufacturing firms should place emphasis on human resource management practices when developing strategies for product and process innovation, since knowledge contributes to innovation performance through a simultaneous approach of implementation of soft HRM practices and hard IT practices. They reiterated the view that although most successful firms today are considered ‘intelligent enterprises’, in order to convert and integrate intellectual resources into useful forms for customers, materials manufacturing without human input have little intrinsic value; especially as most of the processes which add value to materials are knowledge-based activities. Therefore, as has been argued elsewhere, the organization and effective strategies of enterprises should depend on the development and deployment of human resources rather than on the management of physical assets.

Bassi et al. (1998) examined the changing trends in workplace learning which is linked to rapid technological development and the emergence of a global economy. The paper stated that, workplace learning is becoming more strategic and a competitive advantage to both individuals and employers. However, this has resulted to an unprecedented change in the demand and supply of workplace learning opportunities.

The paper identified four major developments that are affecting the field of workplace learning and performance improvements on the demand side (the growing effort given to knowledge management, the integration of learning and communication functions, a resurgence of interest in leadership development and executive coaching and the intensified requirement among employees that career development become an integral part of employment relationship) and four supply side developments (the internet, intelligent tutoring systems, learning software objects and voice recognition technology).

2.3.7 E-supply chain adoption and implementation

This section discussed the adoption and implementation of internet and web technologies in supply chains. Some of the important themes are centred on information sharing, integration, collaboration, international comparison and critical success factors. One of the typical cases reported by Yen et al. (2004) is Eastman Chemical Company's mandate to sell the firm's philosophy for the adoption of an integrated e-supply chain to its business partners globally. The case described the firm's industry, its e-business strategy, rationale, and why an integrated e-solution is integral to a company's competitive strategy. The study also identified the underlying technical requirements for an integrated e-supply chain.

Folinas et al. (2004) examined five dimensions in the evolution of a traditional SC to an e-supply chain and used case studies and best practices to illustrate and support the evolutionary progress. Based on their analysis, a SCM evolution framework was proposed and its implication for current SC practice identified for future development. The findings demonstrated that firms have realised the need for real-time information systems, new business models and the benefits derived from an integrated SC. Their taxonomy also confirmed the existence of different e-business adoption strategies and web-solutions, to integrate and rationalize supply chains.

Nguyen and Harrison, (2004) developed a framework to formulate e-business capabilities and integrated SCM capabilities. The study empirically tested a taxonomy that illustrated a firm's strategic positioning along these two components. Results from the Australian manufacturing industry indicated that firms generally adopted four strategic options. Furthermore, manufacturers seem to compete on three competitive dimensions simultaneously (information integrity, networking and joint efficiency operations and b2b applications). The study also pointed out the different components of e-technology and integrated SC capabilities and discussed how they could be used to formulate different strategic options. Gregory et al. (2007) assessed adoption and implementation of internet technologies in export marketing strategies.

Two papers advocated a network orientation to e-SCs. In the first paper, Sherer, (2005) analysed case studies and demonstrated the limitations of information systems that are utilized to support traditional SCM and introduced the broader concept of 'value network advocacy', to address the identified limitations. According to Sherer, adoption of this concept would guide e-SC development to support more integrated customer-focus notion of flexible and adaptable networks that can provide value and support for customer needs. Similarly, Overby and Min, (2002) proposed a network oriented model of internationalisation to encourage more integrated levels of I-Commerce adoption which, in turn, will further strengthen the relationship between network orientation and its implementation. They argued that the emergence of internet commerce is a significant challenge to traditional internationalisation and proposed International SCM, as a process of internationalisation, which represented the implementation of a global uncertainty-driven new network orientation.

Koh et al. (2007) conducted a comparative survey of two country's pattern of internet usage, impact of the internet on firm performance and internet readiness, from a value chain perspective. They discovered that internet usage and its impact on business vary from country to country. Their findings also indicated that both countries had similar usage, suggesting the global nature of internet adoption as a business tool and the need for firms to fully exploit its value chain potential.

Similarly, Pant et al. (2003) developed a framework for evaluating e-supply chain implementation strategies in free market economies. The framework captured the various approaches that can be used to create an integrated e-SC system and how to implement different SC requirements. The study also discussed the implementation of e-supply chains in two companys. Chen et al. (2004) extended the framework of e-supply chain implementation strategies to transitional economies. The paper proposed seven implementation strategies for traditional economies.

Ngai et al. (2004) reported the results of a survey of critical success factors for web SCM systems. Exploratory factor analysis revealed five major critical factors for implementation of web SCM. Soliman and Janz, (2004) identified the critical factors that can effect the decision to adopt e-information systems. Their findings provided insights for firms using or planning to use internet and web SCM systems.

2.3.8 **Impact of e-SCs**

This section discussed research on the impact of internet and web technologies in supply chains. Keil et al. (2001) noted that the adoption of ICT in modern life is fuelled by digitization of technology that has blurred boundaries between industries and is further increased by access technologies (3rd generation wireless systems, Bluetooth or wireless LAN etc.). They argued that the massive restructuring of economic and management principles taking place, is partly derived from the opportunities created by technology, which is, also partly shaping their evolution. The paper detailed the nature of the impact of internet and web technologies in four selected areas (strategic management through value creation and standards setting, demand and SCM and logistics, organization and leadership and in management education for rapid change).

Lankford, (2004) discussed the potential e-opportunities and problems associated with the sudden increase, in the use of internet to improve performance in supply chains. The advantages included speed, decreased cost, flexibility and the potential to shorten the supply chain. Hausen et al. (2006) conducted a comparative analysis between an SME that uses embedded e-trading systems and another that could improve its transaction efficiency by using an embedded e-trading system. The benefit derived is shown in an experiment that compared traditional transaction processes with that of electronic processes in an SME market. The results indicated major gains in transaction process efficiency for both buyers and sellers using e-trading systems. Electronic trading systems can improve transaction efficiency as compared to traditional transaction processes.

Sodhi, (2001) charted solutions and opportunities for operations research's (OR) in e-supply chains. OR applications could improve planning and execution in e-SCs through an expanded physical scope to include vendors and customers and through an expanded functional scope to include product design, marketing and CRM. Mattsson, (2003) proposed that changes in current market structures are caused by globalisation and redistribution of goods and services via the internet. The reorganisation aspects of globalisation and distribution were discussed, as they relate to multi-national firms, mergers and acquisitions and strategic alliances. The author applied a network view of (structural inter-dependencies) markets, with reference to cultural dimensions, to analyse the implications of the general development trends in research and practice of SCM.

Quayle, (2003) conducted a SCM practice survey designed to identify current trends in the UK industrial SME enterprises. The analysis identified the adaptation of SCM techniques and relationships between customers and suppliers. The outcome indicated a lack of effective adaptation from traditional adversarial relationships to the modern collaborative 'e' supply chain and identified the issues that businesses need to address in order to improve SC performance by grasping the benefits of effective SCM.

Lancioni et al. (2000), Rahman, (a) (2003) and Rahman, (b) (2004) conducted email surveys discuss internet and web usage in supply chains. The most popular areas of use identified by all three papers included transportation, order processing, vendor relations, purchasing and procurement and customer service. Its greatest potential in SCs is to speed up communication between customers and their suppliers, to improve service levels and by reducing logistics costs, thereby, gaining greater productivity and efficiency.

Martin et al. (2008) presented a case study about a company's eventual transition from a part paper-based and part electronic supply chain to a complete e-supply chain system in order to maintain competitive advantage by reducing operational costs and lead times. The case presented the early experience and impact of the transition on the company and its stakeholders. Roethlein et al. (2008) surveyed how four identified manufacturing strategies (internet technologies, design strategy, employee experience and delivery, and facility location) differ in importance to five identified levels of supply chains (base level suppliers, sub-component, component, major component and end-product producers) in US manufacturers. End product producers reported internet technology strategy to be significantly important than other supply chain levels and customer demand was seen as an increasing factor, for the importance of internet technologies, in order to compete effectively.

Motola, (1999) discussed areas in the mining industry that could be impacted by e-commerce. The four areas identified for implementation of internet and web technologies in the sector are; supply chain integration, knowledge management and education, human communications and machine communications.

2.3.9 Defining e-supply chain design

We have discussed and classified the e-supply chains identified from the literature based on their main design themes from the articles and their SCM or e-SCM achievements. Therefore, based on this identification and classification, we define 'e-supply chain design' as 'the use of e-technology, particularly internet and web technologies, to configure or design supply chains (e-SCs) for e-collaboration, e-integration and e-information sharing in order to achieve greater efficiency and productivity'. This description fits well with the perceived purposes and SCM achievement of the e-supply chains as analysed and also is rational and logical based on the overall review of the literature in this study.

2.4.0 **Summary conclusion**

It may be evident to state that e-Supply Chain Management is a multi-dimensional phenomenon; however, this review has identified two main components of e-SCM (e-technology and e-supply chain design) and thus developed a conceptual framework of e-SCM. According to our review, e-SCM refers to the use of e-technology, particularly internet and web technologies, to design or configure supply chains (e-SCs), for greater efficiency and productivity through e-collaboration, e-integration and e-information sharing. It also seems logical to assert that the relationship between the two main components is based on SCM principles of integration, collaboration and information sharing for greater efficiency and productivity, and therefore sustainable supply chains.

Moreover, our review and analyses developed a classification of twenty-three e-supply chain designs based that are based on e-integration, e-collaboration and e-information sharing for high productivity and increased efficiency; introducing and demonstrating the importance of the 'design' element to the general debate on e-SCM. We have identified the major components of e-SCM and the main themes of e-SCs, which in most instances, focus on solving practical problems and can help managers think about and focus on their specific supply chain needs.

CHAPTER THREE

Research Methodology

3. Introduction

This chapter explained the philosophical worldview, rationale, research strategy of inquiry, and the two research sequences that make up the present study. Section 1, explained the research philosophy and rationale of the study, including the goal, aim, and objectives. Section 2, explained our mixed methods research strategy, including the mixed methods design and processes, its purpose, methods of data collection, sampling design, mixed methods integrative strategies and criticisms. Section 3, discussed the research methods, including data collection and sampling. Section 4, explained the two research sequences, each with its own data collection and phases of analysis. In sequence one; Phase 1 detailed a quantitative survey and bibliometric analysis of e-SCM. In sequence two, Phase 2 initiated the development of an e-SCM typology development with the aid of theme analysis through open and selective coding. Phase 3, utilized a conventional content analysis to identify latent e-supply chain designs, relevant to achieve informational redundancy and complete the typology development. Each sequence will seek to explain its procedures and findings.

SECTION ONE

3.1 **The philosophical worldview proposed in this research**

There are three primary considerations which should be given to an overall research design, (1) The worldview or philosophical assumptions, (2) the procedures or strategies of inquiry and (3) the specific methods of data collection, analysis (results) and interpretation (Creswell, 2004). However, discussion and interpretation of results will be dealt with in chapter four. This research is based on a pragmatic worldview; a post-modern philosophy which is based on the writings of Charles Pierce, William James and John Dewey, who are regarded as the founding fathers. There are many versions of pragmatism with different points of emphasis, interpretations and re-interpretations however, Pierce’s pragmatic maxim provide the first explicit characteristic of this worldview. Pragmatist aims ‘to clarify the meanings of intellectual concepts by tracing their conceivable practical consequences'. Later, their attention was shifted to the important consequences of actions based on particular conceptions. The pragmatic worldview gives importance to the consequences of a phenomenon (Cherryholmes, 1992).

Pragmatism is not committed to any one philosophy or reality but draws liberally from both quantitative and qualitative assumptions. Pragmatic researchers are free to choose the methods, techniques and procedures of research that best meets their needs and purposes. For them, the truth is what works best at the time of inquiry. Pragmatism encourages multiple methods, with different worldviews, assumptions as well as the use of different forms of data collection and analysis (Creswell, 2004). In this regard, pragmatism offers an attractive philosophical partner and framework for designing and conducting a mixed methods research study (Johnson and Onwuegbuzie, 2004), from which this study is based.

3.2 **Rationale for Choosing the Pragmatic Worldview**

As a postgraduate management student with training on both constructivist-interpretive-qualitative and positivist-quantitative paradigmatic views during the rise of both globalization and the internet (in the nineties UK) onwards, it was easier not to take sides in the paradigmatic wars (Johnson and Onwuegbuzie, 2004). Moreover, originating from a pre-colonial country and an ethnic minority (lead researcher); made it easier not to accept paradigmatic views from whatever persuasion carte blanche, particularly when they have connotations of superiority or suppressive nuances (Mertens, 2003). It became less of a dilemma then not to accept the *incompatibility thesis* (Mertens, 2003) and to embrace pragmatism because of its plurality and eclecticism. Similarly, we accept that epistemological and methodological pluralism should be promoted so that researchers are informed about other possibilities. In fact, some would argue the logic, that in taking a non-purist or compatibilist position, researchers would utilize methods that offers the best chance of answering their specific research questions, thereby able to conduct better research. In the light of the above discussion therefore, we have decided to use a pragmatist approach for this study.

This also enabled the researcher to utilize a qualitative-dominant mixed research study, taking a ‘qualitative constructivist-poststructuralist-postmodernist-critical stance’ with respect to the research process, while at the same time, including quantitative data and approaches to help provide rich and detailed descriptions and interpretations’ (Johnson and Onwuegbuzie, 2004). It is our view that the pragmatic worldview offers an appropriate paradigm for this study in its stance to use whatever method is deemed necessary to answer the research questions. This ‘so-called decentered approach’ (Van de Vijver and Leung, 1997) will also minimize the risk of both self-referenced bias and of overlooking alternative explanations thereby promoting academic rigour (Beuckelaer and Wagner, 2007). However, our choice of a pragmatic view is not meant to replace either quantitative or qualitative approaches but to draw from the strengths and minimize the weaknesses of both in a single research study and across studies. We hope that the above discussion would also contribute to ascertaining methodological congruence (Thurston et al. 2008).

3.3 **Overarching goal of the present study** (¥a)

This study focuses on a specific field within Operations and Supply Management (OSM), namely e-supply chain management (E-SCM). E-SCM is a young, developing and exploding field that, among other things, analyses the role played by e-technologies, particularly internet and web technologies, to manage supply network operations. E-SCM has led to the emergence of new academic research areas that builds on existing research in a host of disciplines such as information systems, business strategy and engineering; to name a few (Zhao et al. 2008). However, although emerging studies are beginning to examine different facet of this phenomenon (Liu et al. 2010; Mukhtar et al. 2009; Sambasivan et al. 2009, and others), a gap still exist in the literature with regards to its conceptual development (Bi et al. 2010). Furthermore, there has been a call in the SCM literature, for further research into the existence of e-supply chains (Hoek, 2001). Moreover, there should be a concern on the lack of an integrated perspective that combines the examination of the different variables that have been identified, into a single study.

As such, every effort should be made by academia to help understand the nature of this complex phenomenon in order to resolve its conceptual difficulty (and subsequent empirical validation); which is the over-riding goal of this study. According to the e-SCM literature, the subsequent analysis and development of e-SCM will determine future economic growth (Del-Aquila et al. 2003) and possibly, the re-thinking or re-emphasis of management and associated concepts (Lang, 2001 and Ho et al. 2003), pertaining to industries, markets and in businesses (Del-Aquila et al. 2003). Therefore, this study will contribute by providing more insight and better understand of e-supply chain management at this developmental stage of the concept, in the interest of academia and as a contribution to knowledge.

3.4 **Aims and Objectives of the study (**¥e)

The initial aim is to develop a conceptual framework of e-SCM. Our overall mixed research objective is exploratory (¥b). Three objective statements were formulated. The mixed research statements or objectives are divided into three phases:

- Phase 1. To gain insight into the direction, trends and current status of e-SCM
- Phase 2. To identify the components of e-SCM that will aid the development of a conceptual framework, and
- Phase 3. To discover different types of e-supply chains.

Section two

3.5 Mixed Methods Research Strategy

3.6 Definition

This study uses the definition provided by Creswell and Plano Clark, 2007; that mixed methods research focuses on the collection, analysis and mixing of both quantitative and qualitative data in a single study or a series of studies (Molina-Azorin, 2009). Mixed method research dates as far back as 1959, when Campbell and Fisk used multimethods to study the validity of psychological traits and encouraged others to use it to examine multiple approaches to data collection. It was born out of the belief that all methods have limitations and the view that biases from any single method could neutralize or cancel the biases of other methods which further herald triangulation of data sources as a means of convergence, connection or embedded to the integration of quantitative and qualitative data. This has led writers worldwide to develop procedures for mixed strategies that take numerous forms (Creswell, 2004). Mixed method research recognizes that both quantitative and qualitative research methods are useful and important and does not seek to replace either but rather draw from the strengths of each, to minimize the weaknesses of both in single research studies and across mixed studies. Other proponents of mixed methods research include works of Brewer and Hunter, 1989; Newman and Benz, 1998 and Reichardt and Rallis, 1994, in (Johnson and Onwuegbuzie, 2004).

Ultimately, the possibility of mixing methods can be very large because of the many potential classification dimensions, as it opens up an exciting and almost unlimited potential for future research (Johnson and Onwuegbuzie, 2004). Mixed method research strategies or designs can be developed from either a mixed-model (mixing qualitative and quantitative approaches within or across the stages of the research process) or mixed-method (including a quantitative phase and a qualitative phase in an overall research study). Johnson and Onwuegbuzie, (2004) provided a detailed list of across and within mixed-method designs and the different kinds of mixed-methods designs based on Morse, 1991. However, researchers should consider two primary decisions; firstly, whether to operate within one dominant paradigm or whether to conduct the phases concurrently, sequentially (Johnson and Onwuegbuzie, 2004) or transformatively (Creswell, 2004).

Secondly, in a mixed methods design, the findings must be mixed or integrated at some point. Nonetheless, one can easily create more user specific and more complex designs. For example, quantitative-qualitative-quantitative stages or both a mixed-model and mixed methods approach. Furthermore, a design may emerge during a study in new ways, depending on the conditions and information that is obtained. The most important point is for the researcher to create designs that effectively answer their research questions. This view is in contrast to the approach where one completely follows either a quantitative or qualitative paradigm (Johnson and Onwuegbuzie, 2004).

3.7 **Mixed methods rationale** (¥c)

The overall mixed goal or central aim of a mixed methods study is that both the use of quantitative and qualitative methods in combination can provide better understanding of the research issues and complex phenomenon, than either method alone (Molina-Azorin, 2009). As Greene et al. (1989) indicated, mixed methods inquiry is an approach to investigate the social world, that ideally involves more than one methodological tradition and thus more than one way of knowing, along with more than one kind of technique for gathering, analyzing and representing a phenomenon for the purpose of producing better understanding. Creswell, (2004) emphasizes the importance of focusing on the research problem by using pluralistic approaches to derive knowledge about the problem or research issues.

In the same vein, we accept the view that the logic of justification should not dictate what specific data collection and data analytical methods researchers must use and that difference in researchers epistemological beliefs should not be a barrier to using methods that are viewed to be of either the quantitative or qualitative camp (Johnson and Onwuegbuzie, 2004). This study uses mixed methods research strategy because we are convinced both quantitative and qualitative methods in combination would provide better understanding of e-SCM than either method alone. Therefore, the main reasons for using mixed methods strategy within a pragmatic worldview are:

1. It offers the best chances of answering our specific research questions and thereby, to conduct better research.
2. It provides us with the opportunity to combine methodologies that are necessary to answer our research questions.
3. It provides us with the opportunity to combine methods (quantitative and qualitative) that are necessary to answer our research questions.

Our mixed methods rationale is therefore significant enhancement. We hope that by mixing quantitative and qualitative research, interpretation of the data and findings will be enhanced by using quantitative data to enhance qualitative analysis and/or vice versa. However, we are aware that the use of mixed methods research in SCM has never been studied (Burgess et al. 2006). This may be due to the historical precedent of favoring quantitative methods and a positivist worldview in this domain or the pursuance of mono-methods. Our choice of mixed-methods approach however meets with the increasing call for the use of multiple methodologies within the field of SCM (Carter et al. 2008, Sanders and Wagner, (e) 2011 and Mangan et al. 2004). Furthermore, research in a content domain, such as operations and supply management (most would argue), which has been dominated by one method, may be better informed by the use of mixed methods (Greene et al. 1989).

This resonates with the Journal of Operations Management's call and encouragement for multiple methods and diversity of empirical approaches (Boyer and Swink, (e) 2008). Noting their concerns on the academic community's tendency to discount findings of others who are using different methods and why multiple methods are essential for quality research in operations and supply management, Boyer and Swink, (e) (2008) emphasized their belief that multiple methods are required not only to develop a holistic understanding of operations and supply management phenomena but also that multiple methods are more likely to yield high productive outputs with lowered risk of biased findings. Moreover, we are witnessing a volatile and dynamic nature of business context through globalization of competition that requires global co-operation and the expanding and blurring of subject boundaries and shift in thinking (operations management, purchasing and supply management, industrial and relationship management, logistic, service management), reflecting the integration within and across businesses and academic domains (Harland et al. (d) 1999).

