

An Overview of ICT Tools for Supply Chain Management

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1. Introduction

Rapid technology advances and dynamic market forces have altered the business landscape as also fundamentally altered existing business models. Information and Communication Technology (ICT) usage and deployment has opened the doors for companies to compete in any marketplace. Even companies, which have been benefiting from protectionist policies by governments, are now exposed to the perils of increased competition due to liberalization, privatization, pricing pressures and globalization. This challenging and dynamic business environment is popularly referred to as VUCA short for Volatility, Uncertainty, Complexity and Ambiguity. Information sharing between partners in the supply chain is also crucial and these integration attempts are accompanied by ICT initiatives. Such ICT initiatives include:

- Use of bar-coding in logistics systems
- Use of EDI to communicate between branches
- Use of Material requirements planning
- Enterprise Solutions like ERP
- Internet and web services for communication between partners

Early studies on the impact of Electronic Data Interchange (EDI) on Just-in-Time (JIT) shipments in the automobile industry showed significant earnings with lowered shipment errors. Researchers have pointed out that it is necessary to develop a supply chain-wide technology strategy that supports multiple levels of decision-making and gives a clear view of the flow of products, services, and information. An interesting and inclusive attempt to outline the wide impact of ICT in SCM is the definition of functional roles of ICT outlined as follows:

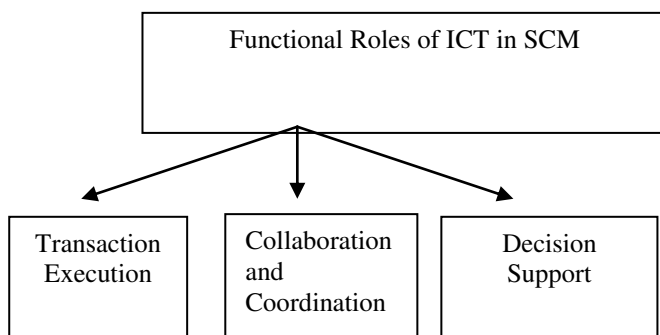


Fig. 1: Functional Roles of ICT in SCM

2. Benefits of ICT Deployment for SCM

Many of the buzz words in SCM such as Vendor Managed Inventory, Point of Sale, Collaborative Planning, Forecasting and Replenishment and ERP stem from ICT usage. ICT tools are great enablers, enhancers, levelers and facilitators of enterprise operations and thereby have become a determinant of competitive advantage for enterprises. Fundamental changes have occurred in today's global economy. These changes alter the relationship that we have with our stakeholders, our customers, our suppliers, our channel partners, and our internal operations. ICT deployment for SCM results in a shift from the linkage between physical processes such as inventory, warehouse or shipping to information-based processes across supply chain operations. ICT advances generate new opportunities when suppliers, business partners and customers work together to co-create and co-produce value.

ICT deployment significantly improves supply chain process integration, which leads to better enterprise performance. Improving buyer-supplier relationships and accessing actionable knowledge in a suitable manner as also managing dialogue and coordination among various stakeholders are other benefits. This greatly increases the ability of the enterprise to respond to market dynamics. Seamless access to the information as also the visibility and transparency of the information increases the efficiency of different supply chain processes.

Deployment of ICT for various processes can bring about spectacular improvements in efficiency. Auto-ID technologies such as bar coding and RFID have rendered inventory management effective and brought about inventory visibility and transparency, transportation management systems have optimized routes for shippers; Internet-enabled services have brought about better communication, collaboration and dialogue among various stakeholders. Other benefits outlined by

researchers include cost savings; improved operational efficiency, inventory visibility & control; quality, reliability & accuracy of information; improved communication, collaboration & customer-connect and innovation & differentiation of products or services.

According to a study published in Harvard Business Review, ICT deployment in SCM helps enterprises achieve competitive advantage through improvement in adaptation, alignment and agility in their supply chains. Information technologies and information sharing are also described as key constructs to achieving supply chain integration. ICT competences are likely to improve an organization's ability to innovate and respond to customer requirements. In other words, ICT impacts all 4Rs of the supply chain namely responsiveness, reliability, resilience and relationships.

