

Information Technology in Supply Chain Management

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ABSTRACT

The exponential growth of Information Technology (IT) with communication technology in Supply Chain Management (SCM) is playing critical role in optimising decisions of the supply chain network flow for achieving organisational competitiveness, improving higher service level, lowering inventory, supply chain costs and reducing electronic risks (e-risks). To achieve integration and effective information sharing across and beyond the organisations, IT in SCM is also required. The organisations are moving towards the virtual supply chain with help of rapid changes in technology and IT applications viz; Electronic Data Exchange (EDI), Radio Frequency Identification (RFID), Bar Code, Electronic Commerce, Decision Support system, Enterprises Resource Planning (ERP) package, etc. It is also easily applicable in curbing the e-risks. Understanding the role and application of IT in managing and curbing e-risks of Supply Chain is the basic theme of this paper.

Keywords: Information Technology, Supply Chain Management

INTRODUCTION

In age of paper-based transaction and communication, the information flow in supply chain networks was time consuming and error prone. Due to globalisation, organisations had started the changing the way of communication, implementation of technology, growing diversity of business transactions and process improvement for sharpening the business performance through IT applications in their Supply Chain Networks. Supply chain management (SCM) is an integrated and complex network concept that refers to the sum of all the processes starting from the procurement of the raw material from the manufacturer/producer and ending with delivery of the end-product to the consumer (Silver *et al.*, 1998) as far back as the 1950's. Due to increased complexity of data, uncertainty risk in supply chains are growing (Christopher & Peck, 2007; Hillman & Keltz, 2007) that lead to an increasing vulnerability of electronic risks (e-risks) also. Hence the upstream and downstream integration of supply chain network is the basic requirement to fulfill the objectives of Supply Chain Management. The IT-enabled SCM can easily manage the flow of information with key business processes, materials, money within and outside the networks and contributes to firm profits by improving quality and by reducing coordination costs and transaction risks (Stroeken, 2000; Mabert *et al.*, 2001; Sanders & Premus,

2002). Many researchers discussed the relation between IT and SCM viz.; Internet increases the richness of communications through greater interactivity between the firm and the customer (Watson *et al.*, 1998), IT as cures for Bullwhip effect in Supply Chains (Lee & Whang, 1997), Internet as the foundation for new business models, process and new ways of knowledge distribution (Laudon *et al.*, 2000), IT in SCM provides a reduction in cycle time, a reduction of inventories, a minimisation of the Bullwhip effect, and improvement in the effectiveness of distribution channels (Levary, 2000), applications of Radio Frequency Identification (RFID) in supply chain (Gould, 2000), advanced information and manufacturing technologies for better managing their supply chains (Talluri, 2000) providing information availability and visibility and allowing decisions based on total supply chain information (Simchi-Levi *et al.*, 2003), Electronic Data Interchange (EDI) (Ngai & Gunasekaran, 2004), inadequate enterprise without IT systems (Davenport & Brooks, 2004), e-commerce applications (Chou *et al.*, 2004), increasing information sharing within organisations and between organisations with inter-organisational systems (Chen & Paulraj, 2004), IT is closely related to process changes, most of the benefits are overlapping and interlinked (Auramo *et al.*, 2005), Electronic Data Interchange (ERP) (Davenport and Brooks, 2004), mobile agent technology, as applied in an e-commerce application (Patel, R.B. &

Garg K, 2004) inter-organisational information systems (Da Silveira & Cagliano, 2006), designing collaborative planning forecasting and replenishment (CPFR) (Danese, 2007), online ordering (Kull *et al.*, 2007), SCM and IT (van Donk, 2008), supply chain coordination and integration, uncertainty and variability (Ambrose *et al.*, 2008), spread sheet based vendor (Mahamani & Rao, 2010), role of IT in SCM environment (Prasad, *et al.*, 2010), importance of e-procurement for an information technology chain (Ronchi *et al.*, 2010), SCRM approach for risk mitigations (Tummala & Schoenherr, 2011), e-commerce depends on information infrastructures and telecommunications for its development (Gilaninia *et al.*, 2011), RFID for SCM (Nair, 2012), e-supply chain and software agents (Nair, 2013) etc. Organisations have realised that it is not possible to achieve effective and efficient supply chains without a sound, robust and well integrated enterprise wide information system (Davenport & Brooks, 2004). The exponential growth of Information and Communication Technology (ICT) in the last decade has significantly changed the paper-based communication to e-communication, which is emerging as a serious threat of cyber-crime through computer facilitation or computer as a target (Varma, T.N. & Khan, D. A., 2013). According to the 2012 Report to the Nations on Occupational Fraud and Abuse, published by the Association of Certified Fraud Examiners (ACFE), \$3.5 trillion worth of fraud occurs every year. Organisations are spending money and time to detect, investigate, analyze and prevent it. Investigators and detecting agencies are forced to wade through massive amounts of data, which potential perpetrators count on to shield them from detection and prosecution. The objective of this paper is to identify the different IT tools. Further, what are the role and applications of Information Technology to manage and curb e-risks in supply chain networks?

