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A Conceptual Framework to Assess Architectural Design Quality by Analytic Hierarchy Process (AHP) and Its Integration to Building Contracts

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Abstract
During the last century theorists have discussed and tried to reveal characteristics of architectural design processes. Since each building design project is unique and has its own context, classification and topics of interests are about the structure of the decision making process, parallels among architectural designing, creative behaviour and problem solving. Recently there are various methodologies developed in order to support multi criteria decision making processes. Frequently refereed ones are Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP). AHP is a powerful and understandable methodology that allows groups or individuals to combine qualitative and quantitative factors in decision making process. ANP methodology allows groups or individuals to deal with the interconnections (dependence and feedback) between factors of complex structure in decision making process. AHP structures a decision problem into levels forming a hierarchy, while the ANP is using a network approach (Van Bakel, 2005; Topçu, 2009).

This paper tries to put out a conceptual framework of a PhD study previously started to assess architectural design quality from the perspectives of design team, client, users, society and contractors by using AHP and its integration to building contracts. The outcomes of the paper will be used in order to develop a handy tool while deciding on appropriate building contract which architectural design quality plays an essential role.

Keywords
Analytic hierarchy process (AHP), Architectural design quality, Building contracts, Multi criteria decision making (MCDM)

1. Introduction

Each design is unique and has its own context. It is obvious that to analyse building in detail and be aware of the imperfections would not be possible before the building is constructed. Moreover each design process has special characteristics which are not standardised easily. Thus many support tools developed for design process are usually used at almost end of the process in order to make design confirmation. On the other hand there is still a lack between the studies on design process support tools and the expectations of design team in design process beginning from the early phases. If the subject matter is architectural

design quality, many researches can be found related with post occupancy process evaluation. These are usually limited with design confirmation. However, there is no comprehensive research on quantifying design quality before design process begins. Contrarily it is obvious that the quality of the end-product will be possible just by the quality of the design itself. There are various types of assessment methodologies most of which were applied on quantifying the results after process finalised.

The objective of this paper is to search the ways of architectural design quality assessment in complex buildings not only during design process but also before design process begins. It is aimed to develop the work in two phases. In the first phase a discussion on the methodology of conceptual framework of a model for architectural design quality assessment by Analytic Hierarchy Process (AHP), and in the second phase outcomes of the first phase will be integrated to building contracts in order to improve architectural design quality. The content of the paper starts with the definition of the problem, discussion of the methodology and the context of architectural design quality. It should be noted that the work presented here does not intend to assess quality of design process.

2. Problem Definition

"Quality is like politics, sex or religion. It is something everyone understands and is convinced that he does correctly. Few would like to explain it, and discussions on it are generally short and superficial, with one or other of the participants soon changing the subject through boredom or embarrassment. We all think we understand the subject, and are all convinced that our ways are right" (Cornick, 1991). Design quality is hard to quantify as it consists of both objective and subjective components. Whilst some indicators of design can be measured objectively, others result in intangible assets, depending in part on the subjective views, experiences and preferences of the people asked. Defining main criteria for architectural design quality has been the key question and stretch back to the ancient times. Since Vitruvius, every architect has different ideas about what the criteria must be. Throughout the history of architecture, definition of criteria and their sub-criteria differs according to the era, technology, culture and the society. Depending on the literature review architectural design quality can be grouped under 3 main tittles named build quality, functionality and impact which these aspects can be seen as a modern-day interpretation of the Vitruvian framework; and there was an extended discussion and many iterations before these terms were agreed upon. For the offered model to explore the design quality of a building, function encompasses aspects of its use, access and space; build quality encompasses aspects of its performance, engineering systems and construction; and impact encompasses aspects of its contribution to form and materials, internal environment, urban and social integration, identity and character (Figure 1) (Simon, 1969; Vitruvius, 1993; Gann *et al*., 2003; DQI, 2005; Harputlugil and Gültekin, 2006; Cook, 2007).

