

A Case-based Reasoning Model as an Organizational Learning Tool

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Abstract

Organizational learning (OL) is a set of activities to obtain organizational memory (OM) by acquiring, sharing, interpreting, integrating and institutionalizing knowledge. Although the OL process of construction firms has been discussed for several times, utilization of the output of these activities has not been investigated in depth. All companies can learn but the advantage of learning is revealed when companies enhance their decision-making abilities through their OM.

The major objective of this study is to explore how construction companies create OM and how they exploit this asset in strategic decision-making process. Within the context of this research, a framework is constructed to model the OL process in a construction company and based on this model; an interview study has been conducted with eight leading Turkish contractors.

This survey revealed the strengths and weaknesses of the firms in terms of OL competence. The most significant point is that although some perceptions and attitudes are common to all companies, some may change due to the differences in cultures, strategies, structures, ages of companies and the markets they are in. Results show that construction companies make use of several knowledge sources and mechanisms to acquire knowledge; they are successful at the collection and storage of knowledge but they are weak in exploitation of the corporate knowledge in strategic decision-making stage. In addition, they are unable to increase their OL competence due to some company and industry specific barriers. One of the key outputs is that companies are not familiar with the decision support systems (DSSs) that benefit from OM. Such systems enable OL by assisting decision-makers in processing, assessing, integrating and organizing knowledge.

In this paper, a case-based reasoning (CBR) model is proposed as an OL enabler and to facilitate decision-making in international market entry decisions within the construction companies. This tool is generated under a software package by adopting CBR as the problem solving approach, which finds solutions to new problems making use of the past experiences which are based on 215 cases from the Turkish construction industry. The model produces two outputs that are indicators of attractiveness of a project and competitiveness of a company,

which are the key decision criteria in an international market entry problem. The application of the tool will be demonstrated by a case study and potential benefits of using the proposed model as an enabler of OL in a construction company will be discussed.

Keywords: Knowledge management, organizational memory, decision support systems, case-based reasoning

1. Introduction

Strategic management of knowledge requires intuiting, interpreting, integrating and institutionalizing of knowledge flows [1] which take place at individual, group and organization levels respectively. Formation of an organizational memory (OM) is a critical knowledge management activity which facilitates organizational learning (OL) process. Stein and Zwass [2] define OM as the means by which knowledge from the past is brought to bear on present activities, thus it helps learning from previous experiences. OM becomes a corporate asset by capturing, organizing, disseminating and reusing the knowledge created by its employees [3].

This paper is based on the findings of a research study carried out to investigate how construction companies create their OM and how they exploit this corporate asset in strategic decision-making. The OM formation process has been modeled considering that the companies mainly learn from their own experiences, from the experiences of competitors and from external sources [4]. Knowledge gained through different sources are shared, interpreted and institutionalized to create OM. Based on this model, a semi-structured interview form has been prepared and interviews have been conducted with 8 leading contractors in Turkey.

Findings of this study reveal that construction companies are successful at acquiring knowledge but they are weak in sharing and utilizing the acquired knowledge in decision-making. Although companies need the tools to support their strategic decisions, they are not familiar with this kind of systems. As a result of the interview findings, a knowledge-based system is decided to be developed to support international market selection, for which the companies necessitate a tool to assist their decision at most. A CBR-based decision support system (DSS) has been developed, which facilitates learning from experiences of competitors in international markets.

2. Organizational Memory in Construction Companies

Since the construction industry is project-based, discontinuous and fragmented, OL is difficult for the companies. For this reason, as well as the systematic knowledge management activities, construction firms should also provide a culture that can facilitate continuous learning in order to benefit from the advantages brought by OL. A successful culture of OL can influence performance, long-term effectiveness and survival of an organization [5, 6]. Lehner and Maier [7] stress the function of OM in connecting past and present decision-making situations that directly influences the performance of a company.

Robey et al. [8] define OL as an intentional and unintentional organizational process, which enables the acquisition of, access to and revision of OM and finally guides to organizational action. Using the logic behind this definition, an OM framework is constructed [4]. Figure 1 illustrates how OM is formed, utilized during decision-making and finally revised. Although companies create OM as a result of the learning practices, the advantage of possessing such an asset should be revealed in the quality of the strategic decisions made in the company.

