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Building Materials Information System as an Architectural Education Tool

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Abstract

Provided that supplementary tools are made available for the students of architecture, it seems possible to deal with the problems caused by the classical architectural education implemented within studios. Building Material Information System is assumed to establish coordination between theoretical and architectural design studios. Thus, the information given within theoretical courses can be adequately transferred to the studios.

1. Introduction

According to the information obtained through the feedbacks from the current education system, due to the breakdowns in coordination between the theoretical courses and architectural design studios, the students fail to transfer the information given within theoretical courses to the design studies carried out in studios.

It is a fact that the development of an architectural design is an entire process that begins with concept design and is not completed until the project is over. When this fact is taken into consideration, the current educational model, in which the subjects given to the students within theoretical courses and the design parameters studied in design studios are handled independently, fails to comply with the professional practices.

Within the limited period of time set for the courses, a partial solution for this problem can be using computer aided tools that have the capacity to support the lecturer and the student. The recent developments in the information and communication technology provide a great deal of advantages about the use and improvement of databases. Also, building material databases and the Internet has important roles to play as information providers. Provided that the students of architecture make use of the so-called facilities, it will be possible to manage the problems of inadequacy caused by the classical architectural education.

The authors of the paper at Istanbul Technical University (ITU), Faculty of Architecture started a research project on 1 January 1999. The subject of the project is developing a "Building Materials Information System (BMIS)" on relational database structure in the context of Turkish construction sector. The main objectives are to gather all the information about the building materials being used in the construction sector and to set up a computer aided information system. By doing this it will be possible to estimate the approximate total building cost of a project even in the preliminary design phase.

One of the further aims of the study is to cover the gap between the theoretical courses and design studios given in the education of architecture, by using the information system being developed. Therefore, the students will make use of the advantages, presented by the information system, for their project studies in design studios. In preliminary design and design phases student will be able to select the building materials for her/his project and find information about performance and proper application conditions of the selected building materials. The student will also be able to estimate approximate building cost of the project in compliance with the building materials she/he has selected. Furthermore, in the design process the student will be able to monitor the changes in the performance and the cost of the project differing according to the selected building materials.

2. Information and Information Systems

We are living in the age of information and the concept of information has become one of the fundamental sources of today's society necessary for the success and the survival of organizations and people.

In simple terms information is the knowledge created by means of data obtained through recorded cases and numbers. Data are the raw cases and observations about the physical formations or the processes in progress. Information is the sum of data existing in an environment where the meanings of such data are established. Information reports, reduces uncertainties, shows the alternatives or helps to eliminate the inappropriate ones, influences the decision-makers and motivates them to take the necessary action [1].

The incoming information must be about the problem that the decision-maker deals with and it must be suitable for the problem. The decision-maker should be able to choose the information that she/he requires so it is

necessary not to overwhelm him/her by the intensity of information about other subjects. The information must be related with the task being performed and it must be about the subjects that are important for the person who demands it.

On the other hand the information system is a set consisting of people, procedures and sources that collect or obtain, process, save and distribute the information in order to support the decision making and control functions of the decision-maker within the organization.

Recently verbal or informal systems are being replaced by computer aided information systems, which make use of hardware, software and human resources while transforming the data into information. The major reasons of the orientation of the organizations towards computer-aided information systems are simply, dramatic increases in the abilities of the computers and decrease in their prices, and inadequacy of the old methods and practices in the complex structure of the business world due to the effects of international economy, worldwide competition, increasing complexity of the technology, obligation to move and progress quickly and social limitations.

3. Information Systems Development

It is a fact that information systems have a great significance as they are used in many areas ranging from data processing within organizations or supporting operational decisions and decision making in strategic planning. However, it is not possible to find a ready-made information system in the market. The information systems can be developed after a long-term process is carried out. It involves a great number of people and necessitates a very effective design and management.

Development of an information system must not be considered only as setting up a new information system from scratch. For an information system in progress, continuous maintenance is necessary. Due to the changing conditions, developing technology and encountered problems and opportunities, the productivity percentages of the information systems being used have been decreasing. No matter which approach is followed in the development of an information system is, one should accept the fact like the other beings, they are born, they grow up and they end.

