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Computer Systems Aided Management in Logistics

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ABSTRACT: This paper aims at presenting a concept of an integrated computer system of management in logistics, particularly in supply and distribution chains. Consequently, the paper includes the basic idea of the concept of computer-based management in logistics and components of the system, such as CAM and CIM systems in production processes, and management systems for storage, materials flow, and for managing transport, forwarding and logistics companies. The platform which integrates computer-aided management systems is that of electronic data interchange.

1 INTRODUCTION

Taking into account the development of computer technologies, we can classify today's production processes as follows:

1 independent, computer controlled machining and assembly stations (CM – Computer Module),
2 FMS – Flexible Manufacturing Systems,
3 CAM – Computer Aided Manufacturing Systems,
4 CIM – Computer Integrated Manufacturing Systems.

Typical operations in today's production systems include technological (machining and assembly), control, transport, storage operations and their combinations. Besides, there are processes of component and raw material supply, co-operation, distribution of finished products and after sale services.

Logistics come to assistance in managing the production system understood in such broad terms. There are clearly distinguished areas of logistics:

– material supply,
– co-operation,
– production,
– distribution.

Processes taking place in these four areas of logistics require efficient management. To improve the system of logistic management of production we have to design and implement a computer system.

This paper presents the idea of a wide range computer system which aids the management of production system logistics.

2 THE CONCEPT OF COMPREHENSIVE COMPUTER SYSTEM OF MANAGEMENT IN LOGISTICS

The production system consists of four subsystems:

1 materials supply, handled by materials supply logistics,
2 co-operation, handled by co-operation logistics,
3 manufacturing, handled by manufacturing logistics,
4 finished goods distribution, handled by distribution logistics.

Figure 1 graphically illustrates a logistic chain of materials supply for the manufacturing process in a production company. Participants of this chain are as follows:

– original suppliers,
– suppliers of components and subassemblies,
– supply centers (see Fig. 1).

Figure 2 shows a logistic chain of co-operation in the manufacturing process in a production company. There are two types of business entities in this chain:

– suppliers to co-operators,
– co-operators (see Figure 2).

Figure 3, in turn, presents graphically a logistic chain of distribution of finished goods from one particular manufacturer. This chain comprises such business entities as:

– distribution centers,
– wholesale and retail stores,
– end recipients (see Figure 3).

Figure 4 illustrates graphically the concept of a full-range computer-based management system in the production process logistics. Its component systems are as follows:

– computer-aided manufacturing – CAM,
– computer integrated manufacturing – CIM,
– material requirement planning (MRPI) and manufacturing resource planning (MRPII),
– management of finished goods distribution – SD (see Figure 4).

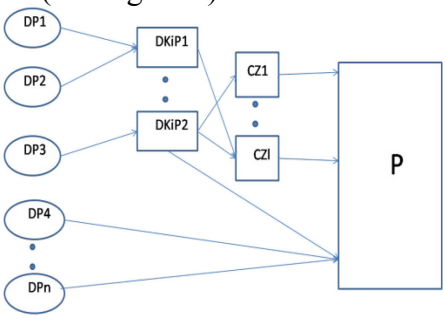

Figure 1. Logistic chain of materials supply. DP – original supplier, DKiP – supplier of components and subassemblies, CZ – distribution centre, P – producer. Source: author's study based on.[1]

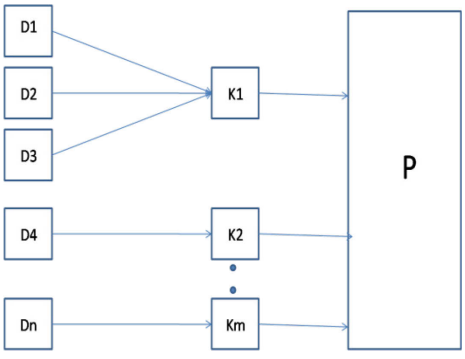

Figure 2. Logistic chain of manufacturing process co-operation. D – supplier to a co-operator, K – co-operator in manufacturing process, P - producer. Source: author's study based on.[2]

