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Management Information System of Purchase Function in e-SCM

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Summary

Modern business conditions are characterized by constant change and adoption of the spirit of novelty as a business orientation of all market participants. During that, a numerous business philosophies are improved, but completely new ones are created, that is trying to respond to the challenges and obstacles of turbulent environment. This refers to the concept of e-supply chain too. Management of e-supply chain is a topic that is very relevant in the field of business economics and management information systems. The aim of the paper is to present a developed and tested model of management information system for managing purchasing processes in the e-supply chains. The methodological approach is based on the general theory of supply chains, business process management and management, stakeholders and standards requirements. The main results of research are related to the verification of developed model of management information system for purchasing processes managing in e-supply chains.

Keywords

management information system, purchasing, e-supply chain

1. Introduction

The value of supply chain management (SCM) philosophy is that "the overall performance of the entire supply chain are improving by simultaneous optimization of all the links in the supply chain in relation to the overall performance as a result would be if every single link separately optimized"(Burke & Vakkaria, 2002). In order to achieve coordination/integration of all links in the supply chain, information is critical Technological advances in information systems and information technologies provide the potential to facilitate this coordination, which allows the virtual integration of the whole supply chain. Thus, the highest level is achievement of the synchronization of functions in the supply chain from the entire network into one, "virtual "organization, able to optimize the competence and resources from anywhere, and anytime in the supply chain in order to comprehend the market opportunities using the Internet.

The information should be readily available to all companies in the supply chain and business processes and should be structured in a way that allows the fully using of information.

To cope with the challenges they face, companies need to adopt management techniques that are based on the processes, especially if they want to successfully manage their supply chains. The need for such changes in organizational design derives from the fact that, despite the changes that can be seen in today's economic and social environment, values and principles of the industrial revolution continues to define the organizational structure of many contemporary companies.

This research was conducted in the company, which is the third link in the supply chain in the automotive industry. The authors particularly analyzed the process of purchasing in e-supply chains. Research was conducted from the aspect of the business goals and objectives of information system, global requests, demands and needs of stakeholders, macro and micro organizational structure, management and decision-making processes, processes that exist in the organization, procedures, and guidelines which defines technologies and ways of processes execution and activities, competencies and responsibilities, time, constraints, deadlines, business and technical documentation, standards applied, generated reports for different levels of management and decision making processes, internal and external communications, and other resources. (Arsovski, 2008)

As for management information system development to manage purchasing processes in e-supply chain the following methods and techniques were used: BSP (Business System Planning), BPM (Business Process Management), process-oriented method for analysis of complex structured system of SSA (Structured System Analysis), object-oriented method for system analysis, data modeling

method for ERD (Entity Relation Diagram), Case tools BPwin and ERwin and RDBMS.

The theoretical and methodological aspects of research relate to:

- Company management requirements model development according to information system to support purchasing processes in e-supply chains and
- Development of logical process model, data model, interface model, the network model and distribution processes and data in the network.

Applicable part of research refers to:

- Application of methodology for design of management information system to support purchasing processes in e-supply chains in the automotive industry and
- Model development of management information system for the purchasing processes of e-supply chains.

2. Background

SCM is a hot topic in the literature and relates to many scientific disciplines. The connection can be found in the literature about Engineering (Kouvelis & Milner, 2002), Operational Research (Chan, Muriel, Shen, & Simchi-Levi, 2002), Accounting (Thomas & Mackey, 2006), Information Systems (Subramani, 2004), Marketing (Juttner, Christopher, & Baker, 2007), Finance (Guillen, et al., 2007), and Economy (Warburton, 2007).

Christopher (2005) defines supply chain management as "managing relationships between organizations that are located above and/or below the (parent) organization in a supply chain."

For Harrison and Van Hoek's (2005), "Supply chain management is the planning and control of all processes that link partners in a supply chain with the purpose of servicing the needs of end users." According to these authors, any company in the supply chain is a partner.

In one of the most frequently cited papers relating to supply networks (Cooper, Lambert, & Pagh, 1997) SCM is defined as "the integration of key business processes from end user through suppliers that offer products, services and information that add value for customers and other interested parties" (Chan & Qi, 2003).

Choi and Hong (2002) claim that managers are confronted simultaneously with three kinds of complexity in the supply network: vertical, horizontal and spatial. Most problems relating to SCM result from the inability to coordinate several activities and partners and uncertainty (Turban et. al., 2004).

