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DECISION SUPPORT SYSTEMS FOR LOGISTICS MANAGEMENT

Abstract:
The environment where managers make decisions has been significantly changed these years. Today, organizations design their products in one country, purchase of materials and raw materials in the other one, production is done in the third country, and finished products are brought out in many countries in the world. Logistics, as a transaction intensive function mutually connect these substantially different business processes and enables more effective and efficient management of the long logistics chains. In realizing such a task, the intensive use of information technologies that provide timely transaction processing and give support in decisionmaking processes is especially important for logistics. The work reviews information systems development in the field of logistics, and a special attention is paid to the conceptual level of the global structure in decision support systems (DSS). Possible contents of identified subsystems are cited and potential development trends of its application are discussed.

Keywords:
logistics, DSS, trend.

ACM classification
H.4 INFORMATION SYSTEMS APPLICATIONS, H.4.2 Types of Systems

JEL classification
M1 – Business Administration, M15 – IT Management

INTRODUCTION

The implementation of new philosophy in the business environment attached importance to the logistics in the organization. In supporting numerous and complex business processes of logistics, organizations increasingly used information technologies. This related especially to the organizations trying to keep the position of the leaders or to become leaders in the field of their business. Information technologies became their key competitive advantage. Logistic business process management became inconceivable without computer supports.

Decision Support Systems (DSS) are a subset of computerbased information systems (CBIS). The general term CBIS is a constellation of a variety of information systems such as office automation systems, transaction processing systems, management information systems and management support systems. Management support systems consist of DSS, expert systems and executive information systems. In the early 1970s, scholars in the CBIS area began to recognize the important roles information systems play in supporting managers in their semistructured or unstructured decision making activities. It was argued that information systems should exist only to support decisions, and that the focus of the information systems development effort should be shifted away from structured operational control to unstructured critical decision in organizations. Decisions are irreversible and have farreaching consequences for the rest of organizational life. The importance of effective decision making can never be overemphasized. Decision making is, in effect, synonymous with management.

The traditional way of information system development for transaction processing meant the initial decomposition of an information system of the organization into parts (information subsystems or information modules) covering some functional areas, then a gradual application of information technologies in so identified segments, and the automation of their business processes. In this way, the applications of logistics functional area processed transaction independently, within the business function, treating them separately as special activities. These applications represented automated tools for transaction processing only, i.e. the data of logistics business processes. They gave possibilities to the user to keep data, to process them, and to present them in the desired and appropriated way. The basic and real problem was that there was not a 'real' and 'substantial' connection between independently developed applications that used different functional areas. The transactions and data of logistics business processes could not be connected with the other functional areas, it meant that they didn't have an adequate information support. Some logistics business processes stayed noninformed unconscious of happenings in the activities of other business processes and frequently without numerous information.

During the 90ies, wishing to eliminate the noticed shortages and in order to connect functional areas, a new concept of information systems development for transaction processing was developed. It was called the Enterprise Resource Planning (ERP) concept of information systems development in the organization, it means developing an information systems with a complete integration of software applications, i.e. one data storage as a joint resource used by the all applications. The applications of all the functional areas were finally connected mutually limited processes. A lot of methods, techniques and heuristic knowledge were included in the software solutions, that managers, experts and office staff used as an effective resource to organize and realize business processes and tasks.

Introducing the new concept contributed a more qualitative information support to logistics business processes. The necessary connection between the data that was originally realized in the functional areas of logistics with the data from all the other functional areas of the organization. By the ERP concept developed information systems of the organization, i.e. logistics information system, attain their goals the advancement of quality and the availability of information, integration of business processes and systems, simplification of business process integration in the technological structure and the system security supporting further development of the whole business. At the same time, the ERP system brings some restrictions, i.e. the shortages in information systems development. This system is very rigid in realizing, it disables the organizations to integrate software solutions of different suppliers in modeling this system and to connect easily in the supply chain with consumers and suppliers because of incompatibility.