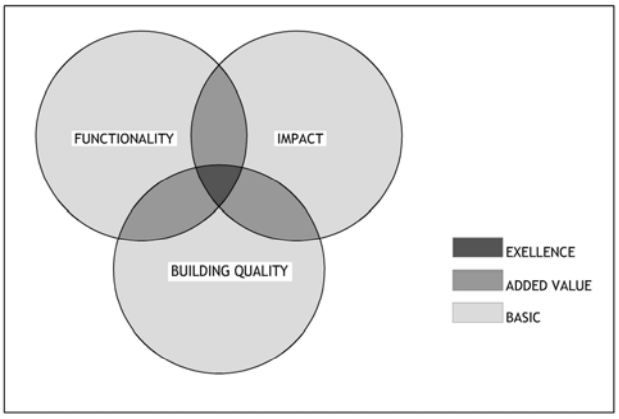

Figure 1: Architectural Design Quality Value Drivers according to CABE (OGC 2004)

CABE (Commission for Architecture and the Built Environment) listed “functionality”, “impact” and “building quality” as value drivers each of which has individual impacts on design. The intersection of two values can be defined “the added value” to the design. Ideally, intersection of these three value drivers, illustrated as “excellence” on Figure 1, can be accepted as achievement of Architectural design quality.

3. Conceptual Framework of Methodology

Regarding the outline of problem statements, it is necessary to develop a new methodology which will be offered to assess the architectural design quality before design process begins. As an assessment tool AHP will be used. The main cognitive framework of the methodology will basis on 6 main ideas.

1) It is obvious that decisions made in the design process are effective on the architectural design quality. Proposed model should assist to make choices and should cover all the design process beginning from outline design to final design.
2) Architectural Building design differs from other object designs as it has functionality and a user profile. Thus the evaluation cannot be limited with only design team actors. Other participants in the process as client, contractor, users and society should be involved in the assessment process. Their effects on decision should be defined by weighing algorithms which is able to differ case by case.
3) Architectural design quality is assessed by different ways in every era and each society. Thus an adaptable model should be designed for different societies instead of creating a universal model. Proposed model should be applied to selected units and should let the adaptations to be made.
4) Model must put out an operating unit in which design actors, client, users, contractors, and society can put forth their ideas/approvals in order to share each other for better integration. For this reason, model should be available for anyone not only professional design actors but also the other members of decision makers.
5) In order to improve the proposed model it is beneficial to give feedbacks, to evaluate alternative ways and to assist selection of the best choices.
6) Data entering and operating system should be flexible and adaptable. The interface must be clear and easy to operate.

As a starting point of the work, existing tools and models developed for assessment of Architectural design quality is reviewed. Unlike the other methodologies to quantify architectural design quality, it is aimed to propose a model that will offer hierarchical pair wise comparison to find out the choices of decision makers to guide the design teams for better buildings.

3.1 AHP

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making (MCDM) approach and was introduced by Saaty (1980, 1990). The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain and for helping to capture both subjective and objective evaluation measures. The AHP is a decision support tool which can be used to solve complex decision problems. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, decision makers and alternatives. The pertinent data are derived by using a set of pairwise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency (Triantaphyllou and Mann, 1995; Saaty, 1980; Saaty).

For this research project AHP has been chosen as a methodology for assessment of architectural design quality since the AHP provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions. Also applications all around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education are a plus.

3.2 AHP Structure

AHP, decomposition by hierarchies and synthesis by finding relations through informed judgement is structured by Saaty (1990) as below:

Following statement of the problem, structure of the hierarchy with goal, criteria, sub-criteria, properties of alternatives and the alternatives themselves is constructed. To remove ambiguity every element in hierarchy must be defined carefully (Figure 2).

