# 50
**Chapter**

# Information Technology and Supply Chain Management

## Chapter Outcomes

After completing the chapter, you will be able to:

- Understand the importance of information technology in supply chain management.
- Describe how information driver affects the performance of other supply chain drivers.
- Know how advances in information technology are deployed in supply management.
- Understand the scope of emerging IT technologies for enhancing SC performance.

## 50.1 INTRODUCTION

Flow of information across any supply chain coordinates the physical flows and the interdependencies of organizations in the supply chain. The managers of the supply chain make use of this information to make decisions related to the different aspects of supply chain: inbound logistics, manufacturing/operations and outbound logistics.

Information technology links all the activities in the supply chain in to an integrated and coordinated system that is efficient, responsive, and flexible and should be able to adapt to mass customization which enables to produce high volumes of customized products at lower costs. The scope of supply chain is made up entirely of information and the breadth of this information determines whether the scope is global or local.

## 50.2 INFORMATION ATTRIBUTES FOR SUPPLY CHAIN DECISIONS

For making accurate decisions in supply chain, the information should possess the following attributes;

1. **Information Accuracy:** Helps to understand the true picture of the state of supply chain to make better decisions.
2. **Timely Accessibility of Information:** Accurate information if not available or

outdated, will not assist in making right decisions. For better decisions; managers need accurate upto date information.

3. **Information of Right Kind:** Capturing right information and making it available at right time will help to make effective decisions across the supply chain.

Information is the key ingredient in each phase of supply chain decisions right from strategic to planning and to the operational phase. Information is made use of when making variety of decisions about each driver of supply chain.

(*i*) **Facility driver:** Location decision, capacity creation and schedules of facility demands information on tradeoffs among flexibility and efficiency, demand and taxes etc. Example Firms use their information to decide where to locate warehouse and cross docking facilities.

(*ii*) **Inventory driver:** Setting inventory levels and policies requires information on demand pattern, costs associated with inventory.

(*iii*) **Transportation driver:** To decide transportation networks, routes modes of transportation, vendors and shipment tracking needs the vital information.

(*iv*) **Sourcing driver:** Information on delivery schedules, quality, product margins, minimum lot sizes and lead times is important information to make a sourcing decision.

(*v*) **Pricing and revenue:** Pricing policies need information on demand both volume and segment wise buying capacity, product margin, lead time and availability.

## 50.3  GOALS OF SUPPLY CHAIN IT

1. **Collect Information on Each Product from Production to Delivery or Purchase Point, and  Provide Complete Visibility for All Parties Involved.** Data about orders and their status is an important part of managing an efficient supply chain. This is sometimes called track and trace. RFID Technology has evolved to focus on the Internet of things – which sometimes involves RFID as in shipment and product tracking but also includes the use of data from different devices, and integration of that data into existing or new business solutions.

2. **Access Any Data in a System from a Single Point of Contact:** "Single point of contact," which is about the ability to provide access to the same information from the same data so there is consistency. The rollout of Enterprise Resource Planning (ERP) systems in most companies has largely resolved these issues although many companies still do not have complete clean data. An interesting development in the context of relying on single point of data has been the influence of block chain technology on the concept of how to maintain ledgers which used to be maintained through central clearing houses.

3. **Analyze, Plan Activities and Make Trade-offs Based on Information From the Entire Supply Chain.** The need to analyze data has become even more pertinent due to the increasing pace of changes in many industries and the new data (often called big data) available from various sensors and activity on the internet (such as competitor pricing). Traditionally, analytics was done either with off-the-shelf software or through Excel spreadsheets. Custom solution development was slow and cumbersome and the tools to transfer the development depended on IT departments to bring to users. There have been two major developments related to enabling analytics. First, the growing use of machine learning (sometimes called

artificial intelligence) with new languages such as R and Python providing strong built-in capabilities. The second is the ease of deploying cloud computing.

4. **Collaborate with Supply Chain Partners.** When we talk about supply chain collaboration we note that availability of advanced systems such as Supplier Relationship Management (SRM) and Customer Relationship Management (CRM). There are also processes such as Collaborative Forecasting and Replenishment (CPFR) as well and Vendor Managed Inventory (VMI). All these have been around for a while. Cloud services have made it easier to collaborate across companies and the software that supports. This has become easier to use and more accessible.

## 50.4   SUPPLY CHAIN IT FRAMEWORK

The managers understand how the information is utilized by various segments of IT within the supply chain. The scope of decisions has broadened across which companies make decision because of IT. From enterprise perspective all processes all along supply chain are categorized in to three main areas: processes focused downstream, internal processes and process focused upstream. The important macro level processes are as follows:

1. Customer Relationship Management (CRM): Processes that focus downstream interactions between the enterprise and its customers.
2. Internal Supply chain Management (ISCM): Processes. That focus on internal operations within the enterprise
3. Supplier Relationship Management (SRM): Processes that focus on upstream interactions between enterprises and its suppliers.
4. The fourth important building block that provides foundation on which micro processes rest is referred to as Transaction management foundation (TMF) which includes basic ERP systems, infrastructure software and integration software.

