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A building elements selection system for architects

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Abstract

This paper explains the development stages of an expert system BES for the evaluation and selection of the building elements. The work covers all kinds of building elements that are available in building construction including retaining walls, foundations, external walls, internal walls, floors, external stairs, internal stairs, roofs, external chimneys, internal chimneys, windows, and external doors and internal doors. The selection is based on the importance of performance requirements of the building elements and their expected performances. The selection is achieved by SMART Methodology, and the expert system shell "Exsys Corvid" is used to construct the expert system. Use of computer and Internet with its advantages in handling vast amount of data makes the system widely applicable and a useful design aid for architects. The decision-making feature of the system provides a suitable selection among numerous alternatives. The paper explains the experience gained through the use of this method and discusses further development of the system.

Keywords: Building elements; Performance requirements; Exsys corvid; Architectural design; Design aid; Smart methodology and expert systems

1. Introduction

The selection of building elements correctly among a vast number of alternatives is an important problem in architecture. Selection of building elements depends on different factors. Wrong building element selection causes serious problems concerned with economy, construction functionality and appearance, which will not be easy to correct. This paper deals with an expert system proposed for this purpose. The architecture of the building element selection system is shown in Fig. 1.

As already known, expert systems are computer programs which are composed of knowledge about one special field and are used for solving the problems as human experts can solve. In expert systems there are a number of advantages. Firstly, expertise of human is perishable because human may change jobs, become ill or even die. However, computer expertise is permanent. Secondly, human expertise is difficult to transfer. Expert systems can be shared in many places at the same time. Finally, human expertise is very expensive, the salary of an expert person is more than the cost of personal computer and the related software. Expert systems are therefore much more affordable. There are some disadvantages of expert systems compared to human beings. Firstly, human is creative and inspired; however, computers are uninspired. Secondly, human is flexible and easily adapts to other domain knowledge; however, computers are not very flexible. Thirdly, humans possess common sense, however, expert systems cannot apply knowledge to a problem beyond their domain, because expert systems have got a rather narrow focus about a particular problem. Fourthly, human learning is more advanced than the expert system learning [1,2].

Expert system building tools, called "shells", allow users to develop an expert system in an easy way. The "shells" are also expert systems that have been emptied of their rules so that the knowledge engineer concentrates on entering the knowledge base without having to build everything, including the inference engine and user interface. It is very easy for non-programming experts to be familiar with them. The shells are also not flexible. Therefore it is not easy to change or modify the way they work. In the literature there are a number of expert system shells in the market [1]. Any expert systems developed with EXSYS asks questions to the system designer about the subject or domain. The designer

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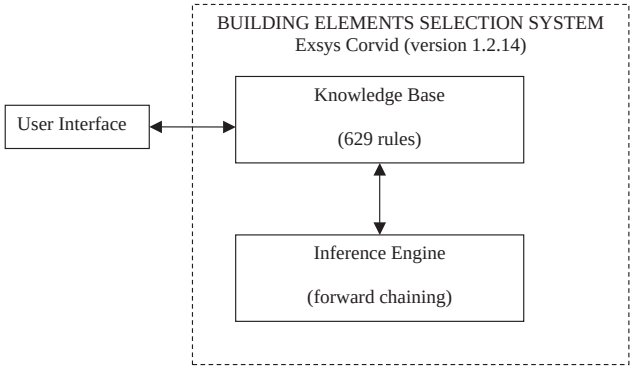

Fig. 1. Architecture of the building elements selection system.

responds by selecting a single answer or multi-answers from a list. The program will ask questions till the conclusion. Conclusion is sometimes the selection of a single solution or a list of possible group of solutions arranged in the order requested by designer. The program on request, can explain how it arrives at its conclusion [3,4].

There are also some expert systems for selection making. Rivard et al. [5] proposed a shared conceptual model for the building envelope design process in order to provide communication between the different members of building design team. The wealth of data in this area are organized into major envelope entities, which are then decomposed into cohesive sets of data called "primitives" to form the conceptual model. This study focuses on modeling the user requirements and does not address the modeling of the building envelope design. In addition, the grades of the building elements in terms of performance specifications are collected from the expert people by a survey. SMART methodology is used for this selection [6–8].

Mohan had made a review of expert systems in building construction area at its infancy [9]. After this review many more expert systems were introduced. It is worthwhile to mention the most important ones.

Altunay [10] proposed a model for the selection of internal finishes. This model handles floor covering materials made of wood, stone, ceramic, metal, concrete, plastic, carpet, partition walls, plastering and painting materials. The factors that are taken into consideration are: strength and durability, maintenance, ergonomic, health and safety, acoustic, fire resistance and aesthetics. In order to evaluate the importance of the factors Paired Comparision Scoring Matrix Method was used. The functional spaces included in this model are bathroom, kitchen, laundry, entrance, bedroom, living room, corridor and lobby. The user of the system establishes the weight of importance for each factor. Then the system integrates this input with knowledge and proposes some material alternatives with the highest score.

Mahmoud and Al-Hammad [11] proposed another model for the 'evaluation and selection of floor finishing materials'. In this model there are three filters. The first filter narrows down the material options considered for evaluation and selection. Second filter has two parts. The first part determines the performance requirement criteria weights via paired comparison scoring matrix methodology. In the second part, the determined performance requirements criteria weights for each of building's functional space will then be used in evaluation matrix. The third filter is about the cost analysis of the selected materials. In this stage the selected materials from the previous filter are examined and ranked according to their costs. As a result, the one with the lowest cost is recommended.

Cheung, Kuen and Skitmore proposed a model for the selection of architectural consultants [12]. The model is based on multi-criteria evaluation model.

In summary, none of the existing methods for building element selection cover all the building elements. The selection criteria used are not complete. None of the existing methods tackled the problem of performance requirements since they are different for each building element.

2. The proposed system

The expert system proposed in this article is called Building Elements Selection System (BES). It is a design aid for architects in selecting building elements during the early stages of design process. Any wrong decision without an expertise knowledge at this stage cannot be corrected at the later stages in an architectural design. The professional architects and the students of architecture will be able to benefit from this design aid. This separation is necessary because both types of designers have different levels of knowledge about building elements and their performances. The system will aid in international building construction arena and will also be available via the internet.

The method for the selection of building elements consists of the performance requirements of building elements, knowledge acquisition and knowledge representation. The architects who will use BES will be asked to input important weights for the performance requirements. Simple Multi-Attribute Rating Technique (SMART) is used for changing the weights of importance of the performance requirements, to the normalized weights. It will also help in selecting the best alternatives. Edward developed Smart Methodology in 1971 as a basic method for assisting the decision-makers by simplifying complex decisions through a series of stages [6]. In this method, even if there are two competitors at minimum, with equal weights of importance, the selection can be made. However, there is another selection method called Analytic Hierarchy Process or Paired Comparison Method. As its name implies, this method cannot give any result between two equal weighted competitors. It works for a pair to select the one with greater priority. Smart is preferred to BES because of this attribute.

Exsys Corvid version 1.2.14 was chosen as an expert system shell for BES because it can be used via Internet as well.