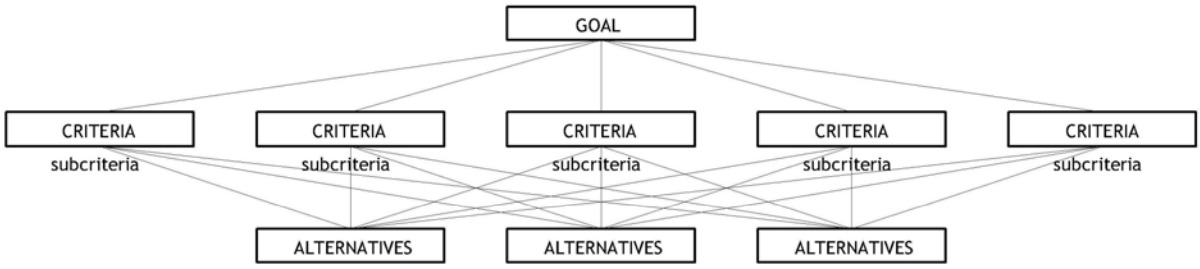

Figure 2: Analytic Hierarchy Process (AHP)

Questions for pairwise comparisons must be stated clearly. Subcriteria are prioritized with respect to their criteria. Pairwise comparison judgments are entered; priorities are calculated by adding elements of each column and dividing each entry by the total of column. Average over the rows of resulting matrix is found for priority vector (Figure 3) (Figure 4).

PAIRWISE COMPARISON MATRIX (FOR JUDGEMENT)	A	B	C	D
A	1			
B		1		
C			1	
D				1

Figure 3: Pair-wise Comparison Matrix

Figure 4: Pair-wise Comparison Weighing Scales

The weights in the hierarchy composed to obtain composite priorities and also the composite values of the state variables which collectively define the composite outcome (Table 1), and finally in the case of choosing among alternatives highest priority is selected.

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute Equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favour one activity over another
5	Essential or strong importance	Experience and judgment strongly favour one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance demonstrated in practise
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

Table 1: Pairwise Comparison Weighing Scales Definition (according to Triantaphyllou and Mann, 1995; Saaty, 1980)

4. Model

Proposed AHP based model will provide a conceptual framework for assessment of architectural design quality. The model puts out of AHP structure with its goal, decision makers, and criteria with their subcriteria and alternatives respectively with their hierarchical relationships (Figure 5). For the model criteria and subcriteria are chosen from Gann *et al.,* (2003). The model provides a flexible system to adapt or change decision makers profile, quality criteria and their subcriteria. Model is aimed to be flexible enough to adapt various types of buildings, different project teams profile and diverse societies.

Goal : Architectural design quality
Decision makers : Design Team (architect, engineers, spec., advisors etc.)
Users
Contractors (sub contractors)
Client (government, private,
Society
Criteria : Functionality (Space, Access, Use)
Impact (Form and Materials, Identity, Character)
Building quality (Engineering Systems, Construction, Performance)

Alternatives : Architectural design Alternative 1
Architectural design Alternative 2
Architectural design Alternative 3