In the development and maintenance of Supply chain's information systems both software and hardware must be addressed. Hardware includes computer's input/output devices and storage media. Software includes the entire system and application programme used for processing transactions management control, decision-making and strategic planning.

## 50.5   CREATING INFORMATION VISIBILITY

Information visibility within the supply chain is the process of sharing critical data required to manage the flow of products, services, and information in real time between suppliers and customers. If information is available but cannot be accessed by the parties most able to react to a given situation, its value degrades exponentially. Increasing information visibility between supply chain participants can help all parties reach their overall goal of increased stockholder value through revenue growth, asset utilization and cost reduction. To improve responsiveness across their supply chains, companies are exploring the use of collaborative models that share information across multiple tiers of participants in the supply chain: from their supplier's supplier to their customer's customer. These trading partners need to share forecasts, manage inventories, schedule labor, optimize deliveries, and in so doing reduce costs, improve productivity, and create greater value for the final customer in the chain. Software for Business Process Optimization (BPO) and Collaborative Planning, Forecasting and Replenishment (CPFR) are evolving to help companies collaboratively forecast and plan amongst partners, manage customer relations, and improve product life cycles and maintenance. Traditional supply chains are rapidly

evolving into "dynamic trading networks" comprised of groups of independent business units sharing planning and execution information to satisfy demand with an immediate, coordinated response.

Perhaps no other company has been as successful in implementing information visibility as a competitive strategy than Dell Computer. Dell has fulfilled its commitments to customers through the company's direct model, in which it holds only hours of inventory yet promises customer's lead-times of five days. Component suppliers who wish to do business with Dell have to hold some level of inventory, since their cycle times are typically much longer than Dell's. By utilizing the Web, Dell provides its supplier with forecasting information and receives information about the supplier's ability to meet the forecasts. Dell uses i2 Technologies products for demand-fulfillment operations and products from Agile Software for engineering-change-order and bill-of-materials management. Communication between engineering changes, component availability, capacity, and other data between Dell and its suppliers flows both ways, in addition to forecasting and inventory data. Dell is also able to review suppliers and place Web-based orders into their factories in hours. After outsourcing to third party contract manufacturers, Dell executives realized that many of these manufacturers did not have adequate visibility of customer orders. This was a major driver in the initiative to increase visibility of orders. Dell's build to order web-based customer model has become the benchmark for other industries, and organizations such as General Motors, Ford, BMW, General Electric, and others are seeking to create "build-to-order" models using the Web as the platform for taking customer orders.

Some of the considerations that must be planned for in implementing an information visibility system include the size of the supply base and customer base with which to share information, the criteria for implementation, the content of information shared and the technology used to share it. Clarifying these issues will help to ensure that all participants have access to the information required to effectively control the flow of materials, manage the level of inventory, fulfill service level agreements and meet quality standards as agreed upon in the relationship performance metrics.

Information, its accuracy and availability can have significant impact on the design of operation and the management controls that levy on it. Readily available information can facilitate lowering inventory levels through to reducing lead times. However different organizations may harness the power of these tools in different ways and efficiency gains can be levied from optimizing information flows. These can be characterized by some of the following opportunities

- Improved forecasting
- Reduced variability
- Increased collaboration between manufacturers and distributors
- Increased sales channels between buyer and seller
- Increased flexibility within the supply chain
- Reduce lead times.

Supply chain management systems are one type of inter organizational system because they automate the flow of information across organizational boundaries. A firm using a supply chain management system would exchange information with its suppliers about availability of materials and components, delivery dates for shipments of supplies, and production requirements. It might also use the system to exchange information with its distributors about inventory levels, the status of orders being fulfilled, or delivery dates for shipments of finished goods. There are many examples of other types of inter organizational information systems.

## 50.6   ILLUSTRATION OF SCM USED IN FURNITURE COMPANY

Fig. 50.1 illustrates the supply chain management systems used by Haworth, a world-leading manufacturer and designer of office furniture described in the Window on Technology. Haworth needed to synchronize manufacturing and distribution activities to cut costs and boost efficiency by having material flow continuously from multiple manufacturing centers to multiple distribution centers. It implemented new systems for warehouse management and transportation management. These systems enable Haworth to deliver multipart shipments requiring assembly in the correct sequence, accommodate shipping volumes that can vary by a factor of 10 from one day to the next, and handle last-minute changes in customer orders. Customer orders, shipping notifications, optimized shipping plans, and other supply chain information flow among Haworth's Warehouse Management System (WMS), Transportation Management System (TMS), and its back-end enterprise systems and other corporate applications.

