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http://www.isarc2008.vgtu.lt/

The 25th International Symposium on Automation and Robotics in Construction

June 26–29, 2008

ISARC-2008

REASONED DECISIONS IN CONSTRUCTION MATERIALS SELECTION

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ABSTRACT

The significant part of the constructions' value consists of construction materials price. Thus proper selection of construction products has significantly impacted on construction effectiveness. With the aim of using financial resources for the construction effectively, it is very important that well considered and reasonable decisions should be made regarding the selection of construction materials. Additionally, in seeking to facilitate the work of decision-makers, computer technologies are used that operates according to particular models. These models are based on special mathematical methods in order to facilitate decision-making and apply to a certain decision area. In this article, the possibilities of applying methods for popular decision-making are analyzed regarding the selection of construction materials.

KEYWORDS

Construction materials selection, reasoned decisions, decision support, real time system

1. INTRODUCTION

Construction information technology (IT) can be used on the national, organization and project levels.

On the national level IT may be used to disseminate the information on laws, norms, standards, technical issues, the results of research and experiments, contract offers, foreign experience, etc.

IT at country or European levels have been analyzed and written about in a variety of research literature. For example, Hassan and McCaffer [3] report on findings from a project funded by the European Commission entitled European Large Scale

Engineering Wide Integration Support Effort (eLSEwise) and present business and ICT trends in the European LSE construction industry. ProcureZone is [1] a "One-Stop Procurement Resource and Hub" that simplifies the purchasing process for buyers and suppliers throughout the constrnuctio industry.

On the organizational level IT is used to get and process the data on financing and investment possibilities (videotext) as well as on real estate (GIS), government-provided services (expert systems), producers and their products (electronic catalogues), etc.

Cheung et al. [2] describe the development of a Web-based Construction Project Performance Monitoring System (PPMS) that aims at assisting project managers in exercising construction project monitoring.

Alshawi and Ingirige [1] briefly explain the main features of the currently available web-based software, which comes under the umbrella of web-enabled project management tools.

Mohamed and Stewart [7] have performed an empirical investigation of users' perceptions of a web-based communication tool that has been adopted by large construction projects. According to this investigation, the IT can make a positive contribution to operational indicators such as document transfer and handling, enhanced coordination and communication between project participants, and reduced response time to answering queries, etc.

Husin and Rafi [4] review current available Internet-based computer-aided design tools and explore the possible utilization of these in architectural practices.

E. K. Zavadskas, L. Ustinovičius and A. Stasiulionis [9] have analysed possibilities to apply *Electre III* method evaluating the effectiveness of investment to commercial objects.

Maintenance of existing buildings is also important. It is expedient to make a multicriteria system for decision-making related to buildings' maintenance. T. Vilutienė and E. K. Zavadskas [8] have presented a system of criteria, which helps to make decisions related to maintenance of residential houses. Evaluation was made using the following multicriteria methods: WSM (weighted sum model), WPM (weighted product model), AHP (analytic hierarchy process), ELECTRE and TOPSIS methods' variation and the multicriteria complex proportional evaluation method.

Possibilities to use various methods of the game theory while making decisions in the construction sector were analysed by E. K. Zavadskas, L. Ustinovičius, Z. Turskis, F. Peldschus and D. Messing [10]. Authors have created a software which enables calculations using simple min-max principle, extended min-max principle, Wald‘s rule, Savage criterion, Hurwicz‘s rule, Laplace‘s rule, Bayes‘s rule and Hodges-Lehmann‘s rule. Investment to construction or reconstruction of a residential house in Nida is provided as an example of this software.

Many e-commerce systems for construction material procurement have emerged in the past few years. These systems have become the e-trading marketplaces for manufacturers, suppliers, agents and purchasers for buying and selling construction materials. Owners of these E-commerce systems vary from manufacturers, suppliers, agent companies, or even application service providers [6].

Kong et al. [6] expected that by enabling information sharing between different parties in the construction material procurement process one can facilitate improved information communication and coordination, have better strategic planning and decision making, and rapidly and flexibly supply chain management.

