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IT Supply Chain & Management

Supply Chain Information System

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1 Introduction

1.1 Background

The supply chain - a term increasingly used by logistics professionals – encompasses every effort involved in producing and delivering a final product, from the supplier's supplier to the customer's customer. Four basic processes -- Plan, Source, Make, Deliver -- broadly define these efforts, which include managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer.

Because of its wide scope, supply chain management must address complex interdependencies, in effect creating an “extended enterprise” that reaches far beyond the factory door. Today, material suppliers, channel supply partners (wholesalers/distributors, retailers), and customers themselves, are all key players in supply-chain management. In order to efficiently and effectively manage a supply chain, as well as to gain competitive advantage, ***supply chain information system*** (SCIS) is increasingly become extremely important.

1.2 Objective

This paper describes the key components of a supply chain information system (SCIS), their interaction with each other within SCIS, and their contribution to improve efficiency and coordination. This paper will also discuss technical standards or interfaces and any potential problems.

1.3 Methodology

Following this section, this paper will describe supply chain perspectives of information functionality and principles. It will then continue on SCIS applications on the transaction systems, management control, decision analysis and strategic planning application. We will complement the discussion with SCIS supporting technologies and applications. The conclusion will try to extract the major points in this paper.

2 SCIS Information Layers

Information is viewed as one of the keys to logistics competitive advantage for the future. However, simple SCIS which handles only basic order processing, is not adequate to achieve this goal. Competitive SCIS must include:

2.1 Transaction system

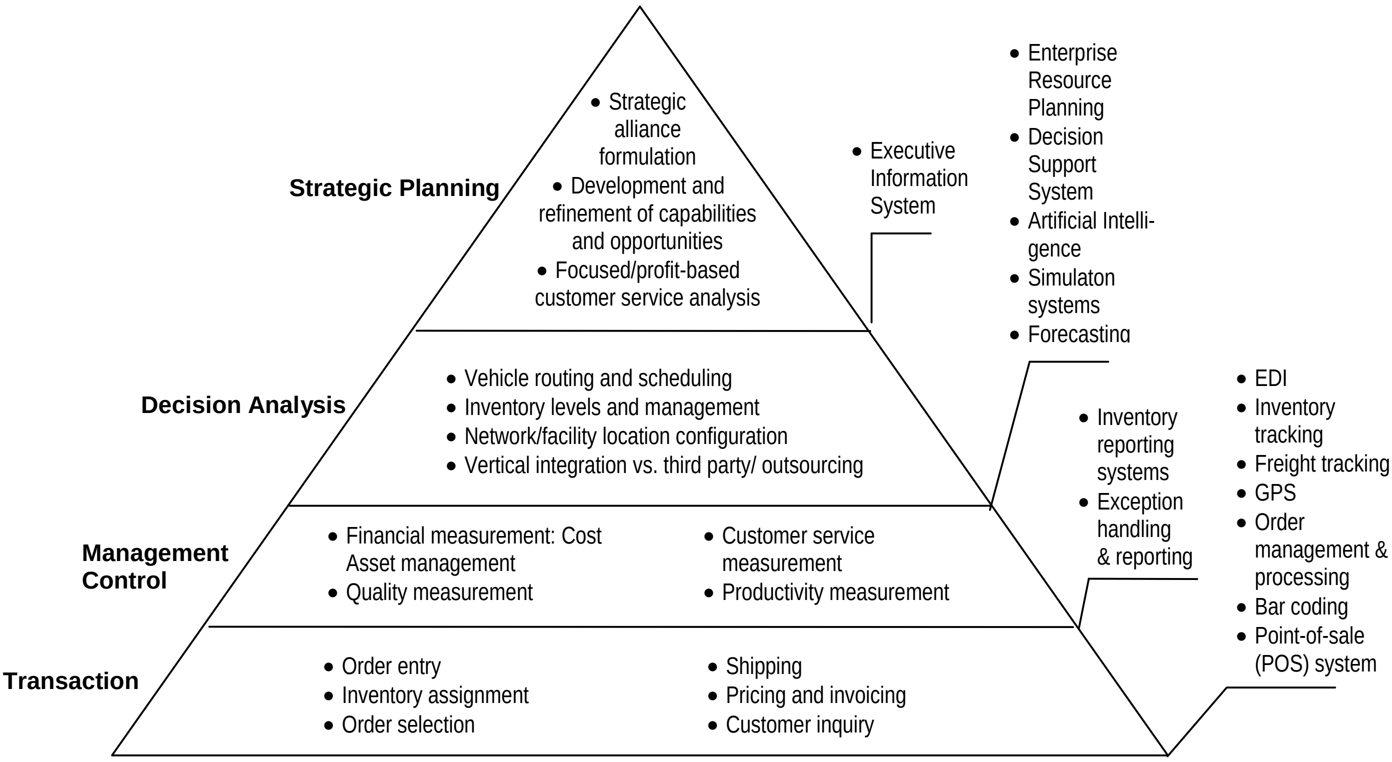
This level is the heart of SCIS, which initiates and records individual logistics activities. Transaction include order entry, inventory assignment, order selection, shipping, pricing, invoicing and customer inquiry. Transaction system is characterized by formalized rules, large volume transactions and an operational day-to-day focus, which focus on system *efficiency* (faster processing or higher transaction volume with fewer resources). Electronic data interchange (EDI) has become a transaction system messaging standard.