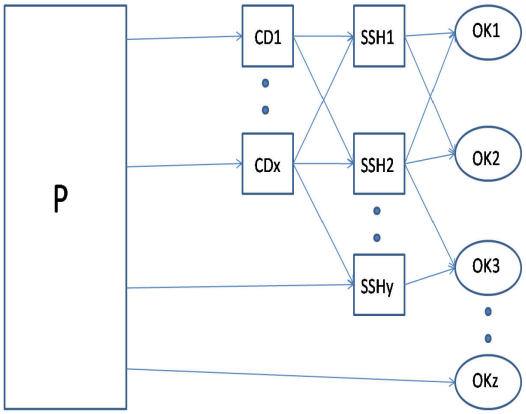

Figure 3. Logistic chain of finished goods distribution. CD – distribution centre, SSH – wholesale and retail network, OK – end recipient, P - producer. Source: author's study based on.[3]

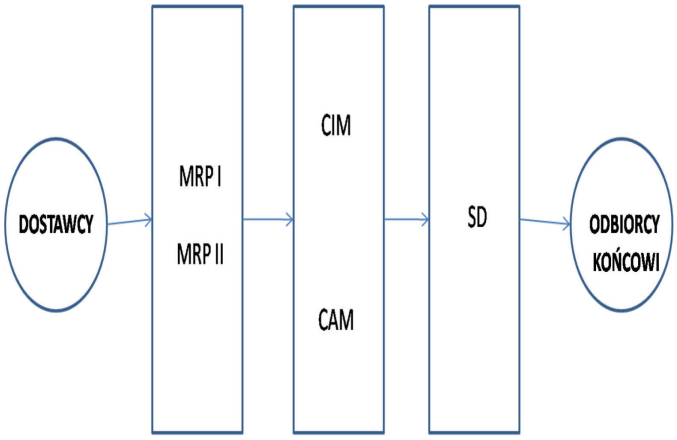

Figure 4. Concept of computer integrated management system in production logistics. MRPI – computer system for material requirement planning, MRPII – manufacturing resource planning system, CAM – computer-aided manufacturing system, CIM – computer integrated manufacturing system, SD – computer-aided goods distribution management system. Source: author's study

The chart of a computer integrated management system in production logistics shown in Fig. 4 indicates with arrows the direction of material flow, or to be exact, the flow of all production factors involved in the process of manufacturing a finished product and its distribution to end users. However, electronic flows of data between the main components of the comprehensive computer system run in the opposite direction. It is in the first step of the logistic distribution chain that information on the demand for given maker's products is recognized and processed. This is done in the computer system of distribution by collecting and aggregating orders from end recipients for given product models and types of a given manufacturer. Besides, in projecting the product demand the amounts in stock of each member of the logistic distribution chain are taken into account. Data from the computer-based distribution system are transferred to production manage-

[1] See Śliwczyński B.: Planowanie logistyczne. Podręcznik do kształcenia w zawodzie technik logistyk. Biblioteka Logistyka, Poznań 2007

[2] See. Śliwczyński B.,: Planowanie logistyczne ….

[3] See Śliwczyński B.: Planowanie logistyczne….

ment systems, i.e. CAM and/or CIM, which are operated in the production company.

After information is processed in CAM and/or CIM systems, the latter in particular, the resultant information is obtained in the form of, e.g. a plan and schedule of manufacturing. This information and the data from current monitoring of the materials in stock and the state of materials flows in production lines are directed to MRPI and/or MRPII systems.

Based on the computer-aided systems of production resources control the material flow is managed in the logistic chain of materials supply and the logistic chain of production co-operation, from original suppliers and co-operators to producers.

The computer integrated management in production logistics comprises several computer systems, used in such areas as:

- forwarding,
- transport services,
- transport terminal services,
- customs offices,
- banks,
- insurance companies
- standardization offices,
- others.

The key condition for successful design and operation of a computer integrated management in production logistics is that the co-operating computer systems share the relevant information. This objective is obtained by access to a common integrated data base (data warehouse) and by the use of common standards of electronic data interchange – EDI.

3 BRIEF CHARACTERISTICS OF BASIC COMPONENTS OF THE COMPUTER INTEGRATED SYSTEM OF MANAGEMENT IN LOGISTICS

3.1 *Computer Integrated Manufacturing – CIM*

The basic aim of CIM is a comprehensive computer-aided system for integrated implementation of production orders. One can say it is an integrated system of production order execution.