In essence, 'today's research world is becoming increasingly inter-disciplinary, complex and dynamic; therefore many researchers need to compliment one method with another and all researchers need a solid understanding of multiple methods in order to facilitate communication, promote collaboration and to provide superior research' (Johnson and Onwuegbuzie, 2004). Consequently, the use of mixed methods research though pertinent but controversial, might help to provide better research findings and outcomes that will add to the knowledge base of e-SCM at this teething stage. As reported by Johnson and Onwuegbuzie, (2004), a pragmatic and balanced or pluralistic view might help to improve communication among researchers from different paradigms in their attempt to advance knowledge.

3.8 **The purpose of using a mixed methods study for this research** (¥d)

The mixed methods research literature posits several purposes or approaches for conducting mixed methods research (Bryman, 2008). Facilitation or development is where one research strategy is utilized to aid the research study through the use of another research strategy (Greene et al. 1989, Bryman, 2008 and Molina-Azorin 2009). The purpose for this sequential mixed methods study was to first use a quantitative survey to explore the existence, experience and use of e-SCM within a ten to eleven year period (1998-2009) using bibliometrics from which inferential or descriptive data could be examined (quantitative research). The qualitative research phase used the identical sample to facilitate a typology development of e-SCM through a literature review, an exploratory thematic analysis and a conventional content analysis'.

The intent, based on the work of Sieber, 1973 and Madey, 1982 in Caracelli and Greene (1993), is to use the result of one methodology to inform and develop the other, sequentially (Bryman, 2008). Therefore, we used the identical sample from the quantitative research (Sequence 1, immediately below), to inform the qualitative research (sequence 2) and also to develop the qualitative analyses; thus enriching the sample of the quantitative research (Molina-Azorin, 2009) for typology development through a secondary qualitative analysis, theme analysis and a conventional content analysis, in a bid to better understand the e-SCM phenomenon.

Moreover, the combination of quantitative and qualitative research in this study facilitated different mixed methods achievements (Bryman, 2008) which could not have been possible through a single approach:

- Enhancement or to build upon the findings from one approach – our study augmented the quantitative findings by gathering data using qualitative research approach.
- Utility or improving the usefulness of findings – the combination of the two approaches proved to be more useful to us, for example, findings from the quantitative studies can be further corroborated by the qualitative study.
- Context – the combination, in terms of the qualitative research, has provided

better insight and understanding in connection to explaining the relationship between the components of e-SCM.

- Illustration – the use of our qualitative data to illustrate or explain quantitative findings.
- Credibility – employing both approaches enhances the integrity of the findings.
- Sampling – the same sample is used in both approaches.
- Unexpected results – the fruitfulness of employing both approaches generated surprising results that could not have been understood if only one approach have been used e.g. quantitative research or qualitative research.
- Explanation – the qualitative approach helped to explain the findings generated by the quantitative approach, e.g. the interpretation of networks.
- Process – quantitative research provided a more structured findings but the qualitative approach provided better and meaningful understanding.
- Completeness – employing both approaches provided a more comprehensive account of the concept.
- Triangulation – the combination of both approaches mutually corroborated findings.

3.9 **Selection of the mixed research design** (¥g)

Our current mixed methods design is a two-stage qualitative-dominant sequential mixed methods study that includes quantitative and qualitative studies with a four-stage mixed analytic design (Onwuegbuzie et al. (a) 2007). In addition, the mixing takes place across the stages of the research process (Johnson and Onwuegbuzie, 2004). For example, the current study included both quantitative and qualitative objectives, quantitative and qualitative data collection, quantitative and qualitative data analysis and within-stage mixed-model design (quantitized list) of qualitative analysis and integration at some points. Figure 5, illustrates our mixed methods research design model with time order paradigm emphasis, mixed data collection, analysis, purpose and integrative strategy.

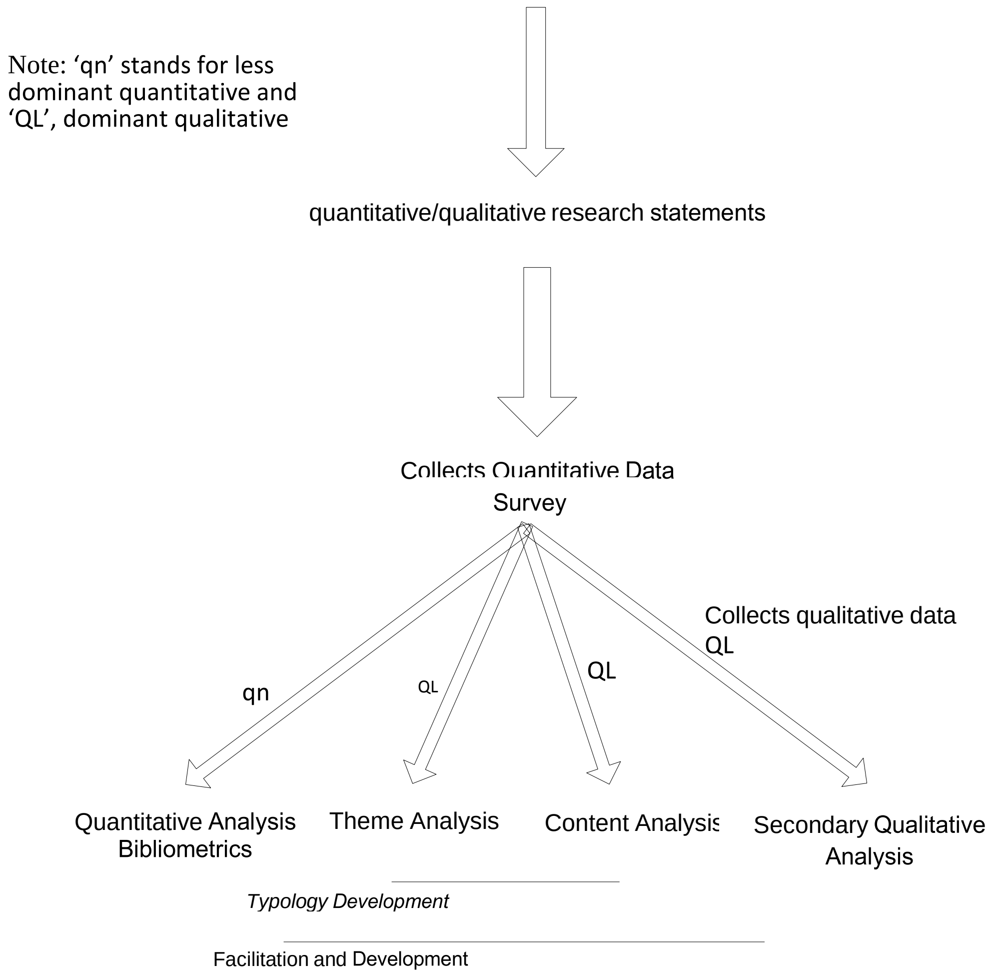

Figure 5: Mixed Methods Process

3.1.0 **Mixed methods analytic process**

This study used a sequential design and an identical purposive sample, for both the quantitative and qualitative components of the study. The first sequence consisted of a single analysis (phase 1-bibliometrics-quantitative), whilst the second sequence consisted of three qualitative analysis (phases 2, 3 and 4) respectively. The first qualitative analysis of sequence 2 (phase 2) was a theme analysis (open code and selective coding) of the identical sample from sequence 1. A conventional content analysis (phase 3) was then conducted on the nested sample in order to identify latent e-supply designs through data saturation. A secondary qualitative analysis was carried out to identify, verify and synthesize the e-SCM literature. Figure 6, indicates the four-stage mixed methods analytic process.

quan → QUAL → QUAL → QUAL

Figure 6: Our mixed methods analytic design

3.1.1 Mixed Methods Research Process

The mixed research process of this study is comprised of 13 distinct, interactive, iterative and dynamic steps: (1) determine the mixed goal of the study, (2) formulate the mixed research objectives, (3) determine the rationale for mixing quantitative and qualitative approaches, (4) determine the purpose/s for mixing quantitative and qualitative approaches, (5) determine the mixed research question/s, (6) select the mixed sampling design, (7) select the mixed research design, (8) collect quantitative/or qualitative data, (9) analyzing the quantitative/or qualitative data, (10) legitimizing the data sets and mixed findings, (11) interpreting the mixed research findings, (12) write the mixed research findings and (13) reformulate the mixed research questions (Onwuegbuzie et al. (b) 2009). Stages in the study where these steps are being used will be recognized by the Yen sign (¥), followed by the corresponding letter to represent the specific step as described above.

Our priority and implementation of data collection resulted from emphasis on the research question and objectives and the need to understand one form of data before proceeding to the next (Molina-Azorin, 2009). Although we sought out past mixed methods studies, mainly from, Tashakkori and Teddlie, 1989; Caracelli and Greene, 1993; Johnson and Onwuegbuzie, 2004; Collins et al. (a and b) 2006; Onwuegbuzie et al. (b) 2009; Bryman, 2008 and Molina-Azorin, 2009, to guide our current study; to a large extent, our design is not limited to these studies but rather emerged during the study because of the conditions and information that we obtained. Thus, researchers should mindfully create designs that effectively answer their research questions as opposed to the common approach in traditional quantitative or qualitative paradigm where selections are made from a given menu of designs (Johnson and Onwuegbuzie, 2004). In a similar vein, we recognize and embrace the opportunity to revise our objectives and our purpose, should the need arise, as the steps to a mixed method design are not necessary linear or unidirectional.

3.1.2 **Mixed methods integrative strategies**

a. Typology development

The current mixed method study is typology development. Typology development is a mixed method integrative data analytic strategy that encourages meaningful and creative integration during analysis, interpretation and reporting stages (Caracelli and Greene, 1993). Through typology development, the analysis of one data type can produce a typology (or set of substantive categories) that can be used as a framework or applied in analyzing contrasting data type. For example, the set of conceptual dimensions resulting from our qualitative analyses could form explanatory variables for statistical analyses of quantitative data (e.g., ANOVA, regression analysis) in future studies.

b. Process integrative strategies

The current mixed methods research study also incorporates a seven-stage conceptualization of the mixed data analysis process which includes: (1) Data reduction stage: this involves reducing the dimensionality of the quantitative data and/or the qualitative data, (2) Data display: this involves describing pictorially, the quantitative/or qualitative data, (3) Data transformation (optional): – converting quantitative data to be analyzed qualitatively or vice versa (i.e. quantitizing or qualitizing data, see glossary), (4) Data correlation: a process by through which quantitative data is correlated with qualitative data or vice versa, (5) Data consolidation: where both quantitative and qualitative data combines at some stage to create variables and data sets, (6) Data comparison: involves comparing data between both qualitative and quantitative data sources at some stage and (7) data integration: which seeks the integration of both quantitative and qualitative data into a coherent whole or two separate sets of coherent whole (Johnson and Onwuegbuzie, 2004). These analysis processes will be recognized by the Greek letter Pi (π) and the corresponding number as above. Therefore the present study will be employing different levels of integration; (1) some integration during analysis in the different phases and sequences (2) some process integration during the study and finally, (3) coherent integration during discussion and interpretation as viewed by Caracelli and Greene, (1993).

3.1.3 **Selection of mixed sampling design model and data collection**

a. The sampling scheme for this study is a two-dimensional sequential mixed methods identical purposive sampling model. The size of the sample was informed primarily by the research design and research questions/objective. The sample size is appropriate and not small to make it difficult to achieve data saturation and also not large enough to make it difficult to undertake case-oriented analysis (Onwuegbuzie and Collins, (c) 2007). The identical nature of the sample would help to maintain credibility and improve the quality and interpretative consistency of inferences made from the underlying findings of the study (Collins et al. (a) 2006).

b. Data collection Method (¥h)

The data collection consisted of a secondary qualitative analysis, a large exploratory survey of articles in Web of Knowledge (WOK) of the Social Science Citation Index, a thematic analysis and a conventional content analysis. It is important to note that we consider the qualitative analysis phases to contain an implicit data collection process through the iterative and interactive processes from initial first step-coding until informational redundancy or data saturation (Bryman, 2004).

3.1.4 **Criticisms of mixed methods**

A. The two main criticisms of mixed methods research are: (1) the embedded methods argument and (2) the paradigm argument (Bryman, 2004: 2008). The first argument argues that research methods are rooted in fixed epistemology and ontology that cannot be mixed. This view has influenced the thinking that mixing methods in research is neither feasible nor desirable. However, this view is difficult to sustain because research methods are capable of being put to a wide range of tasks (Bryman, 2008). The second argument relates to the first, seeing both qualitative and quantitative research, as paradigms with their own epistemological assumptions, values and methods which are incompatible and inextricable. We recognize that both types of research are connected with traditional epistemological and ontological assumptions; however, as has been mentioned elsewhere in this study, we view neither to be superior or determinant. In addition, both approaches have areas of overlap and commonality and it is not even clear that quantitative and qualitative research approaches, are in fact, paradigms (Bryman, 2008).

Consequently, we accept that greater importance should be given to the strengths of the data collection and data analysis techniques associated to each approach (Bryman, 2004), and also agree that today, it is the concrete research problem or aim, rather than, the philosophical position that should determine the design or overall strategy of a study.
In the same vein, we agree and accept the possibility of using either data or both, regardless of the overall strategy of a piece of research and also the possibility of using techniques and methods for data processing and analysis associated with the chosen general approach or to combine methods of a quantitative and qualitative nature (Niglas, 2009). Nonetheless, we have sought to address some of the specific issues relating to mixed methods research as follows; (1) Plurality of mixed methods, (2) Mixed methods conceptualization and analytic framework, (3) interpretive consistency.

B. The plurality of mixed methods

We have sought to address this issue by providing a holistic design framework as recommended for a mixed methods study, which address the different integrating and methodological aspects which together define the design of our study. This involves the time sequence of the different phases, the time orientation of sample design, the relationship of the quantitative and qualitative sample (identical), the built-in logic of integration, data collection, data analysis and eventual integration of interpretation. This methodological congruence has created an open, creative but systematic and organized view on the relationships between different aspects of our mixed methods design (Niglas, 2009; Collins et al. (a) 2006 and Leech and Onwuegbuzie, 2010).

C. Our mixed methods conceptualization and analytic framework

Our mixed methods meets with the 13 distinct steps of conceptualization as recommended (Collins et al. (b) 2006) and discussed above in section 2. Furthermore, we have utilized the fundamental principle of mixed methods. That is, (1) our mixed methods analysis involves the use of quantitative and qualitative analytical techniques that are used sequentially, sometime after the data collection process, from which interpretations are made in an integrated and iterative manner; (2) In our sequential mixed analysis, the quantitative study and analytic phase informs the subsequent qualitative study and phases, through the use of identical sample. In other words, findings from both analytic sequence will be interpreted iteratively; (3a) Similarly, both data types were used in our study (quantitative and qualitative) i.e. multitype; (3b) both analysis types (multianalysis) were used; (3c) as has been mentioned, the analyses were conducted sequentially and (3d) also, the qualitative phase of the study is given priority or more weight than the quantitative analysis. Therefore, our analysis can be regarded as multi-type mixed analysis which can lead to meta-inferences being formulated (Onwuegbuzie et al. (a) 2007). Moreover, we have undergone or achieved the seven stages required for a mixed methods analysis of quantitative and qualitative data within a mixed methods framework (Onwuegbuzie and Teddlie, (d) 2003).

D. Generalization and interpretive consistency

The main aim of this study is to provide insight and better understanding of e-SCM and not to make statistical generalization. However, we will endeavor to align our generalizations to the design elements of the study, especially between the inferences made that stem from our data analyses and sampling designs. As such, we will ensure not to make external statistical generalization unless the sample on which these generalizations are drawn and made, are representative. Internal generalizations will only be made if the sub-sample of key unit/s on which the generalizations are based is representative of the study sample from which the key unit/s were drawn and to which the interpretations are being made. Similarly, we will undertake analytical generalizations only when data saturation or information redundancy has been achieved. That is, when we can no longer obtain any new or relevant information from a concept or category and when the said concept or category has been well established. In the same vein, we will only make case-to-case transfer generalizations, if the case to which the generalization is being made is adequately similar in a special way. Moreover, we will also be cautious about making meta-inferences that involve combining interpretations stemming from both qualitative and quantitative findings. In this way, we aim to achieve interpretive consistency and sample integration legitimacy (Onwuegbuzie et al. (b) 2009). Other critical aspects relating to mixed methods research will be addressed at the legitimation section after the final data integration and discussion chapter.

SECTION THREE

3.1.5 Research Methods

3.1.6 Data collection, sample selection and population

3.1.7. Data Collection

Data was primarily collected through a quantitative survey using bibliometrics (citation, co-citation and network analyses) and the documentation of category development procedures in a qualitative theme analysis of the identical survey sample through open (manifest) and selective coding, a latent content analysis and a secondary qualitative analysis.

3.1.8 Sample selection and population

Our target population was the Web of Knowledge of the Social Science Citation Index (SSCI). A review of the literature helped to focus multiple keyword search-terms in purposive sampling of articles during 1989-2009. This period was deemed to be representative of the e-SCM literature because of the relatively young and under-developed nature of the concept. Only journal articles were utilized in the study because of our belief that they are most commonly used to acquire information and in the release of new findings.

The SSCI is one of the most popular educational databases for economic and social science research internationally; as such it commands a huge international writer and readership base. Further research identified some usage constraints (Harzing and Van der Wal, 2008; Hult and Chabowski, 2008) however, SSCI was mainly chosen because it allows for easy retrieval of citation and co-citation count, unlike Business Source Complete. As such, it has become a standard foundation for conducting citation-based research (Charvez et al. 2008). The SSCI is also popular, practical and provides an easy access and retrieval system (McCain, 1990 and Ramos-Rodriguez and Ruiz-Navarro, 2004). These are the main reasons why web of knowledge was chosen for this study. Nevertheless, data cleaning exercises (before citation and co-citation analysis) were carried out (using EditPad-Lite and Excel) at different stages of the study to minimize and solve criticism relating to over-counting of citations (Klein and Chiang, 2004).

3.1.9 Use of Bibliometrics

The main reason for using bibliometrics is because of the young and uncharted or rather under-developed nature of e-supply chain management and its literature. One approach of assessing the state of development of a disciple is to examine theory or a large body of academic literature quantitatively (Chavet et al. 2008). Bibliometrics is an objective approach to measure the statistical pattern of different variables with the purpose of shedding light on the processes, nature and course of a discipline through analysis of various facets of written communication of that discipline (Nicholas and Ritchie, 1978). As such, bibliometrics was deemed appropriate to investigate the structure of e-SCM literature in order to provide insight and understanding concerning its theoretical or conceptual status, its cross-disciplinary nature and to identify any emerging trends or relationships. Similarly, by examining publication trends across time, insight into its growing diversity of interest becomes apparent. The use of bibliometrics was therefore seen as critical in charting or unraveling the intellectual structure of e-SCM at a single point in time. Using bibliometrics would also help in establishing a baseline in tracking changes in the evolution of e-SCM. This also ties in with the main aim of our research methodology which is based on creating better insight and understanding of e-SCM.

3.2.0 Use of Theme Analysis

In simple terms, the aim of theme analysis is to identify themes which reflect a set of data. Therefore, thematic analysis through category development was utilized in our attempt to identify the components or main building blocks of e-SCM in order to aid the development of a conceptual framework. As such it fits in with the aim of this study. Although we accept that the search for themes is an activity that could be attributed to most qualitative data analysis, we also agree that thematic analysis transcends any one code and is built up out of groups of codes. In this regard, we concur that findings can only be significant after reflection, theorizing and interpretation (Bryman, 2004).

1. Documenting the qualitative analyses

This study will adopt a category development strategy which would enable public scrutiny of the qualitative analyses, in order to enhance the rigor and credibility of the research method. The coding and category development of data will facilitate a two-dimensional approach, designed to document the process (Constas, 1992). We are aware that many people still questions the qualitative orientation because of its privatization of qualitative analysis. Appendix 11 and 12 provides a description of this process, whilst appendix 10 outlines the definition of data codes and categories.

2. Open coding of manifest themes

A qualitative theme analysis using open coding manifested nine categories or components of data from the identical sample including a latent component. The nine groups or components are (1) E-integration, (2) E-collaboration, (3) E-technology, (4) E-business, (5) E-information sharing, (6) E-commerce, (7) E-logistics, (8) E-procurement and a (9) Latent group. This is largely based on our familiarity with the e-SCM literature.