INFORMATION TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers (Harland, 1996). The sharing of information among supply chain networks allows the supply chain drivers to work together with the goal of integrated and coordinated supply chains for effective supply chain management. Information also enhances the performance and reduces the risks of supply chains because it provides processes executed transactions and it creates opportunity for decision makers when they

need it and in the format they need it. This is where IT comes into role and it consists of hardware and software applications. IT also plays an important role in integrating suppliers, manufactures, distributors and customers to satisfy the quantity and quality of products. Organisations can gather vital information along the entire supply chain and react quickly to any predictable market changes, thereby gaining competitive advantage by effectively utilising SCM (Tummala & Schoenherr, 2008). Providing information availability and visibility, enabling a single point of contact for data, allowing decisions based on total supply chain information and enabling collaboration with partners are the objectives of IT in SCM (Simchi-Levi *et al.*, 2003). The functional roles of IT in SCM have been outlined as Transaction Execution, Collaboration and Coordination and Decision Support (Auramo *et al.*, 2005). IT systems such as data integrity, real time availability, visibility and processing capability of information and standardisation of business process are expected to facilitate better matching of supply and demand between supply chain members and create an excellent backdrop for embarking on integration with external partners in the supply chain (Tarn *et al.*, 2002). Rigorous use of information technology in supply chain is also generating chance of cyber crime as “computer-assisted” such as hacking, phishing and “computer-focused” as hate crimes, telemarketing/internet fraud crimes. Widely used terms for crime involving computers are computer crime, computer related crime, computer misuse, cyber crime, digital crime, e-crime, internet crime, online crime etc. Therefore IT is considered a critical prerequisite for managing supply chain (Davenport & Brooks, 2004). The critical role of IT in SCM is also curbing e-risks.

Electronic Records Management

Paperless business transactions through Enterprises Resource Planning (ERP) Systems, Automatic Identification (Auto ID) and Electronic Data Interchange (EDI) are collectively known as Electronic Records Management (ERM). The objective of ERM implementation in SCM is to ensure the accountability of process flow, which is fruitful to reduce cybercrime risks (e-risks) generate during the e-communication.

Bar code and Scanner

Bar codes consists of ladder orientation (width lines in a horizontal order) or picket fence orientation (width lines in a vertical order), where data is stored in magnetic or optical form as a part of communication system. The

organisations are using it in supply chain networks to automate tracings and tracking products and services at each process flow. It also provides necessary accurate and timeliness of information which is useful to reduce errors (Ellram *et al.*, 1999) because it is the representation of a number or code in a form suitable for reading by machines. Bullwhip effect, which is commonly being experienced by the consumer goods industries which lead to tremendous inefficiencies such as excessive inventory investment, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules, where bar codes and scanners have been developed and applied in the portions of supply chain to remove inaccuracy. A significant result was achieved by Wal-Mart to introduce this technology in their sales and distribution data in year 1983 and later in 1987 by implementing satellite communication for real time inventory data. FedEx enables this to provide their customers with detailed tracking information in real time. This is commonly used in product identification, speeds data entry, enhances data accuracy, minimizes on-hand inventory, improves customer service, reduces product recall, verifies orders at receiving and shipping, reduces work-in-process idle time, monitors and controls shop floor activity, improves shop floor scheduling, optimises floor space, improves product yield/reduces scrap, attendance recording, ATM card, debit and credit cards in banking organisations. Bar code helps us to reduce risk in supply chain which is rising due to manual oversight or fraudulent data entry by insider. Bar codes duplicity in process generatense-risks, which can be eliminated by application of biometric authenticity and authorisations. But there is a risk of data diddling which is performed by unauthorised modifications to data prior or adding fraudulent data during input or altering/omitting the desired input data or wrongly posting a transaction, making alterations or additions in the master file records, posting the transactions partially, destroying the output and substituting the counterfeit output or entry of a virus that changes data, the program, the database or application, exchanging valid disks and tapes with modified replacements into a computer or computer system by anyone associated with the process of creating, recording, encoding, examining, checking, converting, and transporting data into a computer.

Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a technology which is based on the use of tags that emit and receive the identity in the form unique serial number of an object through wireless using radio signals and on readers that

collect the data transmitted by the tags and forward them into the company's information system for further evaluation and analysis. RFID and bar code are based on Auto ID technology but in bar code, the reading device scans a printed label with optical laser or imaging technology and in RFID the reading device scans a tag by using radio frequency signals. By adopting RFID technology, supply chain can be enhanced by visibility into customer needs, efficient business process, reliable and accurate order forecasts, productivity improvement, operating cost reduction, better tracking, counterfeit identification, and theft predication (Attaran, 2007), RFID include authentication (Coronado *et al.*, 2004), reducing channel volume and enhancing forecasting and planning capabilities (D'Avanzo *et al.*, 2004). Amcor uses RFID for managing the warehouses (Michael *et al.*, 2005), Wal-Mart began setting deadlines for suppliers to start using RFID tags on their shipments in 2003 (Coronado *et al.*, 2004). Suppliers are able to manage product recalls and return of faulty and defective materials by using RFID through its Electronic Security Marker (ESM) (Sabbaghi *et al.*, 2008), Adoption by Indian Retailers (Chandan *et al.*, 2009), RFID is an emerging technology that is being increasingly used in logistics and supply chain management in recent years (Jedermann *et al.*, 2009). The RFID tags play a significant role, as the latest form of artificial security tags, which can easily be integrated with existing chains. RFID helps the organisation to avoid duplication of items, as the tags are unique and authenticated. It can also reduce the chances of fraud generated by manipulation in entry, authorisation from the supplier to customer. Cost and implementation constraints secure RFID tags and smart cards require specialised cryptographic implementations.

Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is the computer to computer interchange of business documents and/or information in standard, structured, machine retrievable data format (computer can process the information without human assistance) (Sanchez & Perez, 2003) between trading partners and commonly referring specifically to the application of EDI communication standards such as the EDIFACT and the ANSI X.12. It was the replacement of the traditional forms of mail, courier, or fax. It was used for the paperless communication within supply chain network to share transactional data (Garcia-Dastuge & Lambert, 2007), order processing, inventory controlling, accounting, transportation, quick access to information, better customer service, increased productivity, improved tracing and expediting, cost efficiency, competitive

advantage, and improved invoicing within in bound and out bound supply chain. EDI is also tremendously beneficial in counteracting the Bullwhip effect and supply chain organisations can overcome the distortions and exaggerations in supply and demand information by using technology to facilitate real-time sharing of actual demand and supply information.

Enterprise Resource Planning (ERP) Systems(e.g., SAP,Oracle, PeopleSoft)

Enterprise Resource Planning (ERP) is organisational planning systems, which works around core activities of business and has all logical interfaces to achieve seamless flow of information through the entity within the supply chain context, often interfaced to external systems. It is “not a system, but a framework that includes administrative (finance, accounting), human resources (payroll, benefits), and Manufacturing Resources Planning (MRP) (procurement, production planning) and it is a common term for a co-operating software that manages and co-ordinates much of a company’s resources, assets and activities (Boyle, 2004), ERP system is an enterprise information system designed to integrate and optimise the business processes and transactions in a corporation (Moon, 2007). ERP systems help the organisations for automating and integrating their Supply Chain Management and business. Basically, they allow data capture without manual interference for the whole business into a single software package from raw material to customers with all information flow. Some of the benefits ERP systems could bring include cost-cutting in internal operations, efficiency across the extended supply chain, enhanced customer service, and network relationships (Davenport & Brooks, 2004). The development and pervasive use of ERP systems provides the critical infrastructure necessary for the effective evolution of the assurance function from a periodic event to an ongoing process through the integration of continuous auditing applications (Kuhn *et al.*,2010). The evolution of ERP took over with the continuous improvement for integration and planning with creative thinking. The milestones of ERP are :

◆ 1960’s Material Requirement Planning (MRP)

The Material Requirement Planning (MRP) is a computerised production and inventory control systems which inputs are bills of material (BOM), item master, requirement, order and output are master production schedules (MPS). It plays a major role in manufacturing organisations. It is the heart of MRPII (Manufacturing Resource Planning).

◆ 1970’s Closed Loop MRP

In the changing conditions of manufacturing environment, the priority planning and capacity planning were tied in with MRP to accommodate the variations in demand and supply using feedback from tactical plans and execution levels. This closed structure is called as closed loop MRP.

◆ 1980’s Manufacturing Resource Planning (MRP II)

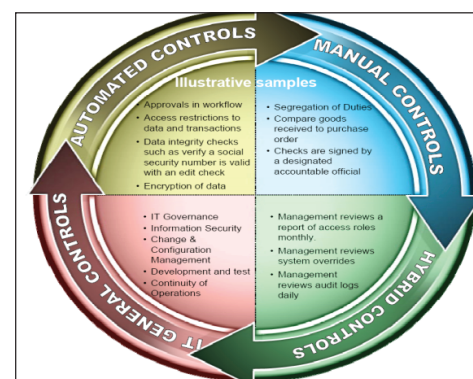
Manufacturing Resource Planning (MRP-II) is a production planning system that converts a Master Production Plans (MPS) into planned order releases. In MRP, the MPS is treated as input information but in MRP II, the MPS would be considered a part of the system and it would be considered as a decision variable.

