



KNOWLEDGE MANAGEMENT IN EXPERT SYSTEMS DEVELOPEMENT

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Abstract:

In business surroundings characterized by tough competition and more demanding customers, in order to ensure stable market position and good relationship with customers, companies' main task becomes proper use of corporate knowledge. Knowledge management is directed towards identification, creation and exchange of knowledge. Many concepts of knowledge management have roots in the area of expert systems and artificial intelligence in general. Knowledge acquisition, knowledge representation, methods and techniques of coding the knowledge for expert system development purposes are directly associated with these activities for knowledge management purposes. From the aspect of knowledge lifecycle expert systems can be applied in knowledge creation, knowledge transfer or dissemination and usage of knowledge. Utilization of expert systems is particularly spread in the area of finance, especially in the tax planning, financial diagnosis, financial accounting, credit process, and credit risk measurement. As part of more comprehensive expert system for creditworthiness estimation, this paper presents expert system for business efficiency estimation from the aspect of knowledge management.

Keywords: Business-efficiency expert system, knowledge management.

1. INTRODUCTION

In nowadays business surroundings where companies are faced with tough competition their main task becomes proper management of large amounts of data at their disposal in order to successfully achieve better market position by obtaining useful and relevant information and knowledge. Revealing information and knowledge hidden in data and through their proper use companies can encourage their business, improve a decision-making process, and develop foundation for better market positioning. Right here lies a connection between intelligent systems and knowledge management (KM) concept.

Intelligent systems rely on the expertise and experience of human-expert(s) in solving different problems and as such they simulate their reasoning and behaviour in a specific problem domain. Usually a domain expert provides "rules of thumb" about the way problem is being evaluated, either explicitly with the help of experienced system developers, or implicitly, extracting the rules from relevant data sets (Grljević & Bosnjak, 2010). Intelligent systems can be used to create corporate knowledge, for its transfer and dissemination.

KM is an organizational practice that promotes a holistic approach in identifying, managing and exchanging intellectual property of the entire organization as well as unarticulated expertise and experience of its employees. In practice, KM often involves the creation of new knowledge, access to valuable knowledge from external resources, the use of available knowledge in the decision-making process, sharing corporate knowledge and best practice, etc. KM significantly exceeds realms of design and use of tools and technologies for gathering, analyzing and transfer of data, since its primary focus are individuals and groups as creators and users of knowledge. However, since it significantly contributes to the development of the organization and its better market positioning, any technology or method that supports development and dissemination of knowledge is considered as key success factor of today's organizations.

There are different categories of IT tools for knowledge management support: computer-mediated communication (CMC) tools, content/document management systems (C/DMS), tools that will most likely use artificial intelligence (problem solving tools, intelligent agents, and data mining (DM) tools), and Web portals. These tools are mapped to the knowledge life cycle in (Sison, 2006.). During knowledge creation the following tools can be utilized: CMC, C/DMS, expert systems (ES) or decision support systems (DSS), intelligent agents (IA), and DM tools. During the knowledge transfer and knowledge usage it is desirable to use CMC, C/DMS, ES, DSS, or IA.

This paper describes the similarities of KM and intelligent systems and their applicability in Customer Relationship Management (CRM), as well as one example of knowledge management through expert systems in financial sector.

2. KNOWLEDGE MANAGEMENT AND ARTIFICIAL INTELLIGENCE IN CUSTOMER RELATIONSHIP MANAGEMENT

The main precondition of strengthening companies' market position and development of competitive advantage lies in customer satisfaction. In order to establish an effective relationship with customers, organizations must have qualitative customer knowledge that implies not only structured data, such as historical data about a contact, account, etc..., but also unstructured information such as letters and faxes from customers, as well as additional types

of information useful for marketing, sales and service activities. In order to raise the level of customer satisfaction with products, services and even the company itself, it is necessary that a company provides high quality data, which includes its accuracy, relevance, timeliness, safety, and the possibility of their exchange and portability. It is noted in (Buttle, 2009) that the fulfilment of a CRM vision depends upon how well the knowledge is set on points of sail and customers points of access. For these reasons, companies are increasingly turning towards utilization of artificial intelligence and the development and implementation of expert systems for knowledge management. Expert systems have the possibility of collecting, storing, organizing, interpreting and distributing knowledge to users at their access points in order to meet the goals of marketing, sales and service.