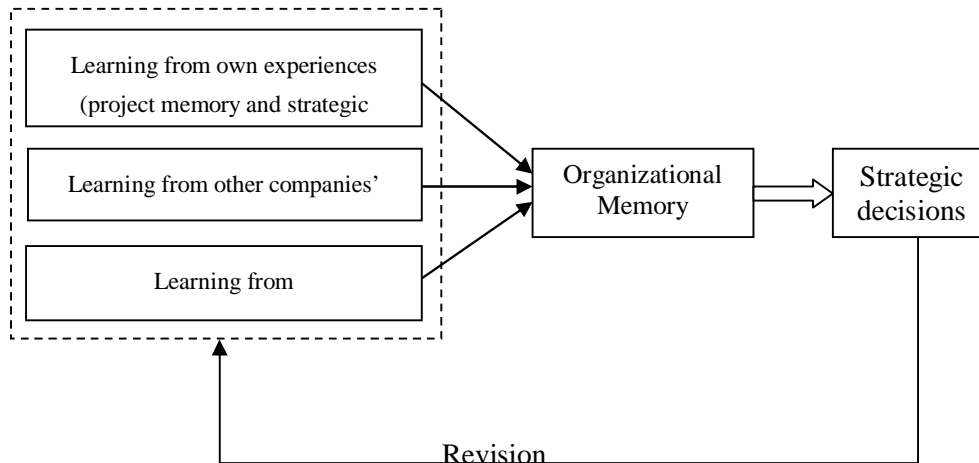


Figure 1 Framework explaining the OM formation and utilization

The three components that constitute OM are own experiences of the company, experiences of other companies and knowledge gathered from external sources. OM is used to improve strategic decisions and after the actions are taken, new experiences are added to OM. This is a cyclic process rather than a sequential process as newly acquired knowledge from the given decisions should be used to revise OM. How this cycle operates in each company depends on company characteristics and the height of OL barriers.

3. Research Study

Semi-structured interviews are carried out by company professionals in order to highlight the realities of the Turkish construction industry in terms of OM. 8 companies volunteered to participate in the research. The structure of this interview study is demonstrated in Figure 2. Questions are grouped under eight headings, one of which is the company information and other seven topics are related to the knowledge management practices are discussed below.

