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THE CONCEPTION OF THE SYSTEM SUPPORTING MANAGEMENT IN THE AREA OF KNOWLEDGE MANAGEMENT IN ENTERPRISES OF MECHANICAL ENGINEERING INDUSTRY

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The paper presents the conception of the system supporting management in the area of knowledge management in mechanical engineering industry enterprises. Specified conditions and assumptions for the construction of the working out IT system were given. The detailed structural range of the information system was discussed. Additionally, the authors presented the universal tool, knowledge network system KNS, which is useful in dealing with qualitative information, which frequently occur in knowledge management.

Keywords: knowledge management, network knowledge system, structural range of information system

1. Introduction

The development of IT tools for supporting knowledge management is the important element for improving the effectiveness of management, primarily in production companies, which use high-technology solutions in which the product is dedicated to well-defined recipients [11, 13, 14]. The sophisticated system of internal processes in these companies [2,3] requires the use of solutions that support knowledge processes such as the knowledge extraction, knowledge collection, knowledge transfer and knowledge use in the activity of an enterprise to support to

make best decision demanding processing both quantitative and qualitative [9, 10, 15]. The present access to the knowledge of high value for authorized users is the key factor of the knowledge management system.

In the context of this article the conception of the system supporting knowledge management (the acronym SSKM) was presented. This article presents the assumptions of this conception and the scope of the structural range of the system. Working out the conception is an important step in the realization of R&D project "The computer system supporting knowledge management in mechanical engineering industry enterprises".

This paper presents the problem of supporting users in the working out system to use the knowledge efficiently i.e. editing, structuring and organizing of knowledge. Knowledge is significantly different from the data, which usually contain information about individual objects. The data is well-structured information, which can be simply organized. Knowledge management is more complex. There are at least three reasons for occurring problems: the need to save the information of very different form and content, the lack of a predetermined structure of information and the difficulty in handling qualitative information. To solve these problems, the knowledge network system KNS is described in the article. In the KNS system determined the standard store of knowledge in the form of elementary objects that combine formal structure consistent with the possibility of recording the various types of information.

2. Assumptions of the conception of creating system supporting knowledge in mechanical engineering industry enterprises

Determining the functionality of information systems should be based on the insightful analysis of the processes involved in knowledge management in mechanical engineering industry enterprises. The survey and personal interviews with senior managers in selected mechanical engineering industry enterprises, conducted in 2011, have established the basic assumptions of the construction of the SSKM system in these companies [2]:

- the activity of analyzed enterprises is focused on the execution of contracts with specific requirements of individual customers (production unit, mainly big machines as production on request), which means that the main "axis" of the SSKM system is to support knowledge processes related to the preparation, implementation and monitoring of contracts,
- due to the fact that the activity of the analyzed enterprises is particularly sensitive to changes in economic conditions (sensitivity to the economic slowdown is greater) and influenced by many factors of low stability, in particular the order book, parameters of contracts with customers, parame-

ters of contracts with suppliers and subcontractors, it is necessary to make the system be able to assess the validity of the contract at the stage before signing the agreement [1], including economic and technical criteria,
- high degree of uncertainty and variability in the level of production capacity requires the dynamic use of available resources, and this is closely related to the effective management of knowledge processes, mainly in the collection, transfer and use of knowledge,
- executed contracts require high competence of the company's employees both technical and organizational, as well as the cooperation with external experts, which makes it necessary to support competency management and allocation of human resources within the SSKM system.

3. The structural range of the system supporting knowledge in mechanical engineering industry enterprises

For the purpose of building the system, the general structure of the work realized in the framework of the contract in mechanical engineering industry enterprises was determined as follows:

1. Initial making the offer bid - to determine whether the enterprise is able to realize the contract. If so, the additional task is to determine the estimated price (where the experience in the realization of similar products in the past plays a huge role).
2. Making the offers bid - after acceptance by the customer of the estimated product price, the construction and technology department offered, based on the assumptions, the required construction, technology and design. The above-mentioned information is directed to the purchasing department, which identifies potential suppliers of materials and components needed for production. From this base, with the addition of labour costs, there is the valuation of the whole product.
3. Realization and monitoring of the contract implementation - after signing the agreement between the firm and the client the contract implementation begins i.e. the contract specification of construction and technological requirements are analyzed, the purchasing department place orders for supplies and/or for processes outsourcing and start up the production based on internal resources. At the same time the control of realized tasks is performed.