As stated in (Dous, Kolbe, Salomann & Brenner, 2005, pp. 167–178), initiatives and efforts of CRM and knowledge management are directed towards the same goal: achieving continual improvement aimed at customers. This business orientation is named in literature as customer knowledge management, and it is narrowed to the usage of knowledge FOR, FROM and ABOUT customers in order to enhance and improve all aspects of business and customer relationships. *Knowledge about customers* includes basic information about customers, their purchase history and tendencies, etc. Based on this kind of knowledge company will have better understanding of customers requirements and a possibility to meet their needs more successfully. *Knowledge for customers* is information customers require to interact with the company, such as knowledge about sales, marketing, services and information about products. This kind of knowledge is usually implicit because it relies entirely on the experience of workers in sales or employees in marketing and services sector. Intelligent systems, especially expert systems, successfully translate this kind of knowledge into explicit knowledge. *Knowledge from customers* is a feedback received from customers regarding products and services and how they understand and perceive the shopping experience and it helps to enhance products and services.

Knowledge management and customer relationship management are strongly supported by artificial intelligence products because of their capability of reasoning, knowledge representation and ontologies. In literature (Sison, 2006), as basic tools for knowledge management support that are also widely used in the field of CRM, the following are cited: expert systems, data mining and software agents. They provide a way of automatic customer guidance to the information, products and other resources that are adapted to their needs, location and/or preferences. For example, in the financial sector, financial institutions and banks faced with uncertainty and competition often use neural networks for better understanding and usage of the data required for asset management, trade, credit card fraud detection and portfolio management.

3. EXPERT SYSTEMS AND KNOWLEDGE MANAGEMENT

Knowledge management comprises several basic functions: knowledge identification, creation and its exchange. Once the knowledge is discovered and formalized, the company's goal is to use such knowledge for business improvement, and to insure it – to retain the knowledge in the realms of company. Many concepts of knowledge management are not new. Its roots can be found in the area of expert systems and artificial intelligence in general. From the aspect of knowledge lifecycle, expert systems can be applied in all its three phases: knowledge creation, knowledge transfer and usage of knowledge.

In each expert system is embedded in an appropriate manner a large amount of high-quality knowledge of the problems from a certain domains of human activity, (Bosnjak, 2006). Expert system, as an intelligent program, can then process embedded knowledge in order to successfully solve problems from its field of expertise, in a way that would be considered intelligent if the same problems would solve man. Knowledge implemented in an ES is situated in the knowledge base that is separated from the program that uses knowledge to solve problems - so called inference engine.

Knowledge acquisition phase of expert system development process is directly associated with the identification of knowledge in knowledge management. Since developed expert systems offer the possibility of formalizing and automating acquired knowledge they are used to retain the knowledge in the organization for its further usage after the domain expert is gone. Knowledge representation for knowledge management purposes is related to the knowledge representation and methods and techniques of coding the knowledge in the field of expert systems. Thus, many aspects of knowledge management are derived from expert systems and artificial intelligence domain which leads to a conclusion that expert systems should be an integral part of knowledge management systems. For example, the U.S. Department of Labour (www.dol.gov) is using for years a Web-based expert system as an integral part of their knowledge management system. One of the functions of this ES is determination of the benefits of war veterans (Liebowitz, 1998).