2.2 Management control system

This second level focuses on performance measurement and reporting to provide feedback. It is also important that SCIS be able to identify *exceptions* as they are being processed. Management control exception information is useful to identify potential customer or order problems. For example, proactive SCIS should be able to predict future inventory shortages based on forecast requirements and anticipated receipts. Management control system includes the reporting module of inventory information system.

2.3 Decision analysis system

This third level includes decision applications to assist managers in identifying, evaluating and comparing logistic strategic and tactical alternatives. Typical analysis includes vehicle routing and scheduling, inventory management, facility location, cost-benefit analysis of



operational tradeoffs and arrangements. It may include modeling and analysis tool, which can report a wide range of potential alternatives. Unlike management control, decision analysis focused on evaluating future *tactical* alternatives, and it needs to be relatively unstructured and flexible to allow considerations of a wide range of options. The users need relatively more expertise to use it. Decision analysis SCIS emphasis shifts from efficiency towards *effectiveness* (i.e. identifying profitable vs. unprofitable accounts). Decision analysis system may include (obviously) decision support system (DSS), enterprise resource planning (ERP), artificial intelligence application, and simulation/modeling system.

2.4 Strategic planning system

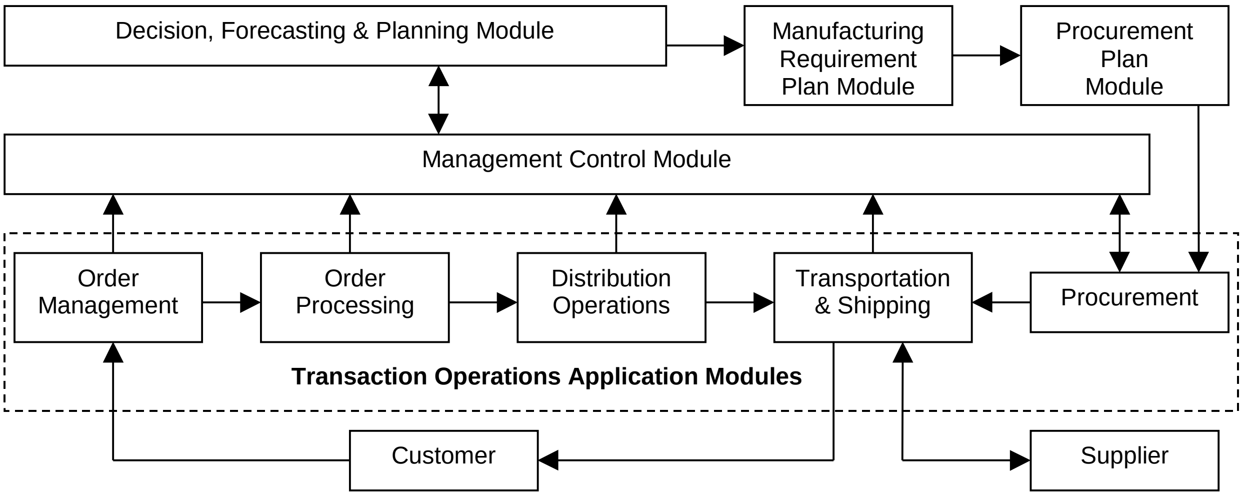
The last level, focuses on information support to *develop* and *refine* supply chain strategy. Often it is an extension of the decision analysis level, but typically more abstract, less structured and long-term focus. Examples of strategic planning decisions include synergies made possible through strategic alliance, development and refinement of firm capabilities and market opportunities, as well as customer responsiveness to improved service. The system may employ an executive information system (EIS) with drill-down feature to let executives dig more information from the layers below.