3. Selective Coding of themes into Categories

Selective coding further developed the sample into two distinct categories (sub-categories including an unknown sub-category), based on an inductive analysis. The two main categories are (1) E-Technology and (2) E-Supply Design. E-Technology represents the main dimensions through which the internet impacts supply chain management. At this stage of selective coding, E-technology consisted of 4 sub-categories namely: (a) e-integration, (b) e-collaboration, (c) e-information sharing and (d) technology. The ‘technology’ sub-category is defined as the use of internet and web technology in supply chain management, ‘e-integration’ is the use of internet and web technology for supply chain integration, ‘e-collaboration’ is the use of internet and web technology for supply chain collaboration and ‘e-information sharing’ is the use of internet and web technology for information sharing in supply chains. The ‘E-Supply Design’ category consisted of different types of e-supply chains. At this stage, only four types of e-supply chains were manifested. These are: (1) e-commerce, (2) e-logistics and (3) e-procurement and (4) unknown type.

3.2.1 Use of Content Analysis

Content analysis is a description of a family of analytic approaches ranging from impressionistic, intuitive, interpretive analyses to systematic textual analyses. Content analysis is both reliable and valid when applied properly because ‘it permits the research to transcend the realm of impressionistic generalizations, which are subject to individual preferences and prejudices’ (Kondracki, 2002). The specific type chosen by a researcher varies according to their theoretical and substantive interest. The differentiation is usually limited to classifying it as primarily qualitative versus quantitative research method. This study employed a qualitative content analysis (QCA). There are two main differences between qualitative and quantitative content analysis. They differ in the procedure they use to produce the code and the uses that they make of the counts. Firstly, in qualitative content analysis, researchers are much more likely to use the data themselves as the source of their codes. Even when they use pre-existing ones, they often modify those codes and add new ones in order to capture the specifics of their data as exhibited in this study.

Secondly in QCA, counting leads to the crucial further step of interpreting the pattern that is found in the codes. QCA places emphasis in understanding the new context that is revealed by the coding and counting process. For QCA, counts can be seen as both the end of a descriptive process and the beginning of an interpretive process. Counting is seen as a detection of pattern to guide further interpretation of the data. For example, the current study identified a percentage of latent data that needs further interpretation. QCA calls for describing pattern of data (not only manifest but more importantly identified latent data) and also interpreting the pattern of data (Mayring, 2000).

QCA is defined in this study as ‘the subjective interpretation of the content and context of text data through the systematic classification of coding and identification of themes and patterns’, adapted from (Hsieh and Shannon, 2005). Qualitative content analysis is one of numerous methods used to analyze text data. ‘It focusses on the characteristics of language as communication with attention to the content or contextual meaning of the text’. It goes beyond mere counting of words to examine language intensely for the purpose of classifying text into an efficient number of categories that represent similar meanings. These categories can represent either explicit or inferred communication. Its goal is “*is to provide knowledge and understanding of the phenomenon under study”,* (Hsieh and Shannon, 2005). In addition, (Kondracki, 2002) pointed out that content analysis can also be used to measure knowledge and improve education of practitioners.

As such, content analysis represents a perfect strategic fit with our mixed methods research aim of providing knowledge and better understanding into the phenomenon that is e-SCM.

Current application of content analysis show three distinct approaches: conventional, directed and summative. Our use of conventional content analysis (CCA) is specific to its aim of describing a phenomenon. As has been mentioned, CCA is appropriate when existing theory or research data on a phenomenon is limited as is the case in the current study where latent data was identified in our study sub-sample. Therefore, our use of CCA was justifiably chosen specifically to analyze the identified latent data. The second main reason CCA was used is because its results can be used for conceptual development or model building (Hsieh and Shannon, 2005). The current analysis could not use pre-conceived categories; instead the coding and 'theme-ing' of data allowed categories to flow and new insight to emerge through immersion and prolonged engagement of the content and context of the data. The advantage of this approach is to gain direct information from the articles without imposing preconceived categories or theories. Therefore, knowledge generated from this analysis is based on the unique perspective and actual data of each article. Content analysis is also inexpensive, easy to understand and very appropriate for documenting trends and historic materials. The above reasons fit well with the aims and objectives of this study. Moreover, a structured documentation system for category development was utilized, which provided consistency and rigor. It is important to note that the use of quantitative method in the same study greatly minimizes these limitations through the form of triangulation and validity.

3.2.2 Secondary qualitative data analysis (SQDA)

Secondary qualitative data analysis or a literature review (chapter 2) involves the analysis of pre-existing data from previous research studies and other contexts. It can be used for the following goals: (a) to address new or additional research goals, (b) to verify, refute or refine findings of primary studies by re-analysing pre-existing data and (c) to synthesise research which is the focus of its use in this study. There are five types of SQDA: (1) supra analysis, which is employed by the current study (it transcends the focus of the primary study from which the data were formed to address theoretical, conceptual, methodological or empirical questions), (2) supplementary analysis (more in-depth or emergent issue/aspect that was not fully considered in primary study), (3) re-analysis, (4) amplified analysis (combination of data from two or more primary studies) and (5) assorted analysis (combination of secondary analysis qualitative data with primary research and/or analysis naturalistic qualitative data). SQDA can reveal new themes and additional results from data (Leech and Onwuegbuzie, 2008). Our secondary qualitative data analysis helped to identify the main components for a conceptual development of e-SCM and classification of e-supply chain designs thereby acting as a kind of corroboration mechanism for the study.

3.2.3 Limitation of research methods

3.2.4 Bibliometrics

Relevant limitations are mostly centred on issues of variability of citation, unavailability of full-text articles, the time-consuming nature of bibliometrics and validity of judgements. No research has been carried out in quantifying the limitations of bibliometrics in SCM (or e-SCM). The time-consuming nature of bibliometrics did affect the time-frame allotted to the study somewhat, however, this was balanced and justified against the importance and successful accomplishment of the research study. The study was able to secure the full-text version of all articles in the sample. Even though the variability of citation behaviour can be explained in different ways, it has been thoroughly contended that its effect cannot be statistically significant (Raan, 1998). However, as has been mentioned elsewhere, manual manipulation was carried out to offset over-counting of citations from SSCI. In the same vein, recent work has undermined the view that the efficacy of bibliometric analysis in terms of assessing inter-disciplinary research is questionable (Rania et al. (a) 2001). Furthermore, validity of judgements based on bibliometric information is widely acknowledged particularly as available evidence does suggest good correlation results attributed to bibliometric studies (Rania et al. (b) 1998). Moreover, most negative skewing effects can be offset by selecting adequate sample size (Sharif et al. 2009). Although, we consider our sample size to be appropriate within acceptable parameters, our aim was to provide better insight and understanding into e-SCM, not to make statistical generalisation.

A bibliometric study is merely one of such (quantitative) tools that are available to map the structure and development of e-SCM. Using other qualitative (as was implemented in this study) approaches has allowed for corroboration and triangulation of observed structures and/or revelation of alternative patterns. SCM is a multi-disciplinary domain, restricting our analysis to one database and/or set of journals (SSCI), in addition to discounting expert opinions, did introduce bias although already justified. Future research may want to compare practitioners' views to restricted scholarly work such as this. Periodic replication of this method may reveal changing intellectual structures or convergence of core concepts. Such longitudinal strategy could use the current study as benchmark for future studies. Therefore, as has been expressed elsewhere (Sharif et al. 2009), rather than looking at limitations, the focus should be on improving the quality of journal publications and consolation should be taken from the view that drawing correct judgements from such a complex form of analysis, demands expertise that requires due recognition.

3.2.5 Theme Analysis

It is vitally important that the researcher is extremely familiar with the data for successful implementation of theme analysis. The lead researcher in this study collected and transcribed all data; therefore 'unfamiliarity with data' was not a problem. Similarly, in theme analysis, the process of coding is subjective and may be biased through the expectation of the researcher. However, this point is balanced by the use of quantitative methods which are more credible, objective and independent. More importantly, we followed the three main stages of theme analysis as recommended by Boyatzis (1998). These are: (1) deciding on sample and design issues, (2) developing code themes which could be (a) theory driven, (b) prior data or prior research and/or (c) inductive and (3) validating and using the codes/themes.

3.2.6 Content Analysis

A brief history of Content Analysis (CA) identified several limitations (see Mayring, 2000; Kondracki and Wellman, 2002 and Krippendorf, 2013), especially with regards to quantitative content analysis. However, we identified three pertinent challenges to content analysis; (1) failing to develop a complete understanding of the context will lead to failure to develop key categories, (2) difficulty of ascertaining the 'why' question in content analysis and (3) conventional content analysis can easily be confused with other qualitative methods such as grounded theory or phenomenology. These two latter methods share similar analytical approaches with CA but go beyond content analysis to develop theory or nuanced understanding of the lived experience unlike Conventional Content Analysis (CCA). This is because both sampling and analysis procedures make it difficult to infer theoretical relationships of findings from conventional content analysis (Hsieh and Shannon, 2005). Firstly, *prolonged engagement* with every aspect of the data by the lead researcher for a period of over three years limited any partial understanding queries. This provided the opportunity to code the data, persistent *observation* of the data and also unlimited time to study the pattern of the data, in order to gain complete understanding of both content and context. Moreover, the use of quantitative methods in the same study established triangulation. Secondly, one of the main reasons for the use of conventional content analysis that has been mentioned elsewhere in this study is because its results can be used for conceptual development or model building rather than theoretical relationships (Hsieh and Shannon, 2005). Finally, although the difficulty to ascertain the 'why' question in CA is widely recognized, however, this mainly relates to quantitative content analysis, which is different to the qualitative analysis carried out in this study (Bryman, 2004: 2008).

Some critics see content analysis as a descriptive method that may not reveal underlining motive for observed patterns. However, the main reason for its use in this study is primarily to describe latent data, as such, it fits well with the aims and objectives of this study. Furthermore, our use of mixed analysis provided opportunities for further interpretation of observed patterns. Moreover, a structured coding and category development system was utilized, which provided consistency and rigor (see appendix 11 and 12). It is important to note that the use of quantitative method in this study greatly minimize these limitations through the form of triangulation and validity.

Section Four

3.2.7 First Sequence Quantitative Research Study

3.2.8 Research Statement: To gain insight into the structure, direction, trends and current status of e-SCM.

3.2.9 Introduction

This sequence details an exploratory quantitative survey using bibliometrics (citation and co-citation analysis) conducted between October 2008 to February 2009, in an attempt to investigate and classify the structure of e-Supply Chain Management. It is the first sequence of a wider mixed methods research study on e-SCM. The study used multi-search terms based on an initial literature review (purposive sampling) to source data from Web of Knowledge (then Web of Science) of the Social Science Citation Index (SSCI). Bibliometric software tools were used to analyze specific fields of interest inter alia, to identify and classify network relationships of the concept.

3.3.0 Data collection procedure

One standard method of sourcing articles is by selecting a panel of experts in a given field and then identifying and retrieving documents which cite their work (Pilkington, (a) 2008). Another common approach is to create a candidate list of core articles from one or more highly regarded and representative journals in the field of study (Ramos-Rodriguez and Ruiz-Navarro 2004 and Pilkington and Lyston-Heyes, (c) (1999). We contend that both aforementioned approaches were not suited at this stage because they might introduce limitations and subjectivity. Furthermore, as the concept is in its developmental stages, it might be difficult to find established experts in the specific field. In a similar vein, its unmapped and underdeveloped nature might signify no established experts in the field and no established documented publishing outlet for the concept.

3.3.1 Sample population

This study decided to source data directly from web of science on the social science citation index. Several authors (Harzing and Van Der Wal, 2008; Hult and

Chabowski, 2008 and Charvet et al, 2007) have commented on some of the constraints of using Web of Knowledge (WOK). However, WOK was chosen because of its popularity, practicality of easy access and retrieval system and also, as it is the standard foundation for conducting citation-based research (McCain, 1990 and Ramos-Rodriguez and Ruiz-Navarro, 2004). However, data cleaning exercises (before citation and co-citation analysis) and manual checks were carried out at different stages of the overall study to minimize and solve criticism relating to over-counting of citations (Klein and Chiang, 2004).

3.3.2 Sample selection technique - Keyword Search Phrases

Our secondary qualitative analysis help to focus the keyword search phrases chosen. Using Web of Knowledge, the study initially use five logical but focused keywords "e-supply chain management", "e-supply chains", "e-supply", "e-supply chain AND management" and "e-supply chain strategy" to source core articles from Web of Knowledge during the period 1998-2009. As research in this area is relatively recent, the scope of this investigation is limited to this time-frame (1998-2009). This period is deemed to be representative of the e-supply chain management literature for this study. These produced a total of 100 articles altogether; discounting other materials such as proceedings papers, editorial materials and news items. We believe journal articles are the resources that are most commonly used to acquire information and release new findings, therefore unpublished working papers, doctoral dissertations, text-books, news reports, conference papers and master's dissertations are excluded. The number of hits of peer-reviewed articles was regarded as too narrow and the decision was made to broaden the search terms in order to improve the sample.

The literature indicated that Harland et al. (c) (2006) broadened their keywords search terms in order to get a more representative sample in their study to find out whether or not Supply Chain Management may be called a discipline. Hult and Chabowsky, (2008) also used a total of 17 keywords search terms to identify source related articles in their examination of the intellectual structure of research in sourcing literature. While increasing the number of keywords may tend to add noise (Pilkington and Hayes, (c) 1999 and Charvet et al. 2008) contends it is appropriate for an under-developed concept and also for a preliminary study.

The following seven more search terms were used to increase the results of the hits. “Electronic supply chain”, “IT-enabled supply chains”, “internet supply management”, “e-supply chain collaboration”, “e-supply chain integration”, “It-enabled supply chain management” and “e-collaboration”. This brought the total hits to 714 articles. Manual manipulation was required to standardize the data and correct any inconsistencies. For example, some of the citation data was changed into upper-case characters and put through word-stemmer for easy management of words. Recurrent abbreviations and hyphenated words were also standardized. Table 1, is a sample of raw data from WOK. After removing multiple articles, 487 remained and were taken forward for bibliometric analysis.

Table 1: Sample of raw data from WOK 1989-2009

FN ISI Export Format
VR 1.0
PT J
AU Liu, KJ
Zhang, ZG
AF Liu, Kaijun
 Zhang, Zigang
TI Capacity allocation in a competitive multi-channel supply chain
SO JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
LA English
DT Article
DE E-supply chain management; capacity allocation; demand substitution;
ID GAME-THEORETIC ANALYSIS; DISTRIBUTION-SYSTEM; CHANNEL; COORDINATION
AB This paper addresses the capacity allocation problem for a capacitated

3.3.3 **Phase 1: Data Analysis – Quantitative (**¥i)

3.3.4 **Bibliometrics**

An objective approach that can be used to examine a body of academic literature is quantitative technique. One of such objective approach which is closely akin with quantitative research is bibliometrics (Glanzel et al. 1994). “*The definition and purpose of bibliometrics is to shed light on the process of written communications and of the nature and course of a discipline by means of counting and analyzing the various facets* *of written communication"* (Nicholas and Ritchie, 1978). Bibliometrics provide information about the structure of knowledge and how it is communicated. As such, bibliometrics meets with the aims and objectives of this research.

Charvet et al. (2008) reported that bibliometrics is '*the mathematical and statistical analysis of bibliographic records'*, comprising of various methods, usually grouped as citation and co-citation analysis. According to them, citation analysis is based on the direct count of references made to or received from other documents. Alternatively, co-citation analysis exploits paired citations as a measure of association between documents or sets of documents. "*Metaphorically speaking, citations are frozen footprints on the landscape of scholarly achievement; footprints which bear witness to the passage of ideas"* (Cronin, 1984) argued that "it is therefore possible to deduce direction from the configuration and depth of the imprints to construct a picture of those who have passed by, whilst the distribution and variety can provide clues as to whether the advance was orderly and purposive".

The approach can be used to identify groups of authors, topics or methods and can help understand the way in which clusters relate to each other and provide a useful insight into which papers and authors are considered influential in "the field's view of itself". Normally, the common interests in the body of citations are extracted using factor analysis or multidimensional scaling (MDS) of the correlations in a co-citation frequency matrix to identify the implicit dimension (Pilkington and Fiztgerald, (b) 2006).

A number of bibliometric studies have been conducted recently in several related areas. In 1999, Pilkington and Heyes, (c) (1999) performed a co-citation & citation analysis in production and operations management to determine its latent structure and elucidate the difficulties in establishing POM as a distinct discipline. More recently, Pilkington, (a) (2008) performed a citation and co-citation analysis coupled with network analysis to identify the main interests and sub-fields in the Institute of Electrical and Electronic Engineers, Transactions on Engineering Management (IEEE TEM) and showed Management of Technology (MOT) to be distinct with new product development, innovation, diffusion and technological evolution.

One of the most recent is a citation and co-citation analysis of SCM by Charvet et al. (2008) demonstrating a clearly identifiable intellectual structure that revealed four emerging clusters of research. It would seem that citation-based research in business management is concentrated on the influence of journals, authors and theories (Hult and Chabowski, 2008: Harzing and Van der Wal, (b) 2007). While bibliometric analysis is increasingly being used across a wide variety of fields particularly in Management, the authors are not aware of any bibliometric study of e-SCM.

3.3.5 **Citation and Co-citation Analysis**

Bibliometrics was used for citation and co-citation analysis of our surveyed data in the first instance, in an attempt to investigate and classify the structure of e-Supply Chain Management (e-SCM). Three main steps are required to perform a citation and co-citation analysis. A relevant pool of documents is identified, selected and then citation counts are extracted between the documents and made into a raw co-citation matrix. Finally, either the co-citation matrix or its corresponding correlation matrix is analysed using multivariate analysis (Charvet et al. 2008). Our data analysis, extraction, manipulation and co-occurrence networks were carried out using three bibliometric software tools (Bibexcel, NetDraw and UCINET) and two edit software packages; EditPad-Lite and Excel.

Appendix 1, shows a sample of the converted source .doc file with nice tags (PT-, SO-, CD-, PY-, DE-, TI- etc.) at the start of each line indicating what the information in the record is about and neat end of line "|" and end of record flags "ER||" as shown. Bibexcel has also put semi-colons between categories which can have multiple entries, such as authors. This helps when it comes to splitting them out before pulling out the fields you want to use for further analysis later. Only four fields were further analysed in this study Source Title of Publication (SO), Article Keywords (DE), Year of Publication (PY) and Title Keywords (TI).

Table 2 is a publication title citation. The citation has kept the name of each journal with the numbers on the first column linking where they came from. Table 3 shows a sample of the frequency of publication title citation that describes the range of interests covered by the e-SCM concept.

A. Source Journal Title of Publication

Table 2 – Sample of Source Journals Titles π1

1	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING, 2007, V16, N4, P450-468
2	INTERNATIONAL JOURNAL OF FLEXIBLE MANUFACTURING SYSTEMS, 2007, V19, N4, P463-485
3	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 2008, V113, N1, P193-204
4	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY, 2008, V36, N7-8, P825-8
5	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT, 2008, V28, N1, P68-75
6	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT, 2008, V20, N2, P169-184
7	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 2008, V184, N3, P1044-1061
8	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY, 2007, V34, N7-8, P799-8
9	INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING, 2007, V20, N6, P588-601
10	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL, 2007, V12, N4, P297-303

It presents the outlet in which authors publish current research in e-supply chain management and would help in classifying research in e-SCM. This includes the expected high ranking for supply chain management journal, management science, operations research, information systems research and transportation journal and research. Table 4 is a citation of publication year.

Table 3 – Frequencies sample of Source Journals π1

38	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
32	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
27	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
27	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
19	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
19	PRODUCTION PLANNING & CONTROL
17	JOURNAL OF OPERATIONS MANAGEMENT
15	INTERFACES
15	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
13	TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW
12	MANAGEMENT SCIENCE
12	INDUSTRIAL MARKETING MANAGEMENT
9	INFORMATION SYSTEMS RESEARCH
9	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
9	PRODUCTION AND OPERATIONS MANAGEMENT
9	DECISION SCIENCES

7	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
7	INTERNATIONAL JOURNAL OF ELECTRONIC COMMERCE
7	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT
7……… …	INFORMATION SYSTEMS MANAGEMENT
6……… …	INFORMATION & MANAGEMENT
6……… …	JOURNAL OF MANAGEMENT INFORMATION SYSTEMS
5……… …	JOURNAL OF COMPUTER INFORMATION SYSTEMS
5……… …	TRANSPORTATION JOURNAL
5……… …	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT

B. Citation of Source Journals

Table 4 Citation sample of Publication Year π1

1	2007
2	2007
3	2008
4	2005
5	2005
6	2005
7	2005
8	2004
9	2004
10	2003
11	1999
12	2008
13	2007
14	2005
15	2005
16	2005

3.3.6 **Co-citation Analysis**

According to Pilkington, (a) (2008), co-citation analysis can be applied to different levels of aggregation to investigate different categories of relationships; an analysis of co-cited journal titles for example, can show patterns in the generation and development of knowledge.

71	2007
69	2008
68	2005
59	2004
58	2006
55	2003
35	2001

30	2002
15	1999
13	2000
8	2009
6	1998

Table 5: Co-citation sample of Publication Year π1

Table 5, is a co-citation indicating the frequency of the publication year. The Publication Year co-citation was then exported into Excel and a simple corresponding graph plotted as indicated below in Figure 7. This chronology depicts not only the very short history of the concept but also establish annual coverage and academic interest. The graph clearly indicates an almost gradual annual increase in interest in the concept marred by an unexplained and unexpected dip around mid-2005. This could be because of a wane in interest or a period of saturation. The most active period was clearly during 2006 to 2008. The gradual peak since 2000 could also indicate renewed interest, development and trust of internet and web technologies after the burst of the internet bubble.

