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Quality and Assessing Quality in Architecture Building

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***Abstract*:** *At present, "Quality" is an inaccurate and unknown issue in different sciences. In this research, reviewing specialized literature in assessment method of architecture quality in the world, a new method for field-oriented and functional determination of architecture quality definition is devised. The goal of this research is assessing appropriate architecture but also emphasizing on user needs (user's sound) in architecture buildings. Users and consumers considering their local experiences in architecture spaces and also different aspects of their characteristic and culture, create subjective images of quality in their minds. So, initial required data in this method are subjective perceptions by the users. For overcoming on initial sophistications, AHP method was used for selecting quality criteria. As a result, fundamental quality factors were specified in building after occupancy according to users view. A mechanism is required for drawing building quality while it should analyze user group decision makings as well as integrating quality priorities; this is while that these can be obtained through Fuzzy making integration. So, for improving obtained results, some buildings were selected through Fuzzy method and were assessed by users. Results showed that quality in building can be measured and defined on the basis of aboriginal and local values while methods used for this purpose may produce different results. This research can be seen as a landmark while is used by designers through reducing distance between designer and consumer for accessing to higher quality or significant criteria and also property factors, potential buyers or tenants while trying to explore qualitative buildings. This research also can be used as aboriginal and local researches and reviews.*

Keywords: *Building Quality, Fuzzy logic, AHP, Architecture.*

1. Introduction

Regularity buildings are not language signs which merely transfer data. Before saying anything through architecture, it should prepare a space for living. In descripting global life structures and presence and other spaces, Schultz [1] suggests: "it isn't representative of a mathematical relationship with the universe, but it also refers to a space for our daily life; an environment which life stream occurs within it".

This research concerns about pretermitting quality in buildings since it only is transmitted into second priority and became secondary subject. This is while focus of considerations has been not mainly about physical construction levels, when we examine quality definitions and also functional optimization agenda. As, new building generations emphasize on reduction of energy consumption, construction and maintenance prices and construction time. In the worst case, designing fall toward producing unexciting and boring buildings and finally design quality will be lost for improving the process. Although sustainable building production has been organized appropriately for energy and environmental related topics, especially about energy management, it isn't applied in any architectural dominant paradigms [2].

In this stage, quality definition and evaluation would be discussed as a main issue. Quality measurement brings up major practical and conceptual issues. Some buildings have specific physical features such as modern heating and cooling equipment and the others have emotional features like the sense of smell, sound etc. However, in this research, those features would be considered which cause to create a high quality place. This place meets the mental and body needs of building users, it also turns environment into a pleasant living

environment for human while accepts their behavioural patterns. These features are known here as "user's sound".

All humans have an experience in their surrounding spaces, undoubtedly; an experience which could be defined hardly by the words in it's whole without losing its main parts. The reason why we find a building or a space unfamiliar usually is that, that building or environment seems to us meaningless and empty or it is impossible for us to establish a relationship with that environment. In brief, all of these are when a man experiences an environment, significantly [3]. On the other hand, there isn't any construed pure experience, independent from cognitive, cultural and social defaults and hence, no experience is independent from interpretation but is the same as it. Thus, supposed cognitive believes and systems and all of previous individual experiences are the fields of their present and future experiences [4]. Now, if we reach to analyze building induction and perceptual load regardless of the way of people's space perception, we should measure user's experiences as final evidence and we should gait toward hearing "user sound", in the building.

2. Methodology

Adopted strategies should be about creating words and "user's voice", existing knowledge extraction and the willing of users while all are about different features of building quality. There are different definitions of building quality which are suggested by experts and decisions makers and designers. General view about quality is that it isn't real and tangible [5]. Quantitative measuring of design quality is so hard. According to Simon, desired designing started from complicated and unknown point [6]. Methodology is evolutionary and nonlinear which is related with inner system approaches [7].

Concepts are important for measuring quality in buildings, so firstly this question arises to us that what are quality definition factors and criteria according to user's view? And also which measures certify users about quality of buildings? First phase involves of improving a method which can combine building experts and general user's view and extract factors. Considering the fact that metrology is a field which mainly focuses on measuring methods of quality study, this field is more successful in controlling and providing quality [5]. For this purpose two techniques were applied in this research namely AHP and Fuzzy Logic. In the first phase, firstly initial criteria were specified by experts and public building users were assessed by AHP technique and in conclusion, the amount of each criterion weigh was measured for rating on the basis of "user's sound".