There are numerous papers published on the topic of the impact of the Internet on SCM (Lee, 2002; Swaminathan & Tayur, 2003). In addition, papers consider various processes in supply chains. Some of the papers are descriptive (Clarke, 1998; Graham & Hardaker, 2000; Gunasekaran, Marri, McGaughey, & Nebhwani, 2002). There are also papers that are empirically based (Cagliano, Caniato, & Spina, 2005; Frohlich, 2002; Frohlich & Westbrook, 2002).

3. Business Process Management

Process-oriented organization is the organizational form that identifies compatible and integrative nature of business processes. Key business processes are the building blocks of the organizational solutions and together with the traditional functional units create its structure. In this way, through the joint development and interactive structures and processes development, companies integrate all their activities towards achieving objectives and improvement of business operations.

Managing business processes in supply network is a complex task that requires the manager to activate properly the mechanisms of coordination to perform the necessary adjustments and coordinate activities carried out by different, interdependent network members.

The paper analyzes and represents the third link in the supply chain in the automotive industry (the company X). For the observed company the structure of supply chain and requirements of company management and stakeholders is determined for the information system, which should support efficient purchasing processes in supply chains. Supply chains of the company for individual projects are intertwined and form a global supply network. If we bear in mind that the average number of parts installed in one car is about 15,000, and today most of these positions develop and manufacture tens of thousands of manufacturers of components in different regions of the world and that each component belongs to more than one manufacturer, it may be concluded that it is a very complex supply chain. It was precisely determined which supplier (Tier) in the supply chain belongs to the adequate supplier.

Time during the previous participant in the chain produces materials from the time when order of the next participant (its customer) in the supply chain was placed, is a lead-time. Time can be

expressed in hours, days or, weeks. This time should be added to transportation time required for transport of goods from the supplier site to the location of the customer. If the different time required for the implementation of an order to take into account is the fact that different materials are packed in varying numbers, the need for synchronization and optimization of transportation times and quantities are obvious.

The frequency of sending orders directly relates to lead-time necessary for its realization and frequency of transport, which will translate the orders from supplier to customer. Optimization and synchronizations of time and quantities is intended to provide minimum transportation cost per unit of input materials with optimal safety stocks of that material, and to meet demand for delivery on time in the box and the number of pieces on request. The only way to properly perform this is to map the supply chain processes and each supplier single process in the supply chain (Rejman Petrović, 2010).

Since the supply and fulfilment of customer requirements are the key supply chain processes, the paper presents Management Information System (MIS) of the purchasing processes for the company X.

3.1. Analysis of Management, Stakeholders and Standard Requirements

Company stakeholders can be divided into internal and external stakeholders. The internal stakeholders include owners, board of directors and employees. External stakeholders are customers, suppliers, competitors, government and special interest groups, media, trade unions and various financial institutions.

The owners articulate their demands globally, express them through sales growth percent and the percents of reduction in transportation costs, and supply chain optimization. After that, articulated requirements use the company management to develop an annual plan accepted by the Steering Committee. Analyzing the business plan of the company X in 2010, a defined objective to increase sales by 18% can be noticed, which implies the purchasing plan for 20% higher than the previous year, transport cost optimization by 8% and optimization of shipping costs by 20%. Specific goals have been set also: 100% OTD (On Time Delivey) suppliers, supplier payment terms in 60 days and inventory turnover in 15 days.

Customer requirements, when it comes to the purchasing processes, are realized through finished products order of the observed companies, the supply of specified materials/parts with pre-arranged prices, specified technical characteristics and quality, just in time. One of the largest buyers of the company X articulates their request via shortcut 100/0/30. This means that company X as a supplier must provide 100% delivery on time, with 0 ppm (parts per million - without poor quality) within 30 days after the launch of production. From this, a clear mission of the purchasing processes of company X stems that also requires from its suppliers to fulfil customer requirements. A requirement that customers can make is the request relating to the optimal stock for the purpose of supply chain security.

The dominant requirement from suppliers relates to the agreed payment terms and request for more accurate predictions without major fluctuations of ± 20%, which is standard in the automotive industry.