ICT can also be classified as ICT advances and ICT alignment. ICT advancement measures the extent to which a firm applies the state-of-the-art technology to augment its supply chain capabilities while ICT alignment reflects a firm's strategic emphasis in coordinating and integrating its own IT with that of its supply chain partners.

3. ICT value-add for enterprises

In 1994, an early study done on 193 automobile suppliers with respect to EDI usage for Just in Time shipments demonstrated encouraging outcomes. EDI application dramatically brought a reduction in the shipment errors thereby bringing about substantial savings for the EDI-enabled enterprises. Cisco estimated savings of US \$500 million leveraging web-services for its supply chain integration. Major suppliers of Wal-Mart such as Proctor & Gamble (P&G) have direct access to Point of Sale (POS) information from Wal-Mart retail outlets. By migrating placing of orders to an online application, Intel could eliminate hundreds of order clerk positions. Celestica, one of the world's largest electronic manufacturing services companies, has applied a web-based ICT tool to manage its network of suppliers across the globe. Thereby, the company could improve its customer-responsiveness, primarily helping its customer, Dell to maintain its delivery promise to end-users. Motorola used collaborative planning forecasting and replenishment tools and dramatically improved their supply chain visibility by ensuring that shelves are fully stocked and inventory levels are reduced. Seven-Eleven Japan used 70,000 interconnected Point-of-Sale (POS) terminals in stores, and computers at headquarters and supplier sites to capture real-time information and to track inventory so as to achieve greater supply chain transparency, enabling store owners to strategically stock and price items thus changing the nature of retailing in Japan

4. Overview of ICT tools for SCM

Several ICT tools are well-entrenched and widely deployed in the supply chain context. These include:

- Electronic Data Interchange (EDI)
- Bar coding and Scanner
- Enterprise Resource Planning (ERP) Systems
- Warehouse, Transportation and Inventory Management Systems

However several ICT tools for SCM are not widely deployed. We refer to them as fast emerging ICT tools. Emerging ICT tools like software agents, RFID, web services, electronic commerce, cloud computing, social media, mobile technologies, high performance computing, business analytics and decision support systems hold tremendous promise for improving supply chain performance and integration. These tools are being deployed to aid various operations for supply chain planning and execution. The rapid adoption of the Internet for communication with all stakeholders seems to reflect the potential of the new-age communication media. The impact of various emerging tools and their application domains in SCM are listed as follows:

- **RFID:** RFID enables managers to capture and deliver information necessary to make good decisions. This Auto-ID technology offers businesses increased supply chain and inventory visibility for greater operational efficiency, better tracking of transportation and warehouse channels with reduced inventory. RFID is widely being deployed for various SCM processes like inventory management, asset tracking, VMI, demand shaping, production workflow and customer relationship management. RFID is now very popular in retail establishments all over the world.
- **Decision Support Systems (DSS):** Supply chain partners increasingly have to resolve conflicts among themselves in the face of extreme cut-throat competition. Decision Support Systems (DSS) is a potent tool that can be deployed for conflict-resolution in such situations and also designed to provide analysis and comprehension of complex supply chains effectively. DSS are being used to IT-enable strategic supply chain activities like inventory & transportation management, capacity & demand planning, production & distribution planning and sales forecasting.
- **Software Agents:** A decentralized approach to SCM using software agents has the benefit of solving the tasks by various participants in the supply chain network through their local intelligence and problem-solving paradigms. Using agent-based technologies, suppliers and manufacturers can negotiate through interaction mechanisms and

distribute various activities in a decentralized manner more efficiently. Software agents have made inroads in various activities of the supply chain like production planning, production monitoring, workflow modeling, negotiation, logistics, scheduling and transportation management.