◆ New generation ERP

In the new generation ERP, the whole supply chain management concept is incorporated extending the planning concept to trading partners where the complete visibility throughout the enterprise is possible and the concept of virtual enterprise is supported using electronic commerce. It will have implications in terms of Just in Time (JIT), Business Process Reengineering (BPR), changes in organisational structure, people, and change management.

The security issue within ERP is a challenge for each organisation. The IBM suggests the different controls within ERP for any organisation as shown in Fig. 1.

Fig. 1: Source IBM Global Business Services



SAP, Oracle, Baan, and People Soft are the market player in ERP systems package with high level of integration by utilising a single data model, developing a common understanding of what the shared data represents and establishing a set of rules for accessing data. These ERP packages are playing a vital role in organisation to reducing the fraud or e-risks from their supply chains.

SAP

SAP is the biggest ERP provider with its product R/3 which was founded in 1972 by five former IBM systems engineers. The company has 17500 client organisations through 120 countries. Organisations are using SAP solutions for purchase-to-pay, order-to-cash, or HR processes and using third-party tools for fraud detection or using proprietary relational databases. In either case, the need to export data out of the SAP system compromises both data security and governance which limit the amount of data that can be analyzed. SAP announced SAP Fraud Management in year 2013 with HANA platform, which is part of SAP's Governance, Risk and Compliance (GRC) product portfolio, along with Process Control, Access Control, Risk Management and Global Trade Management, Business Objects and Business Intelligence. These solutions give us to enhanced real-time fraud analysis. SAP HANA detects, investigates, analyzes, and prevents irregularities or fraud in even ultra-high-volume environments, similar to Oracle and Baan having similar features. Some applications of SAP are to detect and prevent fraud which occurred in e-environment such as False Vendor Payment, which is created due to lack of segregation of duties, where vendor creation or modification in bank account number in vendor master, Goods receipt notes/ Service Entry Sheet and invoice creation and approval are performed by the same user. It can be easily detected and prevented by defining proper segregation of duties logic.

Distribution Requirement Planning (DRP)

Distribution Requirement Planning (DRP) is a management process that provides a linkage between warehouse operations (store, distribution center, or warehouse that carries product for sale) and transportation requirement that ensures that supply sources (third party supplier, a regional distribution point, or a factory) which be able to meet the demand. DRP applies the time-phased logic to replenish inventories in multiechelon warehousing systems. DRP-II extends DRP to include the planning of key resources in a distribution system – warehouse spaces, manpower levels, transport capacity and financial flows.

Electronic Supply Chains

Electronic Supply Chain (ESC) is a supply chain that is electronically managed in form of EDI-based or Internet-based between or among participating organisations. Basically it is a Virtual Supply Chain, which links

organisations to allow them to buy, sell and move products, services and cash by using Internet-based applications to transact and exchange information with their downstream or upstream. American-On-Line and lastminute.com have achieved innovative results using ESCs (Gunasekaran *et al.*, 2004). In this collaborative Planning, Forecasting and Replenishment (CPFR), Vendor Managed Inventory (VMI), Efficient Customer Response (ECR) and Quick Response have been easily managed. Intel began to recognise the power of the Internet as a corporate communication channel by using the internet as “brochureware”, to share technical information and market the Pentium processors (Sammon *et al.*, 2007).

Fig. 2: Evolution of E-Supply Chain



Electronic Commerce (e-Commerce)

Electronic Commerce (e-commerce) means tools and techniques to manage business in a paperless environment. E-commerce includes electronic data interchange (EDI), email, electronic funds transfers, electronic publishing, image processing, electronic bulletin boards, shared databases, and magnetic/optical data capture (such as bar coding), the Internet, and websites in form of B2B (Business to Business) as Covisint, B2C (Business to Customer) as Amazon.com, Wal-mart.com, C2B (Customer to Business) as priceline.com, C2C (Customer to Customer) as e-Bay auction, P2P (Peer to Peer) and Mobile, or m-Commerce. In 1995, Intel formed the Internet Marketing and E-Commerce Group (IM&E) to centralise online marketing efforts. In year 2013, Flipkart became worth net Rs. 1200 crores in single largest funding for an e-commerce company in India. Hence it plays a major role for integrated supply chain management (SCM) and changing the dynamics of business in form of following:

e- Procurement

An e-procurement is expected to be integrated into the wider purchase-to-pay (P2P) value chain with the trend toward computerised supply chain management. An e-procurement is done with a software application that includes features for supplier management and complex auctions with value chain consisting Indent Management, e-Tendering, e-Auctioning, Vendor Management,