3 SCIS Application Architecture

3.1 Core Transactional System SCIS Application

Operations include the transaction activities necessary to manage and process orders, operate distribution facilities, schedule transportation, and integrate procurement resources. This process is completed for both customer and enterprise replenishment orders. Customer orders reflect demands placed by enterprise customers. Replenishment order control finished good movement between manufacturing and distribution facilities. This core SCIS application make extensive use of EDI and bar code technology.

Customer's order will be processed. If the desired product is available in the inventory, the product will be shipped accordingly. But if the product is not available, a schedule for production has to be made, which later may trigger procurement process. Not that other modules, which sometimes considered external to SCIS such as MRP (Manufacturing Requirement Plan) module, will definitely be affected by the SCIS.



Each of those modules transaction level modules can be described below:

3.1.1 Order Management

This is the entry point for customer orders and inquiries by automated (EDI) or traditional (fax, phone, paper) means. It can also offer information such as product availability or delivery dates. Order management primary functions includes order entry, inventory availability, order acknowledgement, order modification, pricing, order status inquiry, reassign order source, service management and credit check.

3.1.2 Order Processing

Order processing assigns or allocates available inventory to open customer and replenishment orders. Among its functions are: generate invoice, inventory reservation, release reserved inventory, verify shipment, reassign order source, create/process/release blanket order.

3.1.3 Distribution operations (Inventory control / Warehousing)

Distribution operations incorporate functions to guide physical activities like product receipt, material movement, storage and order selection, therefore often termed *inventory control* or *warehousing* control. Typical distribution operations includes: assign & track storage locations, inventory control, labor scheduling, lot control, order selection location replenishment, receiving and put away, and storage control.

3.1.4 Transportation & Shipping

This application module is intended to coordinate shipping to customers and from suppliers. We will discuss more on the ‘Freight Information & Tracking System’ sub-section later.

3.1.5 Procurement

Procurement manages purchase order preparation, modification, and release, in addition to tracking vendor performance and compliance. Although procurement systems have not traditionally been considered part of SCIS, the importance of integrating it is obvious when managing the entire supply chain. Integration of procurement and logistics schedules/activities allows coordination of facility and transportation utilization.

3.2 Management Control System applications

In order to monitor the transaction layer applications, ***reports*** to the supervisors are generated. Some of the application in this level differ in the amount of human interaction required. Some application will report instantly for every new orders entered, and always require manual intervention for approval. Such systems do not illustrate the exception-based criteria discussed earlier, since all replenishment orders require explicit approval. More sophisticated applications automatically place replenishment orders and monitor their progress through the replenishment cycle. The sophisticated applications illustrate a more ***exception-based*** philosophy, since planners are required to intervene only for “exceptional” replenishment orders.

One of the concern of this application is ***to measure*** whether the customer service level established by the management has been achieved or not. Naturally, it involves measuring other modules as well such as inventory level, turn over and productivity level.

In some implementation, the control system application may involve some low level decision support system, forecasting, or planning features. The division stated in this paper is not meant to be rigid. More discussion on them follows.

3.3 Decision and Forecasting applications

Planning, decision making and coordination include the activities necessary to schedule procurement, production, and logistic resource allocation throughout the enterprise. Specific decision includes managerial objectives, determination of logistics, manufacturing and procurement requirement.

3.3.1 Decision Support Systems (DSS)

A Decision Support Systems (DSS) is an interactive computer-based system intended to help managers make decisions. A DSS helps a manager retrieve, summarize and analyze decision relevant data. It may be primarily a data oriented DSS or a model-oriented DSS. It may be an enterprise-wide DSS that supports a large group of managers in a networked, client server environment with a specialized data warehouse or a desktop, single user DSS on the PC in a manager's office.

As we mention before, a specific DSS may only support lower level operation decision making, or it may support more strategic and long-run decision making and problem solving. In logistics, it may help to assist logistics executives in their decision processes, to support, but not replace, managerial judgement, and to improve the effectiveness of logistics decisions.

