Computerized logistics information systems — a key to competitiveness

Anton Čižman
Univesity of Maribor, Faculty of Organizational Sciences
4000 Kranj, Kidričeva 55/a, Slovenia
E-mail: anton.cizman@fov.uni-mb.si

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Part of an organization's ability to use logistics as a competitive weapon is based on its ability to assess and adjust actual logistics performance real time. This means the ability to monitor customer demands and inventory levels as they occur, to act in timely manner to prevent stockouts, and communicate potential problems to customers. This requires excellent, integrated logistics systems which impact all of the logistics activities. In this paper we examined how computer and information technology can be used to support logistics management. Customer order cycle and order processing systems are pointed out first. Then advanced information technologies such as decision support systems, artificial intelligence, and expert systems which are being used directly to support decision making in logistics, are examined.

1 Introduction

Logistics activity is literally thousand of years old, dating back to the earliest forms of organized trade. As the area of study however, it first began to gain attention in early 1900s in the distribution and farms products, as a way to support organization's business strategy, and a away of providing time and place utility. Since the second World War, logistics began to receive increased recognition and emphasis.

The first dedicated logistics text began to appear in the early 1960s, which also is the time that Peter Drucker, a noted business expert, author, and consultant stated that logistics was one of the last real frontiers of opportunity for organizations wishing to improve their corporate efficiency. These factors combined to increase the interest of logistics.

Computer and information technology has been utilized to support logistics for many years. It grew rapidly with the introduction of microcomputers in the early 1980s. About this time, information technology really began to explode, which gave the organizations the ability to better monitor transaction intensive activities such as the ordering, movement, and storage of goods and materials. Combined with the availability of computerized quantitative models, this information increased the ability to manage flows and to optimize the inventory levels and movements. Transactional systems such as materials requirement planning (MRP, MRP II), distribution resource planning (DRP, DRP II), and just-in-time (JIT) allow organizations to link many materials management activities, from order processing to inventory management, ordering from a supplier, forecasting and production scheduling. Information technology is seen as the key factor that will affect the growth and development of logistics [13].
The order processing system is the nerve center of the logistics system. A customer order serves as the communications message that sets the logistics process in motion. The speed and quality of the information flows have a direct impact on the cost and efficiency of the entire operation. Slow and erratic communications can lead to lost customers or excessive transportation, inventory, and warehousing costs, as well as possible manufacturing inefficiencies caused by frequent production line changes. The order processing and information system forms the foundation for the logistics and corporate management information systems. It is an area that offers considerable potential for improving logistics performance.

Organizations of all types are utilizing computers to support logistics activities. This is especially true for companies thought to be on the "leading edge," that is, leaders in their industry. Such firms are heavy users of computers in order entry, order processing, finished goods inventory control, performance measurement, freight audit/payment, and warehousing. A recent study of world-class logistics practices cited logistics information systems as a key to competitiveness [11].

Going beyond "transaction processing and tracking," decision support systems (DSSs) are computer-based and support the executive decision-making process. The DSS is an integrative system of subsystems that has the purpose of providing information to aid a decision maker in making better choices than would otherwise be possible.

To support time-based competition, organizations are increasingly using information technologies as a source of competitive advantage. Systems such as quick response (QR), just-in-time (JIT), and efficient consumer response (ECR) are integrating a number of information-based technologies in an effort to reduce order cycle times, speed responsiveness, and lower supply chain inventory.

In addition, more sophisticated applications of information technology such as decision support systems, artificial intelligence, and expert systems are being used directly to support decision making in logistics.

Despite the accessibility of sophisticated information technology, the successful implementation of computerized logistics information systems into companies remains a complex and elusive issue. This situation is still more expressed in smaller manufacturing organizations, particularly those operating in Slovenia and in the other Central European countries facing intense transition processes for incorporation into the European Union and the global information society. This case is characterized by a lack of related methodological and management knowledge and skills [8, 15] in companies, which is the major weakness rather than limited funding for investments in advanced information technology.

Therefore the purpose of this contribution is to introduce the readers with the ways that computers and IT can be used to aid the logistics mangement which plays a key role in the economy. The paper begins with the customer order cycle which is the heart of logistics information systems. After that some significant order processing systems are pointed out and the use of typical logistics management informations systems to support decision making is examined.