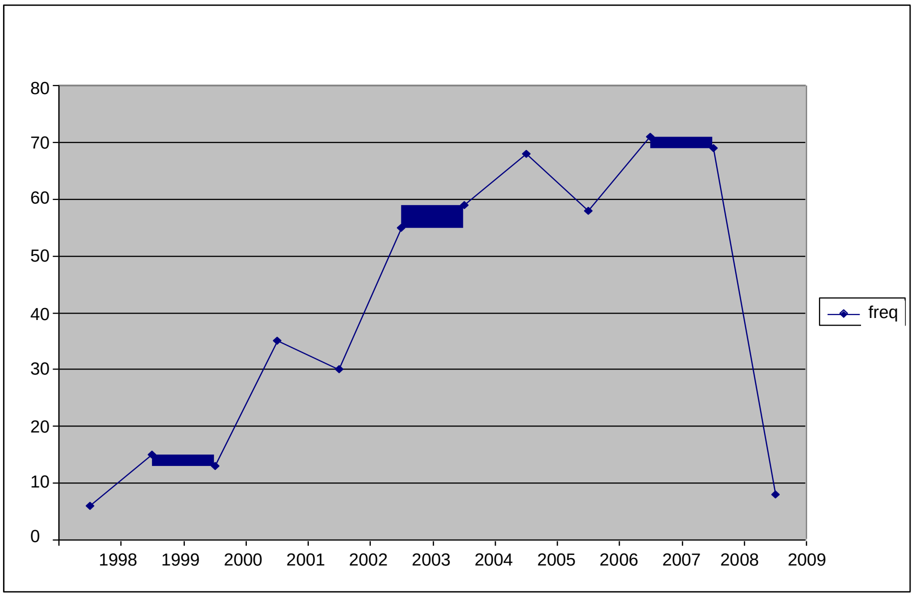

Figure 7 – Graph of Frequency Publication Year π2

3.3.7 **Co-occurrence and Networks**

Another useful approach is an examination of article keywords and title keywords to look at the relationships and network-maps. This process is called co-occurrence in bibexcel and it was achieved by making frequency files of the keywords to help select the terms to analyze, then using this index to analyze the citation files in order to produce a co-occurrence file. The co-occurrence file of both the article (see Table 6) and title keywords were then made. The most important or highest paired article keyword is ‘supply change management’ and‘electronic commerce’.

Table 6 – Co-occurrence sample of stemmed Article Keywords π2

23	SUPPLY CHAIN MANAG	ELECTRONIC COMMERC
23	ELECTRONIC COMMERC	SUPPLY CHAIN MANAG
16	INTERNET	SUPPLY CHAIN MANAG
10	SUPPLY CHAIN MANAG	INTERNET
9	ELECTRONIC DATA INTERCHANG	SUPPLY CHAIN MANAG
9	INTERNET	ELECTRONIC COMMERC
8	SUPPLY CHAIN MANAG	ELECTRONIC DATA INTERCHANG
6	SUPPLY CHAIN MANAG	INFORMATION SHAR
6	INTERNET	SUPPLY CHAIN
6	PROCUR SUPPLY	CHAIN MANAG
6	PURCHAS	SUPPLY CHAIN MANAG
5	ELECTRONIC COMMERC	INTERNET
5	ELECTRONIC COMMERC	SUPPLY CHAIN
4	SUPPLY CHAIN MANAG	PROCUR
4	ELECTRONIC COMMERC	PROCUR
4	SUPPLY CHAIN MANAG	COLLABOR
4	SUPPLY CHAIN	INTERNET

The co-occurrence file was then imported into excel, where the leftmost frequency column was transferred to the rightmost column. The transformed three-columned file was then cut and pasted back into the text editor where a .dl header was added to turn it to a dl file format for further analysis in UCINET much like the sample of stemmed title co-occurrence .dl file underneath in Table 7.

```
dl n = 5000 format = edgelist1
labels embedded
data:
Suppli    chain     191
chain     manag     40
suppli    manag     40
Inform    chain     22
inform    suppli    21
```

Integr	chain	16
e-suppli	chain	15
electron	suppli	15
electron	chain	14
electron	commerc	14
impact	suppli	13
chain	industri	13
case	studi	13
suppli	network	13
inform	technolog	13

Table 7 - A sample of e-SCM title .dl format file for analysis in UCINET $\pi 2$

Whilst the above tables give us some insight into the field and represent a fairly standard citation and co-citation analysis, the method does not give a clear account of the concentration of interest. These were addressed by performing analyses on the co-occurrence matrices. In the first instance, the data of the co-occurrence title file was imported into Netdraw in UCINET, which visualise what is happening in the data matrix, as shown underneath in Figure 8.

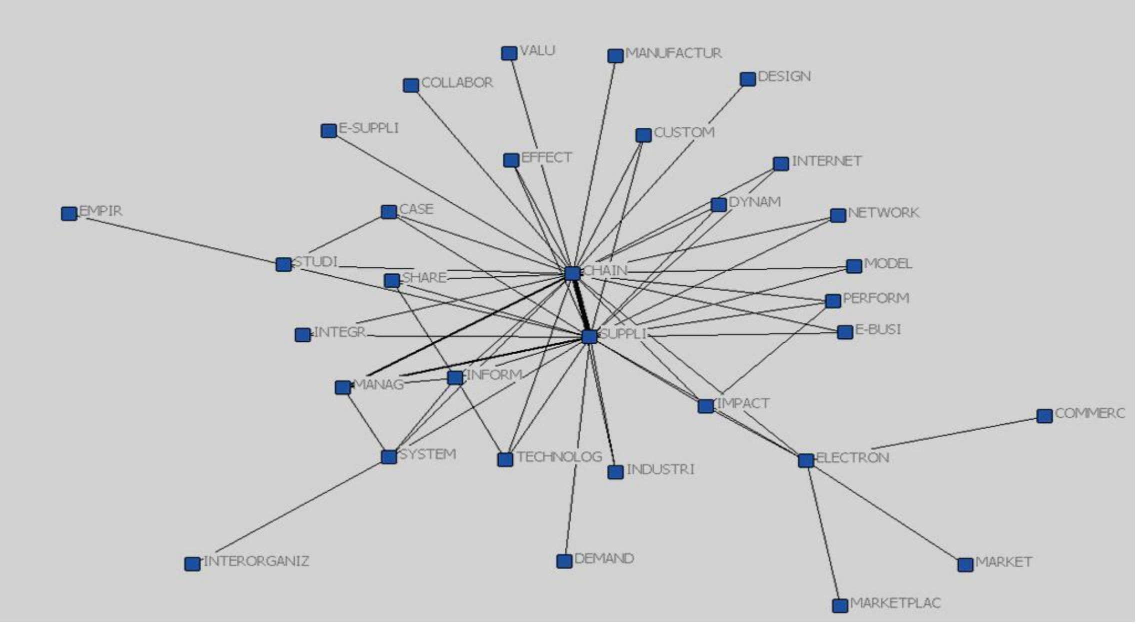

Figure 8: Co-occurrence Network Map of Title Keywords of e-Supply Chain Management $\pi 2$

3.3.8 **Title keyword Co-occurrence**

The title keywords are rather unspectacular with all the expected keywords. The triangle in the middle to the left contains the strongest relationships (‘supply’, ‘chain’ and ‘management’). Each of these in addition sprang a network of already suspected titles. Management’s network consist notably of ‘inter-organization’ and ‘system’. The common title keyword amongst the three seems to be information. The only surprising title keywords are ‘case’, ‘studies’ and ‘empirical’. This might indicate current use of case studies to investigate the concept. This factor would confirm our suspicion of the usefulness of using a first generation citation of core articles in this study.

3.3.9 **Article Keyword Co-occurrence**

An examination of the network relationship of article keywords, to a larger extent, proved more useful. Figure 9, visualizes the network representation of the most used article keywords for e-SCM. The diagram identifies the focus of e-SCM and the three primary networks groups could be named by inspection (‘supply chain management’, ‘electronic-commerce’ and ‘internet’). An expanded interpretation of the main networks will be treated in chapter 4.

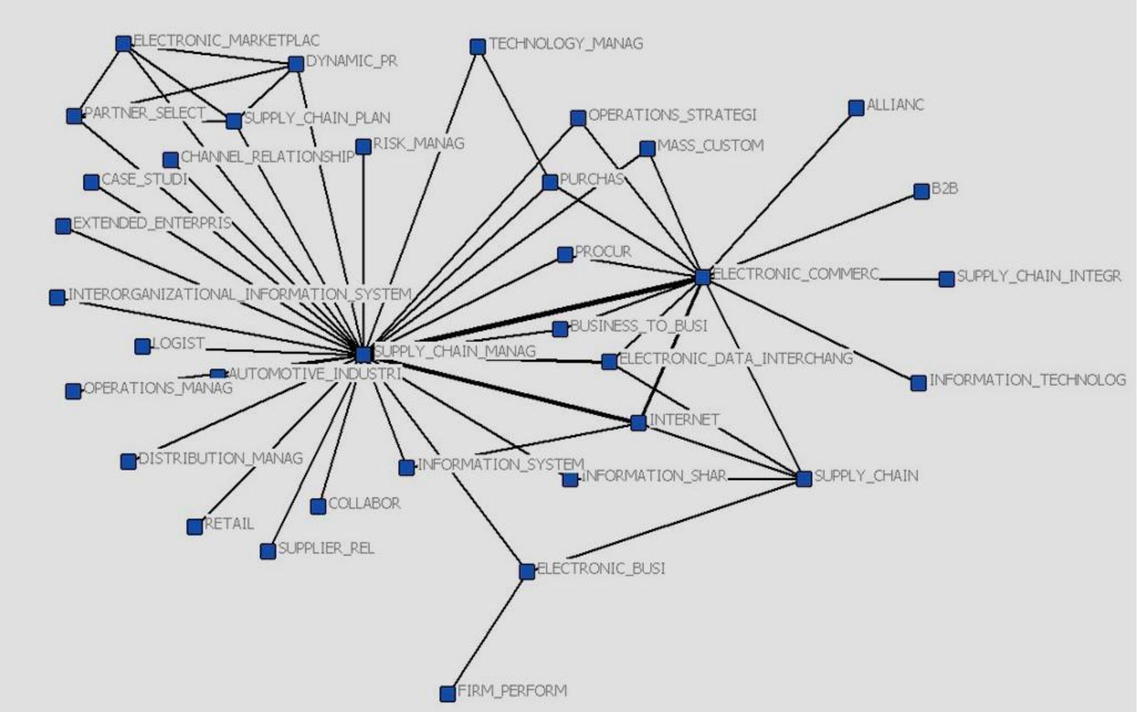

Figure 9: Co-occurrence network map of article keywords of e-SCM π2

3.4.0 **Summary Findings**

1. The study specifically found out that research in e-SCM is mostly published in the following journals (with five or more hits); Supply Change Management-An International Journal, Industrial Management and Data Systems, International Journal of Production Economics, International Journal of Operations and Production Management, European Journal of Operational Research, Production Planning and Control, Journal Of Operations Management, Interfaces, International Journal of Production Research, Transportation Research Part E-Logistics and Transportation Review, Management Science, Industrial Marketing Management, Information Systems Research, International Journal of Information Management, Production and Operations Management, Decision Sciences, International Journal of Advance Manufacturing Technology, International Journal of Electronic Commerce, International Journal of Technology Management, Information Systems Management, Information and Management, Journal of Management Information Systems, Journal of Computer Information Systems, Transportation Journal and IEEE Transactions on

Engineering Management. The scope of most of these outlets is subject-specific and seems to be high impact journals.

2. That major discipline area interest on e-SCM includes Management Science, Organizational Research, Information Systems, Production and Operations Management, Manufacturing Technology, Marketing Management, Electronic Commerce and an unexpected large interest from Transportation.

3. That there is a gradual increase of interest over the last decade (1998-2008). This is an indication that interest is bound to increase with time, as the concept is underdeveloped.

4. There is a very strong relationship network of three main subject area (supply chain management, electronic-commerce (i.e. e-technology) and internet), indicating the concept evolved out of the use of technology, particularly internet and web technologies in SCM. A detail interpretation of major networks will be covered in chapter 4.

5. That e-SCM is not well defined or developed as it is still a very young concept; a good sign/implication for further exploration and investigation. However, further factor analysis was deemed unnecessary with the current study.

6. Finally, in order to get a full value from this bolometric study, periodic replication of the methodology to reveal changes in the nature or convergence of the concept (e-SCM) would be appropriate. Such longitudinal research could use the current study as a benchmark.

3.4.1 **Second Sequence – Qualitative Research Study (Development)**

3.4.2 Research Statement: To discover a structure or components of e-SCM that will aid the creation and development of a conceptual framework.

3.4.3 **Introduction**

This study entails an initial exploratory theme analysis conducted in an attempt to identify the components of e-SCM that will aid the development of a framework through typology development. The analysis represents the first phase of the second sequence. The study uses open coding to identify themes representing each article from an identical sample of the first sequence.

3.4.4 **Typology Development**

Typology development is one of the four major mixed methods analysis strategies which involves analysis of one data type to yield a set of substantive categories or themes (typologies) that could be applied to the analysis of others, which in turn could be used to refine and elaborate on the typology. 'One way to create a typology is to draw on findings and conclusions in the extant literature (Caracelli and Greene, 1993). This phase involves the use of theme-based research to create a typology of e-SCM.

3.4.5 Theme based Research – Qualitative methods (¥i)

Identifying themes is one of the most fundamental tasks in qualitative research. These themes could be abstract, often fuzzy construct which researchers identify before, during or after data collection. They usually come (but not exclusively) from the following (see Bulmer, 1979; Strauss, 1987 and Maxwell, 1996) in Ryan, (2003):

- inducing themes from texts
- reviewing the literature
- the characteristics of the phenomenon being studied
- unmarked texts
- already agreed professional definitions and

- the researcher’s values, theoretical orientation and personal experience of the subject matter.

According to Hsieh and Shannon, (2005) and Baseley, (2009), some of these techniques may involve:

- analysis of words
- a careful reading of larger blocks of texts
- intentional analysis of linguistic features
- physical manipulation of texts
- improving interpretation and naming of categories
- using comparison and pattern analysis to refine and relate categories or themes
- using divergent views and negative cases to challenge generalizations
- returning to substantive theoretical or methodological literature
- creating displays using matrices, graphs, flow- charts and models
- using writing itself to prompt deeper thinking and
- from context and content analysis.

Within qualitative research, thematic analysis has been widely used in ethnographic research (Aronson, 1994). Although many factors can influence the number of themes generated, the current study has utilized the documentation of category development procedures as recommended by Constas, (1992).

3.4.6 **Phase 2 - Theme Analysis**

Thematic analysis is a process that involves encoding qualitative information through explicit coding. These explicit codes may be a list of themes, complex model of themes, indicators and qualifications that are causally related, or a variation of all three (Boyatzis, 1998). These themes represent patterns found in the information that at the minimum describes and organize observational possibilities and at the other extreme, interprets aspects of a phenomenon. Theme analysis involves three main stages:

1. Deciding on sample and design issues.
2. Developing codes themes which could be (a) theory-driven, (b) based on prior

data or prior research and/or (c) arrived at inductively from raw data (i.e. data-driven) and
3. Validating and using the codes and themes.

According to Boyatzis, (1998), themes can be identified at the manifest level (directly observable in the information) or at the latent level (underlying the phenomenon). This thematic analysis involves all three stages, but primarily, code themes developed from prior data and prior research, at both manifest and latent levels.

3.4.7 **Sample preparation**

The sample of 487 articles from the bibliometric study was brought forward to use for the secondary review. This represents an identical purposive sample scheme. The complete bibliometric details of each of the 487 articles was manually printed and read to get an idea of what they contain. It was discovered that three units of the sample (i.e. three articles) were duplicated (Gaonkar and Viswanadham, 2005; Alt and Fleisch, 2000 and Lin et al. 2002) while a further two (Kunaporn et al. 2005 and Alexander and Simoneau, 1999) were disregarded because they relate to waterjet peening and marine geology respectively and were therefore not relevant. This process brought the sample size to 482; more than enough to use in our research design (Collins et al. (a) 2006).

3.4.8 **Open Coding and data collection**

One process that is used to break down, examine, compare, conceptualize and categorize data is open coding. This method yields concepts that can later be grouped or regrouped into categories and involves simultaneous data collection process (Bryman, 2004: 2008).

3.4.9 **Open coding of bibliometric records**

This activity saw the open coding of the bibliometric records of all 482 articles. Each record was read (title, abstract, key-words and other relevant details) and given a code and label that represented a key concept or thought (from reading of the details and knowledge of the literature). Themes were then selected that could best describe the process/es, procedure/s or operation/s. However, after several weeks this process was abandoned because the mere bibliometric details of each article, in most cases, contained insufficient information and at times, confusing information, from which to recognize and base a theme; evidenced from multiple coding of the bibliometric details of most of the articles. For example, the bibliometric record of Singh et al. (2005), attached in appendix 1, contains little or no information on which to base a theme.

3.5.0 **Open coding of each article πa**

This stage involved the manual collection of all 482 articles. Each article was read, re-read (title, abstract, content) and given a code and themes that capture key concept or represent more than one key thought. Themes were then selected that could best describe the process/es, procedure/s or operation/s. These themes or concepts were discerned directly from the content to become the initial coding scheme. Six themes emerged at this stage. To a large extent, they reflected the key areas identified in our literature review. Five of the themes were clearly identified at manifested level, whereas the sixth was latent.

We were able to identify these themes from prior knowledge of the e-SCM literature based on key words, title, abstract and focus of articles relevant to each theme. Table 8 underneath, illustrates the six initial coded themes with total sample articles. Data saturation was not achieved at this stage because of the latent data. However the data was more organized and structured for selective coding.

Through open coding, the study sample was divided into six themes including a large quantity of data that could not be identified (latent) at this level. Although data saturation could not be reached, the data was much more organized and structured for further analysis.

Concept/theme	**Total sample articles**
1. E-integration	59
2. E-technology	45
3. E-collaboration	47
4. E-information-sharing	40
5. E-business	38
6. Latent	118
Total	482

Table 8: Open-coded themes/sub themes with article representation of e-SCM π1 π2 π3

3.5.1 **Selective Coding**

Selective coding is 'a procedure of selecting the core category, systematically relating it to other categories, validating those relationships and filling in categories that need further refinement" (Byrman, 2004). 'Category' refers to a combination of several concepts at a higher and more abstract level. We classified each article using a selected focus (category). The aim of this coding, then, was to identify and categorize all instances of each phenomenon. This process is also similar to the directed form of content analysis, where the aim is to conceptually extend or validate a theoretical framework, guided by existing literature or research (Hsieh and Shannon, 2005). This second iterative and interaction process enabled us to re-code or reclassify the entire sample into two main categories, each further divided into sub-categories or concepts. We have elected to name the first category 'E-technology' because it generally represents the use of electronic technology in SCM. This first category consists of four sub-categories, namely:

1. Technology (23.5%), representing the use of electronic technology particularly internet and web technologies in SCM

2. ‘E-integration’ (29%), representing the use of internet and web technology for integration in supply chains
3. ‘E-collaboration’ (24%), representing the use of internet and web technologies for collaborating in supply chains, and
4. ‘E-information sharing’ (23.5%), representing the use of internet and web technologies for information sharing in supply chains. This category was 100% manifest, representing 50% of the overall sample.

The second category contains three emergent e-supply chains: ‘e-commerce’ 14%; ‘e-logistics’ 11% and ‘e-procurement’ 22%, representing 50% of this category sample, whilst 50% of the category sample was latent. The three emergent e-SC designs were recognizable because of their popularity in the e-SCM literature. Since this category consists of three different designs of e-supply chains, we have elected to name it ‘e-supply chain design’ or (e-SCD). Existing literature thus helped to focus the coding around the variables of interest and thereby improving the initial coding classification. For example, our literature review suggested five important dimensions of e-SCM:

1. The use of e-technology in supply chains
2. The use of internet and web technologies for integration in supply chains
3. The use of internet and web technologies for collaboration in supply chains
4. The use of internet and web technologies for information sharing in supply chains, and
5. The general ability or capability to use internet and web technologies to design different e-supply chains, referred to, as e-supply chain design or e-SCD.

Therefore e-technology becomes a category consisting of four sub-categories whilst e-supply chain design (e-SCD) becomes another category, representing only three different types of e-supply chain designs at this stage. However, because of the unknown data represented in this category (e-SCD), informational redundancy was not achieved. Nevertheless, our coding scheme represents processes and rules of data analyses that are logical, systematic and scientific.