The company X must continuously improve their processes, equipment, knowledge and skills to compete for their customers. This includes the constant improvement of information system in order to achieve the A rank of supplier in automotive industry and stay in this range in the future.

Government, special interest groups and trade unions requests are articulated through the sets of laws and regulations, which must be strictly respected in business. When it comes to unions, companies accept greater responsibilities than the statutory minimum, to ensure greater employees' satisfaction.

In order to ensure supply chain common approach, terminology synchronization, product development, improvement of the manufacturing process and reporting standard, ISO/TS 16949 was made. It was developed by the body for issues relating to the automotive industry (IATF – International Automotive Task Force). Some requirements that prejudice purchasing processes are:

- Mandatory use of a multidisciplinary approach for planning processes, devices and equipment,
- Mandatory implementation of the plan for overcoming unpredictable situations;
- Obligation that all purchased products must be harmonized with the requirements of customers, purpose of products requirements, requirements of standards, requirements prescribed by the company being in accordance with the legal requirements and regulations;

- Obligation of suppliers to comply QMS with ISO/TS 16949:2002;
- Obligation that quality of purchased products is determined with one of the following methods: receipt and evaluation of statistical data by the company, the receiving control and/or test sample characteristics, assessment or testing by the second or third person, along with data relating to the quality of delivered products, partial assessment of the specific laboratory or by another method, in agreement with the user;
- Mandatory monitoring of suppliers from the aspect of quality of previous deliveries;
- Mandatory implementation of the FIFO method;
- Mandatory implementation of statistics tools;
- Mandatory implementation of processes required for solving problems, preventing errors, the application of corrective measures on similar processes and analysis/testing of complained products.

3.2. Analysis of the Purchasing Processes in the Automotive Industry Supply Chain

In most existing organizational models, this feature is a unique organizational unit, although, in the case of complex and large companies purchasing, this function can be organized into several units that make up the unique organizational unit of purchasing.

In the observed company process of purchasing is, along with sales and logistics processes, hierarchically subordinated to commercial processes. The analysis of the purchasing processes in this company, and in line with business objectives, management and stakeholders requirements, defines the following processes: purchase resource planning, supplier evaluation, contracting, purchase realization, reception and storage of incoming materials/parts and verification of deliveries and resolving complaints from suppliers.

Purchase Resource Planning

Basic prerequisites for purchase resource planning are:

- Existence of products database and specifications;
- Inventory of finished products, work in process and material/parts and
- Manufacturing plan.

Information system of the company X contains data about products and materials/parts that are arranged by the product specifications from the three levels, where the materials/parts are on the third level, particular sub-assemblies are on the second level, and complete assemblies are on the first level. Given that a material can be used for making many different final products, functional links within the information systems were established, which unite the need of the materials for all products.

Also, the information system contains data about the current state of materials/parts, WIP and finished products in all locations (warehouses, cutting lines, sewing lines, finished products warehouses, complaints warehouses), and even the amount of material that is in transport to the company X in case of regular orders.

Based on customer orders via EDI, which are forwarded to information system X, or sales plans in case of purchase plan on an annual basis, and inventory of products a manufacturing plan is formed. Based on the manufacturing plan, both annual or weekly, and on the basis of stock and WIP materials/parts and finished products, the information system calculates the required quantities of materials/parts for purchasing, as well as the value of purchasing. When it comes to plans for the regular weekly ordering, the information system calculates the exact dates when the materials/parts must be in the company to the customer ordered goods delivered on time.

When a company has multiple suppliers for individual parts or materials, purchasing functions through the plan establishes the participation of each supplier in the purchase plan. Also, the purchasing function is programming delivery schedule for each supplier, taking into account the dynamics required are meet the requirements for purchasing, but also for the suppliers to determine the optimal delivery schedule.

Evaluation of Suppliers

The company establishes effective and efficient processes to identify possible sources of materials to be purchased, monitor existing suppliers or partners, as well as to evaluate their ability to deliver the required products, as well as to ensure effectiveness and efficiency of the overall purchasing processes.