2 Customer order cycle

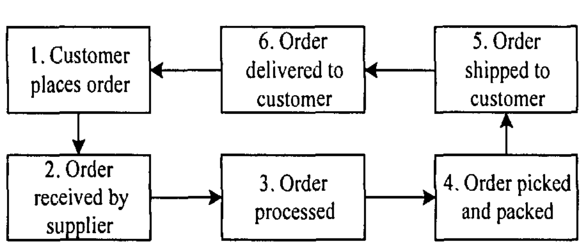
The *customer order cycle* includes all of the elapsed time from the customer's placement of the order to the receipt of the product in an acceptable condition and its placement in customer's inventory. The typical order cycle consists of the following components: (1) order preparation and transmission, (2) order receipt and order entry, (3) order processing, (4) warehousing picking and packing, (5) order transportation, and (6) customer delivery and unloading.

Figure 1 illustrates the flow associated with the order cycle. In this model taken from the customer's point of view, the total order cycle is 13 days [14]. However, many manufacturers make the mistake of measuring and controlling only the portion of the order cycle that is *internal* to their firm. That is, they monitor only the elapsed time from receipt of the customer order until it is shipped. The shortcomings of this approach are obvious.

In the example presented in Figure 1, the portion of the total order cycle that is internal to the manufacturer (steps 2, 3, and 4) amounts to only 7 of the 13 days. This ratio is usual for companies that *do not have* an *automated order entry* and *processing system.*

Improving the efficiency of the seven-day portion of the order cycle that is "controlled" by the manufacturer may be costly compared to eliminating a day from the six days not directly under the manufacturer's control. For example, it may be possible to reduce transit time by as much as one day by monitoring carrier performance and switching business to carriers with faster and more consistent transit times.

A change in the method of order placement and order entry may have the potential for the most significant reduction in order cycle time. An *advanced order processing system* could reduce the total order cycle by as much as two days. In addition, the improved information flows could enable management to execute the warehousing and transportation more efficiently, reducing the order cycle by another one or two days.



Key:

1.	Order preparation and transmital	2 days
2.	Order received and entered into system	1 day
3.	Order processing	1 day
4.	Order picking/production and packing	5 days
5.	Transit time	3 days
6.	Customer receiving and placing into storage	1 day
	Total order cycle time	13 days

Figure 1: Total order cycle

3 Advanced order processing systems

The Order entry

A customer may place an order in many ways. Historically, customers handwrote orders and gave them to salespeople, mailed them to the supplier, or telephoned them to the manufacturer's order clerk, who then wrote it up. Today, it is more common for a customer to telephone orders to a supplier's customer service representative, who is equipped with a computer terminal networked to the supplier's database.

This type of system allows the customer service representative to determine if the ordered products are available in inventory, and to deduct orders automatically from inventory so that items are not promised to another customer. This improves customer service because if there is a stockout on the item, the representative can inform the customer of product availability and perhaps arrange product substitution while the customer is still on the telephone. In addition, this type of system almost completely eliminates the first two days of the order cycle described in Figure 1.

Electronic methods, such as an electronic terminal with information transmitted by telephone lines, and computer-to-computer hookups such as electronic data interchange (EDI), are commonplace today. These methods support the maximum speed and accuracy in order transmittal and order entry. Generally, rapid forms of order transmittal require an initial investment in equipment and software. However, management can use the time saved in order transmittal to reduce inventories and realize opportunities in transportation consolidation, offsetting the investment.

There is a direct trade-off between inventory carrying costs and communications costs. In many channels of distribution, significant potential exists for *using advanced order processing to improve logistics performance.*

The Order Processing

Once the order enters the order processing system, various checks are made to determine if (1) the desired product is available in inventory in the quantities ordered, (2) the customer's credit is satisfactory to accept the order, and (3) the product is scheduled for production if not currently in inventory. If these activities are *performed manually*, a great amount of time may be required, which can *slow down* (i.e., lengthen) *the order cycle.* The norm is that these activities are performed by computer in a minimal amount of time; often these activities can be performed simultaneously with other order cycle activities. The inventory file is then updated, product is back-ordered if necessary, and production is issued a report showing the inventory balance.