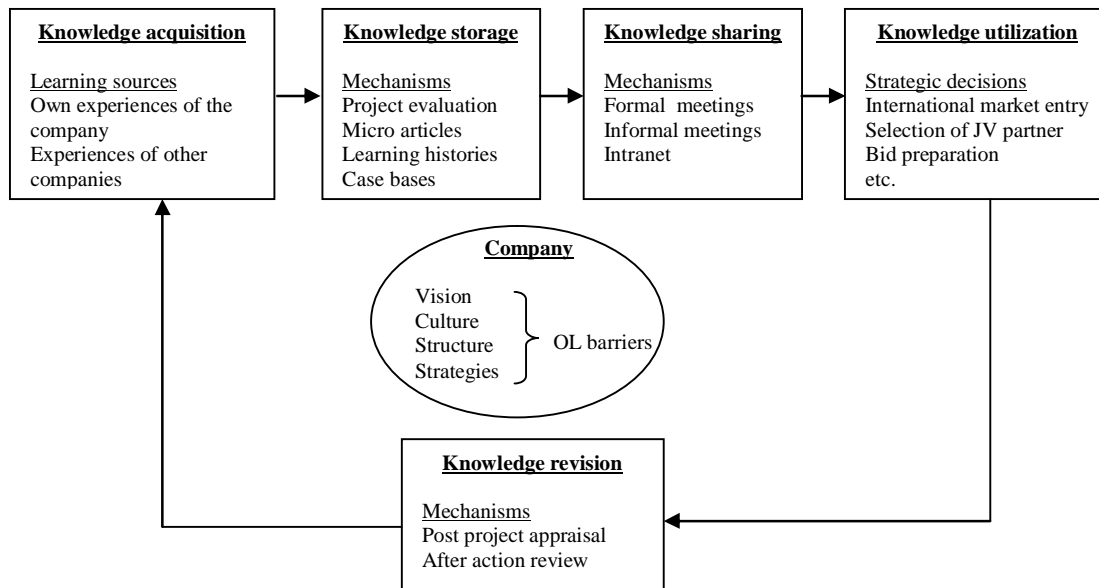


Figure 2 Structure of the interview

1. Learning from own experiences: Lessons learnt from own experiences of the company can be examined under two categories; the knowledge gained from the projects, namely the project memory and the knowledge gained from strategic decisions. These two sources shall be improved as more projects are carried out and more strategic decisions are made. Since the unit of work performed in the construction industry is project, companies mainly learn from the projects they have undertaken and parties involved in these projects. Knowledge may well be acquired as a result of “unrealised projects” where the experiences related with bidding, business development, financial management activities etc. are of paramount importance. Companies do not only learn from the completed projects but also from the ones that companies intend to perform but are not awarded. In this respect companies are asked to state which kind of data they collect and how they store information within their organizations.

2. Learning from other companies’ experiences: Construction companies may learn from success/failure stories of their competitors or if they establish long-term or short-term (project-based) partnerships with other companies such as clients, contractors, suppliers etc., they may learn from their practices, expertise and perceptions. Also, relevant expertise of companies operating in sectors other than construction may be transferred to the construction business.

3. Learning from external resources: External learning sources are the parties, which are not directly involved in the projects that construction companies perform, or not among the parties they cooperate or compete with. The company managers are given a list of possible external learning resources such as universities, consultancy firms, governmental or foreign bodies that are not clients, etc. and they are asked to state from which resources they learn.

4. Organizational memory: While individual knowledge is an important part of OM, it is always at risk of being lost. Knowledge acquired through the learning sources have

two types, namely explicit (codified) and tacit. Explicit knowledge can be accessed by company members easily since it becomes a corporate asset by being stored in computers in the form of electronic repositories or it is documented in paper form. The tacit knowledge is hidden in the beliefs, perceptions, norms and actions of individuals and requires to be transferred to explicit knowledge in order to be stored. Under this heading, there exist questions regarding the contribution of different learning sources to the company's memory and the percent distribution of knowledge types according to how they are accumulated in the company.

5. Utilization of OM in strategic decision-making: Due to the unique nature of each construction process, inherent uncertainties and incomplete scope definition, it is almost impossible to have all the needed information at the time of decision-making and mostly decision problems are solved by expert judgment. Entering an international market, entering a new market related/unrelated to construction sector, selection of JV partners, preparation of bids and restructuring of the company are among some of the critical strategic decisions made by companies. To facilitate decision-making, DSS, which combine analytical methods with expert opinion, are proposed to be utilized. In this study, it is argued that OM is a valuable asset that must be built and exploited in order to give more reliable decisions at the corporate level and enhancing the codified component of the memory will aid strategic decision-making with a DSS. The research sample is asked to evaluate the importance/effectiveness and utilization level of OM and DSS during decision-making.

6. Organizational learning competence: A company is assumed to have high OL competence if it is good at benefiting from knowledge acquisition sources, if it has knowledge storage mechanisms, if this knowledge is shared and interpreted by the company members, if the end product of these knowledge management activities, namely the OM can be effectively utilized in decision-making process and if the company can continuously revise its OM. Companies are evaluated in terms of the learning practices performed within their organizations.

7. Organizational learning barriers: Although OL is accepted to be necessary and critical concept for the survival of the companies, due to some reasons, OM creation is not at the desired level in most firms. In literature some authors mention the existence of some enablers and barriers to capture and diffuse knowledge such as structure effects, cultural context, the climate for change, skills and capabilities, technological mechanisms and objectives. To find out the dominant barriers to OL, the company managers are asked to list why they are not fully performing the requirements of OL and the causes of deficiencies to structure the OM.

4. Research Findings

Important conclusions can be derived from the answers of the respondent companies, which are extensively discussed in Ozorhon et al. [9]. The most significant point is that although some

perceptions and attitudes are common to all companies, some may change due to the differences in cultures, strategies, structures, ages of companies and the markets they are operating in.