Radio Frequency Identification (RFID) is a vital piece of technology that can provide innumerable benefits to the business owner. RFID chips are placed on every product and provide a way for business owners to easily track their inventory. Due to the increased visibility RFID chips provide, they will substantially improve supply chain efficiency by detecting any order anomalies as they occur, enabling employees to immediately correct mistakes. In addition, it allows for easier and more consistent tracking, enabling business owners to have maximum control and visibility over their products at all times. Since RFID chips provide computerized product management, they can eliminate the potential for errors, simplify the supply chain, and reduce operating costs.
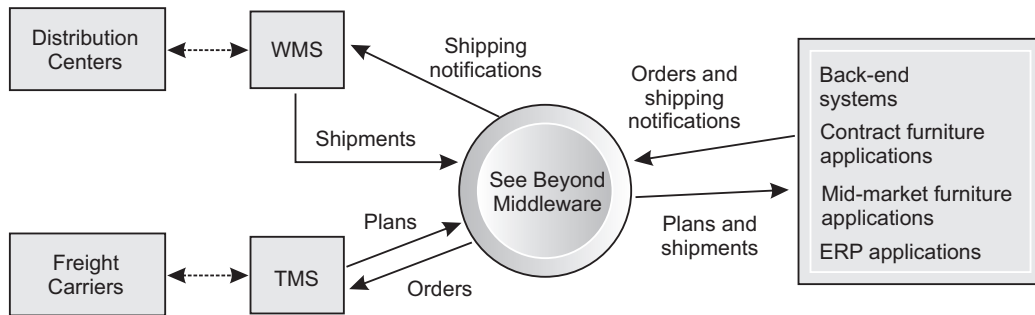


**Fig. 50.1:** Haworth's supply chain management systems

## 50.7   EMERGING TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT

The Internet has an enormous impact on how people communicate, shop, and work. This technology has also created changes in how companies conduct business in the 21st century. One of the areas of business that is likely to see tremendous change in the coming years is supply-chain management. By harnessing the power of the Internet, supply-chain management will continue to evolve in ways that will enable enterprises to change the way they manage inventory, place orders with suppliers, and communicate critical information with each other.

While some of these technologies have existed for years, or decades in the case of radio frequency identification tags, the harnessing of the Internet to these technologies offers the potential for transforming supply-chain management. Improved supply-chain management also means improved inventory control and increased profits.

In 2001, Nike missed its revenue target by a significant dollar amount. The shortfall was explained in part by a failed supply-chain automation project. "Some estimate that

new technologies could strip out more than $30 billion in excess inventories" (Fonstad). The term e-business – as distinct from e-commerce – can be used to describe the adoption of the Internet to accelerate the goal of supply-chain integration (Lee) Four emerging technologies and practices in e-business will have a dramatic impact on supply-chain management.

1. Virtual marketplaces
2. Radio frequency identification tags (RFID)
3. Synchronized planning
4. Supplier performance management

## Virtual Market Places

Metal Junction is the virtual marketplace owned by two of India's largest steel producers. Tata Steel and Sail Steel traded more than 5,000 tons of steel in March 2002. By March 2003, tonnage had increased to 43,000 tons per month (Mills).

What is a virtual marketplace and what are its applications to industry? Virtual marketplaces have many names such as e-markets, net market places, and electronic markets. These markets all have common characteristics.

1. Reliance on the Internet
2. Buyers and Sellers come together without an intermediary
3. Neutrality (all buyers and sellers are treated the same)
4. Information is provided about sellers and products

In its most fundamental form, a virtual market place brings together buyers and sellers through the internet. At its highest level, a virtual market place gives a purchaser and supplier the opportunity to re-engineer the sales administration process, improve forecasting and scheduling, renew its go-to-market approach, shorten its order-to-cash cycle, and enhance customer service (Steel24-7). Ideally, virtual market places are centered on a particular industry. Some prominent examples are steel, agricultural products, and automotive parts. In addition to providing information on vendors and general information about its products, a virtual market may also offer product specifications, side-by-side comparisons, technical papers, and market analysis.

Many challenges exist in setting up an e-marketplace. Primary among these are identifying the tools necessary to use the market, providing a secure environment, pricing, payment, and fulfillment. For an orderly marketplace, Internet protocols must be selected. The cost of the technology to access and engage in the market must not be prohibitive. Security and privacy must be adequate to ensure confidential transactions. Authentication and authorization of users from many organizations must be possible. Private communication must be assured.

Pricing policies may be set or bartered. A common example of bartering, or auctioning, is E-Bay for consumer products. Payment procedures can be predetermined or arranged between the buyer and the seller. Finally, fulfillment of orders must be insured. As in the case of traditional marketplaces, failure to deliver in a timely manner will result in firms losing market power and ultimately may lead to failure (McKnight).