- **Cloud Computing:** Cloud computing and associated technologies like virtualization, and software as a service is touted as the next 'big' thing and game changer for enterprises. With several enterprises off shoring their manufacturing and service operations to low-cost hubs in Asia with poor infrastructure and transportation networks, visibility has become a major challenge. Cloud computing can integrate all partners in this increasingly global extended supply chain into an online social network like community with real-time information on all elements in the supply chain. Several solutions are now available and many enterprises have made the shift with good results. Application areas where cloud-based solutions are available include demand forecasting, demand planning, e-procurement, distribution, inventory, warehouse and transportation systems.
- **Web Services:** Web services are application interfaces accessible via Internet standards that use XML and that employ at least one of the following standards: Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) or Universal Description, Discovery and Integration (UDDI). These standards, and the next-generation standards that are being built on them, are defining the way that forward-thinking enterprises manage lightweight integration tasks. To fulfill orders, the retailer has to manage stock levels in warehouses. The stock re-ordering and replenishment are automated using web services to spectacular results.
- **Business Analytics:** Business analytics aims at building fresh perspectives and new insights into business performance using data, statistical methods, quantitative analysis and predictive modeling. Advanced analytics is being employed for several processes in supply chain planning and execution like demand forecasting, inventory management, production & distribution in planning.
- **High Performance Computing:** High Performance Computing (HPC) systems bring additional benefits of scalability, integration, portability, processing power, storage and interoperability for SCM. Mega corporations and retail giants like Wal-Mart and Pratt & Whitney have deployed HPC for SCM and thereby achieved efficient and effective data administration and analysis.
- **SMAC stack:** An integration of disruptive and game-changing technologies in the form of the SMAC - Social, Mobile, Analytics and Cloud stack promises to be the next wave in enterprise computing. By 2020, IDC estimates that ICT spending worldwide could touch US\$5 trillion mark with fourth-fifth of this driven by the SMAC stack, which is the seamless intersection of the SMAC technologies. Technologies within SMAC complement each other and combined together deliver a force-multiplier effect to transform supply chains into value chains. The resultant value chain would boast of the advantages of robustness, agility, responsiveness, scalability, transparency and visibility. Mobile technologies and cloud computing can easily integrate diverse hardware and storage devices. Social media can facilitate instant dialogue collaboration. Business Analytics provide dashboards after mining the enterprise Big Data available through several sources. SMAC technologies can be easily accessed by all with the recent trend of enterprises encouraging their employees to Bring Your Own Device (BYOD). Various application areas of SMAC stack in SCM could include inventory management, supply chain planning & execution, optimal use of legacy applications, collaboration and customer engagement.
- **Industry 4.0:** This is a recent buzz word given to the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, Internet of things (IoT), robotics, Artificial Intelligence (AI), machine learning, 3D printing and cloud computing and is popularly referred to as the fourth industrial revolution. Industry 4.0 fosters what has been called a "smart factory" and also Industrial IoT (IIoT). Within modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, i.e. connectivity of physical assets, cyber-physical systems communicate and cooperate with each other and with humans in real-time and with humans in real-time both internal & cross-organizational services are offered & utilized by participants of the value chain. The value chain thereby becomes more agile, collaborative, visible and responsive. An example would be a totally connected and retooled supply chain, which can reconfigure itself on receipt of any new data point. If weather delay ties up a shipment, a connected system can proactively adjust itself and modify manufacturing priorities. With respect to SCM, there are some recent studies on challenges and risks of the Internet of Things (IoT) in SCM.

5. Assessment Framework for measuring impact of ICT in SCM

While most researchers and industry practitioners are unanimous about the fact that ICT positively impacts SCM performance and improves supply chain capabilities, there is an identified gap in terms of assessment and measurement of these ICT benefits and capabilities in SCM. This is despite the fact that there are several SCM performance measurement frameworks. There is also lack of clarity on the magnitude ICT has improved the competitive advantage of enterprises through improvement of supply chain.