Findings of this study reveal that construction companies are rather good at creation of project memory. Experiences gained by the company as a result of previously realized construction projects constitute the major component of OM. The experiences of other companies have a limited contribution to OM, although all respondents agree that learning from failure and success stories of other companies is of paramount importance for construction companies. This kind of information usually resides in the brains of experts, but it is rarely stored in databases and institutionalized.

Companies think that the role of OM in strategic decision-making is limited. Intuition and experience usually play a far more significant role when giving bidding decisions, entering a new market or making new investments. All respondents agree on the importance and use of the codified component of OM in order to build mathematical models especially in bid preparation. Companies do not utilize DSS to aid them in decision-making in spite of the fact that they believe it would be beneficial to have such programs. However, answers of the respondents demonstrate that especially for international market entry decisions, assistance of a computer program would be very beneficial.

When the knowledge management activities are considered, in general, companies seem to be most successful at acquiring and revising knowledge. Knowledge sharing is the most important activity, which is followed by the utilisation of knowledge in decision-making however, these activities are not usually performed as successful as they are regarded to be important.

Some OL barriers related with the nature of the construction industry and service/product exist as well as company-related factors such as cultural barriers. Although perceptions about validity of learning barriers change significantly from one company to another, high employee turnover in construction and corporate management/leadership style seem to be common problems that plug the way of OL in construction companies.

5. CBR as an Organizational Learning Tool

In the experience-based construction industry, previously acquired knowledge is critical to solve similar problems that can be encountered in the future. Although the output of construction is a unique project, construction processes show similar characteristics. As CBR is an analogical learning technique, it seems to be a suitable approach to solve construction problems, which are generally solved through past experience and knowledge of expert people.

CBR is “the process of solving new problems by adapting solutions that were used to solve old problems” [10]. Indeed, CBR uses the principles of human reasoning as it learns from the past situations. With this feature, CBR can be applied in problems that can be solved through previous experiences. CBR solves problems through a process that involves some basic steps as

retrieving relevant cases from the case memory, selecting a set of best cases, deriving a solution, evaluating the solution and storing the newly solved case in the case memory [11].

Due to the project based nature of the construction industry and high employee turnover rates, knowledge becomes hard to capture and store. Thus, construction companies should build case libraries that will enhance OL and create OM. These case libraries enlarge OM by institutionalizing the individual knowledge. On the other hand, CBR-based models enable this knowledge to be shared and utilized in the strategic decision-making process. So, development of CBR-based strategic DSS is proposed to increase the OL capability of the companies.

6. CBR-INT

International market selection is a complex decision as numerous factors related with the country, market and project have to be considered and there is no mathematical formulation that can easily associate these factors together with company specific factors with the attractiveness of a project and probability of getting the job given the competitive conditions. There are models developed by many researchers on this subject using different techniques such as cross impact analysis [12], analytical hierarchy process [13] and neural networks [14]. Case-based reasoning (CBR), which exploits past experiences to bring solutions to new situations, has been identified as a promising tool.

The system, as an enabler of OL, is generated under a software package namely, ESTEEM that adopts CBR principles to solve the problems. Experiences of Turkish contractors are used to demonstrate how experiences of competitors may be utilized to facilitate decision-making in a construction company. The model, CBR-INT is developed by using 215 real international project data; 200 cases are used for training the program and 15 cases are used for testing purposes. As input information, 16 features related with the project, market and the country are identified and by the help of CBR-INT, as important indicators, the attractiveness value of an international project and the competitiveness value of a company for that project can be predicted (Figure 3).