A final issue of concern in virtual markets is jurisdiction and governing law. Virtual markets place its members in the global trading community. Since e-markets are a recent phenomenon, defining the legal system responsible for settling disputes is an evolving process. Current legal reasoning places jurisdiction in the locality of the market. In a virtual market, however, one must ask where the market actually exists. While the FTC has attempted to exert control over on-line transactions, a definitive ruling on the jurisdiction for international e-market places has not yet been made.

## 50.8   RADIO FREQUENCY IDENTIFICATION TAGS

In November 2003, Wal-Mart gathered together its 120 top suppliers to announce it would require radio frequency identification tags (RFID) on shipping pallets and cases of merchandise. Wal-Mart set a deadline of January 2005 for its top 100 suppliers. The remaining suppliers will had until the start of 2006 to meet the requirement (Sliwa).

A basic RFID system has three components.

1. Antenna
2. Transceiver
3. Transponder (tag)

The antenna activates the tag, reads, and writes data to it. When an RFID tag moves past a reader, its information is transmitted to a host computer for processing. Most common RFID systems are passive and contain their own power source, have a short transmitting range, operate at a low frequency, and have a low cost. While RFID has existed since the 1960's recent technological changes have reduced the cost and allowed the technology to be used in more applications.

A common everyday use of RFID is the automatic reading of prepaid passes on toll roads. The advantages of RFID are many fold. For example, RFID is extremely fast, non-contact, does not require line of site, and can operate in a variety of weather conditions. In the case mentioned above, the benefits of RFID will go to Wal-Mart, while the costs are the responsibility of the suppliers. Kara Romanov, an analyst with AMR Research, Inc., estimates the start-up costs for a supplier who ships 50 million containers per year will run between $13 million and $23 million. These costs include RFID tags and associated hardware and software (Sliwa).

SamSys Technologies of Richmond Hills, ON and Thing Magic, LLC of Cambridge, MA are two leaders in the application of RID to supply-chain management. Sam-Sys is dedicated to an open system environment that will not limit RID to a single protocol or range of frequencies. This philosophy is based on the premise of many vendors and readers that will work seamlessly together (Sassy).

Thing Magic was founded in 2000 by five MIT graduates. It has developed low cost RFID systems. Presently, ThingMagic is developing and marketing protocol agile RFID tag readers (ThingMagic). In addition to Wal-Mart, the Department of Defense (DOD) is a key player in RFID development and deployment. The Department of Defense has issued a new policy, which requires all suppliers embed passive RFID chips in each individual product if possible, or otherwise at the level of cases or pallets by January 2005. In February 2004, the DOD hosted a summit for its suppliers to discuss its RFID plans (Broersma). To quote Colin Cobain the Chief Technology Officer of Tesco Stores: "The question is not will RFID change the way you do business. The question is will you be ready" (ThingMagic).

## 50.9   SYNCHRONIZED PLANNING ACROSS THE SUPPLY-CHAIN

"Synchronized planning, in the form of collaborative forecasting and replenishment, coordinated production, inventory and capacity plans, information integration, and direct linkages of ERP systems, is one of the most exciting developments in supply chain management in many industries" (Synchronous). Synchronized Planning involves key steps (Lee).

1. Information integration
2. Planning synchronization
3. Workflow coordination
4. New business models

First, information integration requires information sharing and transparency. It is the sharing of information among the members of the supply chain. Information exchanged may include inventory levels, production schedules, and shipment schedules. The benefits include better job scheduling and a reduction of the bullwhip effect. "The effect indicates a lack of synchronization among supply chain members. Even a slight change in consumer sales ripples backward in the form of magnified oscillations upstream, resembling the result of a flick of a bullwhip handle" (Planning synchronization defines what is to be done with the information that is shared. This can include collaborative planning and joint design. The benefits are lower cost and improved service.

If planning synchronization is the "what" is to be done with shared information, workflow coordination is the "how" it is done. Operations that can be coordinated include procurement, engineering and design changes, and production planning. Benefits include early time to market, improved service, and gains in efficiency. Synchronized planning can lead to new business models. Not only can these new business models redefine workflow, they can lead to changes in responsibility for different parts of the supply-chain. A redefined supply-chain can jointly create new products and lead to expansion into new markets (Lee).

Synchronized planning, however, cannot be accomplished without a tight linkage of all companies in the supply chain. Channels of communication must be well defined and the performance of each member in the chain must be monitored. The integrated supply-chain must hold members responsible for their part in the process. As product life cycles grow shorter and shorter, efficient synchronization of the supply-chain grows in importance. To ensure that the supply-chain is driven by consumer demand, and to decrease the bullwhip effect, synchronized planning is critical (Lee).

## Supplier Performance Management

As the supply-chains of different organizations become tightly intertwined, it becomes necessary to measure the performance of each member of the chain. Former Federal Reserve Chairman Alan Greenspan testified before Congress in February 2001 that businesses were unable to anticipate the economic slowdown of the last recession, overbuilding inventories despite significant supply-chain automation (Fonstad). Even the use of the latest technology, therefore, may not guarantee that a supply-chain is operating efficiently.