The quality of underlying data used as input is the most critical element of DSS, because it will determine the answer what users actually ask and determine the decision suggested by the DSS. In some settings, a specific DSS model may use live or "real time" data received over a local or wide area network in its calculations.

The inherent design and capabilities of our DSS also influence the fast based decisions we can make. Users must know exactly how the software models the problem, or else the user can make a wrong decision.

Other potential problem is it is easy for managers to develop unrealistic expectations for their new DSS. Even the best DSS will not eliminate "bad" decisions. Because of its wide scope and high development cost, an enterprise-wide DSS is likely to have credibility with users. So there is a need to recognize that enterprise-wide DSS can compound and magnify the harm from decision errors.

3.3.2 Expert System in DSS

Knowledge-based systems are also sometimes called "expert systems". These computer programs analyze data using symbolic logic, have an explicit knowledge base, and have an ability to explain conclusions in a way that users can understand. Knowledge-based systems can be useful to remind an experienced decision maker of options or issues to consider and it help a new manager make a complex decision.

3.3.3 Modeling & Simulation Tools in DSS

Another integral part of DSS, is modeling and simulation module. Modeling can be defined as the process of developing a symbolic representation of a total system. A model must accurately represent the 'real world' and be managerially useful. For example, for some reason the demand of a certain product drops, the model should give some suggestion how much the procurements for production need to be reduced.

Simulation is a technique used to provide a model of a situation so that management can determine how the system is likely to change through the use of alternative strategies. The model is tested using known facts.

By utilizing expert system, modeling & simulation tools, DSS can forecast and predict appropriate inventory level, procurement, or distribution strategies.

3.4 Strategic Planning applications

The Executive Information System (EIS) allows executives to see critical information at a glance. EIS is a critical management tool that allows users to visualize up-to-the-minute company status in one quick and easy to read reference.

EIS data is displayed graphically, and the information or the graph can be viewed from a different angle. A summary form displays the crucial data elements of the company on a single screen, and allows for drill-downs to detailed information.

EIS has bring the information of SCIS to the executive managers. Performance and best practice can be charted across areas such as sales, billing, parts, scheduling, stock control, and materials. Managers responsible for one of these parts of the business can look at their own cube view and analyze historical and current trends.

Thus, a purchasing manager can evaluate supply channels by charting late deliveries. These can be illustrated as a simple league or against a mean. Of course the view can then be changed to show which products are not being delivered on time across the whole supply chain, and extending to another level, which suppliers are failing to deliver on which products.

EIS is more on exception based, since usually executives don't bother a thing if everything is still under pre-determined level. It will trigger a warning (usually with visual cues on the graphs) whenever something has reach beyond expectations. So, whenever performance exceeds or falls below an expected level, the system can alert users through 'traffic lights'. A sales manager can see sales figures for a region or a product in red or green according to how actual performance compares with a pre-set target. As soon as he sees a 'blip', he can 'drill down' to determine the cause.

Besides EIS, there is also another application, ***Enterprise Resource Planning*** (ERP), which we will discuss later in a separate section. ERP sits between top level EIS application and lower level specific DSS applications.

4 SCIS Supporting Technologies

4.1 Electronic Data Interchange

4.1.1 Definition

EDI is the *inter-organizational*, *computer-to-computer* exchange of *business documentation* in a *standard*, *machine-processable format*. The purpose of EDI is to improve the flow and management of business information, by reducing error due to redundant data entry, and also reduces document-processing time.

EDI is currently being used for all of the most common business transactions such as purchase orders, invoices, quotes, bills of lading, electronic fund transfer (EFT), status report, and receiving advice. It is also used for some very specific transactions such as residential mortgage insurance applications, healthcare claim payments and material safety data sheets. EDI has replaced many traditional modes of transmission of documents, such as mail, telephone, and even faxes.

4.1.2 Standards

Many industry associations have established their own standards for EDI, which are to be used between members of firms within their industry. In the late 1970s the American National Standards Institute (ANSI) chartered an Accredited Standards Committee (ASC) to establish EDI standards that could be used across all industries, now known as X.12 standard. In 1986 the first initiative towards a global standard EDI known now as UN/EDIFACT was launched. It stands for United Nations / EDI for Administration, Commerce and Transport.

EDIFACT is used in many parts of the world today and is expected to become the predominant standard for international EDI activity.