Second phase was also done in this research for the purpose of development. This phase tried to use compatible and effective method for gathering and combining and concluding from user's wide linguistic views in measuring and scoring for comparing quality between buildings, regardless of expert's views and also considering a quality and appropriate building. In this regard, "user's sound" is first gathered by questionnaire in different quality scales for selected buildings and then they were evaluated and were scored via Fuzzy method. This method receives quality data and turns them into quantity ones. Fuzzy Logic has been applied for analyzing and categorizing gathered data via study and also showing quality values which have obtained from respondents.

In addition to these points, it is worth to notice that this method has less incompatibility than AHP technique in terms of selecting buildings which are related to different criteria and these are because of group comparison of Fuzzy Logic compared with pair comparison of AHP technique. Finally, this method can also be used as buildings evaluating criterion all around the world, with more developments.

Proposed method in second phase has been concentrated on individual's perceptions and not on expert's believes and professional assessments.

Fig. 1: Use "Figure/picture" style used here.

User's meeting withdrawals were obtained through questionnaire about some building quality aspects which are shown in appendix. Questionnaire which was completed and delivered comprises building pictures which will show inside and outside spaces, details and other features. Each quality factor in this research was examined and many buildings were examined in this research. Sample population was selected among experienced people while they had perception about similar buildings type which was selected in questionnaire. These people were also should selected among different jobs since oriented expertise views should not be dominant through gathering data.

Building 1

Building 2

Building 3

Building 4

3. Quality Measuring

3.1. Quality Definition

In one of offered definitions which are usually applied in different sciences, it defines quality of offered services as a limitation of providing needs and stakeholder's expectations [8-10]. So, quality can be defined as the gap between client's expectations and received services and if expectations go beyond the function, the result would be client's dissatisfaction. Quality is a complicated class with different levels and related factors [5].

When we try to define indexes and to measure quality according to experts and user's views we would face with some problems such as perceptional gap between experts and typical people, oriented and dogmatic views, being bad taste, different levels of thinking and as a result, different validities in views. However, recent studies refer to lack of direct consideration of user's values and conclude that these values should be examined if they have effects on the way in which quality is understood; they should be examined and user's value management should be innovated [11]. According to Christopher Alexander in "The Timeless Way of Building", we should pass life pattern language ad a gate for reaching to unknown quality [12]. Previous studies have announced that the most important criteria in each assessment of building designing refers to this that does it address user's need? And also what is preoccupation of users? [13]. Different research groups have cooperated with industrial and economic groups and advocates for producing some signs for users, managers, designers and researches to enhance people's housing excellence through appreciating and measuring quality.

3.2. Visual and Subjective Methods

Some methods are created for organizing visual and subjective assessment and have been done for achieving a judgment in value while it will lead to comparison in other's observations. Gobster and Chenoweth did 50 studies in visual quality assessment and examined 1194 different cases by studying quality aesthetic related indexes and features [14]. Bishop with his colleagues did a survey via GIS (Geography Information System), for examining people's interests and their payments for views in high building environments [15]. Sham used an experiment for knowledge extraction using artificial intelligence for perceptional designing of a bridge [16]. Moore & Miles have designed a system on the basis of knowledge toward conceptual designing emphasizing on user. A system which is extracted and proved from some major and independent experts and also potentially users [17] and also harmonic method which is developed along visual and subjective approach [18].

3.3. Housing Quality Indicators (HQI)

The HQI system is a measurement and assessment tool to evaluate housing schemes on the basis of quality rather than just cost. They incorporate the design standards required of affordable housing providers receiving funding through the National Affordable Housing Programme (NAHP) and Affordable Homes Programme[19].

3.4. Feedback System

Von Forester discussed the nature of feedback system [20] on the basis of construction [21], strategic planning, programming, designing or other leading processes which could effective or navigator of the system. Regarding assessment, this can respond to all sections or entire process and also after that of building delivery and as project goals in stating function criterion. Boulanger, S., & Hirt [22] designed an acquired multi-knowledge and multi-source system on the basis of human illustrations through this approach for developing a designer tool of FIBRES. Patterson [23] used artificial variables such as water, forest and farms using GIS in property value assessing for developed areas.