3.5.2 **Summary Findings**

This phase has utilized theme analysis to classify two main categories or components (and sub-categories) associated with e-SCM. The two main categories or components are illustrated in Figure 10 (below). Although data saturation was not reached, the data is more structured for further analysis.

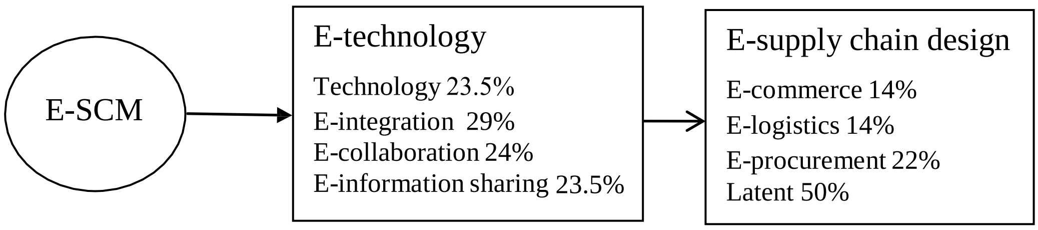

Figure 10: An illustration of the results from the theme analysis πbπe

The E-technology category and concepts were 100% manifested. The e-supply chain design category contains three concepts which were emergent based on their identification in the wider e-supply chain management literature. We have elected to name the three concepts (sub-categories) collectively ‘e-supply chain design’ because they represent different types of e-supply chains (i.e. 50%), whilst the other 50% of the category remains latent.

3.5.3 **Phase 3 Latent Content Analysis – Qualitative (**¥i)

3.5.4 Research statement: To identify different types of e-supply chains.

3.5.5 **Introduction**

In a bid to identify the latent data constituting the 50% nested sample of the e-SCD category in pursuance of the objective, this study poses the question; what are the latent e-supply chain designs? A conventional content analysis was utilized on the affected nested sub-sample (50%) to identify latent e-supply chain designs.

3.5.6 **Conventional Content Analysis**

Qualitative content analysis is one of the most numerous research methods used to analyse text data. This method focuses on the characteristics of language to provide explicit or inferred meaning to the content and context of different categories of textual communication. Conventional content analysis is defined as ‘a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns’ and ‘its goal is to provide knowledge and understanding of the phenomenon under study’ (Hsieh and Shannon, 2005). There are three types of content analysis: (1) conventional (2) directed, and (3) summative. The specific type of content analysis is chosen by the researcher based on the research problems and interests.

This phase of our analysis involves the use of conventional content analysis to describe the latent data from the e-supply chain design category. This method is used when there is limited or insufficient research about a phenomenon and allows names and categories to flow directly from the data and thus allows new insight to emerge inductively (Hsieh and Shannon, 2005). Knowledge gained from this type of content analysis is based on the unique perspective of the sample and also grounded in the data. Moreover, latent content analysis focuses on important hidden rather than observable meaning. It is an interpretative analysis that focuses on uncovering underlying meanings and actions through ‘imputation of meaning’ and ’reading in’ and making inferences on the intent or effect of the content (Leech and Onwuegbuzie, 2008).

3.5.7 **Sample design**

The e-SCD category sample contained only three manifested sub-themes that represents already identified e-supply chain designs in the literature (e-commerce, e-logistics and e-procurement), whilst 50% of the data was unknown (see Table 9). This present incomplete data as the e-SCD sample contains unknown components which have to be consolidated through further analysis. We therefore conducted a conventional content analysis on the nested opportunistic sample (50%) of the e-supply chain design category. The sample was opportunistic because it represents the 50% (133 articles) of latent e-SCD. This provided the opportunity to identify the latent e-supply chain designs comprising 50% of the nested sample data on the e-SCD, in pursuance of our stated research objective.

E-supply chains (designs)	Total articles	Intensity effect size
E-commerce	37	14%
E-procurement	58	22%
E-logistics	37	14%
Latent/unknown	133	50%

Table 9: Quantitised percentage/intensity effect size showing manifest and latent e-supply chain designs π1 π2 π3

3.5.8 **Data collection – Inductive development of latent themes**

Each article was first manually retrieved, read, re-read until immersion was achieved and a sense of the whole content was obtained. Each article was then given a code that appeared to capture key thoughts, activity or concept. These often came directly from the content and then become the initial or subsequent coding scheme. This period of ‘sensing coded moments’ involved creating different groups of articles, labelling each group, defining each group label (what the theme concerns) and identifying how to know when the theme occurs or re-occurs (Boyatzis, 1998). Each group-theme was further re-examined and refined through content analysis of each article at several stages until saturation. Finally, all the codes and labels were organized, defined and tabulated, representing 23 additional e-supply chain designs.

This process, at times took several days or weeks to complete for each theme grouping. For instance; the example below initially included an article by Taylor, (2003), which discusses, among other things, the evolution of e-books and describes how e-books can be downloaded direct from digital warehouses to customers, in the same way that a physical book would.

This description however was the author’s comparison between the similarity of the e-books and physical book supply chain. Nevertheless, since it describes the digital delivery process of e-books, it was initially grouped under the ‘internet document access, delivery and management’ theme. Subsequent further content analysis and refinement of each article and groupings lead to its removal and re-grouping into the ‘internet-intermediaries’ theme. This is because the aim of the article is to describe the role of the US web aggregator OverDrive and other aggregators (e-intermediaries), who are becoming market leaders in the emerging e-book market. Similarly, the latter theme of this group was eventually refined to ‘e-document delivery’.

Theme/Authors **Internet/web document access, delivery &**	Definition	Description of when it occurs
Arte et al. (2003) Burnhill & Law, (2008) Siddiqui, (2003) Birch & Young, (2001) Schulz, (2001) Taylor, (2003) Mei & Dinwoodie, (2005)	The use of the internet/web to access, deliver and manage documents electronically.	Unmediated access & delivery of resources User-initiated and delivery to desk-top Adoption of internet for resource sharing in libraries Internet delivery document system Document delivery with web services Digital access for articles E-resource database & e-journal database e-bills of lading (e-bols) and shipping documentation
Total 7		

This process of content analysis, where each article was used as the main source for theme matching and condensing is aimed at identifying in-depth information gathered from each article. The themes, patterns, understanding, insights and subsequent analysis that emerge, are the fruits of qualitative inquiry. This consisted of six main phases of analysis (Chien and Lee, 2007).

1. Becoming familiar with the diversity of the data in the article and attaching codes and remarks to each.
2. Sorting and sifting through the codes of each article to identify pattern and recurrence of themes and relationships.
3. Generalizing the consistencies discerned in the articles and field notes and remarks to each.
4. Isolating the patterns and clustering commonalities and differences between themes and creating a thematic index of articles.
5. Comparing and contrasting, condensing and mapping between categories and themes identified, making interpretations and providing explanations.
6. Summarizing results and re-examining the data, where necessary.

3.5.9 **Identification and definition of latent e-supply chain designs**

The iterative and interactive process involved led to the identification and definition of the twenty-three latent e-supply chain designs as catalogued in appendix 2. Appendix 3 contains our e-SCM typology of the current study with article citation and e-supply chain design.

3.6.0 **Summary Findings**

This study conducted a conventional content analysis to identify latent e-supply chain designs from the literature. Twenty-three e-supply chain designs were identified and described from the latent data before data saturation was achieved, bringing the total e-supply chain design to twenty three (i.e. emergent and latent). Appendix 4 is a list of both emergent and identified (latent) e-supply chain designs.

The encoding of the latent sample brought the total e-SCD to 26 (272 articles) at data saturation, representing 100% of this category. Table 10 below illustrates the combined total sample of the study with quantitized percentage intensity effect rate.

Table 10: Percentage component distribution of articles to overall study sample

Categories Representation	Number of Articles	Percentage
E-technology	217	50%
E-supply chain design	265	50%
Total	482	100

Chapter Four

Research Results and Interpretation

4. **Introduction**

This chapter is divided into four sub-sections. Section 1 brings together the research results and analysis; section 2, interpretation of network relationships of e-supply chain management (e-SCM) in the light of the findings; section 3, a three dimensional mixed methods model of e-SCM; and section 4, mixed methods legitimation issues.

Section one

4.1 Discussion of results and analysis

The main aim of this study was to develop a conceptual framework of e-SCM. The three research statements that were identified are:

1. To gain insight into the direction, trends and current status of e-SCM;
2. To discover a structure or components of e-SCM that will aid the creation and development of a conceptual framework, and
3. To identify different types of e-supply chains.

The study is based on a survey sample of 482 articles from the Social Science Citation Index (SSCI) between 1998 and 2009.

4.2 **Objective 1: To gain an insight into the direction, trends and current status of e-SCM**

Using bibliometrics in the first sequence, the study found that the status e-SCM rose steadily from around 1998 until 2007, when it reached its peak, with a gradual decline in interest in 2008. Its most active period was clearly between 2004 and 2007. During its peak, interest in the concept was so great that over fifty articles were being printed every year in academic journals. In 2007 for example, over seventy articles were published about e-SCM in the SSCI after which interest seemed to start waning gradually in 2008. One explanation of the loss of interest during 2008 could be that the concept has reached its point of saturation in its development, or that interest had been diverted to other sub-specialist areas such as developments in intelligent e-SCD, mobile and wireless e-SCD, or other e-supply designs. Nonetheless, periodic study of this nature will help to maintain the evolution and development of the concept. It is important to note that the sudden dip in 2009 represents the end of the study period.

Moreover, during this exciting chronology of e-SCM, articles were been published not only in leading SCM and related journals such as; SCM: An International Journal, Journal of Operations Management, Journal of Production Economics, International Journal of Advance Manufacturing, Journal of Systems Science and Systems Engineering, International Journal of Flexible Manufacturing Systems, International Journal of Information Management, Technology Analysis and Strategic Management, International of Advanced Manufacturing Technology, International Journal of Computer Integrated Manufacturing, but also journals in a multitude of other academic domains.

Others include: Group Decision and Negotiation, IEEE Transaction on Professional Communications, Research Policy, IEEE-ASME Transactions on Mechatronics, Communications of the ACM, IEEE Transactions on Systems Man and Cybernetics, R and D Management, Industrial Marketing and Data Systems, Harvard Business Review, Sloan Management Review, Journal of Computer Information Systems, Production Planning and Control and others.

This demonstrated the multi-disciplinary and complex nature of e-SCM (see appendix 6). A closer observation of the mix of journals also revealed a heavily engineering-based orientation, systems orientation, including intelligent designs and cybernetics research, etc. Also of note are specialist journals in management communications, technology and computer-integrated systems. This might suggest the importance of the influence of a ‘design element’ for development of different e-supply chain designs.

Network relationship maps further helped to illustrate the multi-discipline and multi-dimensional relationship between the main concepts associated with e-SCM. This multi-disciplinary nature of e-SCM represents an integration of various existing bodies of knowledge and concepts to form one holistic, integrated, concept or strategy that stretch across boundaries and joins together what are essentially bodies of work relating to the management and operation of business conducted within organization, co-operatives and global networks as a common flow of supply activities (including associated decisions); a confirmation of Harland et al's emanation of supply strategy (1999), and thus, the conclusion of discussion on the achievement of the first objective.

4.3 **Objective 2: To discover a structure or components of e-SCM that will aid the creation and development of a conceptual framework**

Using mixed methods data analysis (in the context of perceptions held by authors with regard to the components of e-SCM from our research sample of 482 articles), two specific types of research areas were identified as being associated with e-SCM according to SSCI, as illustrated in Table 10. The identified areas or categories are:

1. E- technology, representing 217 units or 50% of the overall sample, and
2. E-supply chain designs, with 265 representatives or 50% of the overall sample at data saturation.

This represents the achievement of our second objective. In addition, our results indicate that e-technology is composed of four sub-categories that were clearly identifiable at the manifest level as illustrated in Table 11 below.

1. 51 of the articles (23.5%) perceive e-technology to be about the use of technology (electronic or digital) in supply chain management, particularly internet and web technologies;
2. 62 of the articles (29%) perceive it to be about the use of internet and web technologies for integration in supply chains (e-integration);
3. 51 of the articles (23.5%) perceive it to be about the use of internet and web technologies for information sharing in supply chains (e-information sharing); and
4. The remaining 53 articles (24%) perceive e-technology to be about the use of internet and web technologies to collaborate in supply chains (e-collaboration).

E-Technology category		No. of articles	Percentage
1.	Technology	51	23.5%
2.	E-integration	62	29%
3.	E-collaboration	53	24%
4.	E-information sharing	51	23.5%
	Total	217	100%

Table 11: Distribution of articles representing e-technology

This result personifies the current literature on e-SCM; for example, on the global use of technology and its efficacy for SCM (Paterson et al. (a) 2003; Paterson et al, (b) 2004; Craighead et al. (b) 2006; Auramo et al. 2005; Wu et al, 2006), e-technology (Vakharia, 2002; Sanders, (a) 2007; Boone and Ganeshan, 2007 and Sanders, (d) 2007), with specific reference to the e-collaboration dimension (Jagdev and Thoben, 2001; Pramatari, (b) 2007; Nucciarelli and Gastaldi, 2008), the e-integration dimension (Frohlich, 2002; Beck et al. 2005; Power and Singh (a) 2007 and Flynn et al. 2010), e-information sharing dimension (Childerhouse et al. (a) 2003; Childerhouse et al. (b) 2003; Dimitriadis and Koh, 2004; Zhou and Benton, 2007; Nurmilaakso, 2007) and e-supply chain design (Graham and Hardaker, 2000; Williams et al. 2002; Hoek, 2001; Akyuz and Rehan, 2009).

4.4 **Objective 3: To identify different types of e-supply chains**

With respect to the e-supply chain design category, 132 articles, representing 50% of the category sample, initially perceive e-supply chain design to be important, with the remaining 50% of the category, latent. The initial 50% was composed of three emergent e-supply chain designs:

1. E -commerce, with 37 articles, representing 14% of the sub-sample;
2. E-logistics, with 37 articles, representing 14% of the sub-sample; and
3. E-procurement, with 58 articles, representing 22% of the sub-sample.

Conventional content analysis on the latent sample identified and classified 23 further e-supply chain designs at data saturation - evidence that strategic and integral e-supply chains not only exist but also that there are different types based on specific configuration or design; thus achieving our third stated objective.

4.5 **Defining e-supply chain design**

We have discussed the latent e-supply chain designs identified from our mixed methods study. This analysis has also introduced and demonstrated the importance of the 'design' element of e-SCs to the general debate on e-SCM. Therefore, based on this identification and classification analysis, we define 'e-supply chain design' as 'the use of e-technology, particularly internet and web technologies, to design and configure supply chains for e-collaboration, e-integration and e-information sharing in order to acheive greater efficiency and productivity'. This description fits well with the perceived purposes and achievement of the articles analyzed and also is rational and logical based on overall analyses of the literature.

4.6 **Research aim: To develop a conceptual framework of e-SCM**

Based on the nature of our study design and the results of this study, we assert that the two main components of e-SCM are e-technology and e-supply chain design and thus, our e-SCM conceptual framework. The framework asserts that e-supply supply chain management refers to the use of e-technology, particularly internet and web technologies, to design or configure e-supply chains, for greater efficiency and high productivity, through e-integration, e-collaboration and e-information sharing, thus achieving our stated research aim, as illustrated in Figure 11 (below).

Figure 11: A Conceptual Framework of e-SCM

1. **E-Supply Chains designed for Intermediation or Intermediaries (e-Intermediaries**)

   For example, the changing role of e-intermediaries into virtual enterprises through the use of internet and web technologies has made integration of inter-organizational business processes in virtual space possible (e-integration). This involves dynamic collaboration (e-collaboration) between parties. One of its rewards or achievements is that, as information passes and is digitized through these systems; it is exchanged quickly and in most cases, in real-time, to all parties via e-linkage (e-information sharing). Value creation through e-integration, e-collaboration and e-information sharing ensures greater efficiency and productivity (Ho et al. 2003).

2. **E-Supply Chains designed for Product Development (e-Product Development)**

   The use of internet and web technologies to design or configure product development supply chains can directly connect multiple customers and supplies (e-integration) throughout the entire value chain. This can alleviate much of the inefficiency that has been identified in traditional product development supply chains (Helender and Jaio, (a) 2002). For instance, in an e-supply chain for customised product development (e-Customize-To-Order), all parties can interact (e-collaboration) and communicate information (e-information sharing) related to product design, development, manufacturing and logistics, within the same infrastructure (Jaio and Helender, (b) 2006). In addition, this allows parties to reduce incremental infrastructure investments and enhance collaborative customization among parties internally and externally, thereby ensuring greater efficiency and productivity.

3. **E-Supply Chains designed for the Manufacturing Industry (e-Manufacturing Information Systems)**

   The use of internet and web technologies to design manufacturing supply chains can facilitate greater integration, information sharing and collaboration in planning and control systems. This can: (1) integrate both customer and supplier into a common infrastructure (e-integration) and facilitate improved collaboration (e-collaboration). This will enable demand and inventory data to be visible across the SC (and facilitate e-information sharing) for simultaneous improvements in customer service levels and reduction in overall inventory level. This will, in turn, decrease cost and thereby increase efficiency and productivity, (Shaw, 2000; Kehoe and Boughton, (a) 2001 and Kehoe and Boughton, (b) 2001). Similarly, internet and web technologies are being used to configure specific supply chains for BTO, MTO and ATO requirements (Coronado et al. 2004; Azevedo et al. 2004 and Xiong et al 2003).

4. **E-Supply Chains designed for Wireless Capabilities (e-Wireless Systems)**
   The use of internet and web technologies to design or configure wireless supply chains provides the opportunity for the electronic management of information in a product's lifecycle. It can provide the opportunity for information to be accesed in real-time about any product or service, the opportunity for wireless mobile information sharing and collaboration. It can also provide remote monitoring capabilities in production management to ensure transparent and visible information flow. This can lead to an enterprise-wide inventory visibility that can provide real-time e-information sharing and availability, which in turn, would lead to reduced cost, improved customer service, an increase of inventory accuracy and a decrease of lead-time variability – this enables greater efficiency and productivity (Wamba et al. 2008).

These four examples from this study, clearly demonstrates that the use of e-technology, particularly internet and web technologies, to design or configure supply chains (e-supply chains) can enable greater efficiency and productivity, through e-integration, e-collaboration and e-information sharing.

This conceptual framework also demonstrated an affirmation of Harland et al's (d) argument that a rational, normative approach to supply strategy (based on externalise rational operation strategy approaches to inter-organizational networks) is feasible (and evident in business practice). In the light of the existing SCM (including works on supply strategy and supply networks) literature therefore, this conceptual framework of e-SCM could be summarised as a holistic approach within and between collaborative inter-organisational networks, which allows the formulation and implementation of rational strategies for creating, stimulating, capturing and satisfying end-customer demand through innovation of products, services, supply network structures and infrastructures, in the contemporary dynamic global environment.

Furthermore, it not only represent the increasing scope of work on supply and the value chain that mirrors work in this area overtime, but also extends work on classification of supply networks, based on the 'design or configuration of e-supply chains' and thus, can accommodate and adequately explain the current commercial and market complexity associated with the creation and delivery of goods and services from source to destination and beyond, particularly for managers facing the practical problems of creating and operating supply networks or e-supply chains on a daily basis.

Section Two

4.7 Further interpretation of overall results

Figure 12 below illustrates the overall results of the current study, which are further corroborated by the interpretation of our network relationship diagrams.

First and foremost, according to our illustrated results, e-SCM is comprised of two main components - e-technology and e-supply chain design. We interpret this to signify that e-SCM refers to the use of e-technology, particularly internet and web technologies, to design or configure e-supply chains or specific supply chains and thus, an e-SCM conceptual framework. This is portrayed in networks via both our co-occurrence network maps of title (Figure 8) and article (Figure 9) keywords of e-SCM.

In the network relationship map of title keywords, one can easily draw a triangular network of the three words 'technolog', 'design' and 'e-suppli'; as also the significance of the networks between 'internet', 'design' and 'chain', and 'internet', 'design' and 'suppli'.

In our network relationship map of article keywords, in addition to the strong and obvious relationship between 'internet', 'electronic_commerc' and 'supply_chain_manag' network, there is also a more profound network between 'internet', 'technology_manag' and 'supply_ chain_manag', which again, could be clearly interpreted as the use of internet technology for supply chain management. The ‘e-technology’ category was 100% manifest at data saturation therefore indicating a strong view amongst authors who publish in SSCI that e-SCM is about the use of e-technology, particularly internet and web technologies in SCM.

As far as the relationships between ‘internet’, ‘electronic_commerc’ and ‘supply_chain_manag’ and ‘internet’, ‘electronic_busi’, and ‘supply_chain_manag’ are concern, starting with the latter network, we know from the current study and the e-SCM literature that ‘electronic business’ (e-business) refers to the holistic use of technology, particularly the internet - hence ‘e-business technology’ or ‘e-technology’ (Power and Singh 2007 and Boone and Ganeshan, 2007). For this reason we have decided to name this category ‘e-technology’. We interpret this network as the use of technology, particularly internet and web technologies, for supply chain management. We are convinced this is further indication that e-SCM refers to the use of electronic technology, particularly internet and web technologies in supply chain management, thus illustrating and enhancing our assertion from the findings with regards to their significance in the relationship between e-technology and e-supply chain design.