One way to answer the question of how well a supply-chain is functioning is to develop supplier scorecards. There are five steps in developing an effective scorecard (Golovin).

1.  Agree on what is important and how to measure it
2.  Use web based incident reports to communicate problems as they occur
3.  Engage in continuous supplier management
4.  Measure to prevent rather than react
5.  Use web based software that all suppliers can utilize without making expensive investments in software and training

It is important that the buyer and seller agree at the outset on what is important and how it is measured. This is critical because once decided upon, the supplier will optimize its work to the designated criteria. If just in time delivery is a priority, the supplier may concentrate on this aspect of the order to the detriment of other factors. In addition, benchmarks to measure supplier performance must be realistic and attainable.

Actual performance should then be consistently tracked against these benchmarks. The manufacturer and supplier should work together to develop benchmarks that are consistent with industry performance and product specifications. The use of web based incident reports is important in keeping track of problems as they occur. Incident reports

should not be used only to track problems, but should be used to resolve the problem in real time. It is also important to measure the time it takes the supplier to correct the problem.

Continuous supplier management, sometimes referred to as supplier engineering, has become more important as manufacturers outsource more of their operations. A 90-day review cycle can be ruinous when you are manufacturing an innovative product. "Innovative products typically have a life cycle of just a few months" (Chase). A 90-day review cycle may come close to exceeding the competitive advantage of an innovative product. Effective continuous supplier management must be geared to specific periods and tolerances. This is then tied to web based incident reports that enable alarms to ring when products, or delivery, are out of agreed upon tolerances.

An effective supplier scorecard should be set up to prevent problems as opposed to reacting to them. The sooner you know there is a problem the lower the cost of resolving it and the greater the chance of preventing it altogether. The best scorecard not only measures events after they have happened, they continually monitor performance in real time. The use of automation is key to making this happen. For example, a system that matches invoices with purchase orders will catch pricing errors before a check is cut and a manufacturer's money is out the door. Utilizing web-based software not only decreases the cost of a supplier integrating with a manufacturer, it speeds up the integration process. Web-based software also enables suppliers both small and large to participate in the supply-chain.

The other four points listed above all rely on the ability of a manufacturer and a supplier to participate in the planning, sourcing, quality control, and delivery of a product. The Internet enables all members of the supply-chain to collaborate and work together as a team. Finally, by making supplier performance web-based, suppliers are able to participate in their own performance improvement (Golovin).

## 50.10  RECENT DEVELOPMENT IN SUPPLY CHAIN MANAGEMENT SOFTWARE

1. Base Rate, Carrier selects & match pay (version 2.0) developed by Distribution Sciences Inc. which is useful for computing freight costs, compares transportation mode rates, analyze cost and service effectiveness of carrier.

2. A new software programme developed by Ross systems Inc. called Supply Chain planning which is used for demand forecasting, replenishment & manufacturing tools for accurate planning and scheduling of activities.

3. P&G distributing company and Saber decision Technologies resulted in a software system called Transportation Network optimization for streamlining the bidding and award process.

4. Logility planning solution was recently introduced to provide a programme capable managing the entire supply chain.

## 50.11  TOOLS AND TECHNIQUES OF IT

### Electronic Commerce

It is the term used to describe the wide range of tools and techniques utilized to conduct business in a paperless environment. Electronic commerce therefore includes electronic data interchange, e-mail, electronic fund transfers, electronic publishing, image processing, electronic bulletin boards, shared databases and magnetic/optical data capture. Companies are able to automate the process of moving documents electronically between suppliers and customers.

### Electronic Data Interchange

Electronic Data Interchange (EDI) refers to computer-to-computer exchange of business documents in a standard format. EDI describe both the capability and practice of communicating information between two organizations electronically instead of traditional form of mail, courier, and fax. The benefits of EDI are:

1. Quick process to information.
2. Better customer service.
3. Reduced paper work.
4. Increased productivity.
5. Improved tracing and expediting.
6. Cost efficiency.
7. Competitive advantage.
8. Improved billing.

Though the use of EDI supply chain partners can overcome the distortions and exaggeration in supply and demand information by improving technologies to facilitate real time sharing of actual demand and supply information.

### Bar Coding and Scanner

Bar code scanners are most visible in the checkout counter of super market. This code specifies name of product and its manufacturer. Other applications are tracking the moving items such as components in PC assembly operations, automobiles in assembly plants.

### Data Warehouse

Data warehouse is a consolidated database maintained separately from an organization's production system database. Many organizations have multiple databases. A data warehouse is organized around informational subjects rather than specific business processes. Data held in data warehouses are time dependent, historical data may also be aggregated.