1. DEFINITION AND ARCHITECTURE OF LOGISTICS DECISION SUPPORT SYSTEMS

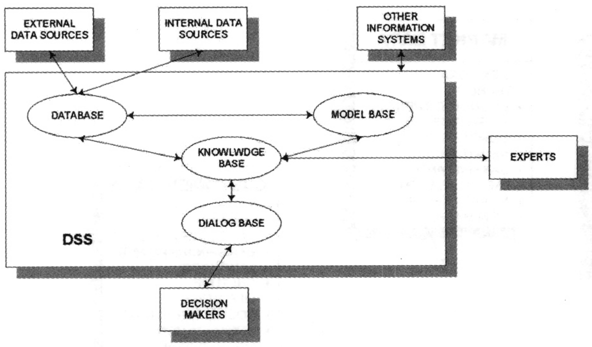
Drawing on various definitions that have been suggested (Alter 1980; Bonczek et al. 1981; Keen and ScottMorton 1978; Spraque and Carlson 1982 [1], a DSS can be described as a computerbased interactive humancomputer decisionmaking systems that:

- supports decision makers rather than replaces them,
- utilizes data and models,
- solves problems with varying degrees of structure: unstructured, semistructured and structured,
- focuses on effectiveness rather than efficiency in decisionprocesses.

A decision support system consists of two major subsystems. The first is a human decision maker; the other one is the computer system. Namely, to represent decision support systems, exclusively as a collection of hardware and software would wrong because making unstructured and semistructured decisions that cannot be programmed without a man is simply inconceivable. The role of human decision maker is to provide and access data in the built database of these systems, but also to use the abilities of common sense and intuition in the whole process of decisionmaking.

The architecture of contemporary decision support systems consists of: a management data subsystem, a management model subsystem, a dialog management subsystem and a knowledge subsystem. The complex architecture is shown in Figure 1, and the

Figure 1. **Architecture of decision support systems**



general function of some elements of the structure will be described later, with a special attention to their characteristics in the field of logistics.

1.1 DATA MANAGEMENT SUBSYSTEM

Data management subsystem consists of: database, database management systems (DBMS), data dictionary and query language. Database as a collection of organized data in the concrete area and DBMS as a set of computer programs for creating and database management, as well as the control of data access in the database are the elements of this subsystem.

The database of decision support systems usually consists of the data extracted from different sources (internal and external), combined, aggregated, different volumes and the level of details, wide time framework, a lot of sources, originated from public, private and internal transactional databases. It enables a direct access to data, intended to end users and it provides unprocessed material for OLAP techniques, the model base and Data Mining techniques.

Internal sources of data are data contained in ERP system database of the organization. These are data originated from some functional fields of the organization, as marketing, sale, accounting, finance which are functional to their character because they give information for business processes in different functional areas. Possible contents of internal database for the needs of logistics decision support systems are represented in Figure 2.

External sources of data can be of very different origin. These are, before all, the data providing some ministries, for instance, the ministries of trade, then the chamber of commerce, the world trade centers, trade fairs, associations in the field of trade (the world, regional or national), trade magazines, banking and other financial institutions, brokers, big consulting houses, foreign diplomatic missions, and so on. To this group of external sources handbooks, monographs and other editions in the field of logistics can be added, as well as commercialized data sources in this field.