4. The Present State of the Architectural Education

Today, like many other faculties of architecture in Turkey, the education at Istanbul Technical University (ITU) Faculty of Architecture depends heavily on architectural design studies carried out in studios [2]. During the eight-semester academic education process, an architectural project is carried out in each term. Depending on the content of the subject analyzed within each term, students select one of the subjects among alternatives. Especially, in the first term the emphasized subjects are perception and interpretation of the space and providing competence to the students about describing their ideas about the space by means of basic design and model construction methods. With this aim small-scale design studies are pursued. As the terms progress, the subject, the scale, the content and the complexity of the project intensify. Within the context of the determined subject, the sub-subjects covered are; the organization of the space, the relations between the inside and outside of the space, the relations among building, urbanized environment and natural environment, the relations among function, form and structural systems, the relations between formation of the space and image-meaning-life scenario, development of critical thinking, stimulation of aesthetic sensitivity and analysis of the past.

The path in the design studios usually starts with research and data collection studies, continues with the analysis of the cases studied beforehand, theoretical studies, "concept" development and environmental awareness activities through transparent, photographs, videos, visits and seminars. They finally end with the determination of solution alternatives about the subject and development of the most suitable alternative. In order to create a critical discussion environment the studio studies are supported with juries.

The scale of study in the scope of the design studios, which form the basis of education at ITU Faculty of Architecture, may change in accordance with the subject selected and its complexity. The final product usually has the scale of 1/200 or 1/100 and compromises the features of the project. Within the scope of these studios, due to the shortage of academic education period, it is usually impossible to study in detail with the scales of 1/20, 1/5 or 1/1, which are the scales mostly used in practice. Due to the time limitations, the subjects such as development of structural sub-systems, integration between sub-systems, selection of building materials and effects of the alternative materials and sub-systems on the total building cost are ignored. In general, it is not possible to conclude design studies carried out on studios ready to be constructed.

However, in Turkish construction sector where the subject in concern is the use of limited sources, it is very significant to choose the construction methods and building materials that are the most appropriate for the set goal and the planned budget. The building materials used in construction have an important role in establishing and sustaining the expected performance from a building. At the same time, it is known that the cost of the selected building materials directly affects the total building cost. Creation of elite environments formed with aesthetic

concerns and new approaches, which make individuals live without any problems, is certainly desirable. On the other hand, one must know that even an owner of a building for whom aesthetic concerns are very significant will perhaps equally emphasize the performance features of the pertinent building and the cost estimation.

The academic education program of ITU Faculty of Architecture includes theoretical courses on the subjects of building materials and building cost. "Building Materials" is a course lectured theoretically and practically in the third academic term. The lectures are two hours per theory and two hours per practice in a week. The main objectives of the course are to introduce the building materials, which are both for structural and for non-structural elements to the students, and to make them capable of selecting the appropriate building material. In the scope of the course, the subjects about building materials are classified at an elementary level according to their functions in building components and their physical, chemical and mechanical properties and mostly suitability in use are examined. On the other hand, in the practical courses it is aimed to make the students recognize the building material types by means of mechanical and physical experiments carried out in laboratories and make assessments about the alternative building materials. In the past, the course was given under three separate courses and the total course hours were eight. In 1997, within the framework of "Education and Training Development Program" (ETDP), the course schedule was decided to include only one course instead of three and the total course hours was reduced to four. Due to this change, it has become impossible to provide the whole theoretical and practical information about building materials to the students within the set course hours.

On the other hand, the course of "Building Cost", in which the cost concepts in each phase of building construction process were lectured, used to be a two hours theoretical course given in the seventh term. Due to the change made in the ETDP, the course has become a part of a "Construction Management and Economy" course given in the sixth term and it is lectured for just four weeks for three class hours per week. The cost concept, cost management, the factors affecting the cost in building construction are tried to be covered and the methods of cost estimation, cost planning and cost control in building construction process are tried to be introduced in theoretical courses. In the practical courses for two hours per week, the issues covered in theoretical courses are studied by means of practices on small-scale projects. Although the software on the subject are mentioned in not only theoretical but also practical courses, due to the shortage of time, it is not possible to enable the students to use such software.

According to the information obtained through the feedbacks from the present education system, there are breakdowns in coordination between the theoretical courses and the design studios. Therefore, the students cannot easily transfer the information given within theoretical courses to the design studies carried out in studios. As one-to-one match between the design studies and theoretical courses is not possible; the students consider some of the theoretical courses, such as "Building Materials", "Building Cost" etc. as if they were separate branches of architecture.

In order to set a solution for this critical subject the lecturers who have given the concerning courses in the past years have sometimes made attempts to form one-to-one connections among studies carried out in design studios and the theoretical courses. However, these efforts have not resulted in success and the problems are still on the agenda.