### Enterprise Resource Planning (ERP) Tools

Many companies now view ERP system (e.g. Baan, SAP, People soft, etc.) as the core of their IT infrastructure. ERP system have become enterprise wide transaction processing tools which capture the data and reduce the manual activities and task associated with processing financial, inventory and customer order information. ERP system achieve a high level of integration by utilizing a single data model, developing a common understanding of what the shared data represents and establishing a set of rules for accessing data.

E-business has been the logical outgrowth of e-commerce. E-business adopts the power of the Internet to accelerate the growth of supply-chain integration. While E-business has had a tremendous impact on supply-chain management, it also can be adapted to both front end and back end business operations (Lee). Improved inventory control and increased profits are two of the benefits of improved supply-chain management. As noted in the introduction, Nike missed its 2001 earnings targets due in part to the failed implementation of a supply-chain automation project. It has also been estimated that more than $30 billion dollars in excess inventories can be eliminated through improved supply-chain management. These real savings can be brought straight to the bottom line.

Four new technologies and business practices that harness the power of the Internet are virtual market places, radio frequency identification tags, synchronized planning (RFID), and supplier performance management. Virtual markets enable buyers and sellers to come together 24/7 in effect creating a store that never closes. The additional advantages

of virtual marketplaces are the elimination of an intermediary, access to product and vendor information, and a neutral market where all buyers and sellers are treated equally. Virtual markets give both buyers and sellers the opportunity to re-engineer their sales administration process.

As noted above, RFID has existed since the 1960's, however, improvements in technology and paring RFID with the Internet has expanded this tracking method beyond its limited past in manufacturing plants. The three components of an RFID system are an antenna, transceiver, and a transponder (tag).

Synchronized planning when applied across a supply chain consists of collaborative forecasting and replenishment, coordinated production, inventory and capacity planning, information integration, and direct linkage of ERP systems. The four key steps in synchronized planning are information integration, planning synchronization, workflow coordination, and the opportunity to develop new business models. Key to synchronized planning is using the Internet for information sharing. The benefits of synchronized planning include better job scheduling and reduction of the bullwhip affect. The bullwhip affect magnifies oscillations upstream in the supply-chain caused by a change in consumer sales. Synchronized planning also defines what is to be done with shared information and how it will be done. As product life cycles grow shorter, efficient synchronization of the supply-chain rewards firms who seize its potential.

Supplier score cards are a method of evaluating members of the supply-chain in increasingly intertwined organizations. As Alan Greenspan pointed out in 2001, many firms were unable to anticipate the last recession and continued overbuilding inventory despite having invested heavily in supply-chain automation. This statement underscores the need develop the tools to monitor the performance of firms up and down the supply-chain. The five steps to develop an effective scorecard are agreeing on what is important and how it will be measured, the use of web-based incident reports, engagement in continuous supplier management, measuring to prevent problems, and the use of web-based software. In rolling out these tools, it is imperative that both the buyer and the seller first agree on what is important and how it will be measured. The other steps flow from the first.

The Internet has had an enormous impact on the personal and professional lives of businesspersons. On the business side, the Internet has brought new life to existing technologies and offered businesses the opportunity to engage in the world marketplace. The harnessing of the Internet by business has enabled greater cooperation and information exchange up and down the supply-chain. The Internet has enabled businesses to improve the supply-chain by the way they manage inventory, place orders, and communicate critical information with each.

## 50.12  EMERGING TECHNOLOGIES REVOLUTIONIZING SUPPLY CHAINS

Innovation is transforming traditional, linear supply chains into ones that are more connected, intelligent, scalable, and nimble. Sensors are enabling data collection, advancements in computing power have improved predictive analytics, and supplemental tools – such as automation and wearable's – are creating digital, continuously operating supply chains and interconnected networks of supply chain workers, according to MHI, the largest material handling, logistics and supply chain association in the United States.

The 2016 MHI Annual Industry Report, developed in collaboration with Deloitte, reflects the views of nearly 900 industry insiders from a wide range of industries including manufacturers, distributors, service providers, and others – more than 50% of them with senior executive, general manager, or department head titles.

The report introduces the concept of the always-on supply chain: "An integrated set of supply networks characterized by a continuous, high-velocity flow of information and analytics, creating predictive, actionable decisions that better serve the customer."