The supplier's management process involves:

- Evaluation of relevant experience;
- Defining the performance of suppliers in relation to those with their competitors;
- Check suppliers references and available data on user satisfaction;

- The financial situation evaluation to gain confidence in the supplier's capacity to act throughout the scheduled period of delivery and collaboration;
- Supplier's response on inquiries, prices and offers;
- Ability to service, install and support, as well as existing data on performance compared to the requirements;
- Knowledge of appropriate requirements of regulations and other normative documents by the supplier and its compliance with them;
- Determination of logistical support capabilities of the supplier, including the location and resources;
- Defining the place and role of the supplier in the community, as well as his social reputation;
- Reconsideration the quality of products being purchased, its price, performance, delivery and responses to problems;
- Checking supplier management systems and evaluating their potential ability to deliver the required products effectively and efficiently within the specified dynamics.

In particular example of the company X, this process has its own characteristics. The first nine elements are responsibility of car manufacturer-finalists (Original Equipment Manufacturing - OEM), as determined on manufacturers of materials used for producing parts of the interior. All conditions, such as price, payment terms, production sites are agreed between the OEM and supplier companies X, even the first (Tier 1) and the second level (Tier 2) suppliers that deliver complete seats, the module has no influence on the choice of supplier. This does not mean that the company X and its customers can not participate in performance monitoring and continuous improvement of suppliers. Rather, through close contact with the supplier, regular audits of its processes and continuous monitoring the quality of delivery, through the systematic solving the problems, the company X participates in the supplier's management process (Ranković, et al., 2011).

Therefore, purchase management continually analyzes suppliers regarding their ability to meet long term needs of the company and continually takes care of suppliers through the evaluation and ranking. The information system by comparing orders sent to the suppliers and the minutes about receipts of delivery, as well as to the parameters that are predefined in information system, establishes indicators by which the company management make adequate decisions and take action to improve the performance of suppliers, and finally to lead to improved performance of the supply chain business processes.

Contracting, Acquisition and Realization of Purchasing

Based on the above mentioned specifics that OEM selects the suppliers of materials, it is also responsible for purchasing acquisition. The process of contracting between the Company X and pre-defined supplier is reduced to signing a document that has the character of the contract (Purchase Order - PO) in which materials are specified, the unit measures, unit prices, payment terms, parity of delivery, and locations of suppliers and company X, the person responsible for all sectors and their contact information, delivery terms OTD 100% and 0 ppm, specifications of packaging, labeling, quality control and technical specifications prescribed by the OEM. The document has no defined quantities, but quantities are defined by regular weekly PO`s or Schedules that the company X sends to its suppliers, where the contract number is connected with it, together with the order and dates when the material have to be received in the company X.

Although the supplier is predefined, the company X has an obligation to verify the first delivery after the arrival of the material by the first order. Verification is carried out by the engineering sector and the sector of quality, with lines of responsibility and authority. Verification is carried out in accordance with the documentation process for the Production Part Approval Process - ppap level 3. The role of purchase function in this process is to define clearly and provide such documents and code related to the International Material Data System, IMDS-number, from the supplier during the first delivery. The feature of this delivery is that it is the first commercial delivery of products, and also a process of its verification is nearly identical to the process of receiving regular delivery.

The required quantities and delivery schedule are confirmed in practice by issuing the PO-Schedule to a supplier. The procedure for creating a purchase order is performed by an information system based on customer orders with defined quantities and dynamics in the time frame of up to 6 months, which is using EDI forwarding to information system (inventory of products, materials in the manufacturing process and materials/parts). The required inputs for the process of purchase planning and ordering are

placed in the databases of information system of company X, with which order form is created.

The company X uses the method of dynamic ordering of materials/parts. This method is based on a specific planning time unit.

Reception and Storage of Incoming Materials/Parts and Verification of Deliveries

In accordance with the established obligations of suppliers in terms of product quality, methods of identification, packaging and delivery schedule, procedure of taking the product by the customer is implemented. This is the final phase in the realization of products purchasing from the supplier and it includes activities receiving (quantitative and qualitative) and storage in the appropriate warehouse. The main document that determines the arrival of delivery and attitude towards receipt is the Reception Record.

During reception, all materials/parts are marked with labels in order to be uniquely identified, so that the code of material/part, the quantity and date of delivery specified by the order entered in the information system via the barcode reader. The Information System does not allow receipt of materials/parts that have not been ordered.

Resolving Complaints with Suppliers

The establishment of close cooperation with suppliers and maintaining information sharing allows along with the improvement quality of products, avoiding disputes about the quality and in return of the product case of quality problems quickly and effectively eliminate and avoid consequences. The consequences may be return of the products to the supplier and loss of time, production delays, and massive cost of the product resulting from cancellation of the operation, jeopardizing the company's image or interruption of further cooperation.