At each of these stages one of the key tasks (often ignored in practice) is risk management, which has been included in the units shown in Figures 2 – 5.

The identification of knowledge areas used in the implementation of the contract was investigated in the form of targeted interviews with companies' representatives (the owners, company directors, managers responsible for the development of new products and technologies to be implemented (e.g. construction and technology department, production preparation department). The questions in the survey related to the use of instruments to support knowledge management are divided into the stages i.e. locating, acquiring, codification and transfer. Respondents are questioned about the company's future i.e. the assessment of desired state of supporting knowledge actions in the execution of the contract. Detailed results and the discussion were presented in previous articles [4,5,10].

Based on the survey results, the interviews suggested the separation of the key areas of knowledge in the assignment of its members (Table 1). With regard to the identified areas of knowledge, respondents evaluated the use of customers' knowledge very low. At the same time the desired level was rated very highly. It is important, therefore, according to the respondents, the need to improve the process of acquiring knowledge from customers. Customers are a very important source of knowledge acquired in the course of using the product.

It should be noted that the cooperation with other organizations (in gaining knowledge about suppliers and competitors) were assessed at a very low level. The respondents emphasized that the reason is the lack of trust in the partner, lack of funds, but also the bad experiences of such cooperation in the past.

Respondents emphasized the need to record the problems in the projects and the ways of their solving. It is very important that in the future projects often involved other employees. It is required to strengthen enterprises to maintain (collecting, updating, disseminating) an electronic documentation. The problem in analyzed firms is the lack of software, which would allow employees to manage products' documents in different versions. The problem was reported by both designers and workers responsible for the client after the sale of the product. Such knowledge is needed not only in the product design and its development, but also in activities such as the after-sale service, maintenance and repair.
As a result of undertaken analyses the architecture of the system supporting knowledge management in mechanical engineering industry enterprises was given (Fig. 1). The key objective of the SSKM in mechanical engineering industry enterprises is to ensure the efficient and effective collection, processing and exchange of knowledge in the process of preparation, implementation and monitoring of contracts.

In figures 1-6 the structure of the SSWM is presented. The structure includes the following units:

- „SUPPLY"
  - „Suppliers' Analysis",
  - „Analysis of Supply Parameters of Contract Realization",

- „Risk Management of Supplies for Contract Realization”.

– „PRODUCTION”
  - „Analysis of Contract Realization Validity”,
  - „Risk Management of Contract Realization in the Production Area”.,

– „DISTRIBUTION”
  - „Clients’ Analysis”,
  - „Service”,
  - „Risk Management of Contract Realization in the Distribution Area”,

– „SUPPORING PROCESSES”
  - „Contracts’ Databases”,
  - „Risk Management of Contracts Portfolio”,
  - „Analysis Tools Supporting Knowledge Management”,
  - „Human Resources Management”,

– „SYSTEM CONFIGURATION”.

Table 1. Key knowledge areas in the process of a contract realization in mechanical engineering industry enterprises

Knowledge area	Board of directors	Project Manager	Sales and Marketing Department	Construction and Technology Department	Supply Department	Production Department	Service
Knowledge of contracts	✓	✓					
Knowledge of processes		✓	✓	✓	✓	✓	✓
Knowledge of good practices		✓	✓	✓	✓	✓	✓
Knowledge of contracts’ realization	✓	✓					
Knowledge of resources and knowledge sources		✓	✓	✓	✓	✓	✓
Clients’ knowledge and knowledge of clients		✓	✓	✓			✓
Knowledge of experts		✓		✓			
Knowledge of suppliers/contractors		✓		✓	✓	✓	✓

Source: [4a]