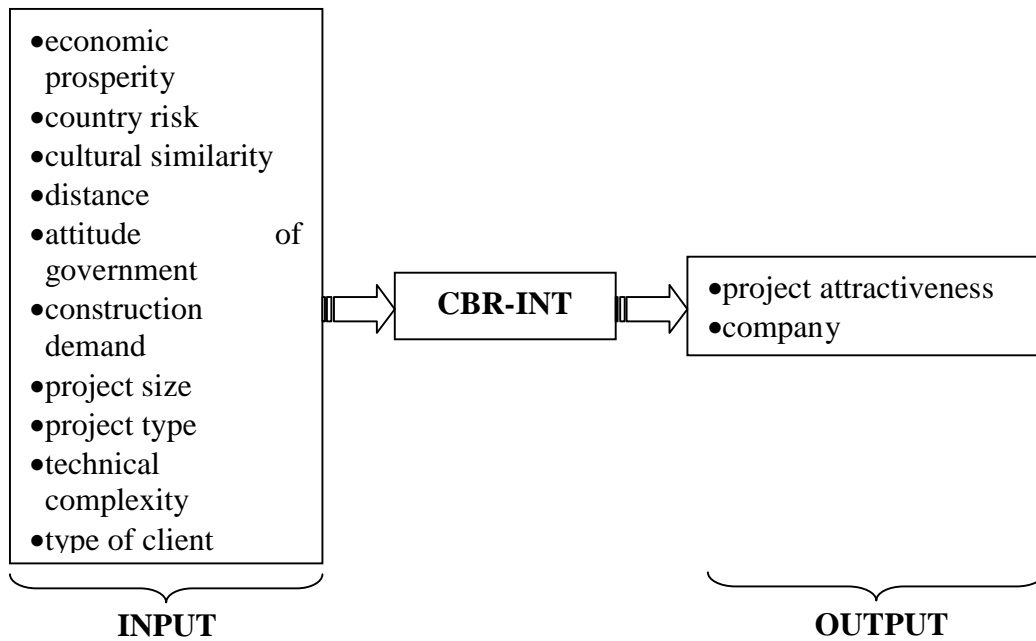


Figure 3 Modeling of CBR-INT

The system adopts both manual and weight generation methods for similarity assessment and retrieves similar cases in the order of their similarity scores to the target case. Adaptation is carried out with different manual methods that will help final prediction. After trying several adaptation models, the best one is selected based on the performance values. The reliability of the best model is found to be around 90%. The case library can be enriched by the incorporation of the latest cases and a larger case library can be used for the retrieval step for the solution of the next problem.

An experienced and large company in Turkey was asked to provide the data of a real international project in order to test the applicability and performance of CBR-INT. The target case was an infrastructure project that requires high experience and where there exists very high competition. The user, business development manager, was requested to specify the values of input parameters; then CBR-INT is run to predict the attractiveness and competitiveness values. Figure 4 presents the retrieved cases list on which similarity scores, case names and corresponding values appear.