Catalogue Management, and Contract Management. The forms of e-procurement are web-based ERP (Enterprise Resource Planning): creating and approving purchasing requisitions, placing purchase orders and receiving goods and services by using a software system based on Internet technology; e-MRO (Maintenance, Repair and Overhaul): the same as web-based ERP except that the goods and services ordered are non-product related MRO supplies; e-sourcing: identifying new suppliers for a specific category of purchasing requirements using Internet technology; e-tendering: sending requests for information and prices to suppliers and receiving the responses of suppliers using Internet technology; e-reverse auctioning: using Internet technology to buy goods and services from a number of known or unknown suppliers; and e-informing: gathering and distributing purchasing information both from and to internal and external parties using Internet technology. In 1998, Intel launched a global online ordering system that reached a record US\$1bn in product orders in the first month of operation. Today, Intel generates over 85 percent of revenue from online orders and virtually all Intel customers are transacting business with Intel over the Internet. Intel is aggressively moving towards paperless purchase orders, shipment notification and deployment processes.

e-Auctions

The electronic auction (e-Auction) is carried out in real time, where participants log in to an auction site using a browser at a specified time and bid for an article as conventional auctions. This is a transparent process and reduces the malpractices.

e-tailing

An e-tailing is a use of the Internet for selling goods over the Internet. The Amazon Company is renowned for the fact that it only sells books over the Internet and doesn't even take telephone orders.

Wireless Internet

Wireless Internet enables wireless connectivity to the Internet via radio waves rather than wires on a person's home computer, laptop, smartphone, or similar mobile device. Wireless Internet can be accessed directly through service providers. Wi-Fi hotspots and wireless LANs are also options for wireless Internet connectivity. In these cases, Internet connectivity is typically delivered to a network hub via a wired connection like satellite, cable,

DSL or fiber optics and then made available to wireless devices via a wireless access point.

Smart Cards

A smart card can generally be defined as a plastic card with dimensions similar to traditional credit/debit cards, into which an electronic device has been incorporated to allow information storage. Frequently, it also has an integrated circuit with data processing capacity.

Digital Signature

The Information Technology Act, 2000 provides for use of Digital Signatures on the documents submitted in electronic form in order to ensure the security and authenticity of the documents filed electronically. This is the only secure and authentic way that a document can be submitted electronically.

Secure Electronic Transaction/Trading/Technology (SET)

It is a proposed industry standard for payment card acceptance over the Internet. At the system heart is a pair of digital keys, one public and one private, held by each party to a transaction. In practice, banks will give both keys to a customer together with a digital certificate for authenticity. When customers wish to purchase over the Internet, they firstly give the public key to the merchant along with the certificate to prove its authenticity. Likewise, the merchant provides its own public key and certificates to prove its own bona fides to allow the transaction to proceed. Problems may arise in key distribution and customer identification in order to ensure that accounts and clients match.

XML (Extensible Markup Language)

Structured information contains words, pictures, etc. which play an important role in Supply Chain Networks data flow and a markup language is a mechanism for identifying structures in a document. XML (extensible markup language) specification defines a standard way of adding markup to documents and data so that content can be processed with relatively little human intervention and exchanged across diverse hardware, operating systems, and applications which are so richly structured documents could be used over the Internet. XML can be exchanged across platforms, languages, and applications and can

be used with a wide range of development tools and utilities. The number of applications which are based on XML documents are large and e-business transactions are only one application area (Ameron, 2000). XML-based solutions provide a significant alternative to traditional EDI and lower the entry barrier to e-business because of the lower investment costs compared to EDI (Nurmilaakso *et al.*, 2002), a cost-effective method of information exchange from system to system between organisations (Simchi-Levi *et al.*, 2003).

