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Tacit knowledge contained in construction enterprise documents
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Abstract
This paper deals with knowledge management in a construction enterprise. Proper knowledge resources are needed to perform tasks specific to construction enterprises. The knowledge is acquired from publications, legal regulations and standards. This is the so-called explicit knowledge. Large knowledge resources are also contained in employees’ minds and derive from their personal experience as well as from databases and documents drawn up for the needs of construction projects. This is the so-called tacit knowledge. Its acquisition can significantly aid construction enterprise management processes.

An IT model of the Knowledge Map designated to small and medium sized construction companies has been developed. The model can be used to save, store and process acquired knowledge and then to exploit it in enterprise management processes. The model has been implemented in two enterprises carrying out design and construction work. Seven knowledge domains important for the proper management of a construction company have been distinguished in the proposed Knowledge Map. One of them is the Documents domain. It stores sample documents appearing at the different stages of construction project implementation and documents occurring at enterprise management level. The samples are used to create new documents. The documents created in the course of enterprise activity form an information base which can be analysed to draw conclusions aiding future management processes.

This paper focuses on tacit knowledge resources contained in documents drawn up for the needs of construction projects. The tacit knowledge areas in the documents, connected with the resources used and the processes carried out, are indicated. Considering the huge number of documents occurring in a construction enterprise, it was deemed necessary to classify them according to different areas of enterprise activity. On the basis of the frequency of use of the particular samples to create documents needed for carrying out a construction project, the more important and less important documents were identified. The analyses also showed that the quality of the documents has a bearing on such project process parameters such as implementation time and cost.

Keywords: construction business, Knowledge Map, knowledge management, documents, tacit knowledge.

1. Introduction

Knowledge is one of the most important resources of an enterprise. Skillful knowledge management can bring significant benefits including labour productivity growth, an increase of quality of provided services and also a strengthening of the competitive position of an enterprise. Knowledge resources of an enterprise can be divided into: explicit knowledge which is possessed from publications, law regulations and standards and also tacit knowledge which is not written anywhere, is kept in the minds of employees and results from their personal experience. Tacit knowledge is also contained in databases and documents prepared for ongoing construction projects and for the correct functioning of an enterprise. Acquisition of such a type of knowledge resource can greatly support management processes in a construction company [Hernád, JMC, & Gaya, CG 2013 Nagati, H., & Rebolledo, C. 2013, Pathirage, Ch., P., Amaratunga, D., G., & Haigh, R., P.: 2007].

The paper presents the computer model of the Knowledge Map which supports the management in a construction enterprise. The model was developed based on the results of tests and analysis carried out in small and medium-sized construction enterprises in Poland. The proposed model uses the process approach for management and includes processes carried out at enterprise level and in the widely considered investment process in the construction industry and also the documents associated with these processes. Due to this assumption the proposed Knowledge Map has universal character and it is possible for it to be applied in construction enterprises conducting both design and executive activity. This model was implemented in construction enterprises.

The article also contains conclusions formulated during the practical use of the Knowledge Map, which are associated with the formation of documents for the purposes of carried out processes.

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2. Methodology of research

The methodology of research conducted with regards to the formulation of the model consist of three stages. The objective of stage 1 was to obtain information which would allow assumptions to be made regarding the formulated computer tool. Research was conducted in two phases.

On the basis of preliminary studies which were carried out in several construction enterprises with the use of the direct interview method, a research questionnaire was formulated which included questions about four areas related to enterprise activity, such as: 1) general data e.g.: location, number of employees; 2) the scope of conducted activity; 3) computer programs used; 4) processes implemented in all spheres of enterprise activity.

On the basis of current laws and regulations and also requirements included in management standards of ISO 9000 series, a set of processes was defined. The task for respondents was to mark processes occurring in an enterprise and to add such processes which were not included in the questionnaire but still happen in an enterprise.

On the basis of the above conclusions, the following assumptions regarding the formulated model were made:

- The process approach to management will be considered in the model, which means that all the typical processes occurring in the construction industry will be included in it.
- The model will be applicable in mainly small and medium-sized enterprises for which there is a lack of simple tools which support management.
- The adopted solution will be flexible and will enable rapid adaptation to the different cases of carried out business activity.

In the second phase, audits in 20 selected companies from the sector of small and medium-sized construction enterprises were carried out. Research was conducted by authorised experts in the area of implementation of quality management systems according to ISO 9000. The purpose of audits was the identification of the organisational state of construction enterprises and detailed analysis of used management processes due to the requirements of ISO 9000 standards.

The purpose of the second stage was to develop a model of the Knowledge Map [Lin et al. 2006, Suyeon et al. 2003, Yang 2007,] based on information obtained from the research and audits. Knowledge areas about a construction enterprise related to process management were identified.

The Knowledge Map was implemented in two construction enterprises, namely, in executive enterprise A and project enterprise B.