We agree that there is a possibility that the former network may indicate the use of web-based sales. This is conceivable because at the heart of the internet revolution retailers’ use of e-commerce to stay ahead of the competition. The commercial exploitation of the internet by retailers (including start-ups before and after the ‘internet bubble’ burst), sparked an emergent body of literature which has been substantial, diverse and popular in the evolution of the use of the internet in commerce (Doherty and Ellis-Chadwick, 2006).

However, we believe that just as ‘electronic business’ and ‘e-business’ are sometimes used in place of ‘e-business technology’ or e-technology, it is evident that ‘electronic commerce’ or ‘e-commerce’ are synonymous in use, meaning ‘the global use of electronic technology (e-commerce) or digital technology in commerce’ rather than ‘web-based sales’ (Bakker et al. 2007). This broader definition of e-commerce has been evidenced in the SCM literature (Duffy and Dale 2002). For instance, Laudon and Laudon 1997 defined electronic commerce as “the process of *doing business electronically*” whilst Taylor and Berg 1995 refers to electronic commerce as “not just a single technology but a combination of technologies, applications, processes, business strategies and practices necessary to *do business electronically*" in (McIvor et al. 2000).

Furthermore, the diagram illustrating our result (Figure 11) also indicates that the e-technology component is composed of (1) technology, (2) e-integration, (3) e-collaboration, and (4) e-information sharing. This is clearly portrayed in our co-occurrence network relationship map of article keywords (Figure 9). One can readily observe the three terms ‘ collaboration’, ‘supply chain interg’ and information shar’, and draw a triangle connecting all three words in a network, which would place the word, ‘internet’ (outside the base of the highlighted triangle) in the middle of this network. In addition, the same network is repeated in our co-occurrence map (Figure 8) of title keywords: ‘collabor’, ‘integr’ and ‘inform’. These two networks again identify the use of internet and web technologies for SC integration (e-integration), collaboration (e-collaboration) and information sharing (e-information sharing), illustrating, enhancing and corroborating the results above. Moreover, our secondary qualitative analysis supports the importance of technology for e-collaboration, e-integration and e-information sharing (e-technology) as dimensions of e-SCM, providing a form of triangulation to corroborate our assertions and significantly enhancing this study. This further confirms our interpretation that ‘e-technology’ represents the holistic use of information technology (specifically electronic or digital technology) - particularly internet and web technologies - in SCM for e-integration, e-collaboration and e-information sharing.

Further, our conceptualization of the e-supply design component is based on the identification and classification of specific and disparate types of e-supply chain; as such, we have labelled this component ‘e-supply chain design’ defined as “the use of internet and web technologies to configure or design specific supply chains for e-collaboration, e-integration and e-information sharing for increased efficiency and high productivity”. This is illustrated by the following networks in our co-occurrence network maps (Figures 8 and 9) of title and article keywords: ‘internet’, ‘technolog’ and e-suppli’ and ‘internet’, ‘design’ and ‘e-suppli’; both interpreted to mean the use of internet and web technologies to design e-supply chains. Other networks - ‘suppli’, ‘chain’ and ‘design’; ‘custom’, ‘internet’, and ‘chain’; and also ‘custom’, ‘internet’ and ‘suppli’ - are variation on a theme, meaning that e-supply chains are of different designs, or custom-made.

It is important to note that the twenty-three further classifications of e-supply designs are not represented in either of our network relationship maps because of their latent characteristics; however, the three emergent e-supply designs illustrated in our results can be observed in a network consisting of ‘procur’, ‘electronic_commerc’ and ‘logist’, signifying the prevalent and popular nature of these designs in the e-SCM literature. This also indicates the inadequacy of quantitative methods in providing more meaningful information with respect to latent data. Nevertheless, both manifest and latent levels contributed equally to this category, proving that latent effect size can be complementary and provide more meaningful qualitative interpretations. This shared perception provided more insight and understanding about e-supply chains by enabling the identification of twenty-six e-supply chain designs in the e-SCM literature.

Two further title keywords networks that are of importance to the study of e-SCM are: ‘internet’, ‘suppli’ and ‘chain’ as well as ‘suppli’, ‘network’ and ‘chain’. These networks may indicate that the two terms ‘e-supply chain’ and ‘supply network’ refer to the same phenomenon. In the same vein, the bibliometric analyses also show a strong indication of the concept’s origin to SCM. This study has developed a conceptual framework on e-SCM, which is based on the use of e-technology to design and configure e-supply chains for greater efficiency and productivity. The manifest nature of e-technology is a strong indication of its efficacy for greater efficiency and productivity through e-integration, e-collaboration and e-information sharing. Although interest in the design of e-supply chains started at a slow pace (i.e. e-commerce, e-procurement and e-logistics), based on the interest identified from the latent sample, we envisage a rapid interest and development of other e-supply designs.

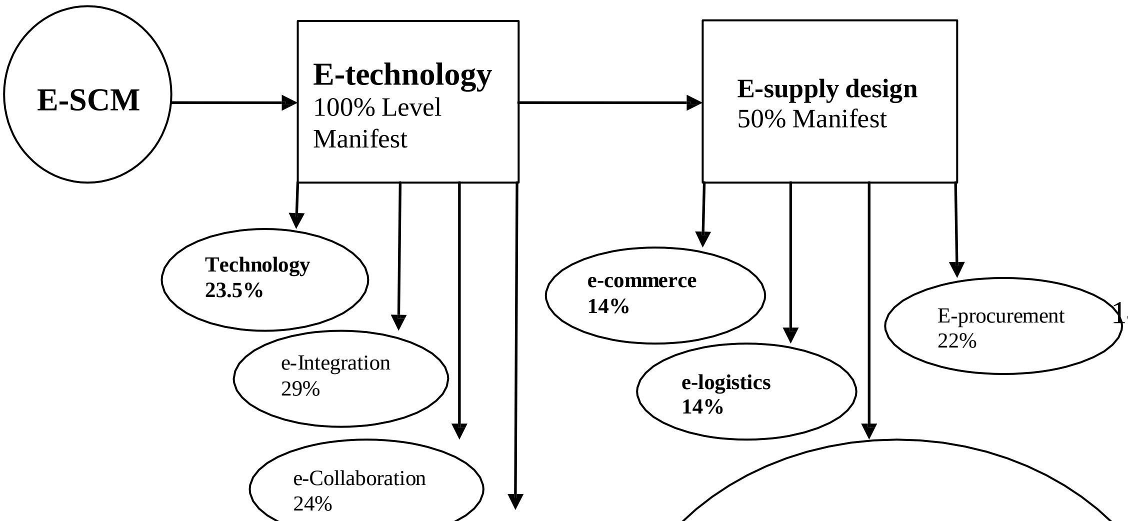

FIG 12: E-SCM Typology illustrating two main components and thus our conceptual framework of e-SCM. A graphical display of quantitized percentage impact, adapted from Onwuegbuzie and Dickinson (e) (2008). See table of abbreviation in appendix 7.

Section Three

4.8 A three-dimensional representation of e-SCM

However, although this study has achieved its stated goals and objectives, the final step in a mixed method study (which would be the focus of our next research) is to operationalize the study results (Onwuegbuezie et al. (b) 2009). Our mixed analytic technique in sequences 1 and 2 can be operationalized to represent a case-oriented and a variable-oriented analysis. Case-oriented analyses focus on selected case(s) and the goal is to interpret or identify common patterns and the like (Miles and Huberman, 1994). This type of analysis can treat a whole entity as a case and therefore accommodate both particularising and analytical generalisation. Although case-oriented analysis is perhaps more suitable for qualitative research and analysis, it can also be used for quantitative research and analysis (Miles and Huberman, 1994) such as single subject analysis, profile analysis, descriptive statistics and, in our case, the bibliometric analysis in phase 1. As such, we regard our quantitative analysis (phase I), as a case-oriented analysis. The results from the bibliometric analysis can therefore be used to interpret e-SCM as a single case or to determine its characteristics (Onwuegbuzie et al. (b) (2009).

Similarly, a variable-oriented analysis involves identifying relationships among entities which are conceived as variables. This type of analysis is mostly conceptual and theory-centered. Its building blocks are variables rather than cases (Miles and Huberman, 1994). Although variable-oriented analyses are more suitable for quantitative research and analysis, they are also very pertinent for qualitative research and analysis - for example, in examining themes that cut across cases (Miles and Huberman, 1994). We therefore regard the qualitative study (sequence 2) as variable-oriented analysis, specifying the two identified components of e-SCM.

Furthermore, our mixed methods quantitative data was collected and processed over a period of five months, as opposed to two years or more for the qualitative data, thus demonstrating the longitudinal nature of the dataset for this study, as illustrated in Appendix 13.

Similarly, the data collected of e-SCM's history, direction and trends, represented experiences or processes that have occurred over a significant period of time, specifically between ten and eleven years, making them long-term experiences or processes. In either type of study, time becomes an important dimension when analyzing the data. Process and experience have a temporal component; they involve evaluating processes or experiences associated to one or more case/s within a specific context over time. Process-and-experience-oriented analyses therefore capture the time elements of the phenomenon of study and demonstrate the longitudinal nature of this study (Onwuegbuzie et al. (b) 2009).

Figure 14 therefore represents all three dimensional models for interpretation (organization and categorization) of our conceptualization of e-SCM. This model includes three dimensions, each focused on a given set of strategies that can be used to analyze and interpret quantitative and qualitative data, positioned at 90-degrees to the other two. Using this model, e-SCM can be positioned within a three-dimensional space as a way of indicating the multi-dimensional complexity or sophistication of the concept. This will help to illustrate the potentially interactive and integrated nature of our quantitative and qualitative data analyses (Onwuegbuzie et al. (b) 2009).

Specifically, combining all three analyses (case-oriented, variable-oriented and process and experience-oriented) can produce meta-inferences illustrating that e-SCM contain underlying variables that are linked over time, as illustrated in the Figure 13.

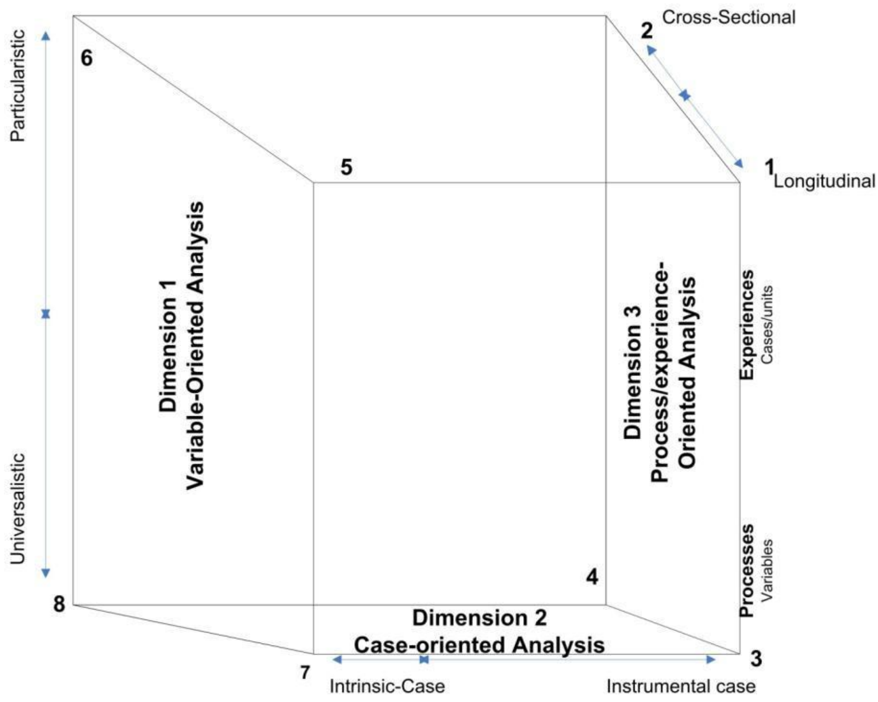

Figure 13: A three dimensional model for interpreting e-SCM

Section Four

4.9 **Mixed-Methods legitimacy**

The literature outlined nine types of legitimation for mixed methods research studies (Onwuegbuzie and Johnson, (f) 2006):

- sample integration legitimation
- insider-outsider legitimation
- weakness minimization legitimation
- sequential legitimation

- conversion legitimation
- paradigmatic mixing legitimation
- commensurability legitimation
- multiple validation legitimation and
- political legitimation

The current study addressed eight types of legitimation. We are convinced sequential legitimation was achieved because of the integrity of our sample; therefore we believe the findings would not have changed if the qualitative phase had preceded the quantitative phase. Also, specifically, sample integration legitimation was optimized by using fairly large and identical samples for both quantitative and qualitative study. This can enable the study to justifiably combine inferences that stem from both approaches, into meta-inferences (Onwuegbuzie and Johnson (f) 2006).

Inside-outside legitimation was shown by capturing the voices of participants (articles) regarding their perceptions as to the characteristics of e-SCM (i.e. insiders' view), as well as comparing their perception to the extant literature (secondary review and e-SCM typology). Weakness minimization legitimation was improved by combining empirical precision (i.e. from the quantitative analysis) with descriptive precision (from the qualitative analyses). Paradigmatic mixing legitimation was enhanced by using a fully mixed-methods research design (Onwuegbuzie, 2005) as well as undergoing all the major steps of the mixed methods research process (Onwuegbuzie and Leech, 2006). Commensurability legitimation was partly addressed by using a team of two research supervisors with diverse research orientation (i.e. qualitative and quantitative); university teaching experience (senior lectureship); leadership (head of technology group and head of department, respectively); and discipline specialisation (supply chain management, operations and production management and bibliometrician); as well as a postgraduate management research student with university teaching experience and with both quantitative and qualitative research methods orientation.

Multiple validity legitimacy was partially addressed by using significant findings to enhance the study and by other techniques (meetings, member checking and cross-checking, clarifications for supervisors, viva and re-submission of thesis) that addressed as many threats as possible, in order to satisfy the legitimacy of the study. Last but not least, political legitimacy was addressed by use of rigorous qualitative and quantitative techniques. Nevertheless, despite the rigorous nature of the research design, replication of this inquiry is needed to assess the reliability of the current results. Further studies could include the use of other forms of qualitative and quantitative methods of analysis so that multiple validity legitimation, conversion legitimation and sequential legitimation could be fully addressed.

CHAPTER FIVE
Conclusion

5.0 This mixed methods research study enriches the e-supply chain management literature by developing a conceptual framework of e-SCM; which was the study's main aim. The framework assert that e-SCM refers to the use e-technology, particularly internet and web technologies, to design or configure specific supply chains - e-supply chain design in general – in order to increase efficiency and productivity through e-integration, e-collaboration and e-information sharing.

In relation to the first objective, the current study finds, among other things, that interest in e-SCM has been steadily increasing between 1998 and 2009, with only a slight decrease in 2008. This may have been caused by saturation as well as a burgeoning interest in the development of other e-supply chain designs. The relationship between networks indicates that the multi-dimensional and multi-disciplinary nature of e-SCM represents an integration of various existing bodies of knowledge and concepts. This integration forms a single holistic concept that reaches beyond boundaries. Bodies of work, relating to the management and operation of business conducted in inter-organization, co-operatives and global networks are amalgamated through the use of e-SCM. These systems of work are regarded as a common flow of supply activities that embody supply strategy in the current complex global climate. The study achieved the second objective by identifying the two main components associated with e-SCM; e-technology and e-supply chain design. Finally, the third objective was achieved through the discovery, identification and classification of twenty-three further e-supply chain designs.

The aim of this study was to develop a conceptual framework for e-SCM; therefore it is unprecedented in many ways. Primarily, this is the first mixed methods study of e-SCM. Secondly, it is the first to directly investigate the components of e-SCM, using a multi-dimensional and multi-disciplinary perspective. Furthermore, up until 2013, no study has developed a conceptual framework of e-SCM that combines the different dimensions identified in the literature. This is the first study that sought to identify and classify e-supply chains based on their design purpose or focus. Lastly, this conceptual framework contributes to the theories of supply strategy and supply network, through providing explanations into how organizations arrange and conduct themselves within modern economic environments, in order to satisfy markets in the short and long term.

The use of mixed methods has enabled this study to achieve the main goals through enhancing the interpretation of significant findings, defined as ‘one that has meaning or representation’, (*Verstehen*) according to Onwubugzie and Leech, (2004). The use of a mixed design in the current study helped to increase the internal validity of the findings. Data sources were significantly enhanced through the development of an identical sample. In addition, the combination of research paradigms provided in-depth analysis and classification of e-supply chain design from the literature and identification of the main components of e-SCM. This has enabled the study to develop a conceptual framework for e-SCM that can be used and validated in further studies.

The quantitative study provided descriptive analysis which supported the qualitative study. Our understanding of the role and importance of e-technology and e-supply chain design in e-collaboration, e-integration and e-information sharing in e-SCM was significantly enhanced. This is supported by the view; ‘that which is subtle becomes obvious when we look through the eyes of the qualitative researcher’, (Constas, 1992).

In consolidating the results of this research, the study developed an e-SCM conceptual framework. E-SCM is composed of the distinctive components; e-technology and e-supply chain design. E-technology involves the use of electronic technology in SCM, in particular, internet and web technologies for e-information sharing, e-integration and e-collaboration. E-supply chain design refers to the use of internet and web technologies to configure or design supply chains in order to increase efficiency and productivity through e-information sharing, e-integration and e-collaboration. Our qualitative analyses strengthened our research findings, through revealing that specific e-supply chain designs that have been configured electronically through the internet and web technologies ensure greater efficiency and productivity. Therefore through e-technology, supply chains are electronically and digitally designed and configured to integrate, collaborate and share information seamlessly, for greater efficiency and productivity.

5.1 **Future Research Directions**

In our view, e-SCM has far reaching implications in the current complex global commerce environment than successful integration, collaboration and information sharing for greater efficiency and productivity. However, as Kehoe and Boughton (b) (2001) pointed out, the academic challenge is to develop and evaluate alternative business models and determine the tools and techniques by which businesses can benefit, from such models and how they can be demonstrated to practitioners. This study demonstrates this and compliments earlier works on the use of technology for supply chain integration, collaboration and information sharing, in order to achieve efficiency and productivity.

E-supply chain design has not been regarded as a main component of e-SCM, particularly in comparison to some of the earlier e-SCM classification studies reported here. Our thematic classification of e-supply chain design have therefore identified and introduced the 'design' element; to be an important aspect that would further aid our understanding of the concept.

We deliberately limit the review to papers published in the SSCI (1998-2009); however, we have also included a wide variety of research that is relevant to understand the concept, as compared to some of the earlier studies. We could not go into prolonged discussion of themes and implications because of the prescribed length and also the comprehensive nature of the study. We have grouped each e-supply chain design according to the main focus of each article. However, we are aware that the classified categories may not be mutually exclusive.

We conclude this paper hoping that SCM practitioners and academics alike, will find this study very informative and useful. We have developed a conceptual framework and definition of e-SCM. Our thematic examination of e-supply chain designs contributes further knowledge that will enhance understanding of the concept, thereby, filling-in gaps that exist in the literature. The research findings reported here can help to stimulate other researchers, to explore research related to their own areas in more detail and for practitioners to develop suitable solutions that can be implemented.

Most of the issues identified here have practical importance and could be the focus of our future studies. In fact, these issues have emanated from the development and practice of SCM, which echo Wall et al.'s (2007) statement, that, 'e-SCM strategies has facilitated the creation of entirely new ways of doing business', which they described as 'an overall strategy of creating or redefining old business models, with the aid of technology to maximize customer value and profit', through the use of internet and web technologies, to improve market share, grow corporate profits and to gain strategic advantage (Lancaster at al. 2006 and Chou et al. 2004). We look forward to continue mapping the evolution of e-supply chain management.