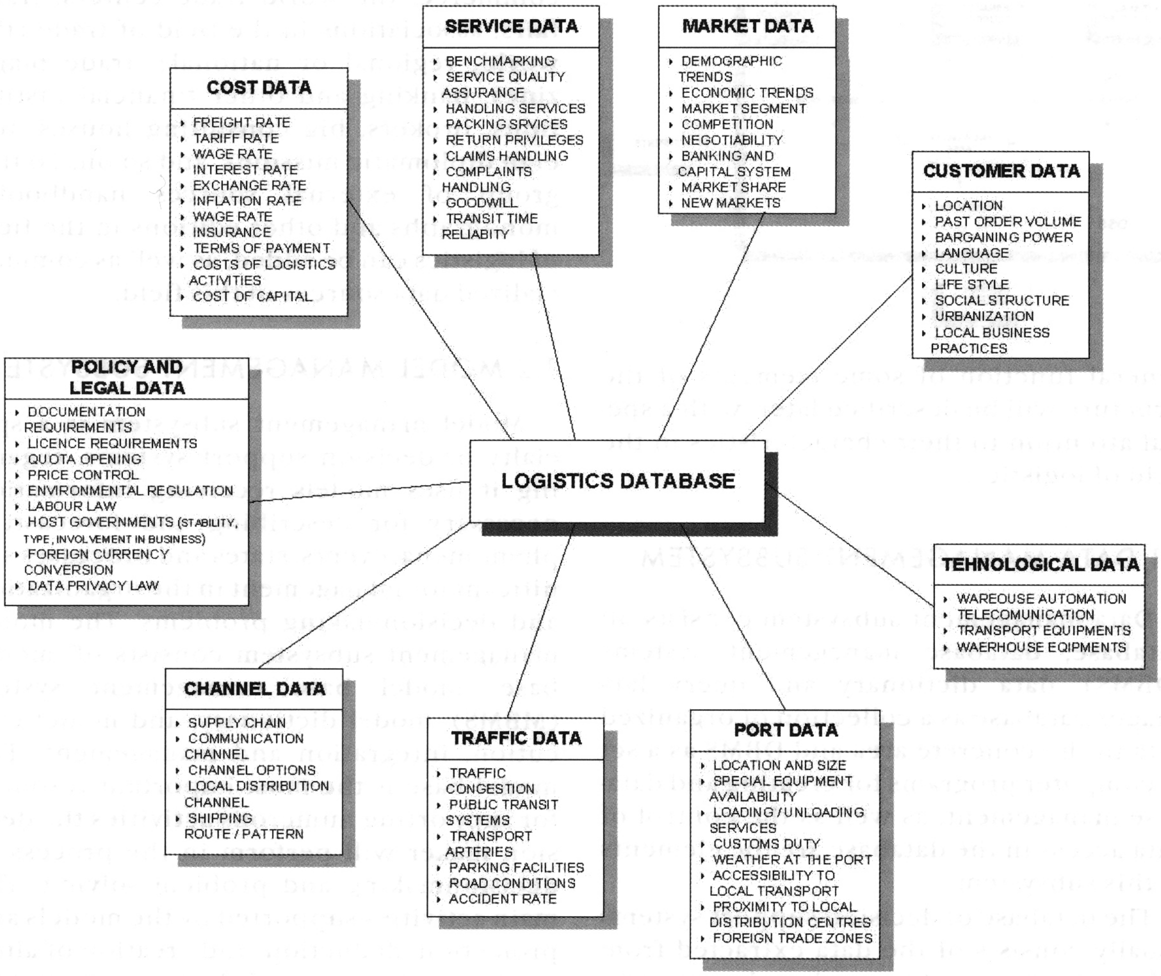
1.2 MODEL MANAGEMENT SUBSYSTEM

Model management subsystem is a specialty of decision support systems, regarding it uses models receiving information necessary for describing and forecasting phenomena, events, states and processes significant for management in the organization and decisionmaking problems. The model management subsystem consists of: model base, model base management system (MBMS), model dictionary, and model execution, integration and management. The model base is the most important resource for supporting numerous activities the decision maker will perform in the process of decisionmaking and problem solving. The main activities supported by the models are: projection, deduction, and creation of alternatives, comparison of alternatives, optimization and simulation. Except the model base, model base management system, as a set of computer programs for efficient creating and management of model base contents, is the second key element of this subsystem.

The model base for the needs in the field of logistics makes more groups of submodels supporting the realization of specific tasks and they can be combined in the applications. The concept for developing a unique, big and esoteric model for all business processes in logistics was deserted long ago because of wide applicableness in this field. Possible contents of the model base for the needs of logistics decision support processes consist of two basic model groups: preliminary models and functional models.

The first group includes: forecasting model, statistical model and simulation model. These models are base for logistic activities because they enable qualitative

Figure 2. **The database for the needs of logistics**



forecasting, adequate statistical processing and simulation. The choice and development of a real forecasting model should enable, with previously done the activities of planning, to minimize the level of risk and uncertainty in the business processes of logistics.

The second group consists of the following subgroups: Network model, Transport model, Inventory model and Warehousing model that are targeted for specific tasks and functions central to logistics decision making. Logistics problems are the problems of finding the least expensive way to transport products from their origin to their destination. Real logistics problems are a huge global manufacturing and distribution problems with wide range of products: where or whether to manufacture some products and how to get them to its costumers around the world in the most economical manner.