Management also can use the information on daily sales as an input to its sales forecasting package. *Order processing* next provides information to accounting for invoicing, acknowledgment of the order to send to the customer, picking and packing instructions to enable warehouse withdrawal of the product, and shipping documentation. When the product has been pulled from warehouse inventory and transportation has been scheduled, accounting is notified so that invoicing may proceed. All of these processes can be automated seamlessly to reduce additional input of data, and avoid the errors, paper shuffling, and nonvalue added of manual effort.

The primary function of the *order processing system* is to provide a communication network that links the customer and the manufacturer. In general, greater inconsistency is associated with slower methods of order transmission. Manual methods of order transmission require more handling by individuals; consequently, there is greater chance of a communication error. Management can evaluate methods of order transmission on the basis of speed, cost, consistency, and accuracy. As shown in Table 1, order transmission should be as direct as possible; orders transmitted electronically instead of manually minimize the risk of human error.

Table 1: Characteristics of Various Order Processing Systems

Level	Type of Systems	Speed	Cost to implement/ maintain	Consistency	Accuracy
1	Manual	Slow	Low	Poor	Low
2	Phone in to customer service rep with CRT	Intermediate	Intermediate	Good	Intermediate
3	Direct electronic linkage (EDI)	Rapid	Investment high; operating cost low	Excellent	High

The order processing system can communicate useful sales information to marketing (for market analysis and forecasting), to finance (for cash-flow planning), and to logistics or production. Finally, the order processing system provides information to those employees who assign orders to warehouses, clear customer credit, update inventory files, prepare warehouse picking instructions, and prepare shipping instructions and the associated documentation. In advanced systems, many of these activities are computerized.

No component of the logistics function has benefited more from electronic and computer technology than *order entry* and *processing*. Some advanced systems are so sophisticated that the orders are automatically generated when stock reaches the reorder point. Advanced order processing systems are shown as the second and third level in Table1.

Inside sales/telemarketing is an extension of the advanced order processing systems. It enables the firm to maintain contact with existing customers who are not large enough to justify frequent sales visits; increase contact with large, profitable customers; and efficiently explore new market opportunities.

Electronic data interchange (EDI) is the electronic, computer-to-computer transfer of standard business documents between organizations [14]. EDI transmissions allow a document to be directly processed and acted upon by the receiving organization. Depending on the sophistication of the system, there may be no human intervention at the receiving end. EDI specifically replaces more traditional transmission of documents, such as mail, telephone, and even fax, and may go well beyond simple replacement, providing a great deal of additional information.

Several types and variations of EDI systems are in use today. The main types of systems are proprietary systems, value-added networks (VANs), and industry associations.

Proprietary systems, also known as *one-to-many systems,* are aptly named, because they involve an EDI system which is owned, managed, and maintained by a single company. Value-added networks, also known as VANs, third-party networks, or *many-to-many systems,* appear to be the most popular choice for EDI systems. Under VANs, all of the EDI transmissions go through a third-party firm, which acts as a central clearinghouse.

Using EDI over the Internet is rapidly becoming a reality. After initial software purchase and systems setup, EDI over the Internet is virtually "free," versus VAN transmission. There is an Internet Engineering Task Force made of prominent companies such as Compaq, Hewlett-Packard, Digital Corporation, Microsoft, Oracle, SAS System, SAP/R3 etc. that is working to ensure the capability of EDI products on the Internet [10].
EDI has many potential benefits. The reduction of clerical work is a major benefit, reducing paper work, increasing accuracy and speed, and allowing purchasing to shift its attention to more strategic issues. One expert estimates that EDI can reduce the cost of processing a purchase order by 80 percent [3].

Of course, it will be necessary to justify an advanced order processing system in terms of cost-benefit analysis. The costs of developing the system, *start-up costs,* can be justified by comparing the present value of improvement in cash flows associated with the new system to the initial investment.

4 The company's logistics management information system

The order processing system sets many logistics activities in motion, such as:

- Determining the transportation mode, carrier, and loading sequence.
- Inventory assignment and preparation of picking and packing lists.
- Warehouse picking and packing.
- Updating the inventory file; subtracting actual products picked.
- Automatically printing replenishment lists.
- Preparing shipping documents (a bill of loading if using a common carrier).
- Shipping the product to the customer.

Other computerized order processing applications include maintaining inventory levels and preparing productivity reports, financial reports, and special management reports.