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Appendix 1

Sample of converted source file into bibexcel format

```
PT- J|
AU- Singh R; Salam
AF; Iyer L|
TI- Agents in e-supply chains|
SO- COMMUNICATIONS OF THE ACM|
LA- English|
DT- Article|
ID- E-COMMERCE; TRANSACTIONS; SERVICES; INTERNET; WEB|
C1- Univ N Carolina, Informat Syst & Operat Management Dept, Bryan Sch
Business & Econ, Greensboro, NC 27412 USA|
RP- Singh, R, Univ N Carolina, Informat Syst & Operat Management Dept,
Bryan Sch Business & Econ, Greensboro, NC 27412 USA|
EM- rahul@uncg.edu amsalam@uncg.edu lsiyer@uncg.edu|
CD- BAKOS Y, 1998, V41, P35, COMMUN ACM; BERNERSLEE T, 2001, V284, P34,
SCI AM; GROVER V, 2001, V44, P79, COMMUN ACM; KISHORE R, IN PRESS
DECISION SU; MCILRAITH S, 2001, P46, IEEE INTELLIGENT MAR; POIRIER CC,
2000, E SUPPLY CHAIN USING; PORTER ME, 2001, V79, P62, HARVARD BUS REV;
SALAM AF, 2003, V46, P325, COMMUN ACM; SIRIN E, 2004, P42, IEEE INTELL
SYST APP; STAL M, 2002, V45, P71, COMMUN ACM; WELTY B, 2001, V44, P67,
COMMUN ACM; YANG J, 2000, V43, P39, COMMUN ACM|
TC- 5|
PU- ASSOC COMPUTING MACHINERY|
PI- NEW YORK|
PA- 1515 BROADWAY, NEW YORK, NY 10036 USA|
SN- 0001-0782|
J9- COMMUN ACM| JI- Commun. ACM| PD- JUN|
PY- 2005|
VL- 48|
IS- 6|
BP- 108|
EP- 115| PG- 8|
SC- Computer Science, Hardware & Architecture; Computer Science,
Software
Engineering; Computer Science, Theory & Methods| GA- 929QE|
JN- COMMUNICATIONS OF THE ACM, 2005, V48, N6, P108-115| UT-
ISI:000229360000025 ER ||
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Appendix 2

Identification and definition of Latent e-supply chain design in SSCI

1998-2009 πaπb

1.E-document delivery	Refers to supply chains that use the internet and web technologies for resource sharing predominantly; document access, delivery and management.
2. E-intermediaries (Cybermediaries or Internet-intermediaries)	These can be generally defined as business organizations that occupy an intermediary position in a supply chain between a buyer and a seller and whose business is based on the use of the internet based ICT and web technology, Barnes & Hinton, (2007). These include internet referral-informediaries; different types of web service intermediaries (WSI) for example web services that are reusable software components, web aggregators (web content aggregator) and e-brokers.
3. E-forecasting	The use of the internet and web technologies to improve accuracy of forecasting supply and demand.
4. E-product development	The use of the internet and web technologies (including multi-agent software systems) for all aspects of product design, assembly, implementation, management & development, to support all types of platforms (mass customization, customized, configure-to-order) and stakeholders (customer, supplier etc).
5. E-leagile systems	E-leagile systems refer to e-supply chains that use lean, agile or a combination of both lean and agile principles.
13. E-wireless device systems	These are supply chains that use the internet and web technologies for wireless data network (WDN) systems (Wi-Fi, Wi-Max, Bluetooth, Zigbee etc) including intelligent web models & portable datafile
7. E-scheduling	The use of the internet and web technologies to enhance planning & improve the efficiency of scheduling. These include multi-agent software systems (MAS).
13. E-manufacturing Information systems (E-MIS)	E-MIS refers to the use of the internet and web technologies for global information systems infrastructure in manufacturing supply chains, driven by real-time information, visibility and connectivity.
9. E-portal	An internet and web technology unifying infrastructure that allows a single shared database to coordinate all transaction within, between and among firms and their partners in real-time.
10. E-global quality management	The use of the internet and web technologies for global quality management

11. E-cycling	The use of the internet and web technologies for the management of different aspects of the end-of-life supply chain of products, including product recovery, disassembling & remanufacturing, waste, recycling and spare-parts management, taking into cognizance eco-conscious, green management and other environmental measures.
12. E-security	The use of the internet and web technologies for point-of-sale and web multimedia content distribution security.
13. E-RFID	The use of radio frequency identification with internet and web technologies for the management of supply chains.
14. E-optimization	The use of the internet and web technologies for optimization of supply chain systems.
15. E-modelling of complex & uncertain SC design systems	The use of the internet and web technologies to model complex and uncertain supply chain design systems.
16. E-adoption/ implementation	Refers to research on internet and web technologies usage in supply chain management
17. E-impact	Refers to research that charts the implication of using internet and web technologies in SCM
18. E-performance measurement	The use of the internet and web technologies for performance measurement in supply chains.
19. E-knowledge management	The use of the internet and web technologies to design knowledge management SC systems to access and exploit knowledge.
20. E-contract negotiation	The use of the internet and web technologies to manage contract negotiation.
21. E-intelligent agent systems	Refers to the use of software agents that integrated various technologies through internet and web technologies for decision support capabilities and value-based relationships between SCs in order to improve effectiveness and efficiency.
22. E-CRM	The use of the internet and web technologies for the management of customer and stakeholder relationships.
23. E-music	The use of the internet and web technologies in the music industry SC Environment

Appendix 3

Typology classification of E-SCM (1998-2009)

Category/concepts Article Citation-482

1.E-technology

Technology	Wu et al (2006), Setia et al (2008), Shah & Shin (2007), Patterson (a) (2003), Melville & Ramirez (2008), Khouja & Kumar (2002), Gonzalez-Benito (2007), Power & Simon (2005), Southard & Swenseth (2008), Patterson et al (b) (2004), Anderson (2001), Bodendorf & Zimmermann (2005), Craighead & Laforge (2003), Swaminathan & Tayur (2003), El Sawy et al (1999), Caskey et al (2001), Beck et al (2005), Johnson et al (a) (2007), Lai et al (2007), Johnson et al (b) (2007), Durgin & Sherif (2008), Wagner et al (2003), Soto-Acosta & Merono-cerdan (2008), Cagliano et al (a) (2005), Zhao et al (2008), Geoffrion & Krishnan (2001), Pai & Yeh (2008), Zhu & Kraemer (2005), Tang et al (2004), Archer et al (2008), Croom (b) (2005), Kim & Park (2008), Lang, (2001), Nurmilaakso (2008), Harland et al (2007), Heng et al. (2005), Webster et al. (2006), Cagliano et al (b) (2005), Bi et al (2007), Han et al. (2008), Phan (a) (2003), Phan & Stata (b) (2002), Lee et al (2008), Forman et al (2007), Craighead et al (2006), Bozarth (2006), Subramani (2004), Jutla et al (1999), Emojorho & Adomi (2006), Swafford et al (2006), Gunasekaran & Ngai (2001).
E-integration	Williams et al (2004), Lyons et al (b) (2005), Madhusudan (2004), Gulledge & Sommer (2004), Wang et al (2005), Dotoli et al (b) (2005), Yusuf et al (2004), Mondal & Tiwari (2003), Tarn et al (2002), Fairchild (2005), Lin (2006), Cruz et al (2006), Dotoli et al (c) (2006), Dan et al (2001), Hwang et al (2008), Nissen & Sengupta (2006), Whitte et al (2003), Frohlich (2002), Cho et al (2004), Forster & Regan (2001), Cingil & Dogac (2001), Marincas (2008), Eng (a) (2007), Wang & Zhang (2005), Lai et al (2008), Mitra & Singhal (2008), Lee et al (2007), Grover & Saeed (2007), Ward & Zhou (2006), Zeng & Pathak (2005), Vickery et al (2003), Sommer (2003), Mason et al (2003), Yusuf et al (2004), Liu et al (2005), Danese & Vinelli (2009), Whitworth (2006), Frohlich & Westbrook (2002), Chi et al (2007), Cagliano et al (c) 2006), Johnson & Johnson (a) (2005), Jones et al (2001), Bala & Venkatesh (2007), Malhotra et al (2007), Sarkis & Talluri (2004), Voordijk et al (2006), Da Silveira & Cagliano (2006), Davies & O'Sullivan (1999) Billington et al (2004), Fan et al (2003), Howard et al (2003), Leguizano et al (2003), Siau (2003), Alt & Fleisch (2000), Blackhurst et al (2004), Morley et al (2003), Ghiassi & Spera (2003), Turowski (2002), Tolone (2000), Saeed et al (2005), Kurnia & Johnston (2000), Shin & Leem (2002).
E-collaboration	Nucciarelli & Gastaldi (2008), Fynes et al (2005), Grey et al (2005), Shen et al (2003), Norta & Grefen (2007), Pramatari & Miliotis (2008), Sarkis & Sundarraj (2002), Young et al (1999), Lim et al (2003), Pramatari (2007), Shirodkar & Kemp (2006), Cassivi (2006), Lin & Lin (2004), McLaren et al (2002), Woo et al (2008), Kale et al (2007), Yang et al (2006), EL-Diraby (2006), Liu et al (2006) Lin et al (2006), Field & Meile (2008), Hvolby et al (2007), Im & Rai (2008) Soosay et al (2008), Monczk et al (1998), Croteau et al (2008), Kotabe et al (2007) Leger et al (2006), Howard (2006), Hsu (2005), Grover & Malhotra (2003), Tang et al (2002), Tseng et al (2008), Free (2008), Wagner & Alderdice (2006), Agarwal & Shankar (2003), Kreskinocak & Tayur (2001), Macpherson et al (2005), Samie & Walters (2006), Gossain et al (2004), Chatterjee et al (2006), Paik & Park (2005), Tang et al (2006), Adamides et al (2008), Singh et al (2005), Rabinovichet al (2007), Jain, et al (2009), McIvor & Humphreys (2004) Lin et al (2005), Fein & Jap (1999), Gaonkar & Viswanadham (2005), Howard (2005), Davidrajuh (2003).
E-information sharing	Chan & Chan (2009), Childerhouse et al (a) (2003), Lin et al (2002), Hill & Scudder (2001), Rafaeli & Ravid (2003), Childerhouse et al (b) (2003), Smith et al (2007), Hope (2006), Yao & Dresner (2008), Furst & Schmidt (2001), Lim & Palvia (2001), Rassameethes et al (2000), Cachon & Fisher (2000), Lee et al (2000), Chiu & Chen (2005), Machuca & Barajas (2004), Kobayashi et al (2004), Ahmad & Schroeder (2001), Francis (2008), Hosoda et al (2008), Karkkainen et al (2003), Chen (1998), Gaur et al. (2005), Kim & Umanath (2005), Van der Aalst & Kumar (2003), Stefansson (2002), Raghunathan (a) (1999), Piramuthu (2005), Liu et al (2008), Sanchez & Perez (2005), Raghunathan & Yeh (b) (2001), Straer et al (1999) Raghunathan (c) (2001), Williams & Frolick (2001), Hsieh et al (2006), Klopper (1999), Jayaraman & Baker (2003), Singh at al (2005), Zhang et al (2006), Karaer & Lee (2007), Seal et al (2004), Van Nunen & Zuidwijk (2004), Lee et al (1999), Kelepouris et al (2007), Chow et al.(2007), Zhang & Li (2006), Davies & O'Sullivan (b) (1999), Zhang (2005), Palaneeswaran & Kumaraswamy (2003), Knolmayer & Walser (2000), Sodhi et al. (2008).

2.E-supply chain design (e-SCs or e-SCD)

E-document delivery design	**A**rte (2003), **S**iddiqui (2003), **B**irch & Young (2001), **M**ei & Dinwoodie (2005) **B**urnhill & Law (2005), **S**chulz (2001).
E-intermediaries	**B**arnes & Hinton (2007), **G**hose et al (2007), **d**el Aquila-Obra et al (2007), **T**ang & Cheng (2006), **T**aylor (2003), Zsidisin et al (2000), Clott (2000), Sarkis & Sundaraj (2002), **H**o et al (2003).
E-forecasting	**B**ayraktar et al (2008), **R**aghavan et al (2004), **Z**hang (a) (2006), **Z**hang (b) (2007).
E-product development	**H**umphreys et al (2005), **H**elender & Jiao (2002), **L**ee et al (2003), **J**iao & Helander (2006).
E-leagile design	**B**ruun & Mefford (2004), **B**uzby et al (2002), **R**aisinghani & Meade (2005), **F**aisal et al (2006), **H**olmqvist & Pessi (2006).
E-wireless design	**G**ehlot & Sloane (2006), **S**oroor et al (2009), **M**arsh & Finch (1999), Wamba et al (2008).
E-scheduling design	**Y**ao & Liu (2009), **C**hua et al (2003), Sadeh et al (1998), **G**arcia-Flores & Wang (2002).
E-manufacturing information systems	**S**haw (2000), **C**oronado et al (2004), **C**hryssolouris et al (2004), **L**yons et al (a) (2004)**,** **K**ehoe & Boughton (a) (2001), **K**ehoe & Boughton (b) (2001), **V**aaland & Heide, (2007), Sadeh et al (2001), **S**tevenson & Hendry (2007), Azevedo et al (2004), **X**iong et al (2003).
E-portal design	**B**oyson et al. (2003), **S**ammon & Hanley (2007), **R**ezayat (2000).
E-quality management	Chin et al. (2006), Tang & Lu, (2002). **S**egars et al. (2001), **S**hao et al. (2006).
E-recycle design	**S**pengler & Schroter (2003), **N**agurney & Toyasaki (2005), **G**e & Wang (2007) **H**ammond & Beullens (2007), **Z**ikopoulos & Tagaras (2008), **Z**hu et al. (2008), **L**ee & Klassen (2008), **R**ios & Stuart (2004).
E-security design	**Y**ang et al. (2007), **N**a et al. (2009), Park et al. (2007).
E-RFID design	**B**i & Lin (2009), **G**essner et al. (2007), **Z**hou et al. (2007), **M**ourtzis et al. (2008), **P**rater & Frazier (2005), Curran & Porter (2007), Mehrjerdi (2008).
E- SC Optimization design	**K**otzab et al. (2003), **D**otoli et al. (a) (2007), **L**aval et al. (2005), Luo et al. (2001), **L**in et al. (2006), Yucesan et al (2001).
E-Modelling (design) of complex systems	**G**oul et al. (2005), **R**abelo et al. (2008), Jain et al. (2005), **A**bdel-Malek et al. (2005), **N**agurney & Matsypura I (2005), Blackhurst et al. (2004), Zhang, (2006)
E-contract negotiation design	**Ba**carin et al. (2008), **L**i et al. (2002), Tserng & Lin (2002).
E-Knowledge management	Lin et al. (2002), Cronin (1998), Bassi et al (1998), **M**arfleet & Kelly (1999), **L**i & Chandra (2007), **G**unasekaran & Ngai (a) (2007).
E-performance management	**S**traub et al (2004), **V**anteddu et al (2007), **C**aputo et al. (a) (2004), **R**einer (2005), Arns et al (2002), **G**ulledge & Chavusholu (2008), **C**aputo et al. (b) (2005) Ho et al (2005), Tang (2004).
E-intelligent agent design systems	**K**umar (2003), **L**o et al (2008), Bandyopadhyah et al (2008).
E-CRM design systems	**R**oss (2005), **T**an et al (2002), **R**eichman (2002), Gianni & Franceschini (2003) **S**heth et al (2000).
E-music design	**H**ardaker & Graham (2008), **G**raham et al (2004), **L**ewis et al (2005).

E-Commerce Design systems	Abukhader & Jonson (2004), Angeles (2007), Anna et al (2005), Ayanso et al (2006), Bakker et al (2008), Leonard & Davies (2006), Barsauskas et al (2008), Bernstein et al (2008), Boyer & Frohlich (d) (2006), Boyer & Hult (b) (2005), Boyer & Hult (c) (2006), Bunduchi (2008), Cattani et al (2006), Chen et al (2008), Chiang & Monahan (b) (2005), Chiang et al (a) (2003), Hovelaque et al (2007), Naim (2006), Kull et al (2007), Kurnia & Johnston (2003), Leonard & Cronan (a) (2002), Liu & Zhang (2007), Mahar et al (2009), Mollenkopf et al (2007),Yao et al (2008), Del-Aguila et al (2003), Rabinovich et al (a) (2003), Rabinovich et al (b) (2008), Yang et al (2004), Randall et al (2006), Seifert et al (2006), Spring & Sweeting (2002), Tsay & Agrawal (2004), Wilhelm et al (2005), Straub & Watson (2001), Murillo (2001), **P**louffe et al (2001).
E-Logistics Design systems	**K**umar & Putnam (2008), **K**rmac (2007), **F**ulconis et al (2007), Wong et al (2006), **R**utner et al (2003), **G**imenez et al (2008), **L**awrence (1999), Tang et al (2007), **B**uyukozkan et al (2008), **W**ang et al (1) (2007), **S**arkis et al (2004), James et al (2004), **B**ottani & Rizzi (2008), Dong et al (2007), **C**arter et al (a) (2005),Bendoley et al (2007), Mudambi & Aggarwal (2003), Sparks & Wagner (2003), Thirumalai & Sinha (2005), Bailey & Rabinovich (2005), Robinson et al (2005) Alptekinoglu & Tang (2005), Yang et al (2006), **L**ewis (2001), Guide et al (2005), Kapuscinski et al (2004), **C**arter et al (b) (2004), Boyd et al (2003), Keene et al (2006), Rabinovich (c) (2007), Lancioni (b) (2005), Katok & Roth (2004), **J**ang et al (2006), **G**raves & Williams (2008), Ravulapati et al (2004), Wang et al (2) (2007), **H**erer et al (2002).
E- Procurement design system	**P**uschmann (2005), **B**enslimane et al (2007), **M**in & Galle (1999), Tan et al. (2007), **P**anayiotou et al (2004), **G**arrido et al (2008),**W**alker & Harland (2008), **G**unasekaran & Ngai (b) (2008), **S**iefert et al (2004), **A**ngeles & Nath (2007), **C**arter & Stevens (c) (2007), **N**agali et al (2008), **O**rdanini & Rubera (2008), **T**assabehji et al (2006), **B**haradwaj (2004), **C**room (a) (2001), **A**ttaran (2001), **D**avid et al (2002), Boyer & Olsen (2002), **X**u et al (2007), **R**osenbloom (2007), **H**artley et al (b) (2004), Aron et al (2008), Hsiao (2007), **S**amiee (b) (2008), Bao et al (2007), Gattiker et al (2007), Tunca & Zenios (2006), Fu et al (2006), Hazra & Mahadeven, (2006), Arunachalam & Sadeh (2005), Ghose et al (2005), Wu & Kleindorfer (2005), **W**ang & Benaroch (2004), Humphreys et al (2006), Parente et al. (2004), Hazra et al (2004), **C**hristiansen et al (2004), **T**ruong (2008), **E**ng (b) (2004), Mahadevan (2003), Bichler et al (2002), Tumolo (2001), Olson & Boyer (2003), Dai et al (2005), Nair (2005), Smart (2005), **D**ai & Kauffman (2002), **B**uyukozkan (b) (2004), **A**igbedo & Tanniru (2004), Martinsons (2008), **R**oar et al (2007), **P**earcy & Giunipero (2008), **M**ithas & Jones (2007), Cullen & Webster (2007), **B**uyukozkan (c) (2004), **M**eixell (2006), **N**issen (2006).
Adoption & implementation of e-supply chain design	**F**olinas et al (2004), **P**ant et al (2003), **Y**en et al (2004), **N**guyen & Harrison (2004) **S**herer (2005), **C**hen et al (2004), **N**gai et al (2004), Koh et al (2007), **S**oliman & Janz (2004), Overby & Min, (2003),Gregory et al. (2007).
Impact of e-supply chain design	**L**ankford (2004), **H**ausen et al (2006), **S**odhi (2001), **L**ancioni et al (a) (2000), **M**artin et al (2008), **Q**uayle (2003), **M**attsson (2003), **R**oethlein et al (2008), Keil et al (2001), Mottola et al. (1999), **R**ahman (a) (2003), Rahman et al (b) (2003).

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Appendix 4

List of quantitized e-supply design with total articles and percentage intensity effect, with classified e-SCD in italics πaπbπcπd

Concept No.	e-Supply Chain Design	Total Articles	Percentage Intensity Effect Size
1.	E-commerce	37	14%
2.	E-procurement	58	22%
3.	E-logistics	37	14%
4.	*E-document delivery*	*6*	*2.2%*
5.	*E-intermediaries*	*9*	*3.3%*
6.	*E-forecasting*	*4*	*1.5%*
7.	*E-product development*	*4*	*1.5%*
8.	*E-leagile design*	*5*	*1.8%*
9.	*E-wireless design*	*4*	*1.5%*
10.	*E-scheduling*	*4*	*1.5%*
11.	*E-manufacturing systems*	*11*	*4%*
12.	*E-porta*	*3*	*1.1%*
13.	*E-quality management*	*4*	*1.5%*
14.	*E-recycling design*	*8*	*3%*
15.	*E-security design*	*3*	*1.1%*
16.	*E-RFID design*	*7*	*2.6%*
17.	*E-optimization design*	*6*	*2.2%*
18.	*E-modelling of complex SC design*	*7*	*2.6%*
19.	*E-contract negotiation*	*3*	*1.1%*
20.	*E-knowledge management*	*6*	*2.6%*
21.	*E-adoption/implementation*	*11*	*4.1%*
22.	*E-impact*	*12*	*4.5%*
23.	*E-performance management*	*6*	*2.6%*
24.	*E-intelligent agent design*	*2*	*0.7 %*
25.	*E-CRM design*	*5*	*1.8%*
26.	*E-music design systems*	*3*	*1.1%*
Total		265	100%

Appendix 5
Analysis of articles for themes in Technology

Technology	Themes (SCM achievement)	References
SCMS, advance planning Systems alignment exploration & exploitation	integration, information exchange, collaboration	Wu et al (2006), Subramani (2004), Setia et al (2008).
IOS, IS / Related resources	integration, collaboration, information flow	Shah & Shin (2007), Khouja & Kumar (2002), Gonzalez-Benito (2007), Patterson (a) (2003) Pai & Yeh (2008), Zhao et al (2008), Han et al (2008).
VMI, ERP, EDI, VPN LAN, internet, computers	information requirement, integration, collaboration	Southard & Swenseth (2008), Lee et al (2008), Bozarth (2006), Emojorho & Adoni (2006), Anderson (2001), Power & Simon (2005), Melville & Ramirez (2008), Patterson et al (b) (2004), Craighead & Laforge (2003), Craighead et a l(2006).
Infocom, digital devices Internet technologies IT architecture	integration, collaboration, information sharing	Lang (2001), Swafford et al (2006).
Internet/web & software agents, information systems	integration, collaboration, virtual exchange of information	Bi et al (2007), Durgin & Sherif (2008), Bodendorf & Zimmermann (2005).
Internet, e-networks Information networks	integration, collaboration, information visibility/sharing	Heng et al (2005), Wagner et al (2003), Webster et al (2006), Forman (2007).
e-enterprise architecture e-IOS, internet/web tools	integration, collaboration, information sharing	El Sawy et al (1999), Croom (b) (2005), Cagliano et al (a) (2005), Cagliano et al (b) (2005).
E-solution/applications E-business technologies	integration, collaboration, information sharing	Johnson et al (a) (2007), Johnson et al (b) (2007), Harland et al (2007), Archer et al (2008).
Internet/web infrastructure Migration from EDI to Internet/web, e-medium Systems	integration, collaboration, information sharing	Swaminathan & Tayur (2003), Lai et al (2007), Tang et al (2004), Zhu & Kraemer (2005), Soto-Acosta & Merono-Cerdan (2008), Geoffrion & Krishnan (2001), Nurmilaakso (2008), Phan & Strata (b) (2002), Phan (a) (2003), Kim & Park (2008), Beck et al (2005).
Internet/web database servers Distributed computing software E-commerce technology infrastructure	information sharing, integration, collaboration	Gunasekaran et al (2001), Jutla et al (1999), Casket et al (2001).

Appendix 6

Level of interest depicting the multi-disciplinary and complex nature of e-SCM

1	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
2	INTERNATIONAL JOURNAL OF FLEXIBLE MANUFACTURING SYSTEMS
3	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
4	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
5	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
6	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
7	EXPERT SYSTEMS WITH APPLICATIONS
8	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
9	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
10	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
11	IEEE TRANSACTIONS ON SYSTEMS MAN AND CYBERNETICS PART A-SYSTEMS AND HUMANS
12	INFORMATION SYSTEMS MANAGEMENT
13	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
14	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
15	INTERNATIONAL JOURNAL OF INFORMATION TECHNOLOGY & DECISION MAKING
16	INFORMATION SYSTEMS MANAGEMENT
17	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
18	PRODUCTION PLANNING & CONTROL
19	JOURNAL OF INFORMATION TECHNOLOGY
20	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
21	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
22	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
23	TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW
24	IEEE-ASME TRANSACTIONS ON MECHATRONICS