Network model Network models are among the most used management science models. Many important optimization models have a natural graphical network representation. There are four specific types of these optimization models: the assignment model, the critical path model, the maximum flow model, and the shortest path model. All of these models are special cases of the minimum cost network flow model. This class of problems entails sending goods along the arcs of a network at a minimal cost when there are possible capacity restrictions on some or all of the arcs. The network flow model of this situation requires the following elements:

- there must be changing cell that represents the possible flow through each arc in the network;
- each arc must have a unit shipping cost which is the cost received per unit shipped along the arc;

- each arc in the network must have a lower bound and an upper bound on the flow through the arc. These upper bounds are called arc capacities;
- each node in the network must have a net supply;
- the arcs run from each source to each sink and represent the flow from a plant to a warehouse along with the unit shipping cost. The network flow problem involves shipping the product from the plants in order to meet the demand at the warehouses.

Transportation model Location problems are treated which involve the distribution of goods from one location to another. These problems can be formulated as transportation models where the objective is to find the lowestcost location alternative. Even when location is not an issue, the transportation method can be used to find the best shipping routes. The general transportation problem can be described in the form of a matrix with shipments from one location to another. In many situations a company produces products at locations called supply points and ships these products to customer locations called demand points. Each supply point has a limited amount that it can ship, and each customer must receive a required quantity of the product. Spreadsheet solvers can be used to determine the minimumcost shipping method for satisfying customer demands. The only possible shipments are those directly from supply point to a demand point.

Inventory model All inventory models have the common characteristic that they attempt to find the right balance between having enough inventories on hand in order to meet customer demand but not so much as to incur excess costs. They require a great deal of capital and affect the delivery of goods to customers. An inventory problem can usually be broken up into two parts: how much order on each ordering opportunity and when order. When the costumer demand is known, the resulting models are called deterministic models. If the customer demand is known, then once the order amount has been determined, it is fairly easy to specify when the orders should be placed... A more realistic situation is where only the probability distribution of customer demand is known. These more difficult problems require probabilistic inventory models.

The general theme is the balance, companies try to find between two competing costs. If they order frequent small quantities, they have little extra inventory on hand but they incur large setup costs. In contrast, if they order infrequent large quantities, then they have small setup costs, but they have large inventories on hand and incur large holding costs.

The most basic of all the inventory models is economic order quantity (EOQ) models. Inventories are swollen, parts are being expedited to get orders out on time, and a pressurecooker atmosphere prevails. It is now possible to remedy this situation through use of a computerized planning and control system called materials requirements planning (MRP). Using MRP, the master schedule is exploded into purchase orders for raw materials and shop orders for scheduling the factory.

Warehousing model Warehousing means: store the delivered items for safe keeping and retrieval. Check if warehousing requires any special handling equipment and storage facilities. Issue the stock against the required internal requisition order. The procurement schedule integrates the procurement list, the schedule of the goods, the procurement lead time and warehousing justintime (JIT) stock control. Consider a company that must produce its goods at plants and store its goods at warehouses before shipping these goods to customers. Suppose that there is a fixed cost associated with the operation of each plant and warehouse.

1.3 DIALOGUE MANAGEMENT SUBSYSTEM

Dialogue management subsystem is, according to many authors, the most important component of decision support systems, because its substantial characteristics as power, flexibility and easy of use derive from the possibility of interaction of the computer system and the user. The functions of the user interface subsystem is to:

- allow the user to create, update, delete database files and decision models via database management system and modelbased management systems;

- provide a diversity of input and output formats;
- provide different styles of dialogues (such as graphical user interfaces, menus, direct command languages, form interaction, questions and answers).

1.4 KNOWLEDGE SUBSYSTEM

Knowledge subsystem is the intelligent part of the structure in decision support systems. Its including in the structure became a need when the 'practicality gap' increasingly appeared – the gap between the model and reality leaving many complicated and unstructured problems unsolved. Under conditions of constant increase of problem complexity and their uncertainty, this gap increasingly appeared, so it was solved, introducing a database in the DSS structure. The database in the new built structure became a resource of rules, facts and heuristics, necessary for solving dynamic and complex problems. Also, the knowledge base contributed to explain easily and learn oftenapplicable processes for problem solving immanent to the experts in some fields.

2. IMPORTANCE OF DECISION SUPPORT SYSTEMS FOR LOGISTICS

Analyzing the previous period of information systems development, we can see that the field of logistics has just been predominant field for development of the most important business applications. According to the researches done by Eom and Lee [2] at the end of the 80ies, the applications of decision support systems in the field of logistics represented more than a one third of the total applications in the organizations.