4.1.3 Benefits of EDI

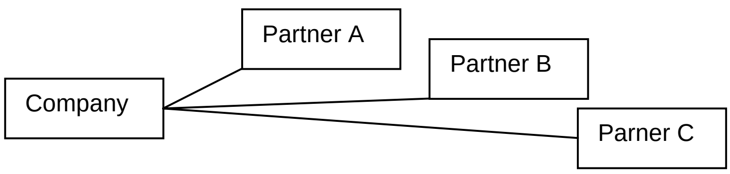
Benefits of EDI are seen as follows:

1. Reduced paper works to be created and filled
2. Improved accuracy due to automated processing
3. Increased speed of document transmission
4. Reduced clerical effort in data entry and mailing
5. Opportunity for proactive contribution by purchasing, because less time is spent on repetitive task
6. Reduced cost of order placement and processing
7. Improved information availability due to speed of acknowledgement and shipment advise
8. Reduce workload and improved accuracy of other departments through linking EDI with other systems, such as bar-coding inventory and electronic fund transfer.
9. Reduced inventory due to improved accuracy and reduced order cycle time

4.1.4 EDI Architecture

4.1.4.1 Proprietary systems

This kind of EDI system is managed and maintained by a single company which links to a number of suppliers or customers. Usually this architecture is found only at large companies, and they maintain a relatively higher trust with their partners to exchange data. The disadvantage is the cost to establish and maintain it is very high.

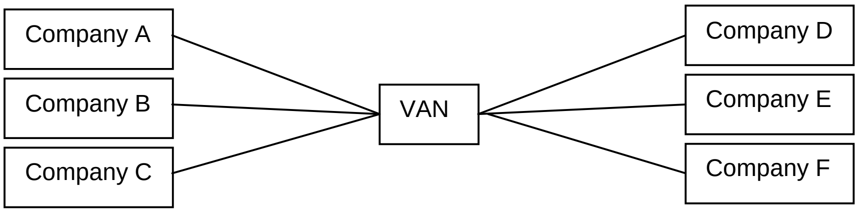


4.1.4.2 Value Added Networks (VANs)

The heart of VANs is a mailbox for each of its customer, where those customers can exchange EDI messages amongst themselves. VANs give added value to the use of EDI, which includes:

1. Time utility: With a mailbox, company does not need to maintain real-time connection with its partners. It can open the EDI messages at its chosen convenient time at will.
2. Translation utility: VANs provide EDI message standards translation service, so a company does not have to worry about the compatibility of his EDI standards with its new business partner’s.
3. Cheaper cost: Shared network is relatively cheaper than wholly owned –or leased EDI line.
4. Send-once-to-many: A single EDI messages can be forwarded to a multiple recipients by VAN.
5. Accountability: Usually VAN generates monthly audit trail to its customer (the company which uses VAN’s mailbox).

6. Security measures: VAN usually offers added-value of EDI by improving its security (e.g. authentication and encryption), and VAN may also act as a buffer between company's computers to the outside world, so no outsiders have direct access to company's internal computer.
7. Interconnectability: If the new partner has already been a customer of another VAN, EDI messages still can be exchanged between VANs.



Currently, the new trend is to use EDI over cheaper public network like Internet.

Problems with EDI is, although there exist standards, but there are still too many standards, so sometimes it *seems* that there is no standards at all. Some argued that, as a manner of fact, special purpose proprietary EDI messages can actually give competitive edge, because it was designed to serves a special function other competitors do not have..

4.2 Bar Coding

Everyday we use bar codes in our daily life. When we buy any product from supermarket they will put the bar codes and scan it. And on the operating side, the scanning of the bar codes will reduce the stock and it will trigger the ordering tick. And these bar codes will help a lot in logistic and supply. Bar codes technology is advancing rapidly.

4.2.1 Definition

Bar codes are a sequence of parallel bars of various widths, with varying amounts of space between the bars. For years bar codes have been promoted as a machine readable license plate. Each label contained a unique serial number coded in black and white bars that was a key into a database containing detailed information. That was the expert wisdom. Yet many end users wanted to code more information. They wanted the bar code to be a portable database rather than just a database key.

Bar coding can help to reduce cycling time, accuracy account of actual receipt for entire material function. The bar code error rate has been estimated at from 1 in 10,000 to 1 in 1,000,0000 compared with 1 in 25 or 30 for manually keyed data.