The information system on the basis of contracts, orders, technical conditions and records of the receipt provides detailed information about the inconsistencies and initiate a complaint records that are electronically sent to the supplier.

4. Management Information System

Using the process approach and methodology for developing information systems, the model of information system management is defined for the purchase function in the e-supply chain, which includes the design of requirements model, the design of logical model of key processes with defined information flows within a logical subsystems, logical design of data model, the logical design of network model and data distribution and logical design of interface model for the different users (Figure 1).

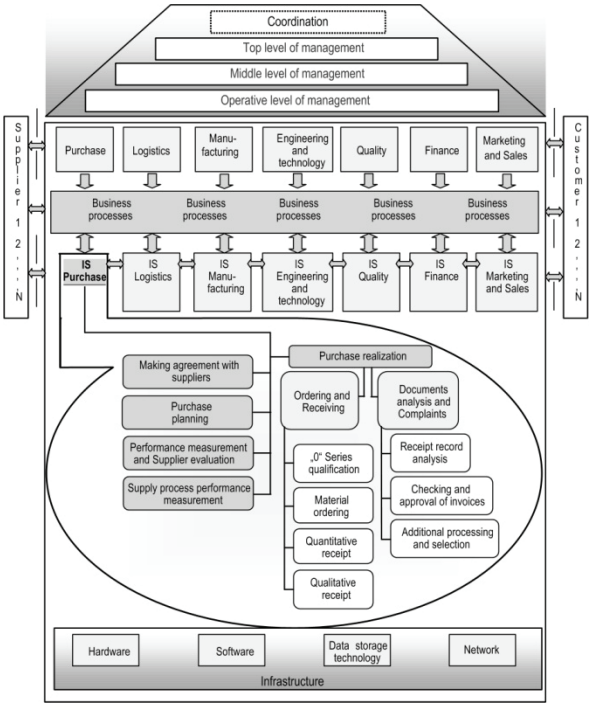

Figure 1 MIS model for the purchase function in the e-supply chain

4.1. Process Model

Presentation and documentation of the structure and data flow between processes of the system and processes with the environment allows process modeling technique. With the help of this technique, logic and hierarchy of process is presented, procedures which apply or will be applied in the processes of the system, documentation is created and used for the process, etc.

The first step of the process modeling is decomposition of the primary processes on the lower-level processes, to the elementary processes as simple business activities that are implemented at the operational level. To describe the flow performance of each process, showing the relations between processes, processes and sources, processes and external objects, as well as processes and internal data stores, the data flow diagram was used (Arsovski, Rejman Petrović, Milanović, Ranković, & Kalinić, 2010).

The process model for purchase function designed using the BPwin software, tool for modeling and analyzing complex business processes, is shown in Figure 2.