In the development of applications two basic approaches have been applied:

(1) Implementation of the integrated decision support system at the level of the whole organization, partly including the field of logistics, too, and

(2) Implementation of specific and independent applications of decision support systems only in the field of logistics.

The applications of decision support systems in the field of logistics give the support to decision makers in a huge number of business processes in strategic and/or operative decisionmaking. This can be seen in Table 3.1

In order to fulfill expectations in the last years for the applications of decision support systems in the field of logistics, they have to be adapt to completely changed conditions in the world economy, and especially the global world market, that has never been bigger. Market expansion and the development of multinational corporations require information, communication and distribution nets of the world size enabling free flow of information and goods, disregarding the national borders. Decision support systems increasingly become strategic important arms for advancing services to customers, for advancing competitiveness and developing the economies of scale in transnational logistics processes. The applications of these systems, by the exact and timely information provide managers in the field of logistics with the resources in order to react fast and make qualitative decisions.

The most important reasons why DSS are used in logistics:

1. Human inability to solve a model involving many variables and constraints. Typically, optimization of a transportation network involves hundreds of decision variables and constraints.
2. It is also humanly impossible to test all the alternatives before taking a decision. Computers best do this kind of repetitive work.
3. It is difficult to track and efficiently manage all the information coming from different sources through paperwork only.
4. Interrelation and timely application of available data forms the basis of DSS.
5. Human methodology of taking decision is not objective, it depends upon many external factors. Use of computers and DSS tends to reduce this kind of subjectivity.

Once when we, in the right way, developed and implemented logistics decision support system, defined and by practice confirmed, it could give numerous benefits in management of its general and specific activities. Benefits can be seen both in the quality of decisionmaking processes and in the quality of made strategic, tactical and operative decisions. At the same time, as a consequence of made decisions some savings appear in

Table 2.1

Business processes of logistics	Type of decision In transport
Choice of transport model	(s)
Choice of transport way	(s)
Routing of vehicles at land and see	(o)
Delivery planning	(o)
Delivery routing and distribution	(o)
Choice of carriers	(o)
Vehicle distribution	(o)
Assessment and control of consignment notes	(o)
Administration of claims	(o)
Performance measuring	(o)
In warehousing:	
Determination of storage number and location	(s)
Choice of storage way	(s)
Sorting and packing of storage goods	(o)
Transfer of storage goods	(o)
Warehousing	(o)
Storage planning and design	(o)
Choice of equipments for storage goods	(o)
Performance measuring	(o)
In order processing:	
Choice of volumes of automated support	(s)
Order tracking and evaluating	(o)
Indebtedness (credit) control	(o)
Invoice harmonization	(o)
Performance measuring	(o)
In stocks management:	
Choice of restocking systems	(s)
Stocks forecasting	(o)
Stock evidence	(o)
Tracking of transferring	(o)
Tracking of stocks turnover	(o)
In rendering services:	
Determining the level of rendering services	(s)
Measuring the level of rendering services	(o)

(s) – strategic decision; (o) – operative decision

different position of costs because of better productivity in doing logistic activities and a higher quality level of logistic services.

The development of new tools and technologies enable decision support systems to have new possibilities both at macro and micro levels. Artificial intelligence techniques, the data warehouse/multidimensional databases, data mining, online analytical processing (OLAP), enterprise resource planning systems, intelligent agents, www technologies, the Internet and corporate intranets are just some of technological suppositions.

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Biography:

Pere Tumbas is Associate Professor at the Faculty of Economics in the field of Information Systems and Engineering. In his career, he has taught Information Systems Development, Management Information Systems, Object Software Engineering, ERP Systems, and related subjects at undergraduate and graduate studies. He is the author and coauthor of several textbooks, handbooks and monographs in the field of Informatics, as well as over 120 works presented and published at international and national conferences, symposia and magazines. During more than 25 years of working at the Faculty, he has participated in carrying out a number of scientific and professional projects and studies in his field. He is editor or member of editorial boards in several international magazines, as well as member of several programming boards of scientific meetings and symposia. He is also member of professional organizations and associations: EUNIS (European Universities Information Systems), IEEE and AIS (Association for Information Systems).

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