Small difficulty for this implementing bar codes is to get an advanced bar code scanner, which can scan in prefer way and distance. In market nowadays, there are three basic types of bar code scanning devices (contact wand, active non-contact scanner, passive non-contact scanner).

4.2.2 Two-dimensional code systems

Two-dimensional code systems have become more feasible with the increased use of moving beam laser scanners, and Charge Coupled Device (CCD) scanners. The 2-D symbol can be read with hand held moving beam scanners by sweeping the horizontal beam down the symbol. However, this way of reading such a symbol brings us full circle back to the way 1D bar code was read -- by sweeping a contact wand across the symbol. The speed of sweep, resolution of the scanner, and symbol/reader distance take on the same criticality as with contact readers and one-dimensional bar code.

There are standard bar codes to differentiate each product. Otherwise it is difficult to know which product is this and to make it globally same code. Usually a company needs to get the Universal Product Code Identification Number, which they can encode into a UPC-A or EAN-12 bar code symbol on their product. In the United States of America a company can obtain a unique six-digit company identification number by becoming a member of the Uniform Code Council (UCC).

4.3 Freight Information & Tracking System (FITS)

The idea of 'extending the conveyor belt', is that the extensive use of logistics information system will eventually lead to minimal warehouse usage. Naturally, *if* most of the goods are not in the warehouse, they must be *moving* somewhere. Actually, the goods are being distributed to some destination. This is why there is a need to have an efficient and effective freight transportation system to 'extend the conveyor belt'. To accomplish this objective, the freight information and tracking system is very important.

Information technology applications in freight transport includes:

1. Freight Management: control & customs check, information & documents to shippers and consignees, cargo tracing and tracking.
2. Fleet Management: vehicle routing and scheduling, vehicle tracing, driver communication and schedule
3. Vehicle Management: route guidance, vehicle operation and control, emergency information, vehicle position monitoring.
4. Finance and Administration: vehicle/driver monitoring, freight documentation, order processing and invoicing, costing/tariff calculations
5. Other related activities: road network information, freight/capacity exchange, market information, access to ship/trains schedules.

4.3.1 Benefits of FITS

The freight information & tracking system allow companies to increase the speed and effectiveness of order processing, which enables the firm to meet demands for higher service standards without increasing operating costs. The benefits of FITS are:

a. greater reliability and confidence in scheduling
b. faster customer billing
c. faster border check & crossing
d. faster freight loading and unloading
e. better control over the fleet
f. more accurate order tracking

4.3.2 FTIS Infrastructures

The information exchanged with freight transport is usually the standard EDI message, but the vehicle communications and location systems may include:

1. *Mobile Satellite Service:* where high speed data or digital voice transmission occurs between ground stations and mobile units, switched through satellites in geostationary orbit.

2. *Radio Determination Satellite Service:* where mobile units use radio navigation to determine their locations, which is then fed by a ground satellite station.
3. *Global Positioning System:* where the mobile unit receives its position from GPS satellite. The data output from a GPS receiver (little white hemispherical GPS antennas) on the vehicle is coupled to a modem's data port that is further coupled to a transmitter – be it a cellular radio transceiver or similar communication system radio equipment. A freight vehicle will use either a cellular radio or two-way paging network to convey the information back to base. At the operator end (homebase/vehicle pool), typical equipment consist of a landline connection, a modem and a desktop microcomputer, loaded with the software that will display the vehicle position.
4. *Cellular Telephony System:* which are operated from ground-based transmitters and can cover a cell size area from 1 km to 100 km. Because limited scope it is used mainly in urban areas.
5. *Short-range Beacon Systems:* which provide communication and location determination by infra-red, radio or microwave transmissions to and from fixed beacons at the roadsides.

4.3.3 Problems

These system will help to indicate location for each vehicle, but the difficulty for the time being is to have suit application to support this system. One of the application which need to be improved is the GIS (Graphical Information System) which can tell the exactly location for the vehicle with the input from GPS system.

Although the EDI message has somehow been standardized, there are still compatibility problems of the communication systems, pretty much the hardware and the communication protocols. Systems developed for one freight company may not be compatible with the system developed for another port in another country.