3.5. Building Performance Evaluation

Building performance evaluation (BPE) is an innovative approach to planning, designing, construction and building occupy. This theoretical foundation BPE, in interdisciplinary domains from ICS, is defined as "Human performance control study and mechanical and electronic systems which were designed instead of them and involved using statistical mechanic and is relate to compatible connections engineering" [24].

3.6. The Post-Occupancy Review of Buildings and their Engineering (PROBE)

PROBE is post-occupancy review of buildings which offers helpful assumptions about user's views and an assessment of technical and building energy performance for officer constituents, designers, designing team and final occupants [25].

3.7. Design Quality Index

This index acts as plan quality guideline by offering design quality improvement tool on the basis of research project. Its method is done through feedback and received perception of designing. Three main DQI tools are perceptional framework, data gathering tool and measurement guidelines. This system started to work in 1999 in England, DQI assessment structure has formed on the basis of three intellectual bases of Vitruvius western architectural designing: "proportion, strength, beauty". These three principles in DQI have been translated for today buildings as "function, building quality and effect". In assessing stakeholders through structured and prescribed questionnaire in an educational workshop (for example: have the buildings situated in their context and field appropriately?). Stakeholders describe design features when they respond to questionnaires and their responds are expressed in Likert's scale. Finally, all of stakeholder's responds would be summarized through a graph which is like radar [13, 26, 27].

3.8. Sustainable Assessment Systems

Since two decades ago many local and international groups have been formed for developing and promoting techniques and guidelines for sustainability in buildings. Generally, these systems preoccupation is in the region of energy saving [28, 29]. These system processes aim to match design and building construction methods considering sustainable environmental criteria.

Building assessment systems aim to establish standards for green buildings by evaluating performance against criteria that called elements of these systems. A typical building assessment system is comprised of a checklist of elements, some of which may be optional. Different point values assigned to each element effectively weight them to account for their differing importance and impact on sustainability issues [30]. The judgments about which elements to include in a system and the assignment of point values are subjective, although some elements can be verified objectively, such as by measuring energy consumption rate[31].

4. First Phase: Quality Criterion Determination

4.1. Multi Criteria Decision Making

One of the most important human features is his ability of decision making. When this decision making has special importance and selecting options are related to other parameters, responsibility and obligation in decision

and selection have special approach. Selection process in discrete spaces and one criterion decision making is simple. However, in independent and multi-criteria decision makings we need to use an appropriate method for distinguishing and assessing selection parameters. MCDM is a subject which deals with decision making process in the presence of different and sometimes contradictory criteria [33]. All of the MCDM techniques try to specify how best options can be selected by using specifications information from user's and final consumer's point of view. Different techniques exist in multi-criteria decision makings (MCDM) such as hierarchical method of AHP, network analysis method of ANP, entropy method, LINMAP and utility method of multi-criteria models (MAUT) and etc [34].

4.2. Analytical Hierarchy Process (AHP)

Hierarchical analysis process is a multi-criteria decision making method which can help to take some decisions which are related to different criteria. By AHP firstly decision issue is constructed, different options are compared in decision making on the basis of raised criteria and finally selecting priority of each of them are specified. Overall, this method is used in rating, selecting, assessing and predicting problems while all of them require decision making. AHP method has been considered as one of the most useful and managers and decision makers interesting methods. This method was introduced in 1980 by Mr. Saati [35]. AHP uses two for two comparisons of criteria for reaching to related priority rating among different options [36]. This method has been used in many researches and by known sustainable assessment systems as was shown in section 5.7, while we can use it in expanding comparison criterion in unknown issues [37].

4.3. Analysis Method Using AHP

For this purpose pair comparison matrix was used. All of recognized criteria and factors are stated in two for two comparisons matrix which represents relative index priorities. So, numerical amounts of priorities with relative importance of an index compared with the others should be weighted. Via researches were done by Saati [36], a range was introduced for comparing criteria involved of numerical amounts between one and nine; while "1" means "equal importance" and "9" shows "very much importance" of an index than the other. All of respondents were asked to compare all of eight criteria two for two, and use 1, 3, 5, 7 and 9 for this comparison. These numbers will show relative weight of each application in a matrix. Expert Choice software (version 11) was used for avoiding calculative equations. Finally, following grades were obtained for user's applications"