3. Knowledge Map structure

Knowledge Map software is based on the combination of the knowledge management idea and the process approach to management. The Knowledge Map structure consists of seven main domains of knowledge relating to an enterprise, referred to as: System and environment, Assets and resources, Processes, Documents, Completed and ongoing projects, Analysis and correction and Lessons learned. Each of the domains have been divided into three knowledge components [Hoła B., Polak A., Sawicki M., Gawron K., Morka M., & Skibniewski M. : 2012a]. The structure of the Knowledge Map and the development of the field Processes and Documents is presented in Figure 1. [Hoła B., Polak A., Sawicki M., Gawron K., Morka M., & Skibniewski M. : 2012b].

The first domain of knowledge, defined as System and Surroundings, is used to identify a construction company and its business environment. This domain contains knowledge about the field of business activity, the organizational structure of the company, government departments and organizations with whom cooperation is either required by applicable laws and regulations or by the nature of business or technology employed.

The second domain of knowledge contains information about assets and resources at the disposal of a construction company. This domain is used to identify the tangible and intangible resources of the company. The tangible resources include personnel, owned equipment and tools, as well as real estate. The intangible resources include intellectual property such as trade secrets, patents, trademarks and copyrights.

The domain processes consist of the applicable processes identified from the completed surveys of the construction companies. This set of processes is divided into three subsets, i.e. main processes, supporting processes and management processes. The elaboration of individual process procedures follows the requirements of the PN-EN ISO 9001:2008 “Quality Management Systems – Requirements” standard.
Figure 1. Scheme of Knowledge Map structure with the development of selected items.

The “Documents” domain of knowledge was divided into three subsets. The first is formed by the internal documents created within a construction company. The second subset contains external documents required by laws and regulations such as: legal acts and decrees, design codes and applicable standards. The third subset, “Control of documents,” specifies the people responsible for creating, supervising and approving the documents, as well as storage of the documents.

The “Completed and Ongoing Projects” domain of knowledge features a dynamic character of the Knowledge Map. In this domain the user will find information about the completed projects or ongoing site work, or about projects still in the planning or design phases. Using the questions contained in the “Defined Tasks” subset, the user can group the processes for each construction project of interest.

The following components are included in the “Analyses and Corrections” domain of knowledge: assessment of processes, staff and suppliers as well as complaints from internal and external customers together with corrective actions taken. The element labeled “Assessments” includes the methodology of assessments of the completed processes, as well as of the project personnel and suppliers. Information concerning lodged complaints, which forms the basis for revisions in service quality and business management, is very important for the proper functioning of a construction company in a competitive market.

The last but equally important domain of knowledge detailed in a knowledge map concerns “lessons learned.” The Lessons Learned domain records business process improvements resulting from the completion of a construction project, individual and collective experience, implementation of employees’ ideas, applications of product or process improvements, and other innovations and changes resulting from them. On the basis of information available it is possible to formulate conclusions and predictions. As long as information has a descriptive and historical character, knowledge concerns future events. It can be concluded that identification and recording of the Lessons Learned contents (innovations and changes) is a condition for the existence of a knowledge management system. This condition can be satisfied by the proposed Knowledge Map.
4. Identification of tacit knowledge contained in documents

The Documents domain contains specimen documents connected with the processes identified in the construction enterprises. The base of specimens and templates was created after the analysis of over 660 documents collected in the course of audits conducted in construction enterprises. Ultimately, the database contains 250 documents with a unified nomenclature. Since the list of documents is not closed, new documents can be added as new processes are introduced in the enterprise.

A preliminary analysis of the documents has shown that they contain a lot of information which can be exploited in the management of construction enterprises. Information concerning construction processes, as well as management and auxiliary processes, can be acquired from the documents.

4.1. Recurrence of a document in enterprise activity

The analysis has shown that documents produced for the needs of enterprise activity are characterized by different recurrence. Therefore, especially in the case of highly recurrent documents, an efficient system of producing and recording documents and processing the information contained in them plays a vital role. The number of visits to the page containing a given document can be adopted as the criterion of document importance. The importance of the information recorded in documents and its use to produce other enterprise documents should be the basis for developing a model set of information essential for enterprise activity.

4.2. Time needed to produce a document

A factor which has a bearing on enterprise management efficiency is the time of execution of particular operations. Well prepared specimens and templates facilitate the creation of recurrent documents and reduce the time of their production. Due to the use of templates, documents will be produced automatically, decision taking connected with the creation of a document will be minimal and the number of errors will decrease. As a result, the time of producing a document, especially when newly employed persons are assigned this task, will shorten.

4.3. Time of document circulation in the investment process

On the basis of the recorded document production times and the administrative deadlines specified in the Code of Administrative Procedure for official documents, this part of the project realization cycle time can be determined, which is connected with the creation and circulation of documents between the entities involved in this process. Owing to this knowledge, the whole investment process and the processes situated on the critical path can be monitored, corrective measures can be taken in emergency situations and the next projects can be properly planned using the experience gained. On the basis of the acquired knowledge the project realization cycle time can be verified and referred to the relevant project owner requirements. This procedure, supported with proper documents, makes the company which offers its services more credible. Thanks to the acquired knowledge, and supported with long-standing experience, model cycles for preparing different kinds of projects in different model realization conditions can be developed.