Expert systems can be used for job training, integration of different sources of knowledge, and solving interdisciplinary problems. Furthermore, their application provides consistency in decision making; they make expertise more accessible, and promote and improve the exchange of knowledge. Expert systems are the ideal technology for formalizing existing knowledge in the organization, for its preservation and documentation, especially in today's business environment where organizations are often reorganized, number of employees is reduced and older and more experienced workers are gone due to different reasons. Therefore, expert systems are very useful for building the institutional memory of the organization before intellectual capital is lost.

Companies, faced with uncertainty, more often turn to artificial intelligence and expert systems in order to develop knowledge management systems that could provide the basis for sustainable future of a company and competence at all levels. In the area of finance, expert systems are widespread, particularly in the credit process, tax planning, financial diagnosis and building plans for banks. The authors in (Yang & Vásárhelyi, 1998, pp. 29–43) have identified areas of management of personal investments appropriate for development of expert systems. Tasks such as advising on the portfolio, financial projections, portfolio accounting, online help, selection of the forms for tax preparation, and tax consulting are just some of them. Determination of financial situation by means of ratios and financial statements analysis represent further areas of financial accounting for which expert systems are developed and deployed.

Port-Man (Chan, Dillon & Saw, 1989, pp. 87–96) is a banking expert system developed with the aim to improve consulting process on personal investments. It accelerates consultations and standardize advices of financial consultants. The task of the system is to choose a set of banking products that will meet the clients' criteria of investing. The selected products are ranked according to rates of return on investment and the degree of risk.

The problem of credit risk measurement is a particularly interesting field. Financial institutions, banks, credit institutions, clients, suppliers and others have to predict the failure of companies with which they are interested in establishing cooperation. As stated in (Facchinetti, Bordoni & Mastroleo, 2001, pp. 472), methods commonly used for this purpose are the econometric analyses that estimate the probability of clients' insolvency, but they do not distinguish creditworthy and non-creditworthy clients at a satisfactory level. The research was conducted in order to overcome the limitations of econometric models and resulted with a fuzzy expert system for creditworthiness assessment. The ES results were compared to the results obtained through econometric analysis conducted over the same data. They came to the conclusion that the fuzzy system offered better solution to this problem and also a better measurement of the discriminant power of the model.

The authors in (Grljević & Bosnjak, 2010) presented another financial expert system which assesses creditworthiness of the company. Creditworthiness is based on a set of indicators that are grouped into five aspects: indicators of the incomes and expenditures structure, indicators of business efficiency, business profitability, solvency and leverage. Each of these groups of indicators measure and evaluate different business aspects of the company, therefore expert system users also have the possibility to measure the quality of only one of the aspects mentioned above. In the sequence of this paper is illustrated, from the aspect of knowledge management, one segment of an expert system for comprehensive creditworthiness assessment: business efficiency expert system. Design and implementation issues of this ES are in more detail described in (Grljević & Bosnjak, 2010, pp. 338–344).

4. KNOWLEDGE MANAGEMENT IN BUSINESS EFFICIENCY EXPERT SYSTEM

Business efficiency can be expressed as a level of savings in achieved business results, and as such it measures the business success against the amount of inputted labour, fixed assets, capital and services necessary for its achievement. To measure the efficiency, one has to consider both the current and the externalized labour – the elements of a work process. Furthermore, business efficiency shows the degree to which the set business goals are achieved, while the necessary resources for their fulfilment are saved up. The business is run efficiently if the achieved output is the result of economic disbursements of assets, third-party services, labour force, and if the produced goods can be sold at preset prices. The increase of efficiency is based on the sparse usage of assets and maximization of revenues.

One aspect analyzed in this expert system is the global price parity, which can be calculated as follows:

$$\text{Sales revenue} / (\text{Expenditure}^1 * (\text{Operating expenditures} + \text{Decrease in inventory} - \text{Increase in inventory}) / (\text{Operating expenditures} - \text{Expenditures of goods}))$$

The higher this indicator, the better the credit rating. The threshold is 1. If the indicator is less than 1, then the company is in a very bad situation, because its purchase prices are greater than sales prices.