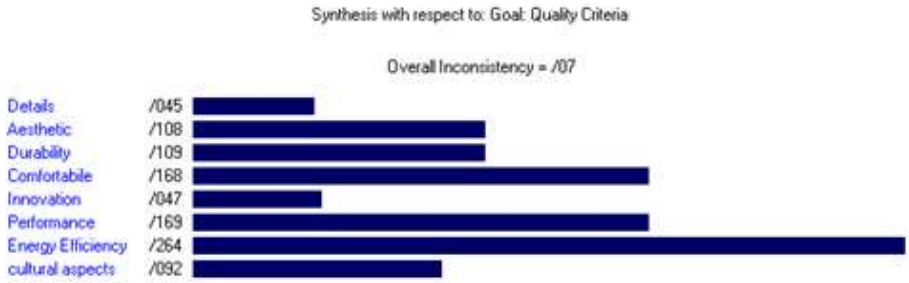

Fig. 2: Result of Quality Criterion rating, AHP Software

5. Second Phase ; Buildings Quality Assessment

5.1. Fuzzy Logic

One of the fundamental concepts in determining and human decision making is acquired and precise perception in connections and relations [38]. Nowadays values and amounts understanding in human decision making are shown by numbers and inaccurate and complicated words such as "approximately" should not be used in these statements. On the other hand, in "user's sound" assessing, as their perceptional language, classic and aboriginal measurements are inefficient within this condition. Simplifying ability of data has an important role in describing sophisticated phenomenon. In human studies, data simplifying ability and using natural human language create some obligations [39]. Fuzzy Logic was introduced for the first time by Asgar Lotfi Zadeh in 1965, which has been used for stating imprecise concepts. So, it can be used for explaining many human related expressions [40]. The most important difference of Fuzzy collections and classic collections is actually, the way of connecting a member with the community. In classic collections a factor can be a member of a community or

not while in Fuzzy collections we can use the membership level [41]. Fuzzy collection eliminates sophistication by destroying strike limit of member division, as changing from membership to non-membership seems gradually rather than being sudden [42]. In traditional logic a thing can be 0 or 1. In Fuzzy Logic, however, each statement can be assumed a value between 0 and 1 and this depends on the level of each member which gains in terms of its attachment.

5.2. Verbal Variables

It seems so difficult to express some phenomenon quantitatively and using qualitative variables in such situations seems necessary [43]. A method which was used by Mon and Chiou would be used in this section for turning subjective variables to Fuzzy numbers as a measurement technique [40, 44]. Verbal quality variables also would be used for assessing of importance levels which were provided in Fuzzy questionnaires. Hence, in each criterion measurement we used quality verbal components as "very good", "good", "appropriate", "weak" and "very weak".

5.3. Making Fuzzy

Since describing subject features by man is inaccurate and qualitative, Fuzzy collection theory offers Fuzzy describers and Fuzzy position, classifying object features can be done by Fuzzy and quality judgments.

Through 120 distributed questionnaires among users, there were overall of 192 complete and valid responds and this represents by 76% contribution. Questionnaire involves of three modern buildings which stood at first stage in national competitions in 2011 and 2012, and a building which belongs to Iran Cultural Heritage Office while it shows life style before entering technology in building industry. Questionnaire has been attached to appendix.

At first respondents designated an importance index on mentioned verbal scale into each building quality factor while was in first phase. While all factors were rated by audiences preferably, it was assumed that an audience in exploring architectural quality in given building had been familiar with its space or similar space and have had presence experience in that space. In making Fuzzy, 1 has been assigned to "very good" and 5 also been assigned to "very weak". In this regard, comparison method has not been used. As, two or more buildings can have same rate simultaneously in given criteria such as "appropriate".

5.4. Rating in Terms of Quality Score

Gathering Fuzzy differences of each building weight than each criterion, yet it cannot be used as rating since, selected criteria have different weights and for specifying final weight we need following equation:

$$\text{Raw Weight} * (1 - \text{criterion weight}) = \text{Final Weight} \quad (1)$$

Which in it Raw Weight is equal to making Fuzzy for each building in each criterion. Criterion Weight also is obtained weights in first research phase for each criterion while is shown in number? Final Weight is measurement criterion and is accepted as quality score.