Processing an order requires the flow of information from one department to another, as well as the referencing or accessing of several files or databases, such as customer credit status, inventory availability, and transportation schedules. The information system may be fully automated or manual; most are somewhere in between.

Depending on the sophistication of the order processing system and the corporate management information system (MIS), the quality and speed of the information flow will vary, affecting the manufacturer's ability to provide fast and consistent order cycle times and to achieve transportation consolidations and the lowest possible inventory levels.

Generally, manual systems are very slow, inconsistent, and error prone. Information delays occur frequently. A manual system seriously restricts a company's ability to implement integrated logistics management, specifically, to reduce total costs while maintaining or improving customer service. Some common problems include the inability to detect pricing errors, access timely credit information, or determine inventory availability. Lost sales and higher costs combine to reduce the manufacturer's profitability.

Indeed, timely and accurate information is valuable. Information delays lengthen the order cycle. Automating and integrating the order process frees time and reduces the likelihood of information delays. Automation helps managers integrate the logistics system and allows them to reduce costs through reductions in inventory and freight rates. The communications network is clearly a key factor in achieving least total cost logistics.

Basic Need for Information

A logistics management information system is necessary to provide management with the ability to perform a variety of tasks, including the following:

- Penetrate new markets.
- Make changes in packaging design.
- Choose between common, contract, or private carriage.
- Increase or decrease inventories.
- Determine the profitability of customers.
- Establish profitable customer service levels,
- Choose between public and private warehousing.
- Determine the number of field warehouses and the extent to which the order processing system should be automated.

To make these *strategic decisions*, management must know how costs and revenues will change given the alternatives being considered.

Once management has made a decision, it must evaluate performance on a routine basis to determine (1) if the system is operating under control and at a level consistent with original profit expectations, and (2) if current operating costs justify an examination of alternative systems. This is referred to as *operational decision making.* The *order processing system* can be a *primary source of information* for both strategic and operational decision making.

An *advanced order processing system* is capable of providing a wealth of information to various departments within the organization. Terminals for data access can be made available to logistics, production, and sales/marketing. The system can provide a wide variety of reports on a regularly scheduled basis and status reports on request. It also can accommodate requests for a variety of data including customer order history, order status, and market and inventory position.

Designing the Information System

The design of a logistics management information system should begin with a survey of the needs of both customers, and a determination of standards of performance for meeting these needs. Next, customer needs must be matched with the current abilities of the firm, and current operations must be surveyed to identify areas that will require monitoring and improvement.

It is important at this stage to interview various levels of management. In this way, the organization can determine what strategic and operational decisions are made, and what information is needed for decision making and in what form. Table 2 illustrates the various types of strategic and operational decisions that management must make within each of the functions of logistics.

Table 2: Typical Strategic and Operational decisions by Logistics Function

Decision Type	Customer Service	Transportation	Warehousing	Order Processing	Inventory
Strategic	Setting customer service levels	Selecting transportation models	Determination of number of warehouses and locations	Extent of mechanization	Replenishment systems
		Freight consolidation programs	Public vs. private warehousing		
		Common carriers vs. private trucking	Public vs. private warehousing		
Operational	Service level measurements	Rate freight bills	Picking	Order tracking	Forecasting
		Freight bill auditing	Packing	Order validation	Inventory tracking
		Claims administration	Stores measurement	Credit checking	Carrying- cost measurement

	Vehicle scheduling	Warehouse stock transfer	Invoice reconciliation	Inventory turns
	Rate negotiation	Staffing	Performance measurement	
	Shipment Planning	Warehousing layout and design		
	Railcar Management	Selection of materials-handling equipment		
	Shipment routing and scheduling	Performance measurement		
	Carrier selection			
	Performance Measurement			

Table 2 (continuation)

Source: American Telephone and Telegraph company, Business Marketing, Market Management Division.

The next stage is to survey current data processing capabilities to determine what changes must be made. Finally, a common database must be created and management reports designed, considering the costs and benefits of each. A good system design must support the management uses previously described and must have the capability of moving information from locations where it is collected to the appropriate levels of management [2, 5].

Data for a logistics information system can come from many sources. The most significant sources of data for the common database are (1) the order processing system, (2) company records, (3) industry/external data, (4) management data, and (5) operating data. The type of information most commonly provided by each of these sources is shown in Figure 2.