Spread Sheet (Microsoft Excel)

Organisations are using Microsoft Excel as standard desktop software and decision making tools in their supply chains, because in comparison to the total cost of ownership with commercial software-based decision making supporting tool, it is less. It is also useful to apply in Supply Chain Networks (SCN), because it has many build-in capabilities to perform and execute quantitative modeling techniques. Microsoft Excel is an ever-present tool and easily use for data analysis because spreadsheets are easy to navigate and flexible enough. Excel allows users for applying analytical test (horizontal and vertical analysis, ratios and trend analysis, performance measures, statistics, stratifications, aging, application of Benford's Law, regression, Monte Carlo simulation), data management/analysis (append/merge, calculated field/functions, cross tabulate, duplicates, extract/filter, export, gap analysis, index/sort, join/ relate, sample, summarize), user forms design, and macros/Visual Basic Applications (VBA). The complexity of supply chains network data allows fraudsters to commit the fraud beyond the scope of internal controls but an effective approach of locating fraudulent on a data-set of supply chain network can be performed by using Benford distribution with help of excel sheet (Varma, T.N. & Khan, D.A., 2012). Hence, Microsoft Excel has become an industry standard in managing and analyzing organisational data of SCN for performance improvement as well reducing the financial fraud as bid rigging, phantom bids, nepotism, substitution, false count, counterfeiting, detecting fictitious accounting entities e.g., ghost employee, fake vendor, fake customer or vendor payments, falsified hours etc.

Data Warehouse and Data Mining

Data Warehouse (DW), which provides a combination of many different databases across an entire enterprise, aids management in the decision-making process with specific characteristic as subject-oriented, integrated, non-

volatile, time variant, accessible and process oriented. Data mining combines data analysis techniques such as statistical analysis and modeling to uncover hidden patterns and subtle relationships in data and to infer rules that allow for the prediction of future results. Data mining helps the organisations in defining business rules (alerts based on intuition and general experience), anomaly detection (alerts are defined based on events that represent statistical deviation from normal or expected behaviour), predictive models (statistical models which derived from event characteristics that are indicators of prior fraud incidents) and social network analysis (alerts are based on the level of association between the current event and individuals or accounts that are known or suspected of fraudulent behaviour).

Intranet/Extranet

The computer networks inside an organisation are often connected via Internet based protocols (HTML:HTTP, FTP, Mail: SMTP, POP3) and are not accessible from outside. By using Web browsers and server software with their own internal systems, organisations can improve internal information systems and link otherwise incompatible groups of computers within supply chain networks for reducing manual intervention. Extranet provides secured access to its Intranet and to additional information and services that may not be part of its intranet and it is secured via a firewall. Internal networks often start out as ways to link employees to company information, such as lists, product prices, or benefits. Because internal networks use the same language and seamlessly connect to the public Internet, they can easily be extended to include customers and suppliers, forming a supply chain "Extranet" at far less cost than a proprietary network.

Internet

Good supply chain management is essential for a successful company. Supply chain management can reach beyond the boundaries of a single organisation to share that information between suppliers, manufacturers, distributors, and retailers. This is where the Internet plays a central role. In terms of advancement in technology and communications capabilities, perhaps the most influential development over the past decade has been the adaptation of the Internet applications into the areas of commerce and mass communications and it provides instant and global access to an amazing number of organisations, individuals, and information sources. A key Internet

concern is the issue of privacy regarding the sensitive information, the level of security for information because supply chains members struggle with the challenge of freely sharing the information. The Internet is a source for cyber criminals. Internet security was ranked the first concern for customers and supply chain members.

World Wide Web

The World Wide Web (WWW) is the Internet system for hypertext linking of multimedia documents, allowing users to move from one Internet site to another and to inspect the information available without having to use complicated commands and protocols. The number of websites relevant to supply chain management is growing at a rapid pace. Enterprise Transportation management was recently launched by Metasys Inc. through the Oracle Web Applications Server; this system deploys a variety of critical information about transportation and distribution applications throughout the supply chain.

Decision Support Systems

Supply chain management involves several decisions like demand planning, logistics network design, sales and marketing region assignment, distribution resource planning, material requirements planning, inventory management, production scheduling, workforce scheduling. The decision support systems (DSS) are computerised support to complex non-routine and partially structured decisions of the supply chain activities of any organisation. DSS assist decision makers in terms of both the design and operation of integrated supply chains. These DSS will help decision-makers identify opportunities for improvements across the supply chain as well as detecting and preventing fraudulent activities.

E-business

E-business is defined as “the use of the Internet or any digitally enabled inter- or intra-organisational information technology to accomplish business processes” (Boone *et al.*, 2007). As classified by Geoffrion & Krishnan (2001), e-business consists of three areas: (1) consumer oriented activity i.e. business-to-consumer, consumer-to-consumer, and government-to-consumer activities, (2) business-oriented activity i.e. business-to-business, business-to-