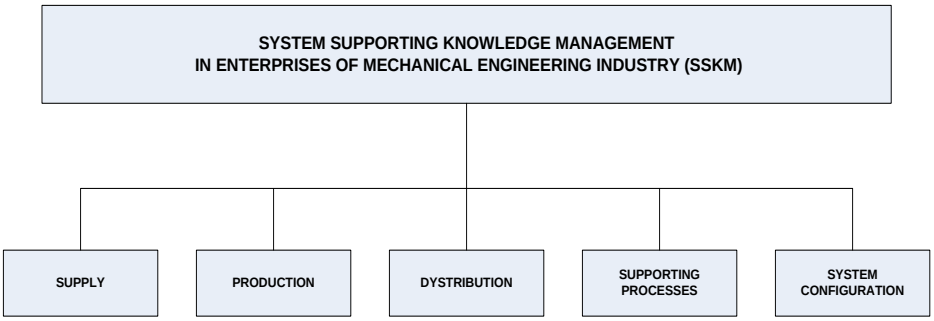

Figure 1. The structure of System Supporting Knowledge Management dedicated to enterprises of mechanical engineering industry

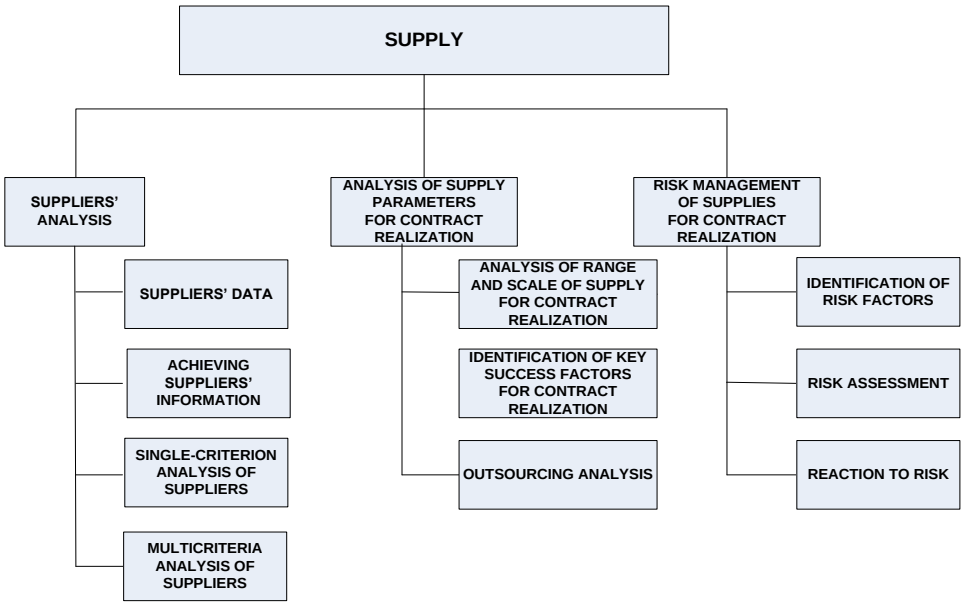

Figure 2. The structure of the unit "Supply" of System Supporting Knowledge Management SSKM