In order to give feedback to the existing criticisms, this issue was reconsidered in the ETDP. The problem was tried to be solved by making some revisions in the "Construction Project Studio" given in the seventh term in the old schedule. Considering the facts that: the development of an architectural design is an entire process that begins with a preliminary design and is not completed until the construction is over; treating the subjects covered in the theoretical courses and the design parameters independently fails to comply with the professional practices, the old course named "Construction Project Studio" started to be given as a course renamed "Architectural Design Studio 5: Construction Project". This course was assumed to be a link in the chain of architectural design studios. The objectives of the course given in the fifth term are to inform the students about the development of sub-systems, such as structural system, HVAC systems, in accordance with their functions and the provision of integration among these; to make the students gain aesthetic concerns as well as ability to present architectural solutions incurring technical and legal issues; to teach the students how to select and apply building materials. Within the scope of the studio, the student has life-like experiences in the design process. The efforts are oriented towards reaching the desired point characterized with the variety of not only design parameters but also subjects to be covered in detailing design process.

It is considered that, within the limited period of time set for the courses, a partial solution for these problems may be using supplementary tools that may aid the student and the lecturer.

Information Technology (IT) is developing at an incredible speed and offers various design, drawing and presentation possibilities. IT not only helps the designer in the assessment of the projects in terms of aesthetics,

but also puts forward new ways to study the projects in structural and economic terms. The high-capacity computers manufactured by the hardware companies and CAD software whose new versions are announced each year, form the basis of above-mentioned supplementary tools. CAD software is effective methods to present the architectural expressions in the best way. A variety of relational database management software, the structural system design, calculation and drawing software, cost estimation and calculation software that can all be integrated with CAD software are just a few of the tools. Furthermore, the new information highway, the Internet is used as a tool to inform people about such possibilities and to distribute such information.

Information about the building materials should be accessible and understandable for designers, because successful use of building materials can only occur as a result of smart design process. Currently, hundreds of web sites serve to AEC community in order to present building materials information all around the world. Some of them are just individual web sites that belong to companies and institutions, giving detailed or broad definitions and scanned brochures of building materials. Some of them are product selectors, providing the entire information about building materials via a search engine. Structure of a web site depends on the factors such as the facilities and financial support of the company or institutions that maintains it, user requirements, user profiles, capacity, scale and characteristic of the construction industry they serve, etc.

5. The Research Project

In Turkey, there are numerous manufacturing companies serving the decision-makers to introduce their building materials both on printed and electronic format. Taking the advantage of storage capacity and versatility CD-ROMs are the most preferred ones. In addition, directories and catalogue files, which organize, index and gather collection of manufacturers' catalogues prepared by public and private sector companies, are the other decision-making sources for design and construction professionals.

However not all of these sources are enough to compare, evaluate and select the building materials as a whole. Almost all of the sources mentioned above whether on paper or electronic media consist of scanned data sheets and brochures of manufacturers, classified in terms of the companies' experiences. Web site contents and links are very poor; most of them are under construction. Although, it is very important, current market prices of building materials are not included. So, it is not practical and out of date for dynamic and rapidly changing Turkish Construction Industry [3].

Finally, it is clear that Turkey does not have a comprehensive and up-to date source in the field of building material information yet, as it is seen in Europe and USA etc.

In order to cover this gap in Turkey a research has been started at ITU Faculty of Architecture on January 1st 1999. The objectives of the studies carried out within the scope of the research named as "Design of a Building Materials Information System on a Relational Database Structure in the context of Turkey (BMIS)" are as follows:

(1) gathering all the information about building materials currently used in market,

(2) setting up a computer aided information system.

The information system will be used both in preliminary design, design phases of the building construction process. It will present not only the appropriate building materials alternatives for the type of a building but also the cost of these alternatives. It will help the participants in the construction sector to make decisions by reporting them the approximate total building cost even in the preliminary design phase.

The research project will be carried out at two stages. The first stage concerns gathering the information about building materials. The information gathered will be entered in the database of BMIS using to the "Building Materials Classification and Coding System". The concerning classification system was developed within the scope of a research project on "A Computer-Based Building Cost Information System (BMBS) in Turkish Construction Sector" completed in 1996. In order to make it available for international users, classification system was related with the CI/SfB classification system. The vast amount of building materials information will be made available to the participants in Turkish Construction Sector.

At the second stage the "Cost Estimation Module Based on Functional Elements", which has been developed in the scope of BMBS research project by means of Progress 4GL relational database management system will be integrated with the information system. The cost estimation module based on functional elements is a computer-aided estimation model that estimates the building cost in preliminary design phase by making use of the data retrieved from similar projects.