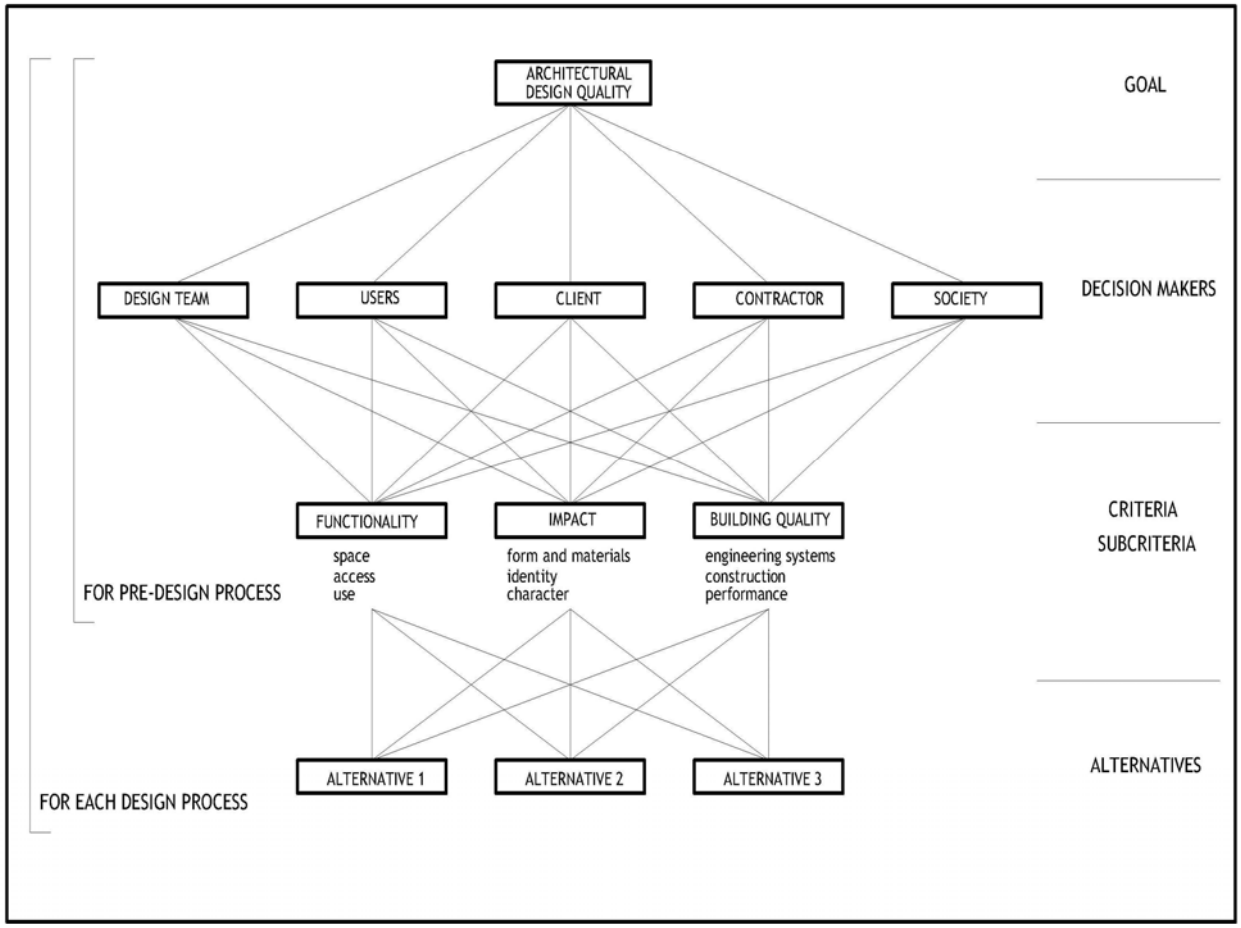

Figure 5: AHP Based Model

Weighing factors which will be used in the calculations of AHP will be changeable for different design teams and diverse societies in proposed AHP based model. Unlike other quality assessment tools, the model aims to supply any of the knowledge about architectural design quality required by design team before design process begins. On the other hand, proposed model can be available for any stage of the design to provide feedback.

4.1 Model Data Gathering

In order to get pair wise comparisons to gather data for proposed AHP based model, interviews and surveys will be made face to face with the participants whom are listed in the cluster of decision makers. For surveys a computer based tool will be used to evaluate the comparison. Computer based tool will be chosen among the AHP programs depending its ease of use. The surveys will be made with a computerized system that allows to link server computer via network. This will allow observing data transfer online and helps to control end-user based mistakes.