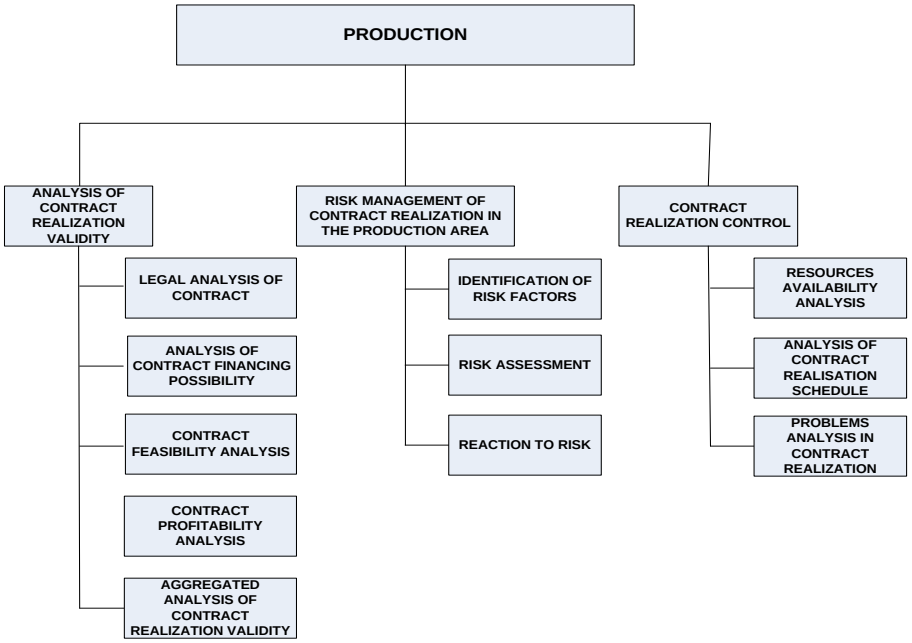

Figure 3. The structure of the unit "PRODUCTION" of System Supporting Knowledge Management SSKM

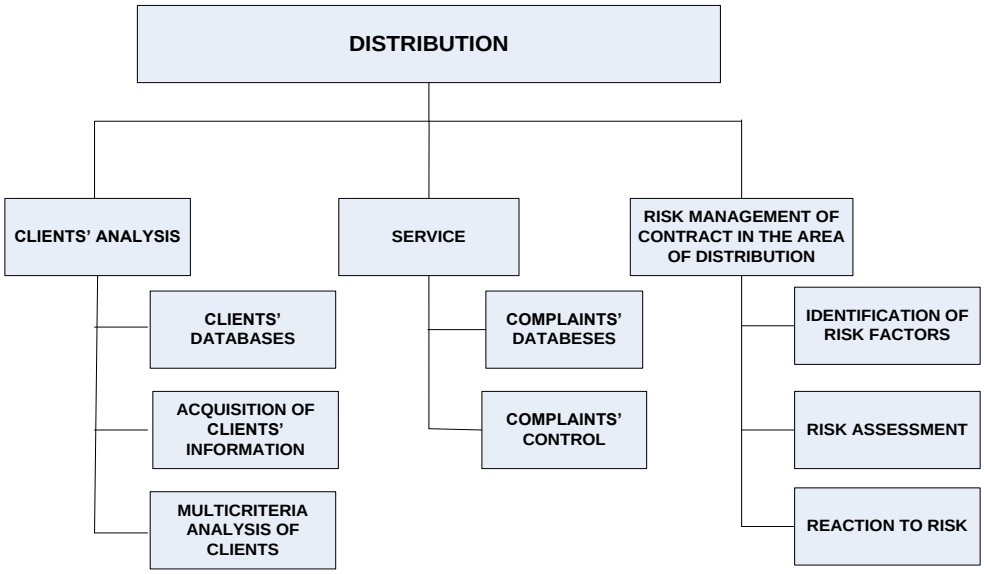

Figure 4. The structure of the unit "DISTRIBUTION" of System Supporting Knowledge Management SSKM