All data that appear in manufacturing processes from material supply, through work engineering to manufacturing and assembly, should always be utilized in planning tasks. While planning production operations the planner should send all data to the production area through strictly defined information channels. All data connected with manufacturing and executed orders are stored in the central data base. Production data are created mainly during the design of a product, then data from orders are added in the planning phase. These data are crucial for manufacturing and assembly. Data that appear in the above areas, i.e. dates/times of completing each manufacturing operation or operational loads of each machine, device and work station are included in the central data base and can be used by the planning system provided that data from the actual manufacturing and assembly units are sent back via a company's data base system or DCN – Direct Numerical Control system.[4]

As computer technologies develop, better technical conditions are being created for the construction of more advanced production facilities that may run automatically, with limited participation of people. The role of the human in such systems focuses on issues such as the programming of computers and computer-controlled production equipment.[5]

The growing presence of computer systems in all spheres of manufacturing company operations and integration of these systems into one all-encompassing computer system brings about many changes in technological processes. Some of these changes lead to:

- shortened time of preparing and executing production orders,
- reduction of operating costs,
- improved internal and external communication,
- more effective design, planning and preparation of production.[6]

One aspect worth emphasizing is increased utilization of company's production capacity by using the company's data base, which allows to eliminate doing the same work twice. Besides, errors due to insufficient communication are avoided. The integration of computer systems enhances the flexibility of production processes, particularly manufacturing processes, thus the manufacturer is able to respond faster to customer's requests, which often refer to details of one particular order.[7]

The CIM system consists of two interconnected subsystems:

1 CAD – Computer Aided Design, which is composed of the mutually co-operating subsystems:
   - CAE – Computer Aided Engineering; its task is to design and engineer new products or to modernize products already made,
   - CAP – Computer Aided Planning and CAPP – Computer Aided Process Planning; these are

[4] See Durlik I.: Inżynieria Zarządzania, Strategia i projektowanie systemów produkcyjnych, Cz. I. Agencja Wydawnicza „PLACET", Warszawa 1998

[5] See Durlik I.: Inżynieria Zarządzania ….

[6] See Durlik I.: Inżynieria Zarządzania ….

[7] See Durlik I.: Inżynieria Zarządzania ….

supposed to prepare the production process in terms of technology, i.e. product construction, technology of manufacturing product parts, subassemblies and the finished product, preparing technical drawings, lists of components and the organization of the machining and assembly process,
- CAD – Computer Aided Design, whose task is to plan the operation of the manufacturing system comprising the manufacturing of parts, assembly of components and the whole product, including measurements, packaging and dispatch of finished products,
- data base (DB) and expert systems (ES), which enable the functioning of all the areas of computer-aided production together with a expert knowledge base (KB) co-operating with these systems;

2 A subsystem of Computer Aided Manufacturing (CAM), which will be described in the next chapter.

3.2 *The system of Computer Aided Manufacturing – CAM*

The Computer Aided Manufacturing (CAM) is defined as a system for preparing programs for the process of manufacturing, control and recording data on the manufacturing output. This system also encompasses such organization functions as production planning, setting the dates of materials and subassembly supply from co-operators or the delivery of finished products.

CAM can be described as:

- a flexible manufacturing system, which is capable of manufacturing at the same time sets of various products of different series size, where quantities and assortments are changed by a computer,
- hierarchically controlled system; computer-supervised and handled by a small team, making up less than 10 percent of the company personnel that would be necessary to perform the same tasks in conventional conditions.[8]

The system which generates software for the machining and paths along which parts and subassemblies will pass through work modules and stations, while these programs and paths are optimized relative to work load and the degree of utilization of machines and assembly devices, production cycles, productivity, energy consumption, environment pollution and work security.[9]

In industrial practice CAM systems, apart from the manufacturing in flexible production systems, also include:

- development of software, or operating plans of machining and assembly, that as a rule are variable depending on the current production situation,
- planning of component paths and schedules of the production,
- optimal manufacturing control,
- optimal product quality control,
- production management.[10]

The computer-aided manufacturing – CAM – is regarded as a development of the designed and functioning flexible manufacturing systems with some functions connected with control at a level of a specific production system. The CAM system is often treated as a transitory stage leading to the computer integrated manufacturing (CIM).