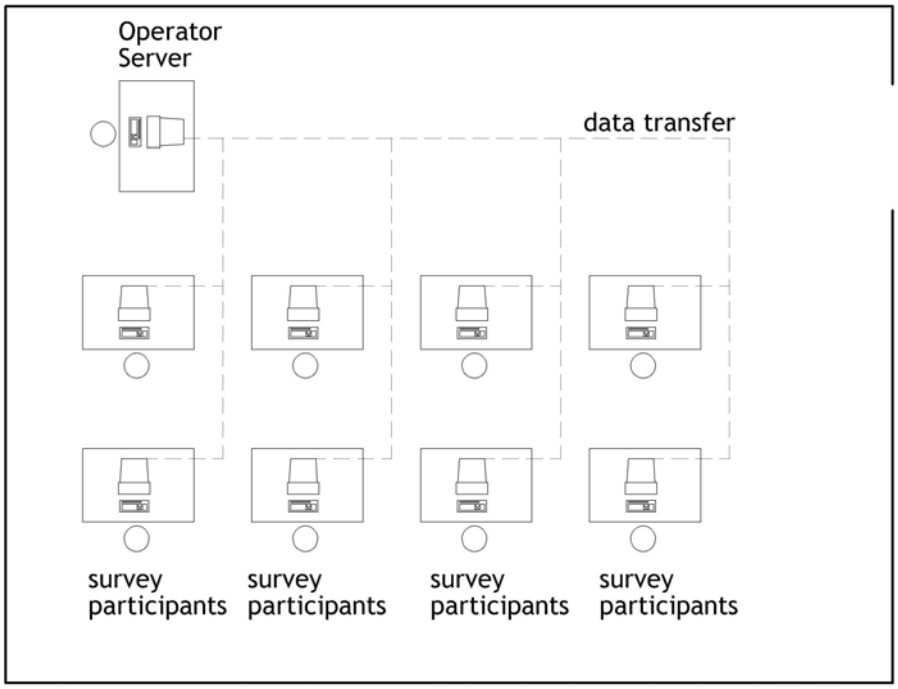

Figure 6: Data Gathering

4.2 Advantages of the Model

The advantages of the proposed model can be listed as follows;

1) Model can be applied in any stage of design including pre design.
2) All hierarchical formation can be changeable for different project teams
3) All criteria and subcriteria for assessment of architectural design can be arranged for different project teams.
4) Model is adaptable for various types of buildings.
5) Weighing factors can be changed for different types of buildings, and for different project teams.
6) Model will provide a base to share knowledge among the design team, client, contractor and society about architectural design quality.

5. Model Implementation and Future Work

This research aims to put out a methodology to assess architectural design quality free of design subjects. The conceptual framework will be examined by case studies which medical faculties as health care facilities in Turkey will be chosen. After AHP scheme is ready to use, the interviews, questionnaires and surveys will be held with the actors of design, users (the doctors-the nurses-the patients etc.), client, contractor and the members of society. All the data will be observed with computer tools and the results will be analysed.

After revealing assessment results of architectural design quality by AHP, in the second phase of the research, building contracts will be observed. It is aimed to improve architectural design quality and its integration to contracts by designing a computer based tool which may provide all participants to choose best building contracts for improvement.

6. Conclusion

Integration is an essential feature of design activity and is traditionally regarded as one of the key tasks of the architect. This is particularly important now, as the spatial, functional, and technical aspects of the building design and construction become increasingly complex and the number of parties involved increases. Little is known about the actual course of the integration process during the design activity, though this is a source of many possible errors. Improved design integration may be expected to lead to a faster building process, fewer building errors and higher architectural quality (Wamelink and Heintz, 2007).

Proposed AHP based model for assessment of architectural design quality for integrated design teams of complex buildings will provide a base to share knowledge among project teams and society, for better buildings. The outcomes of the paper will be used in order to develop a handy tool while deciding on appropriate building contract which architectural design quality plays an essential role. It is believed that this research project will contribute to raise public awareness on importance of architectural design and its quality.

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