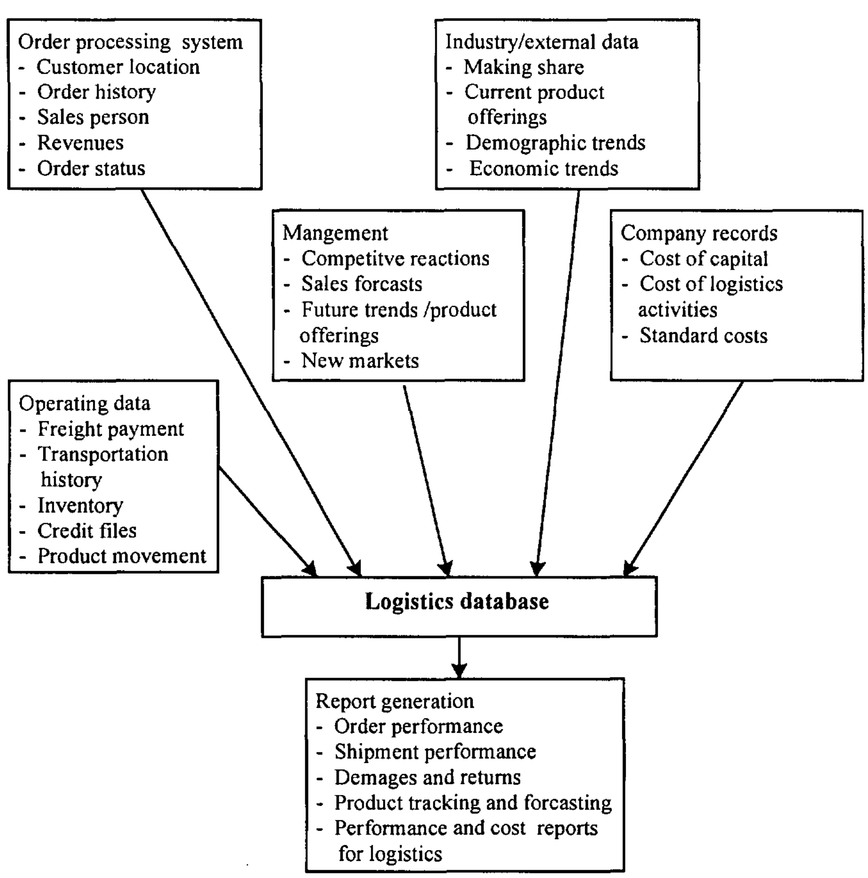


Figure 2: Key sources of information for the logistics database

Usually, the database contains computerized data files, such as the freight payment system, transportation history, inventory status, open orders, deleted orders, and standard costs for various logistics, marketing, and manufacturing activities. The *computerized information system* must be capable of (1) data retrieval, (2) data processing, (3) data analysis, and (4) report generation [1].

Data retrieval is simply the capability of recalling data such as freight rates (in their raw form) rapidly and conveniently. **Data processing** is the capability to transform the data to a more useful form (information) by relatively simple and straightforward conversion. Examples of data processing capability include preparation of warehousing picking instructions, preparation of bills of lading, and printing purchase orders.

Data analysis refers to taking the data from orders and providing management with information for strategic and operational decision making. A number of mathematical and statistical models are available to aid a firm's management, including linear programming and simulation models. **Linear programming** [6, 7, 9] is probably the most widely used strategic and operational planning tool in logistics management. It is an optimization technique that subjects various possible solutions to constraints that are identified by management.

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. Although simulation does not provide an optimal solution, the technique allows management to determine satisfactory solutions from a range of alternatives.

The last feature of an information system is **report generation**. Typical reports that can be generated from a logistics management information system include order performance reports; inventory management reports; shipment performance reports; damage reports; transportation administration reports; system configuration reports, which may contain the results of data analysis from mathematical and statistical models; and cost reports for logistics.

Management Information Systems (MIS), Decision Support Systems (DSS), and Executive Information Systems (EIS) represent a natural progression in information systems development. On-Line Analytical Processing (OLAP) is a recent advance in the field of Information Systems (IS) for decision support. OLAP not only integrates the MIS, DSS, EIS, functionality of the earlier generations of IS, but goes further and introduces spreadsheet-like multidimensional data views and graphical presentation capabilities [12].