The CAM system consists of the following subsystems:

1 CAMC – Computer Aided Manufacturing Control; its basic function is programming and computer-aided control of numerically-controlled manufacturing equipment,
2 CAQ/CAQC – Computer Aided Quality/Computer Aided Quality Control; this subsystem is designed to provide the highest standard of product quality,
3 CAT – Computer Aided Testing, for examining the technical condition of machines and tools.

A production company using computer-aided manufacturing should have the following technological machines and facilities:

- numerically controlled (NC) machines tools,
- machine tools with CNC (Computer Numerical Control),
- machine tools with DNC (Direct Numerical Control),
- IR – Industrial Robots,
- IM – Industrial Manipulators,
- AS – Automated Storage,
- AGV – Automated Guided Vehicles.

The use of CIM and CAM systems requires specific input data, such as production execution orders and data on future demand for the products offered. These data are acquired from the computer system handling distribution logistics. Output data, on the other hand, after processing in the CIM and CAM systems, are production schedules, which themselves constitute input data for computer systems of materials supply and co-operation.

[8] See Durlik I.: Inżynieria Zarządzania ….

[9] See Durlik I.: Inżynieria Zarządzania ….

[10] See Durlik I.: Inżynieria Zarządzania ….

3.3 *Enterprise Resource Planning* - ERP

The computer system of an ERP class can be defined as a set of integrated functional modules, optimizing internal and external business processes, those occurring in the immediate environment of the enterprise. Such optimization is possible through the offering of ready tools enabling automation of data exchange with co-operators within the entire logistic chain. The **main features** of the ERP computer system can be set forth as follows:

- functional complexity – includes all spheres of technical and economic activities of an enterprise; it is implemented within the company functional structure,
- integration of data and processes – refers to data exchange inside an object (between the modules) and with the environment (e.g. through an EDI – Electronic Data Interchange); this feature is implemented within the information structure,
- structural and functional flexibility – ensures maximum adjustment of hardware-software solutions (implemented within the technical and functional structures) to suit the needs of an object at the moment the system is installed and started up; it also enables its dynamic adjustment when the environment generates variable requirements and needs,
- openess – assures the ability to extend the system with new modules, scalable architecture (usually customer -server) and creation of links with external systems, e.g. systems of market partners,
- substantial advancement – ensures full computer aided support of information-decision processes, using mechanisms of free data extraction and aggregation, seeking variants, optimization, projecting etc., as well as, in practice, basing the system on, *inter alia*, such concepts of logistic management as delivery *Just in Time* (*JiT)*, production control according to MRP II standards (*Manufacturing Resource Planning*), MRP II Plus (*MRP - Money Resource Planning* - MRP II developed with financial procedures, e.g. cash flow), the ABC method (*ABC - Activity Based Costing*), Total Quality Management and ISO 9000 standards,
- technological advancement – guarantees the compliance with present standards of software and hardware, making it possible for the system to migrate to new platforms of computer equipment, operating systems, communication media and protocols; it offers a graphical interface and use of, generally, relational data base (due to easy way of creating inquiries), with application of fourth generation programming tools etc.,
- conformity with Polish legislation, e.g. with the Act on accounting, in particular the regulations on book-keeping with the use of information technology, principles of reporting the financial performance of a business facility, principles of preparing financial statements etc.[11]

These systems cover all areas of company operation (finance, logistics, production, human resources), optimize internal processes as well as external processes taking place in the near environment of the company, by offering ready tools and allowing to automate data exchange with co-operators in the whole logistic chain. They also have a capability of dynamic configuration, which enables the adjustment of their functionality to the specific operations of an enterprise or other organization.[12]

- The ERP system comprises the following areas of logistic activities:
- customer service – customer data base, order processing, handling individual orders (products on request: *assembly-to-order*, *make-to-order*), electronic data interchange (EDI),
- production – handling of resources, product cost estimation, purchase of raw materials and components, production scheduling, management of product change (introduction of improvements), projection of production capability, determination of critical level of stocks/resources, production process control (e.g. tracking of a product in a manufacturing plant) etc.,
- finance – accounting, control of accounting documents flow, financial settlements, preparation of financial statements as required by the recipient groups (e.g. for the head office and branches),
- integration of the logistic chain – feature that is likely to determine future directions ERP systems will follow, extending their coverage outside the enterprise.[13]