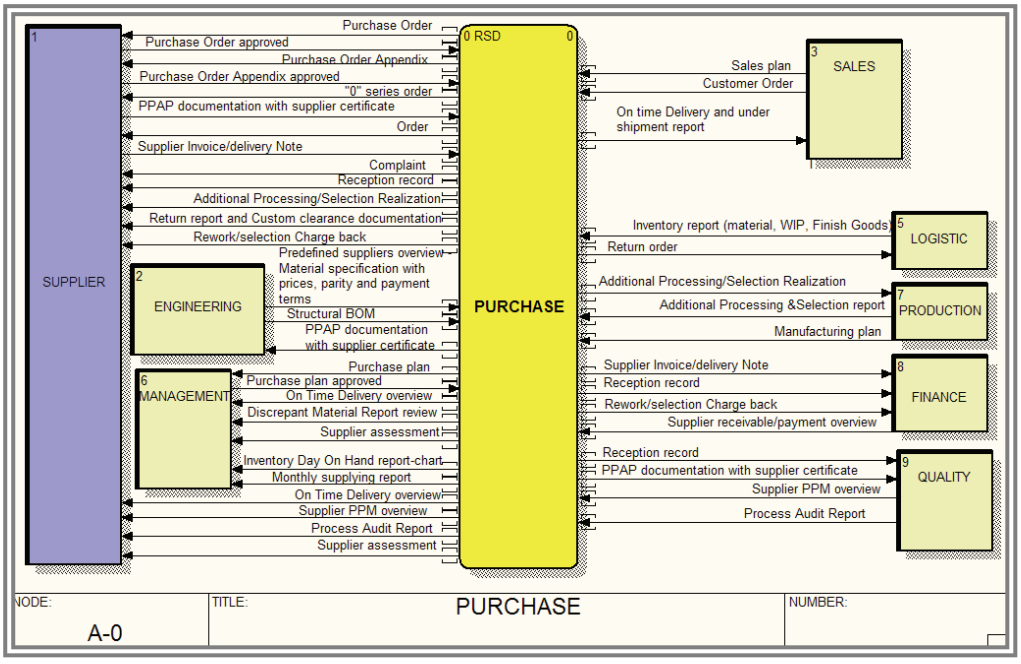

Figure 2 Context diagram for purchase function

On the basis of established matrix processes/data classes, the following logical subsystems of information system was defined for a purchase function in the analyzed company: purchasing contracting subsystem, purchasing planning subsystem, purchasing realization subsystem, the subsystem of performance measurement and evaluation of suppliers and subsystem of performance measurement. Figure 3 shows the root diagram of the first level for purchase function – purchase realization.

4.2. Data Model

The compulsory part of the system analysis is development of a stable and complete data model in the observed business system. During the process of data modeling, we started from an

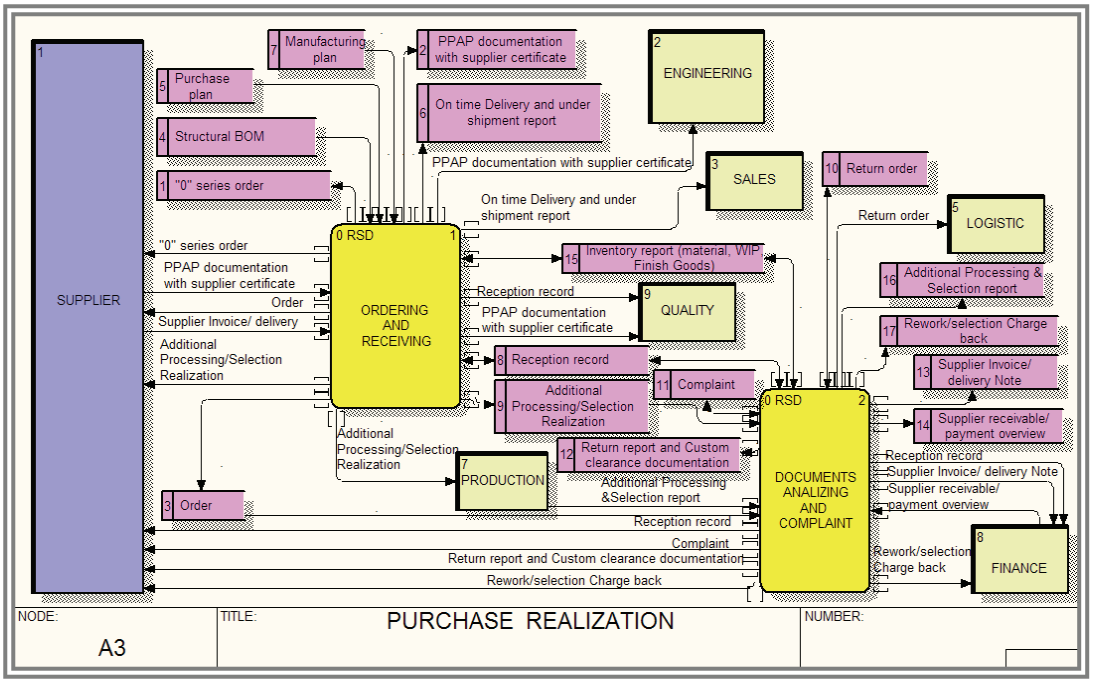

Figure 3 Root diagram of the first level for purchase function - purchase realization

organization model obtained in the phase of strategic information planning. The data model was created during the detailed process modeling, data flow analysis and documents analysis and information needs identified that are important for a specific business area, i.e. the purchase function (Arsovski, Rejman Petrović, Milanović, Ranković, & Kalinić, 2011a, 2011b).