4.4. Knowledge in documents connected with processes

An analysis of the documents occurring in resource management processes has been carried out. As regards human resources, the Knowledge Map model contains documents connected with the particular employees, required by the Labour Code and other laws, informing about: his/her employment, course of employment and dismissal or resignation. On the basis of the collected documents conclusions can be drawn concerning the professional development of a given employee, and taking into account the information contained in the records of the particular processes, the range of his/her work activities and the time of effective work during a working shift can also be ascertained.

From analysis of the documents connected with all employed personnel, the following conclusions of statistical nature can be drawn: the age bracket of employees; their average age; the minimum, maximum and average length of their service; the causes of their resignations or dismissals from work; the professional profile of employees; the tendencies in their professional development; the number of employees per full-time job; the number of persons injured in accidents at work; the number of persons working in occupational hazard conditions and trends in work safety.

As regards physical means, the Knowledge Map contains the following documents: the bill of sale, the operation and maintenance manuals, the user’s manuals, the results of technical tests and information on the
current condition of a resource. From the documents, the specifications of the equipment park and the technical condition of the equipment can be ascertained. Combining this information with the data contained in the Completed and Ongoing Projects domain, the current location of a piece of equipment and its operating costs can be determined, and when the construction season is over, the resources can be evaluated with regards to the degree of their utilization, their cost-effectiveness and also their sale or replacement with new equipment.

The knowledge concerning owned resources is also an important resource exploited in the preparation of new projects. An assessment of the enterprise resources for the needs of a new order enables proper decisions to be made on adding the missing equipment to the equipment park and getting rid of unnecessary or ineffective equipment, which will globally contribute to a reduction in the company’s operating costs and will improve its profitability.

5. Knowledge in documents created in Knowledge Map software

The aim of building the Knowledge Map model was to obtain a tool which aids the management processes in an enterprise. Using the Knowledge Map, software documents describing the dynamic states of an enterprise’s particular components and systems can be created, on the basis of which long-term histories of the changes can be produced. The documents describing the particular states of an enterprise’s components include: reports containing evaluations of processes, employees, suppliers and subcontractors; lists of documents; resources and also completed or ongoing processes etc. On the basis of these records, long-term histories of changes can be produced, development trends in a given area of enterprise activity can be analysed and conclusions concerning preventive and corrective measures can be made.

6. Conclusions

An efficient document management system is an essential component of the construction enterprise management system [Meziane, F.; & Rezgui, Y. 2004]. Documents created for the needs of enterprise activity contain knowledge which can be exploited in management processes to increase a company’s productivity and competitiveness on the construction market [Hamzah A-R., Chen W., & Shamini B., M 2012, Hernad, J.M.C., &Gaya, C.G : 2013]. The following conclusions emerge from the studies and analyses of the documents contained in the Knowledge Map model, carried out as the model was being implemented in a construction enterprise:

- In order to improve a company’s management system and achieve better economic performance it is essential to properly collect, record and process the possessed information [El-Diraby, T. E., &Zhang, J., 2006, Lin, Y. C., Wang, L. C. & Tserng, H. P., 2006, Meziane, F.; & Rezgui, Y. 2004]. The acquired data can be helpful in the creation of similar documents for future projects, which can contribute to a significant reduction in the time needed to prepare them and in the costs involved.
- A specially developed codification system needs to be used to describe particular documents in order to filter the search of the existing set according to defined criteria [Karanikolas, N.N. , & Skourlas, C. 2010].
- The documents created for the needs of enterprise activity are characterized by different recurrence. In order to determine the degree of utilization of the documents in an enterprise a counter of document hits and editing time should be installed in the IT-based Knowledge Map model whereby a bank of statistical information on the rank of the particular documents can be created.
- The analyses have also shown that the quality of the produced documents has a bearing on such investment process parameters as implementation time and cost. In order to create reproducible documents editing-facilitating templates should be used. Owing to this, the operations will be performed automatically and the number of decisions relating to the creation of a document will be minimal. As a result, there will be fewer errors and the execution time will be shorter, especially when newly employed persons perform these operations [Nam, S., Lee, S., Boram Kim, J.G., Kim, & H.-G. STEP: 2014].
- By introducing document production time recorders it will become possible to create a base of standards. The acquired knowledge supported with long-standing experience and the current regulations contained in the Building Code and the Code of Administrative Procedure will provide the basis for developing model project preparation cycles for different model realization situations.
- Thanks to the document-related information contained in the process procedures a set of documents required for a new project will be able to be quickly determined. This will facilitate and accelerate the preparation of the documentation.
- From the accumulated knowledge on the completed projects the following can be ascertained: the actual time it takes to obtain particular administrative decisions, the most common errors in the preparation of
documentation, and also the persons preparing, verifying and issuing particular decisions. This knowledge can be helpful in preparing offers for future projects.

- As regards to an enterprise’s human resources, from the collected documents conclusions can be drawn about the professional development of a given employee and taking into account the information contained in the records of the particular processes, the range of his/her work activities and the time of effective work during a working shift can be ascertained.

- On the basis of the records, long-term histories of the changes taking place in an enterprise can be produced, development trends in a given area of enterprise activity can be analysed and conclusions which have a bearing on decisions can be drawn.

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