6. Building Materials Information System as an Architectural Education Tool

One of the other objectives of BMIS is trying to solve the problems in coordination between the theoretical courses and design studio studies in architectural education.

When the BMIS will be completed, it will also be made available for the students so that they will be able to use it during their architectural education, especially in design studios at ITU. The students will be able to select the appropriate building material among different alternatives in their architectural project design studies and be informed about performance and the properties of building materials. She/he will be able to calculate the estimated building cost of the architectural project according to the selected building material. Furthermore, in the design process the student will be able to monitor and revise the changes in the total building cost differing according to the selected building materials. As the students use the BMIS, the more data will be entered into the database and this will also contribute to the development of the information system.

The student who wants to use the BMIS integrated with BMBS during design studio studies should follow these steps:

6.1. Data Entry

The first step is entering the data related to the project for which building cost estimation is required. A project number given by the student, project name, the local code of the city where the project shall be carried out, project type code (residential, educational, commercial building etc.), construction area, number of the stories in the project, work type of the project (new building, restoration or renovation of an old project etc.), and cost estimation date should be entered.

6.2. Quantity Entry

The second step is entering estimated quantities of each functional element group in the project. Functional elements that constitute a building were divided into nine groups with the help of BMBS classification system, such as ground slab, floors and stairs, external walls, windows, external doors, internal walls, internal doors, roofs and structural system.

The student measures the quantities of functional element groups on the sketch drawings and enters total quantities of each group. This operation is repeated for each functional element group.

If the student does not have enough data related to the project, she/he can use the historical data available in the BMBS database. The student can make an inquiry among the similar projects in the database with the help of project related data entered previously.

6.3. Setting the Unit Price

When the quantity of a functional element group is entered, the student has to define the composite structure of the functional element.

Each composite element alternative for a functional element group comprises all of the layers covering an area of one square meter. If a floor is examined as a composite element alternative, all the layers related to have a finished floor for one square meter have to be considered respectively. For example, the layers of a floor composite element section of one square meter are as follows: ceramic flooring tile + special ceramic tile adhesive + ceramic mortar + bituminous damp proofing material + screed + reinforced concrete floor slab + cement-lime ceiling plaster + ceiling paint.

For each functional element group, the student can not only make a selection among the current composite element alternatives but also create her/his own composite element. By using the BMIS it will be possible to select the appropriate building material from among the existing ones in the market by taking their properties, application conditions and cost into consideration. For each functional element group, the student will be able to obtain the average unit price of the concerning group by using one (or more than one) composite element alternative.

The student will have the possibility of creating infinite composite element alternatives and try each of them for her/his project and monitor the differences likely to occur in the building material performance and total building cost accordingly.

6.4. Cost Estimation

The total cost of each functional element group is determined by multiplying total quantity of the functional element group with the unit price. Then, the sum of the total cost of the functional element groups will show the estimated total building cost.

Here, it must be noted that the cost of the structural system is not included in the cost estimation process so far. At this point, the student has percent of the structural system cost in total building cost of similar projects available in database. The student may modify the percent resulted from the inquiry in accordance with the estimated cost of the project

6.5. Evaluation

When the student use the BMIS while creating the composite element alternatives for the project she/he studies on, it will be possible for her/him to access all the available building materials alternatives in Turkey in one database. Therefore, she/he will be able to analyze and evaluate the performance characteristics of the building material alternatives. This step will enable him/her to

select the appropriate building materials for her/his project. The student will also have the chance of accessing the web site created by the manufacturer or supplier of the building material, if available. Then, she/he will be able to access more detailed information about the building material published by the company.

7. Conclusion

In the light of the information received through feedbacks from the present architectural education system in Turkey, it becomes clear that there is a failure in coordination between theoretical and architectural project courses. Thus, the information given within theoretical courses cannot be adequately transferred to the design studios.

During the architectural education, the students can make use of the advantages of BMIS, which is being developed, in their architectural design studios. As soon as the information system is made available for the use of the students it will be possible to challenge the impossibilities of classical architectural education.

Even in the preliminary design phase, the students will be able to have ideas about what the cost of the building will be in case the alternative building materials are used. Such system will enable them to take back and forward steps for selecting new building materials so that they will be able to view the changes in performance and cost of their projects If they make changes on their projects it will be possible for them to be informed about the effects of such changes on cost. This system will help students comprehend not only the importance of selecting the right building material but also the effects of cost on design.

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