4.1 Database Management

A database management system (DBMS) allows application programs to retrieve required data stored in the computer system. The types of data stored were shown in Figure 2. A DBMS must store data in some logical way, showing how different pieces of data are related, in order for retrieval to be efficient. This is a critical issue in logistics because of the large volume of data generated which may require analysis at a later date. For example, a buyer may want to see a history of transportation carriers with which it has placed orders for a particular item in the past six months.

The DBMS must be able to use the item number to reference the order and "pull up" the pertinent data. If the buyer sees that two suppliers have been used, the buyer may want the system to provide a transaction history with those suppliers over a given time period for all purchased items. The DBMS which must have the flexibility to sort data in a variety of ways that are meaningful to the user is the on-line transaction processing system (OLTP), also known as transaction database [12].

Relational database structures are popular today because they allow access to and sorting of data by relating the data to other data in many ways. This allows a great deal of flexibility. Increasingly, companies are using what is known as a local area network (LAN). This consists of a minicomputer linked to a number of microcomputers or terminals which allow access to a common database, software, and other systems features. LANs give microcomputers the power of mainframe systems.

Regardless of the sophistication of the software and hardware, a system cannot provide good results if the data in the system are not accurate and timely. Thus, systems integrity is vital. If people do not use the system consistently (i.e., do not scan each bar-coded item individually) the system will quickly be inaccurate. Once a system has data accuracy problems, it is very difficult, costly, and time consuming to correct.

4.2 Decision Support Systems

Decision support systems (DSSs) encompass a wide variety of models, simulations, and applications that are designed to ease and improve decision making [1, 5, 6]. These systems incorporate information from the organization's database into an analytical framework that represents relationships among data, simulates different operating environments (e.g., vehicle routing and scheduling), may incorporate uncertainty and "what-if" analysis, and uses algorithms or heuristics. DSSs actually present an analysis and, based upon the analysis, recommend a decision.

The artificial intelligence tools can be incorporated into DSSs, which may contain decision analysis frameworks, forecasting models, simulation models, and linear programming models. They can be used to assist in a wide variety of logistics decisions, such as evaluating alternative transportation options, determining warehouse location, and setting levels of inventory.

While the use of DSSs is not currently widespread, it appears to be growing as the potential contribution becomes more understood, and computing costs continue to decline. Figure 3 shows the components of a DSS.

A DSS is applications oriented. More specifically, a DSS has the following objectives:

- To assist logistics executives in their decision processes.
- To support, but not replace, managerial judgment.
- To improve the effectiveness of logistics decisions.

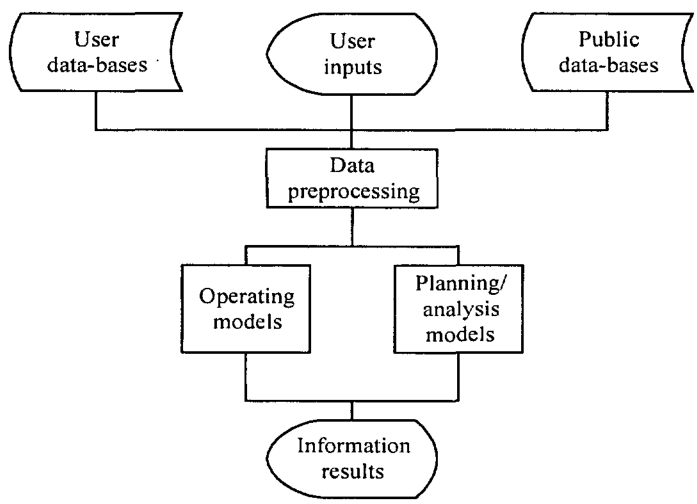


Figure 3: Decision Support System

Perhaps the most critical element of a DSS is the quality of the data used as input into the system. DSSs require information about the environment that is both internal and external to the organization. Thus, an important first step in DSS planning, implementation, and control is to have good external information.

Models are also needed to provide data analysis. 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. By using a model, we are able to establish a current situation and then play "what-if" games. This "what-if" ability is significant. It allows us to quickly consider many different alternatives and test to outcome [9, 14].