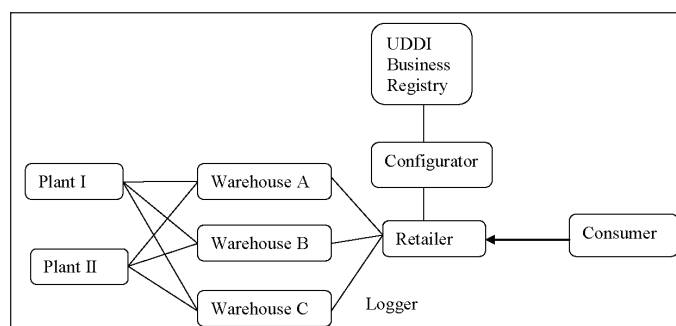
government and government-to-business activities, and supported by (3) the e-business technology infrastructure i.e. network infrastructure, network applications, and respective software tools and applications. The key tools and methods of e-business include EDI (electronic data interchange) and XML (extensible markup language), buy-side e-business applications, sell-side e-business applications, digital market places, Item identification and Content management (Bauer *et al.*, 2001). If e-business is not properly secured then illegal data acquisition is performed by cyber criminals. There is law for copyright protection or Protection from Data or Intellectual Property Theft in every country.

Software Agents

A software agent is a software system, which has attributes of intelligence, autonomy, adaptability, perception or acting on behalf of a user proactively. The intelligence of an agent refers to its ability of performing tasks or actions using relevant information gathered as buyer agents or shopping bots (retrieving information about goods and services from networks), monitoring and surveillance agents (used to observe and report on equipment, usually computer systems), user agents or personal agents and data mining agents (finding trends and patterns from information gather from many different sources). Software agents provide security to the information. Since e-commerce deals with business online, security plays the heart of business. Business needs lots of communication skills which are provided by software agents. Software agents are responsible for customer satisfaction in terms of B2B e-commerce. Software agents can be thus proved as an important entity with respect to e-Commerce. Without software agents e-commerce is like “a man having his leg cut” (Ramya S. Gowda, 2013).

Web Services

Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-process able format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialisation in conjunction with other Web-related standards (W3C glossary).

Fig. 3: Web Services Architecture

The Universal Description, Discovery and Integration (UDDI) protocol is one of the major building blocks required for successful web services. As shown in Fig. 3, there is one retailer, one logger, three warehouses, two plants and one configurator, and thus a total of six web services. UDDI creates a standard interoperable platform that enables companies and applications to quickly, easily, and dynamically find and use web services over the internet (UDDI, 2004). UDDI also allows operational registries to be maintained for different purposes in different contexts. UDDI is a cross industry effort driven by major platform and software providers, as well as marketplace operators and e-business leaders. Hence its application is very useful for supply chain management.

Groupware (e.g., Outlook, Lotus Notes)

= AF19 FA27 2F94 998D FDB5 DE3D F8B5 06E4 A169 4E46

Lotus Notes has been one of the first complete groupware products to hit the market way in 1989, and ever since it has continued to dominate the Groupware market. Developers of Notes realised the importance of security quite early, and therefore we see many Industry Standard Security Features built into Notes over and above security features unique to Notes. Together, they effectively cover many aspects of security that are of significant importance today. Even after there is chance of e-mail bomb attack on supply chain network in a form of net abuse consisting of sending huge volumes of e-mail (sending numerous duplicate mails to the same email address) to an address in an attempt to overflow the mailbox or overwhelm the server where the email address is hosted in a denial-of-service attack.

Mobile Agent

A mobile agent is a software process, which can move autonomously from one physical network location

to another. The agent performs its job wherever and whenever it is found appropriate and is not restricted to be co-located with its client. Thus, there is an inherent sense of autonomy in the mobility and execution of the agent. It is applied in SCM as the delegate of tasks, network load reducer, parallel processing facilitators, code shipper rather than data shipper etc. As distributed system, the mobile agent is subject to security threats such as eavesdropping, corruption, masquerading and denial of service, replaying, and repudiation. Issues such as encryption, authorisation, authentication, and non-repudiation, therefore, must be addressed in a mobile agent. Moreover, a secure mobile agent must protect both the hosts and the agents from tampering by malicious activities.

M2M

Machine to Machine technology (M2M) allows both wireless and wired systems to communicate with other devices of same ability. The modern M2M communication has expanded beyond a one to one connection and changed into system of network that transmit data to personnel appliances. M2M domains are system monitoring/telemetry, asset tracking, digital signature & advertising, and telematics. There are many M2M applications implemented in supply chain such as tracking supply and demand and making informed decisions. Real time monitoring of the process can imply using sensor that makes operations to detect, predict and ensure smooth process. As the concept of Internet of Things, M2M will solidify in future, there will be requirement of optimised the high performance message handling component within the messaging network which be able to handle the connectivity between millions of devices and applications communicating with each others.