3.4 *Computer-aided Supply Chain Management - SCM*

SCM class solutions offered on the market are technologically advanced systems. As a rule, they consist of a group of integrated applications serving various areas of logistic chain management. The basic SCM element is material flow planning at each stage, from material extraction to the delivery of ready product to the consumer, through joint product design, demand and supply planning, monitoring stocks level, shipment dispatch organization, joint information management.[14]

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[11] See Adamczewski P.: Zintegrowane systemy zarządzania ERP/ERPII, Difin, Warszawa, 2003

[12] See Majewski J.; Informatyka dla logistyki, Biblioteka Logistyka, Poznań 2002

[13] See Majewski J.: Informatyka dla logistyki …

[14] See Długosz J.: Nowoczesne technologie w logistyce, PWE, Warszawa 2009

The **integrating function** of SCM systems is also their important feature. It is understood as multifunctional integration – enabling integration and optimization of the main enterprise functions at the planning and execution level,

- integration of many enterprises – using Internet capabilities of communications between enterprises and their business partners and customers,
- integration with other systems within the enterprise – enabling convergence of data with transaction systems (including ERP systems, spreadsheets, data bases, text files).[15]

Complex supply chain management is strictly connected with the occurrence of eight mutually supplementing **business processes**. These are:

- CRM – Customer Relationship Management. This process enables creating a model supporting optimal building, development and maintenance of contacts with customers. Basically, it identifies market segments, allows to generate criteria for customer grouping, and estimate their profitability. All data generated by a CRM system must be measurable, so that an appropriate cost, sales and investment strategy is developed.
- Customer Service Management. Within this application the customer is able to have a constant access to check product availability, delivery dates or delivery status. Access to current information is guaranteed by an interface connected with manufacturer's production and logistic plans. This module supplements data generated by the CRM with planning procedures which define the method of delivery and product supervision for the customer.
- Demand Management. The main function of demand management is to maintain an optimal balance between customer expectations and production capabilities of the manufacturer. Demand management has advanced projection methods, where projected results are synchronized with the production, purchase and distribution. Besides, this process makes it possible to respond immediately to any internal and external disturbances in the process by generating substitute plans.
- Order Execution. Effective order execution calls for the integration of production, logistic and marketing plans of the manufacturer. The manufacturer should attempt to maintain good relations with suppliers within the supply chain, in order to provide added value to customers and reduce product delivery costs resulting from their geographical location, characteristics of raw materials offered and the selection of transport modes.
- Manufacturing Flow Management. The process is directly related with flexible manufacturing of products, their quality control, analysis of deviations and continuous control of stocks in warehouses. There is a close collaboration of manufacturing flow management module with CRM aimed at building an optimal production infrastructure.
- Supplier Relationship Management (SRM). In a sense, SRM reflects the capabilities of CRM. The difference is, however, that SRM influences product and service suppliers. SRM is supposed to identify and build close business relations with Key Suppliers (classification of suppliers by their profitability, development opportunities and methods of servicing sold products).
- Product Development and Sales. The key importance is attributed to how fast a new product or improved product can be launched on the market; in this way SCM integrates customers and suppliers in the process of product development.
- Claim Management. Effective claim management is a major component of SCM. Many companies neglect this aspect, while it turns out to be an essential factor for the company to gain competitive advantage. The process requires good knowledge of environment protection issues and some legal aspects related with product use procedures.[16]

4 CONCLUSION

The presented concept of integrated computer system of management in logistics makes use of computer-aided systems already employed in management and control of manufacturing processes (CAM and CIM), those used in the logistics of materials supply and co-operation (MRPI, MRPII and ERP) and in distribution logistics (WMS and CMR). The integrated computer system also incorporates computer systems supporting management in forwarding, transport, banking, insurance, customs etc.

The electronic data interchange (EDI) is the platform used for the integration all the above mentioned systems.

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[15] See Długosz J.: Nowoczesne technologie w logistyce …

[16] See Douglas M., Lambert [et al.]; tł Lipa M.: Zarządzanie łańcuchem dostaw,. HELION, Gliwice 2007

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