4.4 Manufacturing Resource Planning (MRP I)

In some SCIS scenario, the computer based Manufacturing Resource Planning (MRP) I is used to integrate both *production* and *inventory control* system. The objective is to minimize inventories while maintaining adequate materials for the production process. MRP I systems offer many advantages over traditional systems, including: improved business results, improved manufacturing performance results, better manufacturing control, more accurate and timely information, less inventory and less material obsolescence, etc. But MRP I does have a number of drawbacks. It does not tend to optimize materials acquisition costs. Because inventory levels are kept to a minimum, materials must be purchased more frequently and in smaller quantities. This results in increased ordering costs and higher transportation bills. And in one word, each unit costs higher, because the firm is unlikely to get a large volume discounts. That's why, it is very important to make use such efficient & effective freight transport system, which we will discuss later.

The use of automation, such as automated storage and retrieval systems (AS/RS), in comparison with manual systems, provides reduced labor cost and floor space, while increasing inventory accuracy. As other components of the warehouse become automated, firms need to computerize their tracking and information systems. Items entering the warehouse are bar code scanned and assigned storage locations by the computer. The data collected become part of the inventory information system, which is used for a variety of purpose, including the preparation of business-related documentation.

In each of those areas, the use of computer technology has become widespread. The management of inventory is moving toward greater computer utilization. Significant advantages will result, including improved customer service, lower costs, and more efficient effective operations.

4.5 Enterprise Resource Planning (ERP / MRP II)

Enterprise Resource Planning (ERP) software products are designed to be the vehicle for companies to control, monitor and coordinate the activities in all of their locations. This application sits somewhere between the Executive Information System (EIS) and the lower specific Decision Support System application (such as the previously mentioned SCIS DSS).

It was a concept developed by Gartner Group describing the next generation of manufacturing business systems and manufacturing resource planning (MRP II) software. Beyond the standard functionality that is offered, other features are included, e.g., quality, process operations management, and regulatory reporting. In addition, the base technology used in ERP will give users both software and hardware independence as well as an easy upgrade path. Key to ERP is the way in which users can tailor the application behavior so it is intrinsically easy to use.

The ERP management methodology builds on the theory that an enterprise can maximize its returns by maximizing the utilization of its fixed supply of resources. And information technology, with its increasing computer power and the ability to correlate pieces of information, has proven to be the best tool to do so.

Key functions that ERP systems provide include:

1. Finance / Accounting
2. Sales and Distribution
3. Budgeting and Planning
4. Human Resource / Personnel
5. Fixed Assets
6. Material Management and Inventory Control
7. Master Scheduling
8. Work Order Management
9. Logistics and Warehouse Management
10. Purchasing / Sourcing

By using ERP, it is clear that SCIS, which covers many aspects of distribution, inventory, material management, logistics and warehousing, will be integrated with other enterprise applications.

5 Conclusions

Information is the key to successful supply chain management because “no product flows until information flows”. The inventory manager needs direct access to the organization’s information system to properly administer materials flow into and within the organization. Information technology should be used to improve the management of the supply chain. Accurate and timely information allows a firm to minimize inventories, improve routing and scheduling of transpiration vehicles, and generally improve customer service levels. The types of information needed include demand forecasts for production, names of suppliers and supplier characteristics, pricing data, inventory levels, production schedules, transportation routing and scheduling data and other financial and marketing facts.

Thus, modern information technology will offer opportunities for the fast and safe transmission and processing of extensive amounts of data, both internally for users within the company and externally for supplies and customers. Paperless communication is coming to the forefront whereby routine tasks in order processing and scheduling will be decisively facilitated. As a result, new information technology offers great opportunities for linking the planning, control, and processing functions of inventory management. The proliferation of computerized information systems and databases, coupled with electronic data interchange (EDI), will make this facet of materials management even more significant in the future.

There are seven benefits to use information technology, although the basic setup cost is high.

1. Great accuracy. The use of bar code increases the accuracy at least 100 times.
2. More economy.
3. Faster processing time.
4. Higher visibility. Powerful software can afford an instant overview of the inventory picture across warehouses, retail units, or sales territories.
5. Immediate availability
6. Tighter customer focus
7. Higher productivity

Because the supply chain is so wide reaching, its success depends on nearly all departments within a company. However, the effort to improve supply-chain performance must be driven by senior management. Since the supply chain has become the key opportunity to gain competitive advantage, senior management needs to constantly remind their organizations that an improved SCIS performance is a business issue, not a logistics or computer systems issue.

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