For the purposes of transforming the process model into the data model, we analyzed the data flows and data stores, which are the fundamental characteristics of the system or system state in specific situations. Creating a data model was realized by using the software ERwin, which included identifying the entities in the system, their attributes and relationships. The obtained data model is the basis for interface modeling for the company's management and network modeling of relevant processes and their location in the e-supply chains.

The logical data model for purchase subsystem is shown in Figure 4.

4.1. Model of the Reports Available in MIS System

In data information systems data, inputs are processed into useful information on the basis of which different levels of management make decisions. An information system that is designed in accordance with the requirements and needs of the company and management contributes to their efficiency. Besides information, the information system has other outputs, such as different documents, reviews, reports, etc. They greatly facilitate the implementation of all phases of management activities – planning, organization, leadership and control.

For management purposes at the operational level information system provides in real time precise and detailed daily information on inventories at the warehouses, inventories per materials (Figure 5), supplier delivery status, order status, etc.

Managers at the tactical level require information about potential serious problems with suppliers, a sharp fall in orders number, etc., to be able to plan material requirements per customer orders (Figure 6), as well as to plan needs for materials, etc.

For the needs of managers at the highest level, the information system shall provide information for strategic planning and management control. Managers at the highest level need overall financial results. They need information on turnover and profit for the quarter, about purchase realization for a specific period per suppliers (Figure 7), supplier performances (Figure 8), levels of quality and customer satisfaction, the results achieved by competitors, etc.

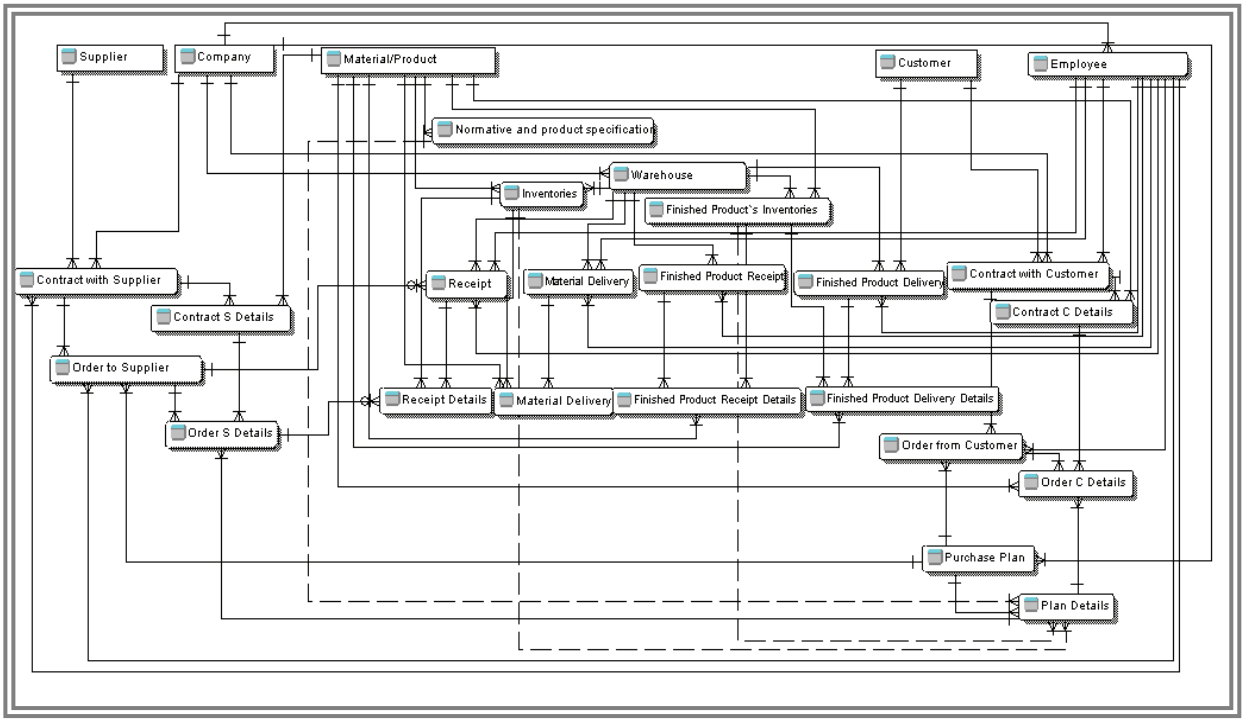

Figure 4 Data model for purchase subsystem

STATUS OF MATERIAL STOCK

ID Material: 225463

ID Werhouse	Name of material	Unit of Measure	Quantity	Currency	Price	Value
MMP	Mondial	m	1127	EUR	11,89	13400,03
MC	Mondial	m	5555	EUR	11,89	66048,95
SUM			6682	EUR		79448,98