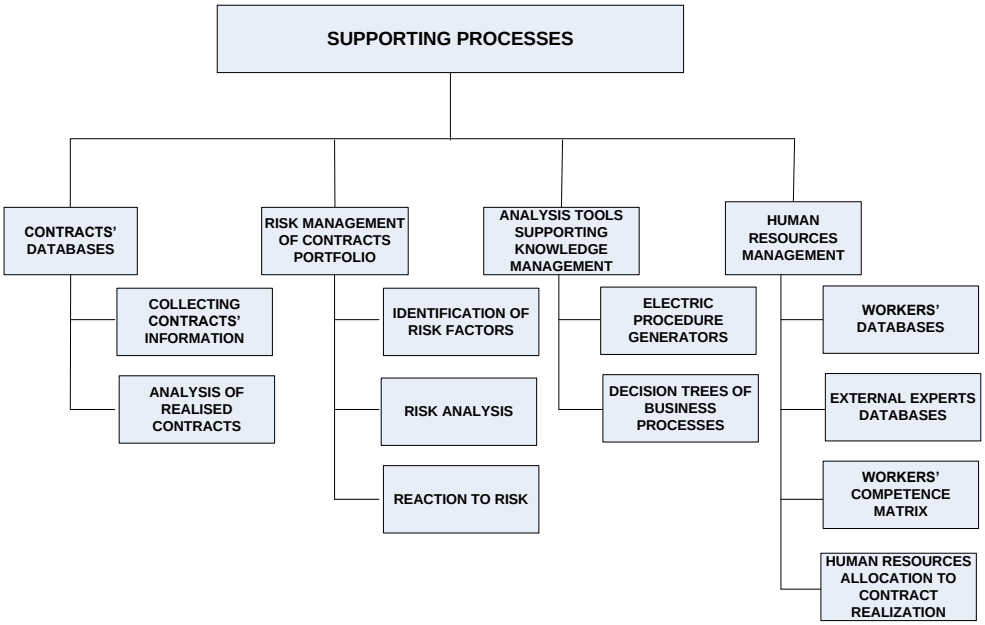

Figure 5. The structure of the unit "Supporting Processes" of System Supporting Knowledge Management SSKM

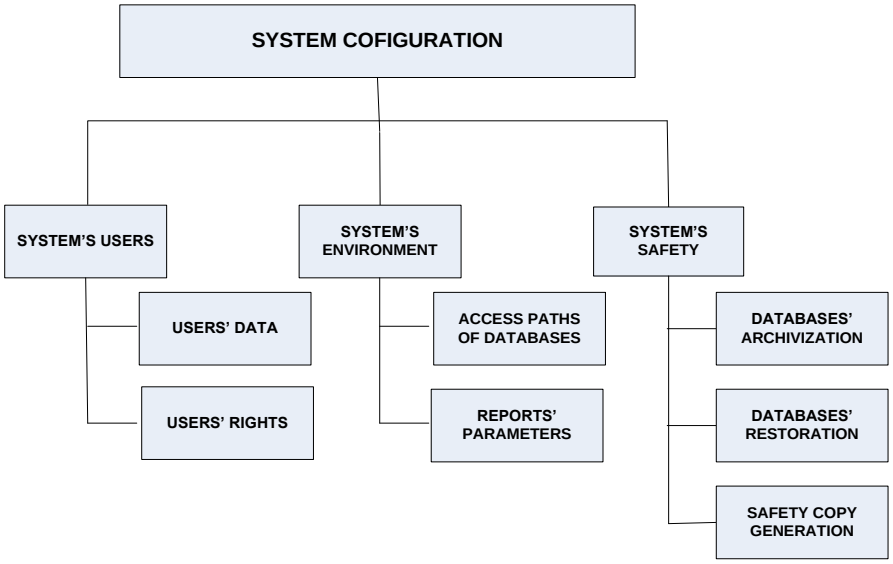

Figure 6. The structure of the unit "System Configuration" of System Supporting Knowledge Management SSKM

4. The network knowledge system

In the proposed SSKM system the majority of recorded and processed information are the qualitative information in the form of texts, drawings, diagrams, graphs, calculation formulas, addresses and other knowledge objects. These knowledge objects are clearly different from the information processed in a standard relational database management system. Important IT tools supporting information management are knowledge systems. In order to achieve the substantial part of the tasks executed in the SSKM system was created the network knowledge system NKS, which will be used in the above-mentioned units. The NKS especially enables splitting the information (mainly qualitative) into elementary knowledge objects and editing, structuring and organizing, and the convenient access to knowledge. The knowledge is significantly different from the data, which usually contain information about individual objects. The data are well-structured information which is simple to organize. Knowledge management is more complex. The main reasons of problems connected with knowledge management are as follows:

1. The necessity of registering the information of very different form and content.
2. There is no predetermined structure of information. In the qualitative information processing it is important to structure the information, especially the establishment of relations "whole - part" and "generalization - specialization". The creation of such relationships requires the interpretation of information and it cannot be done automatically.
3. Difficulties in operating of the qualitative information. In the qualitative characteristics, as opposed to quantitative characteristics, the isomorphic relationships cannot be attributed to the relation of the majority of the set of real numbers. The consequence of this is, among others, the lack of the algorithmic information organization (determining the order and the selection) based on formal criteria.