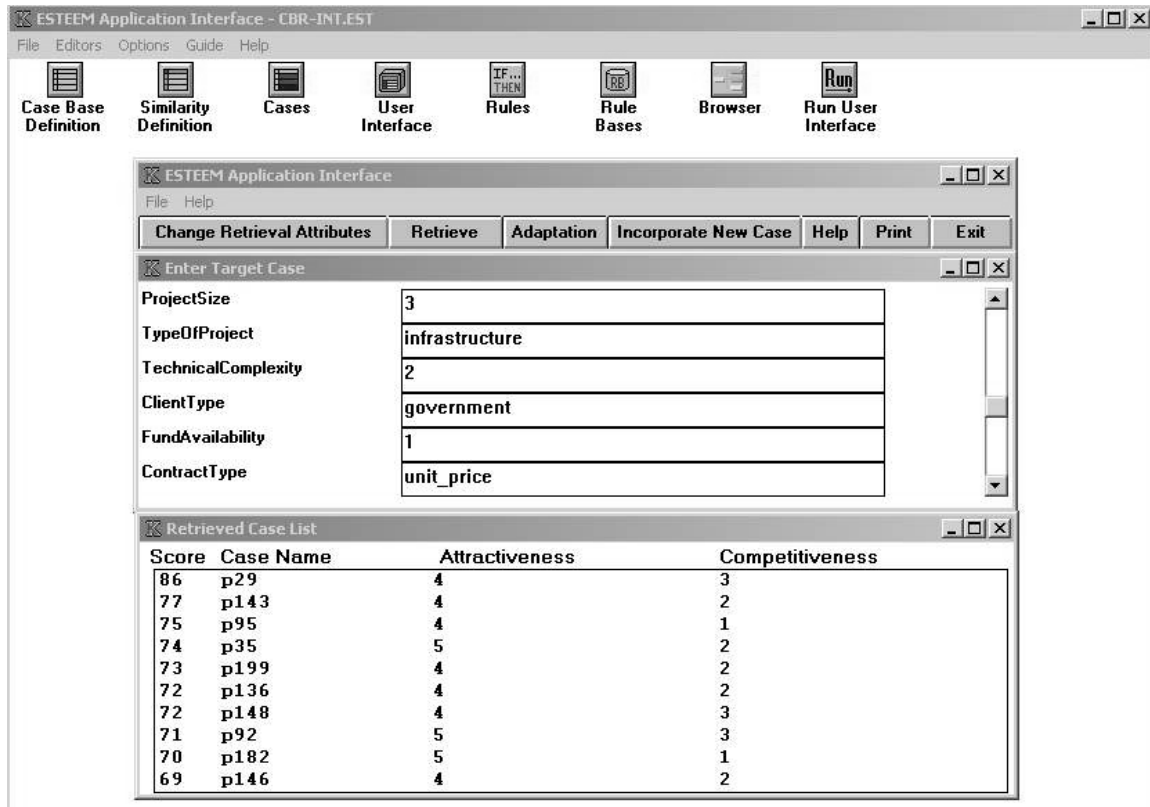


Figure 4 An application of CBR-INT: Retrieval of similar cases

At the end of the application, the project seemed to be highly attractive but the competitiveness value of the company was medium. This situation was expected because the company was meeting the requirements to perform the job but the threat of the competitors was almost impossible to avoid. When the results of the system and the real decision given by the business development manager are compared, it is observed that the model had produced exactly the same conclusions as an expert would do. The manager also was highly satisfied with the performance of the system as it is easy to use and it increases confidence about given decisions.

7. Conclusions

One of the main concerns of this study is to find out how construction companies create OM and how they utilize this asset during strategic decision-making. In the context of this paper, the framework representing the OM formation and utilization is presented; the interview study prepared using this framework is discussed; some of the research findings are summarized and a DSS, which was developed to aid construction companies in international market entry decisions is introduced.

Answers of the respondents denote that construction companies learn from several sources; they are very good at acquiring and storing knowledge but they cannot share knowledge among employees widely. Almost all respondent companies learn mainly from their own experiences;

learning from other companies' experiences and external resources have less contribution to the OM within the companies.

When the knowledge management activities are reviewed, it is seen that companies are most successful at acquiring and revising knowledge. However, they believe that knowledge sharing and utilization of knowledge in decision-making are the most important two activities, which should be carried out in the construction companies, but they are rather weak in these activities. One of the main barriers of OL is the high employee turnover rate that prevents companies embed knowledge within the organization. The other important factor is the firm infrastructure and culture that determine the effectiveness of the learning environment.

One of the most significant points is that the role of OM in strategic decision-making is limited for the construction companies. Company managers usually do not refer to codified knowledge in OM or utilize DSS; rather, they make strategic decisions based on their intuition, experience and expertise. Construction companies especially need a decision support tool for international market entry as found from the interview study. In order to meet the requirements of the industry, a CBR-based DSS is developed.

CBR has become a promising technique in the construction management field due to its ability to reason from the past that well suits to the construction problems. Since in construction industry, decisions are made through experience, construction problems cannot be modeled by strict rules; CBR is a promising technique to aid decision-making in construction business.

The proposed system namely, CBR-INT, is used to predict project attractiveness and company competitiveness when giving bid/no bid decisions in international markets. The reliability of CBR-INT is proved to be high for both prediction of attractiveness and competitiveness and its applicability is shown by a real case taken from the Turkish construction industry. CBR-INT is an example that demonstrates how DSS may increase the OL competence of companies since it requires the acquisition of several data, interpretation of data, transferring it into information, storing in a database and utilization of knowledge at the decision-making stage. CBR is proved to be a promising technique which may increase utilization rate of OM during decision-making and CBR-based DSS may facilitate OL in construction companies.

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