**ADOPTION RATE**
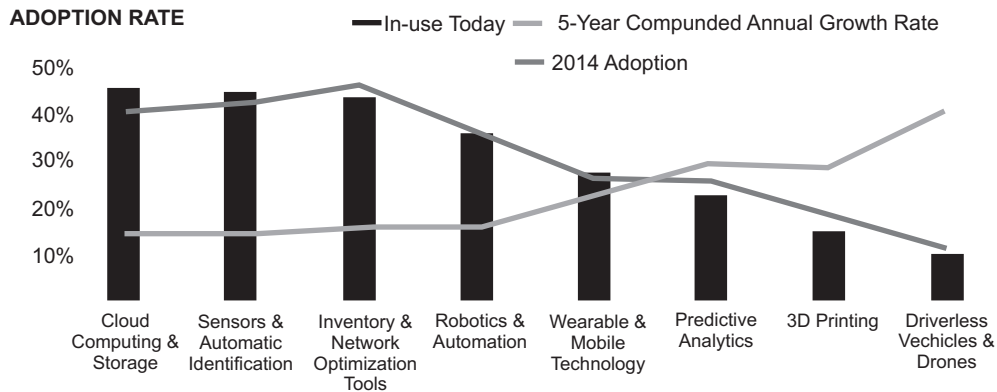


This report also provides an update on eight technologies that are enabling these always-on supply chains and profiles the dramatic impact they are having (and will continue to have) on supply chains and the people who run them. They include:

- Predictive analytics
- Robotics and automation
- Sensors and automatic identification
- Wearable and mobile technology
- Driverless vehicles and drones
- Inventory and network optimization tools
- Cloud computing and storage
- 3D printing

A full 83% (up from 75% last year) of survey respondents believe that at least one of these eight technologies could either be a source of competitive advantage or a source of disruption for supply chains in the next 10 years. In fact, respondents considered each of them to be an even greater source of competitive advantage and disruption than just one year ago.

The survey also found that two of these technologies (robotics and automation, driverless vehicles and drones) have already had a bigger and more rapid impact on supply chains than previously predicted. This accelerated pace of change is dramatically altering the way supply chains work, how they are managed, and how the always-on network is evolving.

"The always-on supply chain has the potential to deliver massive economic and environmental rewards. It can boost productivity and sustainability, drive new markets, and encourage innovation, resulting in exponential change for industry and society as a whole

These technologies include:

- Inventory and network optimization tools
- Sensors and automatic identification
- Cloud computing and storage
- Robotics and automation
- Predictive analytics

- Wearable and mobile technology
- 3D printing
- Driverless vehicles and drones

A survey conducted by The U.S. Roadmap for Material Handling & Logistics group that identified the eight technologies, reports that 75 percent of "respondents believed that at least one of the technologies could either be a source of competitive advantage or disruption in their industry in the next 10 years." The top four technologies selected by respondents include inventory and network optimization, sensors and automatic ID, robotics/automation and predictive analytics.

As a supply chain professional responsible for warehouse, distribution and/or **fulfillment operations**, we will take a closer look at these technologies and see how you can benefit from them. With customer demands for lower delivery costs, faster response times and rising service expectations, managers can focus on using one or more of these technologies to speed fulfillment, increase throughput and lower costs.

### Inventory and Network Optimization Tools

Companies use these tools for transport, supply chain network, production and inventory optimization to help them deploy assets and position inventory in the right location at the right cost to meet the right customer service level. Positioning inventory closer to customers speeds fulfillment times, but with Omni-channel retail, companies need to have a holistic view of inventory to ensure they can fulfill orders, regardless of where the inventory lies. Understand your customers' needs and balance those with costs of holding inventory to keep costs as low as possible. Network optimization tools can be used to determine the optimal location of distribution centers relative to customer segments.

### Sensors and Automatic Identification

The report mentions that by 2018, "the total market for **RFID** is expected to more than double in size to $20 billion." More and more devices are embedded with technology that can communicate and interact with other equipment. The **Internet of Things (IoT)** allows for the remote monitoring of equipment, containers, pallets or packages to see how equipment is performing or to track products throughout the supply chain. Sensors and automatic ID equipment like RFID and bar code readers are among IoT devices. In the warehouse, these devices are used for inventory tracking, receiving, put-away, cycle counting, picking, restocking, and data entry. Adopting these technologies and the IoT improves visibility across the entire supply chain, lowers costs, and streamlines operations. A Warehouse Control System (WCS) is key to IoT success, monitoring and controlling all of the intelligent devices in a warehouse.

### Cloud Computing and Storage

Cloud computing is helping companies share data with multiple supply chain trading partners across many locations. Many vendors are offering their solutions built on cloud-based architectures to lower costs of using software, providing a faster time to market and creating scalability for easier upgrades. Many vendors are now offering their warehouse management systems software in the cloud, eliminating the cost of administration and support. Cloud-based WMS solutions are easily scalable, allowing businesses to accommodate seasonal spikes or changes in demand.

### Robotics and Automation

Robots of today have the ability to do repetitive tasks much faster and cheaper and with fewer errors than humans. Robots are used in the warehouse for the picking, packing, and

slotting of orders; loading, unloading and stacking operations; and in the receiving and put-away areas. Companies are finding that when automation and robotics are deployed, productivity increases, warehouse efficiency is improved and response times are much faster. As the price of robotics comes down in the market, small to mid-sized companies are deploying them, helping these businesses to save on labor costs.