DISCUSSION

The use of information technology (IT) is considered a prerequisite for the effective control of today's complex supply chains. The exponential growth Information Technology in supply chain networks has significantly changed the paper-based communication to e-communication, which is a serious threat of cyber crime (e-risk) by unauthorised or illegal access by means of physical or/ and virtual intrusion to a computer or computer system or computer network. Criminals may commit illegal access of confidential data, theft of data, manipulation in data, and denial of access of system of supply chain networks. They may also perform

the fraudulent activities by help of IT in supply chain networks and it can be curb through help of IT. Barcodes are both cost effective and time saver which eliminate the human error, reduce the paper works to improve the customer service, the usage of this limited to supply chain partners. Improved data integrity allows decisions to be made with real time, accurate data, improving product and category management decisions. Bar code technology facilitates the use of automated replenishment or vendor managed inventory so the right product is always at the right store at the right time. Recently organisations, from both government and corporate sectors had mandate to implement radio frequency identification (RFID) technology for their suppliers. The global standard for RFID such as the Electronic Product Code (EPC) and offer insight into the coexistence of barcodes and RFID increased their importance to curb the e-risks. Asymmetric cryptography with secure bit length still requires significantly larger chips in RFID than symmetric cryptography. EDI is the growing business technology of the 1990s. The major risks to EDI messages are loss of integrity (that is, alteration, modification, or destruction), loss of confidentiality (that is, copied, seen, or heard by unauthorised persons) and non-availability (that is, not accessible when needed). The claims are made by ERP software vendors that their software solutions are complete and designed to be industry specific. In practice, these packages do not support many business processes and frequent up gradation required. Consequently, many organisations are forced to leave some processes unautomated and a few legacy systems in place. The organisations are worried that the implemented package will work in the future or not. However, ERP as SAP implemented integration of different business modules with business data ware and intelligences. Its new tool SAP HANA is very useful to stop fraudulent activities in even ultra-high-volume environments. The Internet not only provides communication in virtual environment, but also enables the opportunity of online business with mutual benefits of customer and suppliers of supply chain networks globally. The online supply chain management creates the e-risks as hacking, spreading or dissemination of malicious software (Malware), theft of internet hours/identity theft, cyber squatting (an act of obtaining fraudulent registration with an intent to sell the domain name to the lawful owner of the name at a premium), privacy violation, cyber terror, etc. Microsoft Excel has many powerful features and by using this for Supply Chain Management can easily detect and prevent fraudulent activity with some limitation of excel sheet that it can process only one million rows or records of data. Implementation of IT in SCM as discussed in the

study appears to have modest role in decision making as well as reducing e-risks by supply chain management. The evolution of high performance and cloud computing systems have started appearing in the domain of SCM and helping to provide transparency and visibility in supply chains. This upcoming technology is predicted to revolutionary changes in field of performance and e-risks prevention of SCM. Similarly next generation Internet connects heterogeneous computing devices to create network traffic that is generated by automated objects from public sectors to day to day life of people rather than human intervention. The IT systems with service oriented architecture and web service standards, expected to come in future, may facilitate better supply chain management.

CONCLUSION

Due to globalisation, outsourcing, customisation, time to market and pricing pressure have compelled enterprises to adopt efficient and effective supply chain management. To survive, organisations will find that their conventional supply chain integration will have to be expanded beyond their boundaries so as to integrate all stakeholders. Adoption of Information Technology tools is vital for such efforts. This paper discusses the role of IT as an enabler in Supply Chain Management with vast benefits to organisations with a comprehensive IT implementation as well as curbing e-risks. Technology is always a double-edged sword. Society that is dependent more and more on technology, cyber crimes are bound to increase because bytes are replacing bullets in the crime world. There will always be new and unexpected challenges to stay ahead of cyber criminals and cyber terrorists but we can win only through partnership and collaboration of both individuals and government. Cyber crime in India has gone by 60% in 2012 in compare of 2011. History is the witness that no legislation and technology has succeeded in totally eliminating crime. Securing Physical and virtual systems which is sabotage on computer systems and their access to information and databases by cyber criminal has always been one of the critical risks for the supply chain management. Criminals may involve deliberated deceit or misrepresentation of facts or significant information to obtained illegal gain from Supply Chain Networks. Information Technology be used as tool against bid rigging, phantom bids, nepotism, substitution, false count, counterfeiting, creating fictitious accounting entities e.g., ghost employee, fake vendor, fake customer or vendor payments, falsified hours etc. The alignments of IT technology in SCM, viz. implementation of Electronic Record Management (Bar Code, RFID, EDI), ERP system (SAP, Oracle, PeopleSoft), Microsoft package, Data

Ware House, software agents, decision support systems, web services, e-commerce, electronic supply chains, etc will overcome the e-risks and increase the performance. In July, 2013 Indian government releases the National Cyber Security Policy.

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