Research is underway to develop an empirical model and assessment framework of the benefits of ICT deployment in SCM and its dovetailing into APICS Supply Chain Operations Reference (SCOR) model. This inter-disciplinary research effort by the author is under the guidance of Dr. S.P. Anbuudayasankar, Associate Professor, Department of Mechanical

Engineering, Amrita Vishwa Vidyapeetham, Coimbatore campus. The rubrics and performance indicators of various constructs for measuring of the impact of ICT in SCM are being used to provide enterprises with an ICT capability index metric for SCM. Well-defined metrics and constructs from the SCOR process reference model namely reliability, responsiveness & agility, which are considered customer-facing and cost & assets, which are internal process-facing are used for the same. Validation of this assessment framework has the potential to open new vistas on selection of appropriate ICT tool after measurement of its impact on the supply chain paradigm and understanding success factors and operational challenges for adoption of these tools. This can translate into immense potential and savings for Indian industry, both large and Micro, Small and Medium Enterprises (MSME) standing to gain considering the fact that global supply chain losses amount to over 100 billion dollars annually.

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Prof. Prashant R. Nair is presently working as Associate Professor and Vice-Chairman of department of Computer Science & Engineering at Amrita School of Engineering, Amrita Vishwa Vidyapeetham (Deemed-to-be-University), Coimbatore campus. He has 19+ years of teaching, mentoring, research and academic administration experience at AMRITA. He has been visiting faculty at University of California, San Diego and Sofia University, Bulgaria as an Erasmus Mundus fellow. His intellectual contributions include 6 books, 2 edited books, 1 book chapter and 40+ research publications in leading journals and conferences published by Narosa, Alpha Science, Springer and IGI Global. He has been on the editorial board of various journals and newsletters including Computer Society of India (CSI) Communications, CSI Transactions on ICT, IEEE MAS Link and International Journal of Data

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13 Essential Types of Supply Chain Management Tools

As Amazon continues to raise the bar, the margin of error within supply chain management gets thinner and thinner. A simple mistake could easily cost your business thousands of dollars and allow your competitors to get ahead. But thanks to supply chain management software, it's never been easier for companies to avoid such pitfalls. Supply chain management tools and techniques make it possible for users to reduce errors and costs while optimizing the entire supply chain. Here are 13 different types of supply chain management tools that make these SCM software packages valuable to companies:

<https://selecthub.com/supply-chain-management/13-essential-supply-chain-management-tools/>

Top Supply Chain Analytics: 50 Useful Software Solutions and Data Analysis Tools to Gain Valuable Supply Chain Insights

Supply chain managers cannot afford to operate in the dark as global operating systems, pricing pressures, and increasing customer expectations become the norm, as Paul Myers, professor of practice in supply chain management at Lehigh University explains. Various economic factors such as rising fuel costs, changing supplier bases, increased competition from low-cost outsourcers, and the continuing global recession significantly impact the supply chain and create waste. Supply chain analytics is the solution to these issues because using data helps companies make more informed decisions with a greater level of insight and have access to better models and simulations.

As data analytics becomes critical in supply chain operations and management, supply chain analytics software solutions and tools have become must-have technologies. Many supply chain analytics tools feature improved forecasting and sales and operations planning to give supply chain managers the business intelligence they need to streamline operations, lower costs, and improve customer service.

We have rounded up 50 of the top supply chain analytics tools to help busy supply chain managers find those that will be of the most value to them. The tools that we chose to include are from some of the leading software and analytics companies, and they all include features to deliver value and improve operational efficiency. Many of the following tools include inventory analysis, transportation analytics, demand forecasting capabilities, and predictive analytics to serve as comprehensive solutions for supply chain analytics. Some of our tools also are supply chain management (SCM) solutions with built-in analytics to give companies a more cost-effective solution. Please note, we have listed our 50 top supply chain analytics tools here, in no particular order.

<https://www.camcode.com/asset-tags/top-supply-chain-analytics/>

Supply Chain Management Products & Buyers Guide

While the supply chain management software market is relatively small (compared to many other markets), the vast disparity in functionality between different SCM programs makes buying decisions much more complicated. Some programs concentrate on business intelligence, others focus on inventory control or transportation management and there are full-suite systems that do all of the above and more. This product & buyer's guide is designed to identify the features associated with supply chain management systems to help navigate the selection process.

<https://www.softwareadvice.com/scm/>