¹ The expenditure includes both expenditure for goods and materials.

Other indicators used for business efficiency evaluation are the ratio of total revenues and total expenditures and the ratio of operating revenues and operating expenditures. The higher these indicators, the better the business efficiency.

The knowledge of human expert in some domain of expertise can be acquired by diversified knowledge acquisition methods and techniques that assure its completeness, consistency, and accuracy. The knowledge of decision making process and key information necessary for decision making and deriving conclusions are stored in ES's knowledge base, during a knowledge engineering process. As a result, one gets an organized, structured collection of reasoning principles and rules, which is transparent, easy to follow and explain. Also the knowledge on possible outputs or system results – advices, suggestions, is incorporated into an ES's knowledge base.

The above mention domain knowledge is acquired and structured in the knowledge base of business efficiency ES. Figure 1 is an illustration of one excerpt from the business efficiency evaluation ES, represented by production rules. Variable II0 denotes the ratio of incomes and expenditures from the main business activity, variable II1 denotes ratio of total incomes and total expenditures, while variable II2 denotes ratio of operating incomes and expenditures. II_Group variable collects points that represent basis for estimation of business efficiency.

Figure 1: Excerpt from knowledge base

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1 [II0] >1
2 --> [II_Group] = [II_Group] + 5
3 --> [NOTE.ADD] The most important factor of business efficiency is ration of incomes and
expenditures from the main business activity. Their ratio illustrates whether the Income
statement is SUCCESSFUL or not
4 [II0] =1
5 --> [II_Group] = [II_Group] + 1
6 --> [NOTE.ADD] The ratio of incomes and expenditures from the main business activity is
not the best, but it can be considered that a company is doing business on so called positive
zero
7 [II1] >= 1 & [II2] >=1 & [II0] > 0.97 & [II0] <= 1
8 --> [II_Group] = [II_Group] - 2
9 --> [NOTE.ADD] The company has a bad financial status since it has finished business year
with UNSECCCESSFUL Income statement.

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Within the expert system's inference process, the data from the current business year for all individual indicators are compared to data from the previous year, and to the average values of indicators for the industry sector the company belongs to. Figure 2 shows an excerpt of such rules from knowledge base. Variable II0P, II1P, II2P denotes ratio of incomes and expenditures from mail business activity, total, and operating incomes and expenditures, respectively.

Figure 2: Comparison of ratios from current and previous year

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12 [II0] -[II0p] > 0
13 --> [II_Group] = [II_Group] + 1/2
14 --> [NOTE.ADD] Increase or decrease of ratio of incomes and expenditures from the main
business activity (for instance, ration increases from 1.2 in previous year to 1.4 in current

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year) is estimated linear, multiplying the difference with 10 (for example, $1.4 - 1.2 = 0.2$; $0.2 * 10 = 2$, meaning that we add 2 points to an overall number of points for business efficiency).

...

24 [II1] -[II1P] > 0

25 --> [II_Group] = [II_Group] + 1/2

26 --> [NOTE.ADD] Increase or decrease of ratio of total incomes and expenditures (for instance, ratio increases from 1.2 in previous year to 1.4 in current year) is estimated linear, multiplying the difference with 10 (for example, $1.4 - 1.2 = 0.2$; $0.2 * 10 = 2$, meaning that we add 2 points to an overall number of points for business efficiency).

...

39 [II2] -[II2P]>0

40 --> [II_Group] = [II_Group] + 1/2

It is important to bring attention to the fact that the KB besides the necessary domain knowledge included in derivation of results of business efficiency expressed in a form of production rules captures also the knowledge explaining the reasoning logic of experts in a form of additional NOTES. Their aim is to describe the conclusion of the ES. As stated previously, at the end of ES run the estimation of business efficiency is conducted on the basis of II_Group variable. Business efficiency can be very favourable, favourable, neutral, unfavourable, and extremely unfavourable. The following figure illustrates this logic in knowledge base.