Amazon is known for their use of robots in their distribution centers. Robots carry shelves of products across the floor to human workers who stack them with new products or retrieve goods for packaging. These robotic shelves allow more products to be packed into smaller spaces while improving the efficiency of the picking process.

### Predictive Analytics

Supply chains are driven by data; analyzing the data gathered from the supply chain helps businesses to gather insights into what is happening and to make better and more informed decisions. Predictive analytics begins with capturing historical data and analyzing that data in a meaningful way. It utilizes a variety of statistical, modeling, data mining, and machine learning techniques to study recent and historical data, thereby allowing analysts to make predictions about the future so managers can plan ahead rather than be in reactive mode. With the data, businesses can understand what they are doing and then use that data to take the company in new positive directions. Predictive analytics lets managers manage inventory better and reduce variability in lead times, enhancing service levels and lowering costs.

### Wearable and Mobile Technology

Wearable and mobile technologies, like Smart Watches or iPads, give people immediate access to information regardless of where they happen to be. Voice-directed scanners allow people to collect and display data without using their hands. Some of the upcoming applications of this new technology include order picking, visual inventory cycle counts, receiving inventory, tracking order and expediting shipments. Voice-directed equipment significantly improves productivity because workers have their hands free to pick orders. Fulfillment accuracy is greater also when compared to manual operations. W&H Systems' next generation. Wearable systems (WS) now works on a Smart Watch, allowing warehouse managers to gather critical key performance indicators to better manage their distribution and fulfillment operations from their wrist. With real-time visibility into warehouse operations 24/7, managers can better meet the demanding requirements of today's modern distribution operations.

### 3D Printing

3D printing technology manufactures products by layering materials from a digital 3D blue print, creating complex designs, speeding products to market, and reducing waste compared to traditional manufacturing methods. It is especially useful in the production of service parts and for new product prototyping. This new emerging technology may eventually transform how many products are manufactured and distributed.

### Driverless Vehicles and Drones

Research shows that by 2017, 20 percent of logistics organizations will use drones as part of their operations. Also, by 2030, driverless vehicles are expected to represent 25 percent of the passenger vehicle population in mature markets. While these products have yet to enter the mainstream consumer market, some companies are using them for last mile delivery of orders by retailers, food delivery by restaurants and parcel deliveries. Driverless vehicles and drones offer several benefits over traditional manned vehicles including lowered costs by using less fuel, reduction of human error, and reduced stress.

By understanding and deploying emerging technologies, companies will be able to stay more competitive in this fast paced world while meeting customer expectations for complete, accurate and quicker order deliveries.

## SUMMARY

World is shrinking day by day with advancement of technology. Supply-chain management is an interesting and complex subject. It goes to the core of new business methods in the 21st century. The near universal availability of the Internet is the enabling technology for changes in how the supply-chain of an enterprise is managed. The Internet also allows organizations to adopt new business practices and enter new markets. By harnessing the power of the Internet, supply-chain management will continue to evolve beyond the changes being implemented today.

Customers' expectations are also increasing and companies are prone to more and more uncertain environment. Companies will find that their conventional supply chain integration will have to be expanded beyond their peripheries. The strategic and technological innovations in supply chain will impact on how organizations buy and sell in the future. However clear vision, strong planning and technical insight into the Internet's capabilities would be necessary to ensure that companies maximize the Internet's potential for better supply chain management and ultimately improved competitiveness. Internet technology, World Wide Web, electronic commerce etc. will change the way a company is required to do business. These companies must realize that they must harness the power of technology to collaborate with their business partners. That means using a new breed of SCM application, the Internet and other networking links to observe past performance and historical trends to determine how much product should be made as well as the best and cost effective method for warehousing it or shipping it to retailer.

The ultimate objective is to get the right amount of their products from their source to their point of consumption with the least amount of time and with the lowest cost. Supply chain management systems can be built using intranets, extranets, or special supply chain management software.

## REFERENCES FOR FURTHER READING

1. David Simchi Levi, Philip Kaminsky, and Edith Simchi Levi. *Designing and Managing the Supply Chain*: Concepts, Strategies, and Case Studies. Irwin McGraw-Hill, (2000)
2. Sunil Chopra and Peter Meindel. *Supply Chain Management: Strategy, Planning, and Operation*, Third Edition Prentice Hall of India, (2007)
3. R.B. Handfield and E.L. Nochols, *Jr. Introduction to Supply Chain Management*. Prentice Hall, (1999)

## REVIEW QUESTIONS

1. Explain the role of information technology in supply chain.
2. How information driver influence other drivers of Supply chain?
3. Capturing, analyzing and making it available across supply chain leads to success of supply chain Comment on the statement.
4. Predict the future of IT in supply chain.
5. Discuss the IT tools and technologies for supply chain management.