On analysing Web-based systems (information systems, neural networks, expert and decision support systems, e-commerce) applied world wide from decision support aspect, it is possible to notice in construction that they supply full-scale information needful for decision support.

However, most of all neural networks, decision support and expert systems are seeking to find how to make the most economic construction decisions, and most of all these decisions are intended only for

economic objectives. Construction alternatives under evaluation have to be evaluated not only from the economic position, but take into consideration qualitative, technical, technological, comfort and other factors as well. Construction alternative solutions allow for a more rational and realistic assessment of economic, technical, technological conditions and traditions and for more satisfaction of different customer requirements. Therefore, application of multiple criteria analysis methods and multiple criteria decision support systems can increase the efficiency of construction process.

2. INCREACING EFFICIENCY OF ONLINE MATERIALS SELECTION SYSTEMS

Based on the analysis of above Web-based systems and in order to determine the most efficient versions of construction alternatives a Multiple Criteria Decision Support On-Line System for Construction (OLSC) consisting of a database, database management system, model-base, model-base management system and user interface was developed by the authors of this paper.

The analysis of database structures in decision support systems according to the type of problem solved reveals their various utilities. OLSC has a relational database structure when the information is stored in the form of tables. These tables contain quantitative and conceptual information. Logically linked parts of the table form a relational model.

The interested parties have their specific needs and financial situation. Therefore, each time when using the OLSC the parties can make corrections of the database according to their aims and their financial situation. For example, a certain client considers the sound insulation of the external walls to be more important than their appearance while another client is of the opposite opinion. The client striving to express his/her attitude towards these issues numerically may ascribe various significance values to them that eventually will affect the general estimation of a refurbishment alternative. Though this assessment may seem biased and even subjective, the solution finally made can meet the client's requirements, aims and affordability exactly.

The model-base of a decision support system should include models that enable a decision-maker to do a comprehensive analysis of the available variants from a database and to make a proper choice. The following models of a model-base aim at performing the functions of:

- Establishment of the criteria weights.
- Multiple criteria analysis and setting the priorities.
- Determination alternative's utility degree.
- Determination alternative's market value.
- Presentation of recommendations.

According to the user's needs, various models may be provided by a model management system. When a certain model (i.e. search for construction alternatives) is used, the results obtained become the initial data for some other models (i.e. a model for multiple criteria analysis and setting the priorities). The results of the latter, in turn, can be taken as the initial data for some other models (i.e. determination of utility degree of market, suppliers, contractors, renovation of walls, windows and roof, etc.).

Since the analysis of construction alternatives is usually performed by taking into account economic, quality, technical, technological, comfort and other factors, a model-base should include models which will enable a decision maker to carry out a comprehensive analysis of the variants available in database and make a proper choice.

The method of complex proportional evaluation [5, 11] assumes direct and proportional dependence of the significance and utility degree of the investigated versions in a system of criteria adequately describing the alternatives and of values and weights of the criteria. A decision maker by using the experts' methods determines the system of criteria and calculates the values and initial weights of the qualitative criteria.

3. PRACTICAL POSSIBILITIES OF THE SYSTEM

At present, using developed OLSC model (fig. 1) allows for the performance of the following functions:

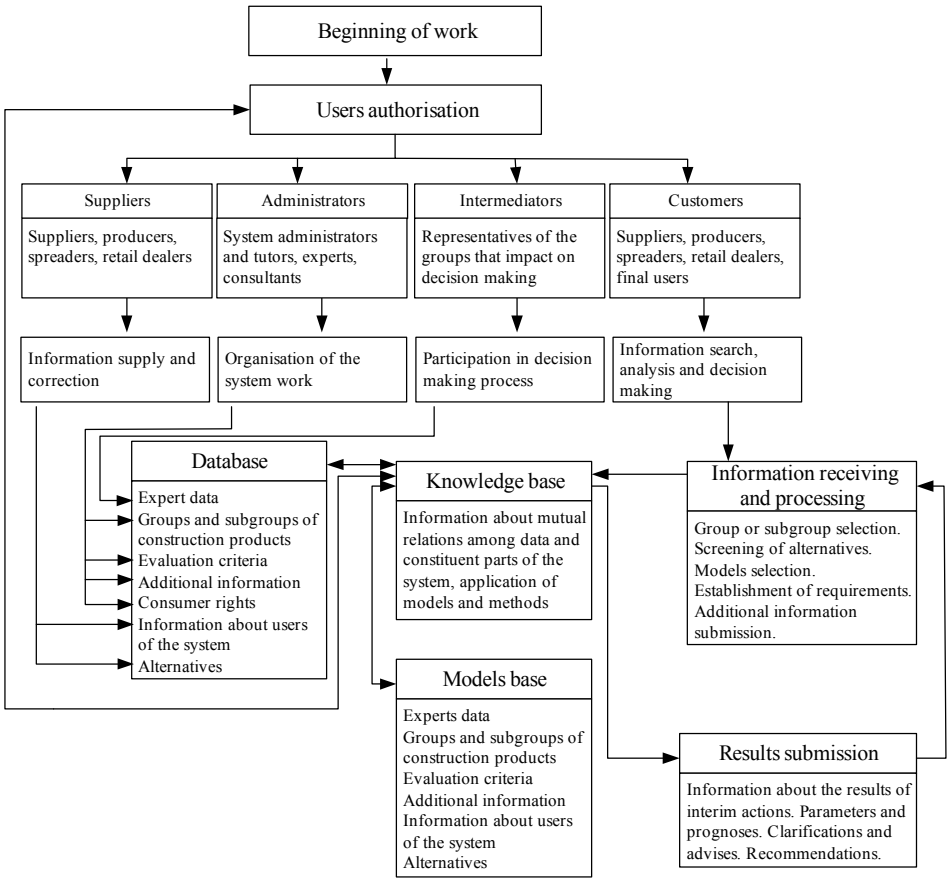

Figure 1. Model of on-line system for construction materials selection

- **Search of construction products and services.** A consumer may perform a search for alternatives from catalogues of different suppliers and manufacturers. This is possible since the forms of data submitted are standardized into specific levels. It also allow to implement intelligent search agents.
- **Finding alternatives and making comparative tables.** Consumers specify requirements and constraints and the OLSC queries the information of specific construction products (services) from a number of online vendors and returns a price-list and other characteristics that best meets the consumer's desire. The OLSC performs the tedious, time-consuming, and repetitive tasks of searching databases, retrieving and filtering information, and delivering the information back to the user. Results of a search of specific construction products (services) are submitted in tables, which may include direct links to a Web page of a supplier or manufacturer. Also, by submission, such a display of the multiple criteria comparisons can become more effectively supported. The results of the search of a concrete construction product (service) are often provided in one table where one can sometimes find direct links to the Web page of the supplier or manufacturer.
- **Evaluation stages of alternatives**. While going through the purchasing decision process a

customer should examine a large number of alternatives, each of which is surrounded by a considerable amount of information (for example, information about windows would comprise the following characteristics: price, discounts given, thermal insulation, sound insulation, rate of harm to human health and etc.). This helps consumers to decide what product best fits their requirements.

- **The after-purchase evaluation stage.** A consumer evaluates the usefulness of the product in the after-purchase evaluation stage.

Other typical construction tasks solved by users are: analysis of interested parties; determination of efficient loans; analysis and selection of rational refurbishment versions; multiple criteria analysis and determination of market value of a real estate; analysis and selection of a rational market; determination of efficient investment versions, etc.

4. CONCLUSIONS

The analysis of information, neural networks, expert and decision support systems, e-commerce used in construction, which were developed by practicians and users from various countries, assisted the authors to create their own Multiple Criteria Decision Support On-Line System for Construction (OLSC). A database of construction alternatives was developed and provides a comprehensive assessment of alternative versions from economic, technical, technological, qualitative and other perspectives. Based on the above database, the developed Multiple Criteria Decision Support On-Line System for Construction enables the user to analyze alternatives quantitatively (i.e. a system and subsystems of criteria, units of measure, values and weights) and conceptually (i.e. the text, formula, schemes, graphs, diagrams and videotapes).

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