Figure 3: Rules for determining business efficiency

43 [II_Group] > 7

44 --> BusinessEfficiencyIndicators= very_favorable

45 ([II_Group] <= 7) & ([II_Group] > 1)

46 --> BusinessEfficiencyIndicators= favorable

47 ([II_Group] <= 1) & ([II_Group] > -1)

48 --> BusinessEfficiencyIndicators= neutral

49 ([II_Group] <= -1) & ([II_Group] > -6)

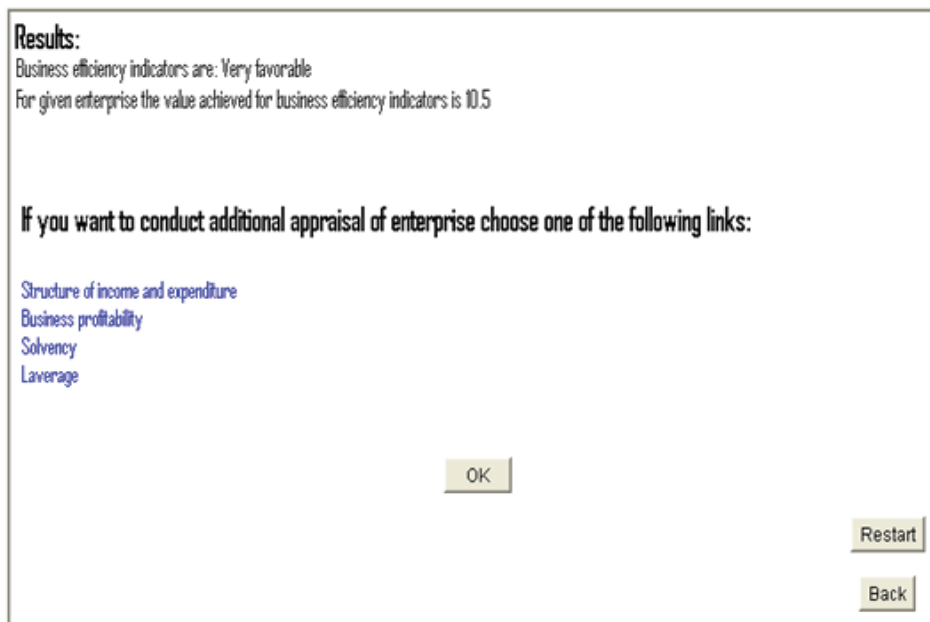
50 --> BusinessEfficiencyIndicators= unfavorable

51 [II_Group] <= -6

52 --> BusinessEfficiencyIndicators= extremely_unfavorable

At the end of ES execution along with the achieved conclusion, the suggestion for further analysis of creditworthiness aspects is displayed, helping the users in conducting the overall business analysis. This is shown in figure 4.

Figure 4: The end of ES execution



According to the above mentioned, the KB of ESs can be considered as a knowledge repository and a reliable way of knowledge dissemination, knowledge sharing and broad availability.

5. CONCLUSION

Introducing knowledge management concepts in all business aspects, organization enforce innovation, further knowledge creation, its dissemination and usage, while it builds competitive advantage. Analyses of some of the aspects of KM, ES and CRM domain lead to a conclusion that they are inter-linked. CRM can be supported by different software tools directed towards knowledge management and increase of corporate knowledge and ESs are one of them.

Based on the results of presented expert system for business efficiency estimation as well as an overall creditworthiness expert system, we could conclude that thanks to the objectiveness, impartialness, and repeat of decisions on business creditworthiness reached by ES, and also to the ease of their understanding and explaining, the ES application fosters quicker, more accurate and better decision making. Consequently, the system users' (financial institutions, banks) satisfaction is leveraged, but at the same time organizations subject to creditworthiness evaluation are more content as they can check the obtained results through Internet access to the Web-based ES runtime routine.

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