Gathering responds and making them Fuzzy considering equations, results were obtained as follows:

TABLE III: Gathering responds for Buildings

	Building 1		Building 2		Building 3		Building 4	
	Raw Weight	Final Weight	Raw Weight	Final Weight	Raw Weight	Final Weight	Raw Weight	Final Weight
Details	2/23	2/13	4/59	4/38	2/89	2/76	2/33	2/22
Aesthetic	2/79	2/49	4/57	4/08	3/84	3/43	3/8	3/39
Durability	2/91	2/59	3/73	3/32	3/39	3/02	1/68	1/50
Comfort	2/35	1/96	2/99	2/49	3/86	3/21	3/39	2/82
Innovation	2/79	2/66	3/28	3/13	2/83	2/70	1/4	1/33
Performance	2/9	2/41	4/02	3/34	3/99	3/31	2/63	2/19
Energy Efficiency	4/56	3/36	4/81	3/54	3/78	2/78	1/7	1/25
cultural aspects	1/5	1/36	1/47	1/33	1/52	1/38	4/77	4/33
sum	22/03	**18/95**	29/46	**25/61**	26/1	**22/59**	21/7	**19/03**

6. Results Analysis

Results showed that energy saving is the most important factor in the first phase while is considered in building quality debates. This issue has been approved in assessments in global sustainable assessment systems and has been attended considerably by experts and users. Next stage in this review has been obtained for "performance" and "comfort" commonly. This is while that "aesthetic" criterion comes next. This indicates that user's view into housing has been technical and functional for having a pretty and beautiful building. So, designers and sustainable assessment systems and others should increase their attention toward building ability to accept than human function with life patterns.

In this research a new approach has been offered for introducing architectural quality criterion and building quality determination; building rating possibility also has been possible. In the second phase the situation before entering criteria weights and building ratings on raw weight is as follows:

Building 2, building 3, building 1 and building 4

But The ranking is based on the final weight:

Building 2, building 3, building 4 and building 1

And also in table reviewing? We see that building number four "energy saving" has been situated in the last stage (as the heaviest criterion), but after entering criteria weights of this building it stands at third rate. This result has been obtained when the amount of maximum and minimum differences in criteria weights has been 22% (0.264, - 0.045 and – 0.22). Considering that, this result has been faced with negligible effect of criteria weights.

The highest amount of weighting differences in buildings is related to cultural criterion which stands at first stage in that traditional building. On the other word, today buildings have failed to emerge within native culture. It is worth to notice that traditional buildings have considerable "comfort" than number one and two buildings according to table. Other worth to notice result in this research has been by 76% consumer participation in responding to questionnaires. This point shows user's attention and importance into quality related debates in building and also their trust into research and scientific methods. This amount of participation can be seen as an important investigation for housing decision makers.

7. Conclusion

Buildings use large amounts of energies, hence different groups all through the world are now exist for developing and techniques promotion for achieving to sustainability in building. Studies showed that there has been little attention into building non-physical and conceptual domains. This concept has been defined as "place spirit" by Schultz. In most of the assessment quality systems in the world, there is not any precise and functional criterion for building sustainability assessment and on the other hand, criteria are different on the basis of aboriginal domains. Nowadays architectures are faced with buildings constructing challenges while require social, aesthetic and popular functional and also sustainable environmental obligations. Many efforts were done by architects and researchers have led to production of sustainable low energy architecture. So, sustainability can be considered as a secondary issue of architecture when it accompanies only some parts of architectural paradigms.

Proposed method in this research about hearing "user's sound", determined quality framework using AHP, and regarding that, scored quality in buildings via Fuzzy Logic. Fuzzy systems theory entered some parameters such as knowledge, practice, judgment and human decision into model using Fuzzy Logic theory and Fuzzy measures, and it also showed grey image from the universe in addition to creating flexibility in model.

Management science and Fuzzy planning indexes are as followed:

- Real restriction coefficients and conditions can be shown easily and with flexibility through membership functions while are determined by planners intuitively; these problem solutions can be achieved using mathematics.
- Management systems required knowledge and skills can be obtained from experts through natural language and also we implement management models and programs simply using Fuzzy conclusion.
- Some different answers can be offered to a question instead of an absolute answer or a number. Since upper and lower limits of responds are achievable, more functional solutions can be offered through adding elites, managers and experts views.

For applying real conditions in model, this method would be more accurate and more functional, and it has been approved for being used by managers and decision makers in quality assessment for understanding and eliminating the existing gap between itself and user's willing, as a result. Results can be used by designers for accessing to higher quality standards or achieving to quality determinative criteria and also for reducing the perceptional gap between designer and user; these can also be used by property agents, potential buyers or tenants when they are searching for high quality buildings.

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