To solve the above-mentioned problems it is necessary to take the following actions:

- determining certain writing standards of knowledge in the form of elementary objects, which combine the formal structure consistent with the possibility of recording the various types of information,
- the disposal of IT tools enable to determine relationships of superiority- inferiority among the elementary objects of knowledge,
- the disposal of tools supporting the valuation of the qualitative information. Evaluating of objects with quality characteristics is based on assigning the numerical value to the object. The valuation is one of the most important methods of structuring poorly-defined quality problems, enabling the creation of a quantitative homomorphic model representing the qualitative problem.

The created system is based on a single, universal structure, so-called the network knowledge system NKS. It enables operating of the knowledge presented in the form of standardized elementary objects. These objects can be combined relationship superiority- inferiority to any structure. The elementary object in NKS combines the formal structure with the possibility of recording various types of information (numerical, text, graphic and other even more complex). The structure of elementary knowledge objects allows assigning different attributes: description and interpretation, classification and valuation, verbal and numerical (e.g. serial number, date of updating, the source of information, assessment of the validity, reliability rating), characterized by actual information.

In the knowledge system of the general application, which is the NKS, the basic language representation is a verbal description. The description in a natural language is particularly useful in presenting qualitative information, poorly-structured, reflecting sequential (e.g. discursive) mental models. The rich vocabulary (the lexicon) of natural language can offer complex information in a compact form. The wide field of meaning (semantic polymorphism) of many natural language expressions enables creating associations and expressing intuition concepts, which are difficult to present in a different way, for example in the form of formal languages. Such structures are linguistic metaphors, parallels, analogies, homologies, exemplifications and others. The descriptive language, however, has limited use in the presentation of quantitative information, multi-dimensional information about objects (eg, spatial), as well as information about the complex, non-sequential dependences (e.g. network).

The network knowledge system can complement the verbal description of any object of MS-Office. It can be a picture, audio file, video sequence, MS-Word document, MS Excel spreadsheet etc. In particular, it is possible to attach objects found in other IT tools supporting knowledge object management: pairs comparing interactive system, rule expert system and dynamic research simulation system [16].

The elementary knowledge object is stored in a database record with the following structure:

I. The substantive information of a knowledge object:
    1. The label (name) – a text field up to 255 characters (typically 100 characters).
    2. Basic verbal description (content) – a note field.
    3. Any object of MS-Windows – OLE object.

II. The describing and interpretation attributes:
    1. Numerical attributes A1÷ A5 – numeric fields.
    2. Text attributes At1 ÷ AT3 – text fields, up to 50 characters.

    Moreover, the record contains auxiliary fields associated with operating of the system. There is also the possibility of additional fields.

Records containing elementary knowledge objects can be linked by relationships of superiority - inferiority, creating a network structure (a directed graph). Each record can be linked to any number of parent and child records. It is possible to establish the relationship forming a loop. It is also possible to register free records, not linked to other records.

5. Conclusions

The presented conception of the system supporting knowledge management SSKM in mechanical engineering industry enterprises was working out on the basis of the recognition of the needs to provide necessary functionalities based on undertaken surveys and direct interviews with senior managers in selected mechanical engineering industry enterprises.

That conception is focused on supporting decision-making processes in contracts' realization. The structure of the SSKM results from the need to provide comprehensive support of knowledge processes in the preparation, implementation and monitoring of contracts for their effective execution. Contracts corresponding to specific customers' requirements need to be an individual approach using enterprise's knowledge resources in a way to support the implemented business processes. The effective accumulation of knowledge and its processing requires the use of appropriate methods and their algorithmization at the stage of working out of the SSKM system.

In the knowledge management the qualitative information is very important. The paper presents the network knowledge system NKS, which is the IT tool supporting the operation of knowledge objects. It will be applied in the system supporting knowledge management in mechanical engineering industry enterprises.

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