4.3 Artificial intelligence and expert systems

Developed out of the field of computer science, **artificial intelligence** (AI) is concerned with the concepts and methods of inference by a computer and the symbolic representation of the knowledge used in making inferences. The term *intelligence* covers many cognitive skills, including the ability to solve problems, to learn, to understand language, and in general, to behave in a way that would be considered intelligent if observed in a human.

AI is a comprehensive term encompassing a number of areas, including computer-aided instruction, voice synthesis and recognition, game-playing systems, natural language translators, robotics, and expert systems. While the number of AI applications is limited, the potential in logistics is staggering. AI has been used to model response time requirements for customer delivery; model transportation costs and times for various transportation modes, locations, and routings; determine which warehouses should serve which plants, with which products, and what inventory levels; model customer service response with various levels of reliability; and perform sensitivity analysis to determine how much inputs can vary without affecting the structure of the optimal solution [1].

Of specific interest to logistics executives are the subareas of AI known as *expert systems* (ES), *natural language recognition*, and *neural networks* [14]. An ES is defined as a computer program that uses knowledge and reasoning techniques to solve problems normally requiring the abilities of human experts. An expert system is an artificial intelligence (AI) program that achieves competence in performing a specialized task by reasoning with a body of knowledge about the task and the task domain.

Expert systems are capable of being applied to a variety of problems in marketing and logistics, including interpretation, monitoring, debugging, repair, instruction, and control. Examples of ES applications can be found in many industries.

Five criteria aid decision makers in determining whether expert systems should be used to solve a particular logistics problem. If any of the criteria are met, an ES may be appropriate:

1. The task or problem solution requires the use of human knowledge, judgment, and experience.
2. The task requires the use of heuristic (e.g.. rules of thumb) or decisions based on incomplete or uncertain information.
3. The task primarily requires symbolic reasoning instead of numerical computation.
4. The task is neither too easy (taking a human expert less than a few minutes) nor too difficult (requiring more than a few hours for an expert to perform).
5. Substantial variability exists in people's ability to perform the task. Novices gain competence with experience. Experts are better than novices at performing the task.

If an ES is appropriate, the next decision facing the logistics executive is whether the system can be economically justified and if EDI can be combined with other systems such as AI. Natural language capabilities of AI are using to make data stored within companies computer much more accessible. This contributes tremendously to the purchasing function as well as other areas of the firm.

Neural networks are still in the development stages. They can be considered an offshoot of ESs because they aid in decision making through the use of logic and rules. A key difference is that neural networks actually create their own rules based on past decisions and outcomes, rather than relying on an "expert." Once developed, these systems will be excellent for any repetitive activity that requires analysis of large amounts of data, more than a human could process effectively. As such, neural networks could be used to alert management to potential problems in supplier performance patterns, quality, delivery, invoicing, and similar issues.

5 Conclusions

This paper demonstrates how order processing system can directly influence the performance of the logistics function. Order processing systems can be used to improve customer communications and total order cycle time, or lead to substantial inventory reductions and transportation efficiencies.

Information is vital for the planning and control of logistics systems. Today's computer technology and communication systems make it possible for management to have the information required for strategic and operational planning of the logistics function. The order processing system can form the basis of a logistics information system and can significantly improve the quality and quantity of information for decision making.

Computers have become an invaluable aid to the logistics executive in making various operational and strategic decisions. Decision support systems, which are computer based, provide information for the decision-making process. The DSS has three components: data acquisition, data processing, and data presentation.

Computers are widely employed in many areas of logistics, including transportation, inventory control, warehousing, order processing, material handling, and so forth. Some of the most exciting areas of computerization are modeling, artificial intelligence (AI), and expert systems (ES). Improved database management contributes to the support of logistics decision making.

Future challenges for logistics performance improvement include the following significant areas: greater participation in setting organizational strategy and strategic planning process; total quality management (TQM); identification of opportunities for using logistics as a competitive weapon/marketing strength; just-in-time (JIT) logistics; the use of quick response (QR) and efficient consumer response (ECR) techniques, better understanding of global logistics and improved logistics information systems; greater participation of logistics professional work teams; appropriate understanding and use of outsourcing, partnership and strategic alliances; greater understanding and appropriate application of technology; green marketing.

It is our belief that this representation will make computerized logistics information systems more comprehensible and acceptable for implementation to a wider audience (managers), enhancing their decision-making effectiveness.

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