ID Material: 189GDW

ID Werhouse	Name of material	Unit of Measure	Quantity	Currency	Price	Value
MC	Vinyl	m	2000	EUR	13,112	26224
SUM			2000	EUR		26224

ID Material: 1843636

ID Werhouse	Name of material	Unit of Measure	Quantity	Currency	Price	Value
MRD	Antla	m	60	EUR	9,81	588,6
MMP	Antla	m	1000	EUR	9,81	9810
MC	Antla	m	17000	EUR	9,81	166770
SUM			6,682	EUR		79,448.98

Figure 5 Report – Condition of stocks by material/product

MATERIAL REQUIREMENTS PLANNING

ID Customer	ID Customer Order	Status of C Order	ID Material	Unit of Measure	Required amounts	Planned date of receipt of materials	Note
Customer CLS							
	7	□ Open	DUS000500	m	6000,00	5.7.2010	Need to purchase
			865123	m	376,58	5.7.2010	Need to purchase
			MAT555	m	22800,00	5.7.2010	Need to purchase
			SE05	m	38000,00	5.7.2010	Need to purchase
			7025TW	m	95,80	5.7.2010	Need to purchase
ID Customer	ID Customer Order	Status of C Order	ID Material	Unit of Measure	Required amounts	Planned date of receipt of materials	Note
Customer CCS							
	9	□ Open	DUS000500	m	5600,00	29.6.2010	Not need to purchase
			865123	m	597,6	29.6.2010	Need to purchase
			MAT555	m	27000,00	29.6.2010	Need to purchase
			854659	m	263,46	29.6.2010	Need to purchase
			DUS000658	m	10800,00	29.6.2010	Need to purchase

Figure 6 Report – Planning materials need after customer order

PURCHASE REALIZATION PER SUPPLIERS

1/6/2010 1/7/2010

ID Supplier	Currency	Velue
S1/7	EUR	123000,00
S21/1	EUR	348240,00
S2/8	EUR	90000,00
S10/1	EUR	167402,81
SUM	**EUR**	**617942,81**

Figure 7 Purchase realization per suppliers in June 2010

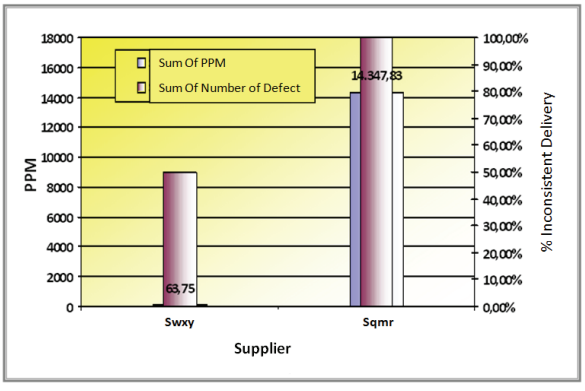

Figure 8 Performance measurement of suppliers

5. Conclusions

The implementation of management information system developed for purchasing processes in the observed company was achieved in the following:

- Economical, functional and rational management of the records about the quantity, quality and level of stocks of input materials/parts, input prices and supply conditions in the market;
- Monitoring of material and financial flows in real time;
- Reduction of the data acquisition processing time and purchasing processes automation;
- Increasing the number of output information due to the rapid and multiplicative intersection of the collected data (data about the materials/parts in the process of development, technological characteristics, requests, data about the required materials/parts for purchasing, current stock of finished products and input materials, materials/parts in transport, etc.);
- Increasing the number of processed data;
- Increasing the quality of information (graphical data display, eliminating human errors in data processing);
- Online communication with suppliers and customers;
- Integration into existing company website, online registration of data on customer satisfaction, as well as information on complaints;
- Reducing the number of employees who work on data processing, not only in purchasing processes, but also in other processes while increasing the time available for creative activities that bring added value;
- Web integration with customers and suppliers systems.

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