25	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
26	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
27	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
28	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
29	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
30	EXPERT SYSTEMS WITH APPLICATIONS
31	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
32	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
33	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
34	INFORMATION SYSTEMS MANAGEMENT
35	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
36	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
37	INFORMATION SYSTEMS MANAGEMENT
38	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
39	PRODUCTION PLANNING & CONTROL
40	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
41	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
42	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
43	TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW
44	IEEE-ASME TRANSACTIONS ON MECHATRONICS
45	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
46	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
47	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
48	INFORMATION SYSTEMS MANAGEMENT
49	INFORMATION SYSTEMS MANAGEMENT
50	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
51	INTERNATIONAL JOURNAL OF FLEXIBLE MANUFACTURING SYSTEMS

52	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
53	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
54	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
55	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
56	EXPERT SYSTEMS WITH APPLICATIONS
57	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
58	INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY
59	INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING
60	JOURNAL OF INTELLIGENT MANUFACTURING
61	IEEE TRANSACTIONS ON SYSTEMS MAN AND CYBERNETICS PART A-SYSTEMS AND HUMANS
62	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
63	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
64	INFORMATION SYSTEMS MANAGEMENT
65	COMMUNICATIONS OF THE ACM
66	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
67	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
68	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
69	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
70	INTERNATIONAL JOURNAL OF INFORMATION TECHNOLOGY & DECISION MAKING
71	INFORMATION SYSTEMS MANAGEMENT
72	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
73	PRODUCTION PLANNING & CONTROL
74	JOURNAL OF INFORMATION TECHNOLOGY
75	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
76	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
77	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
78	INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT
79	TRANSPORTATION RESEARCH PART E-LOGISTICS AND TRANSPORTATION REVIEW
80	IEEE-ASME TRANSACTIONS ON MECHATRONICS
81	JOURNAL OF SYSTEMS SCIENCE AND SYSTEMS ENGINEERING
82	EXPERT SYSTEMS WITH APPLICATIONS
83	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
84	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
85	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
86	INDUSTRIAL MARKETING MANAGEMENT
87	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
88	JOURNAL OF OPERATIONS MANAGEMENT
89	INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING
90	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
91	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
92	JOURNAL OF MANAGEMENT STUDIES
93	PRODUCTION PLANNING & CONTROL
94	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
95	DECISION SCIENCES
96	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT
97	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
98	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
99	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
100	MIT SLOAN MANAGEMENT REVIEW
101	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
102	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
103	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
104	M&SOM-MANUFACTURING & SERVICE OPERATIONS MANAGEMENT
105	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
106	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
107	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT

108	INTERFACES
109	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
110	PRODUCTION AND OPERATIONS MANAGEMENT
111	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
112	PRODUCTION PLANNING & CONTROL
113	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
114	PRODUCTION PLANNING & CONTROL
115	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
116	INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
117	HARVARD BUSINESS REVIEW
118	HARVARD BUSINESS REVIEW
119	JOURNAL OF MANAGEMENT INFORMATION SYSTEMS
120	PRODUCTION PLANNING & CONTROL
121	OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE
122	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
123	PRODUCTION PLANNING & CONTROL
124	OR SPECTRUM
125	RESEARCH POLICY
126	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT
127	OR SPECTRUM
128	JOURNAL OF OPERATIONS MANAGEMENT
129	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT
130	R & D MANAGEMENT
131	JOURNAL OF OPERATIONS MANAGEMENT
132	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
133	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT
134	INTERNATIONAL JOURNAL OF FLEXIBLE MANUFACTURING SYSTEMS
135	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS
136	DECISION SCIENCES
137	OMEGA-INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE
138	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
139	RELIABILITY ENGINEERING & SYSTEM SAFETY
140	RESEARCH IN ENGINEERING DESIGN
141	IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
142	SUPPLY CHAIN MANAGEMENT-AN INTERNATIONAL JOURNAL
143	INDUSTRIAL MANAGEMENT & DATA SYSTEMS
144	IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
145	IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
146	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
147	IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
148	GROUP DECISION AND NEGOTIATION
149	INTECH

Appendix 7

Abbreviations

1. SC – supply chain
2. SCM – supply chain management
3. E-SCM – electronic supply chain management
4. E-SC – electronic supply chain
5. E-SCD – electronic supply chain design
6. E-DD – (electronic)internet/web document delivery SC design systems
7. E-Intermediaries – (electronic) internet/web SC intermediaries
8. E-Forecasting – (electronic) internet/web forecasting SC design systems
9. E-PD – (electronic) internet/web product development SC design systems
10. E-Leagile Systems – (electronic) internet/web lean/agile SC design systems
11. E-Wireless systems – (electronic) internet/web wireless SC design systems
12. E-Scheduling – (electronic) internet/web SC scheduling design systems
13. E-MIS – internet/web manufacturing SC information systems
14. E-Portal – (electronic) internet/web portal SC design systems
15. E-GQM – (electronic) internet/web global quality management SC design systems
16. E-Recycling (electronic) internet/web recycling SC design systems
17. E-Security – (electronic) internet/web security design systems
18. E-RFID – (electronic) internet/web radio frequency identification design systems
19. E-Optimization – (electronic) internet/web SC optimization design systems
20. E-PM – (electronic) internet/web performance management design systems
21. E-CRM – (electronic) internet/web customer relationship management systems
22. E-KM – (electronic) internet/web knowledge management design systems
23. E-CN – (electronic) internet/web contract negotiation design systems
24. E-Music – (electronic) internet/web music SC systems
25. E-MCS – (electronic) internet/web 219odeling219 of complex SC design systems
26. E-Intelligent systems – (electronic) internet/web intelligent SC design systems
27. E-A/I – (electronic) internet/web SC adoption & implementation
28. E-I – (electronic) impact of internet/web supply chains
29. EDI – electronic data interchange
30. B2b – business-to-business
31. IS – information systems
32. IT – information technology
33. CRP – customer relationship planning
34. VMI – vendor management infrastructure
35. Kanban – A Japanese manufacturing system to regulate supply
37. EU – European Union

Appendix 8
Sample of technology sub-component development

TECHNOLOGY	Use of technology in SCs	1. Components	***Origination*** Q. Authority re	a. Participants/ articles	b. Litreature	c. Interpretive	d. investigative	e. program	***b. Verification***	Q. On what grounds?	a. Rational	b. referential	c. Empirical	d. external	e. technical	f. participatory	***c. Normination***	Q. Source used to ID category	a. Paricipants/articles	b. Litreature	c. interpretive	d. investigative	e. program	**2. Temporal designation**	a. Apriori	b. Apostiriori	c. Iterative
51																											
		1		x	x						x	x							x	x							x
		2		x	x						x	x							x	x							x
		3		x	x						x	x							x	x							x
		4		x	x						x	x							x	x							x
		5		x	x						x	x							x	x							x
		6		x	x						x	x							x	x							x
		7		x	x						x	x							x	x							x
		8		x	x						x	x							x	x							x
		9		x	x						x	x							x	x							x
		10		x	x						x	x							x	x							x
		11		x	x						x	x							x	x							x
		12		x	x						x	x							x	x							x
		13		x	x						x	x							x	x							x
		14		x	x						x	x							x	x							x
		15		x	x						x	x							x	x							x
		16		x	x						x	x							x	x							x
		12		x	x						x	x							x	x							x
		13		x	x						x	x							x	x							x
		14		x	x						x	x							x	x							x
		15		x	x						x	x							x	x							x
		16		x	x						x	x							x	x							x
		17		x	x						x	x							x	x							x
		18		x	x						x	x							x	x							x
		19		x	x						x	x							x	x							x
		20		x	x						x	x							x	x							x
		21		x	x						x	x							x	x							x
		22		x	x						x	x							x	x							x
		23		x	x						x	x							x	x							x
		24		x	x						x	x							x	x							x
		25		x	x						x	x							x	x							x
		26		x	x						x	x							x	x							x
		27		x	x						x	x							x	x							x
		28		x	x						x	x							x	x							x
		29		x	x						x	x							x	x							x
		30		x	x						x	x							x	x							x
		31		x	x						x	x							x	x							x
		32		x	x						x	x							x	x							x
		33		x	x						x	x							x	x							x
		34		x	x						x	x							x	x							x
		35		x	x						x	x							x	x							x
		36		x	x						x	x							x	x							x
		37		x	x						x	x							x	x							x
		38		x	x						x	x							x	x							x
		39		x	x						x	x							x	x							x
		40		x	x						x	x							x	x							x
		41		x	x						x	x							x	x							x
		42		x	x						x	x							x	x							x
		43		x	x						x	x							x	x							x
		44		x	x						x	x							x	x							x
		45		x	x						x	x							x	x							x
		46		x	x						x	x							x	x							x
		47		x	x						x	x							x	x							x
		48		x	x						x	x							x	x							x
		49		x	x						x	x							x	x							x
		50		x	x						x	x							x	x							x
		51		x	x						x	x							x	x							x

Appendix 9

Number of hit per keyword search term from bibliometric survey

Keyword Search term	Number of Hits
e-supply	28
e-supply chains	17
e-supply chain management	24
e-supply chain strategy	8
e-supply chain AND management	23
Electronic supply chain	283
e-collaboration	13
e-supply chain collaboration	3
e-supply chain integration	9
Internet supply management	210
IT-enabled supply chains	32
IT-enabled supply chain management	64
Total	714

Appendix 10

Definition of Data Codes and Categories from current study

The entire sample was coded and defined based our category component matrix

1 OPEN CODE THEMES

A. E-business – regarded as the use of internet and web technology in SCs.
B. E-integration – the use of internet/web technology to integrate supply chains.
C. E-collaboration – the use of internet/web technology to collaborate in supply chains.
D. E-information sharing – the use of internet/web technology for information sharing in supply chains.
E. E-technology – the use of internet/web technology in supply chains for integration, collaboration and/or information sharing.
F. E-commerce – the use of internet/web technology in retailing.
G. E-logistics – the use of internet/web technology for logistics activities.
H. E-procurement – implies the use of internet/web technology in all forms of b2b buying and selling including e-marketplaces, procurement and b2c.
I. Unknown/latent – articles that could not be categorize/code based on all the above including the literature.

2. SELECTIVE CODING OF THEMES AND CATEGORIES

A. Category = E-Technology – '*the use of internet and web technologies in supply chains for e-integration, e-collaboration and e-information sharing in order to achieve high productivity and increased efficiency'.*

   Themes

   - E-integration – '*the use of internet & web technologies for supply chain integration in order to achieve high efficiency and increased productivity'*.

   - E-collaboration – '*the use of internet and web technologies to collaborate in supply chains in order to achieve high efficiency and increased productivity'*.

   - E-information sharing – *'the use of internet and web technologies for information sharing in supply chains in order to achieve high productivity and increased efficiency'.*

   - Technology – '*the use of technology to achieve integration, collaboration and information sharing in supply chains for high efficiency and increased productivity'*.

B. Category = E-Supply Chain Designs – ‘*the use of internet & web technology (or e-technology) to configure or design specific supply chains (or e-supply chains) for e-collaboration, e-integration and e-information sharing in order to achieve high productivity and increased efficiency’*.

Themes/specific design identified

- E-Commerce – ‘the use of internet technologies for retail web–based sale’.
- E-Logistics – ‘the use of internet technologies to automate logistics services’.
- E-Procurement – ‘the use of the internet to automate procurement processes.
- Latent category – articles which cannot be readily categorize or coded based on the above descriptions.

3. Content Analysis of Latent Themes/Category

Identified Themes

1. E-Document Delivery System– defined as an e-supply chain designed for resource sharing, predominantly for document access, delivery and management.
2. E-Intermediaries – defined as specialized e-supply chains that occupy an intermediate position between a buyer and a seller. These include cyber-mediaries, internet referral-info-mediaries, web service intermediaries and web aggregators. These are all specialized e-supply chains.
3. E-Forecasting – defined as an e-supply chain designed to forecast supply and demand for improved accuracy and efficiency.
4. E-Product Development – defined as an e-supply chain designed for all aspects of product design, assembly, implementation, management and development to support all types of platforms and stakeholders. Examples includes, mass customization, customized and configure-to-order.
5. E-Leagile Systems – defined as an e-supply chain that use lean, agile or a combination of both lean and agile principles.
6. E-Wireless Device System – These are e-supply chains designed for wireless data network (WDN) system (Wi-Fi, Wi-Max, Bluetooth, Zigbee etc.), including intelligent web models & portable datafile technology.
7. E-Scheduling System– defined as an e-supply chain designed to improved and enhance the efficiency of scheduling, including multi-agent software systems (MAS).
8. E-Manufacturing Information System (EMIS) – Defined as an e-supply chain for global manufacturing information infrastructure, which are driven by real-time information, visibility (collaboration) and connectivity.
9. E-Portal – defined as an e-supply chain that provides a unifying infrastructure and a single shared database to coordinate all transaction within, between and among firms and their partners in real-time.
10. E-Quality Management System– defined as an e-supply chain designed for global quality management.

11. E-Recycling – defined as an e-supply chain designed for the management of different aspects of product's end-of-life, including product recovery, disassembling & remanufacturing, waste, recycling & spare parts management, taking into cognizance eco-conscious, green management and other environmental measures.
12. E-Security – defined as an e-supply-chain designed for point-of-sale and web multi-media content distribution security.
13. E-RFID – defined as an e-supply chain designed with radio frequency identification and internet/web technology.
14. E-Optimization Systems – defined as e-supply chains that optimize systems for high efficiency and productivity.
15. E-Modelling of Complex & Uncertain Systems – defined as the modeling of complex and uncertain e-supply chain systems.
16. E-Performance Management System – defined as e-supply chain designed to manage performance management.
17. E-Knowledge Management – defined as an e-supply chain designed to access & exploit knowledge.
18. E-Contract Negotiation – defined as an e-supply chain designed to manage contracts & negotiations.
19. E-Intelligent Agent Systems – defined as an e-supply chain designed with software agents for decision support capabilities and value-based relationships for improved effectiveness and efficiency.
20. E-CRM – defined as an e-supply chain designed for the management of customer and stakeholder relationships.
21. E-Music – defined as an e-supply chain designed for music industry environment.
22. E-Adoption & Implementation – defined as research of e-supply chain adoption, usage and implementation.
23. E-Impact- defined as the implication and impact of e-supply chains.

Appendix 11 & 12 details a systematic documentation matrix of this coding system.

Appendix 11

A Category Development Matrix

A Category Development Matrix was created (adopted from Constas, 1992) to document the detail process of coded themes, category and content analysis from field notes. This matrix provided a comprehensive, rigorous, defensible and analytic template that described various activities performed in our coded theme and content analysis.

The matrix is composed of 2 domains which identify actions associated with categorization. The first domain is called components of categorization and the second domain is called temporal designation. The first domain identifies three specific set of actions or procedures associated with developing categories. The first procedure is Origination. It identifies the bases of category construction. This procedure asks the question, 'where does the responsibility or authority for creating this category reside? There are five bases of origination; these are, article, program, investigative, literature and interpretative. The second procedure is Verification. Verification details the strategy used to support the creation and application of a category. This element asks the question, 'On what grounds can the creation of this category be justified? There are six bases of verification; external, rational, referential, empirical, technical and participative. The third procedure for developing a category is Nomination. It concerns the naming of a category. This element asks the question, 'What is the source of a name used to identify a given category? Again, this follows five elements or actions; program, article, investigative, literature and interpretative. See appendix 12 for a description and definition of each procedure and element. It is important to note that although the elements of nomination are identical to those under the origination component, they deserve a separate attention because names used to describe categories are not neutral descriptors. They invoke power and often establish real or illusory impression of knowledge and certainty.

The second domain is called Temporal Designation and addresses the question 'At what point during the research process were categories specified? Categories may be created, a priori or before the data was collected; a posteriori or after data was collected or iteratively, that is at various points during the research process, Constas, (1992).

Appendix 12

Components of categorization

Origination

Question: Where does the responsibility/authority for the creation of this category lies?
1. Article/s – refers to the views and opinions of the participants i.e., expressed in the article/s.
2. Program – refers to set of goals/objectives of a program (in the case of program evaluation).
3. Investigative – personal interests, views or intellectual construction of researcher for analysis.
4. Literature – derived from statements/conclusions found in wider literature of other researchers who have investigated similar phenomenon.
5. Interpretative – inductive qualitative analytic method based on organization of data into coded themes and categories.

Verification

Question: On what grounds can one justify these categories?
1. External – refers to a panel of experts outside of the study who verifies categories.
2. Rational – refers to logic and reasoning that reflect some functional consistency or hierarchical relationship. Or face validity.
3. Referential – refers to use of existing research findings or theoretical arguments.
4. Empirical – accomplished internally, examines coverage and distinctiveness reflected by categories.
5. Technical – borrows procedures/language from the quantitative orientation to answer the verification question e.g. inter-rater reliability checks) to substantiate a given theme or category.
6. Participatory – requires the researcher to provide participants or in this case, authors of article/s, the opportunity to review and/or modify categories selected.

Nomination

Question: what is the source of the name used to identify this category
1. Program – refers to names directly from programmatic objectives.
2. Articles – as a source of nomination or “in vivo codes”.
3. Investigative – assigning of names by the investigator based on subordinate abstractions that portrays the essence of a given class of phenomena.
4. Literature – derived from existing theories or appropriate body of literature.
5. Interpretative – inductive qualitative analytic method based on organization of data into coded themes and categories.

Temporal Designation

Question: At what point during the research process were categories specified?
1. A priori or before the data are actually collected.
2. A posteriori or after the data have been collected.
3. Iterative or at various points during the research process.

Adopted from Constas 1992.

Appendix 13

Longitudinal timeline of current study