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Explain the Role of Transforming the Problem Components on Increasing Creativity in Architecture Deign Competitiveness

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Research Article

Abstract

Knowledge has long been in the field of human knowledge. In the evolutionary history of science, many theories and hypotheses have always been proposed and proven. This category reflects the fundamental changes in the manner of thinking in human knowledge. In the contemporary era, knowledge faces more complex issues. Therefore, achieving growth and production in any field by using new methods based on looking to the future is one of the pillars of human knowledge. In the field of architectural design process studies, the growth and development of creativity, that is, how ideas arise and develop in the mind, is one of the topics. Creative results in the field of architecture can be the result of changing the problem components according to the existing contradictions recognition in the field of architectural design process. Since the design process involves the emergence, evolution, metamorphosis of ideas, and the formation of concepts, one of the topics in the design process is the conceptual transformation. Conceptual tradition by changing the way of thinking, offers creative solutions to improve the way of knowing and solving the optimal problem. The role of conceptual tradition in the development of the architectural design process is by changing the components of the design problem. On the other hand, competitiveness is the basis for the growth and promotion of the field of architectural design. Therefore, achieving a meaningful relationship between conceptual tradition and competitiveness in architectural design, to increase creativity in the field of architectural design is research necessity. The research method has been

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done “deductive reasoning” and using “analytical-descriptive” measures, with a quantitative and qualitative approach. Field studies has been carried out using questionnaire. To validate the data measurement, standard evaluation tools and theories of the Delphi expert community have been cited. Preliminary data extracted from the first stage in eight architectural projects were evaluated through Delphi and related factors were extracted. Finally, using pls software and regression test based on the extracted data, the research hypotheses were proved.

Keywords: Tradition; Problem Components; Competitiveness; Creativity; Architectural Design

1. Introduction

The design process is to change the condition in the current situation. This change includes the emergence of insights, the evolution, transformation of ideas, and development of design concepts. The product of design, in the rationality paradigm, establishes the temporary products of the design process and is considered as the main part of knowledge and the knowledge is embodied in the design products. In knowledge or epistemology, emerging products are independent of design position. Procedural components are design problem-solving components or subsets defined at local scale for conceptual development while implementing conceptual ideas. The contextual components refer to the design problem for conceptualizing the link between steps at macro-scale design process. Creative cognition examines human creativity in relation to the cognitive processes that take place in the brain. This field focuses on the perception of how people think and what leads to a creative idea while thinking. It combines the principles of cognitive science, psychological studies, and brain cognition studies (studies based on imaging technology). In this regard, cognitive design, as a research field, examines the cognitive processes that occur in the brain while designing. There are several models that aim to understand how the architect thinks and designs, and to examine the relationship between the stages of thinking and the evolution of thought. Creativity means reaching unprecedented ideas that has worthiness of functionality and novelty of the product. In the present study, after controlling and coding the data, data was extracted from the questionnaire and interview. Measurement tools have been used for evaluation, standard evaluation and theories of the Delphi expert community have been cited to validate the data measurement. Preliminary data extracted from the first stage were evaluated in seven architectural projects of research through Delphi. Finally, using pls software and regression test based on the extracted data, the research hypotheses were proved.

Research questions

1. What is the influence of improving the position of the methods of changing the problem components on the architectural design competitiveness?

2. Can the design problem transformation increase the competitiveness of the architectural design?

2. Research Method

Scientific research is a process that includes a set of steps and actions that have a systematic connection and relationship. The process of scientific research is a set of regular and continuous steps that makes scientific research possible from beginning to end. Generally, the process of scientific research consists of five continuous stages, selection, analysis and explanation of the research problem, selection, design and description of working methods, data collection,

classification, and analysis and interpretation of data and compilation of results. In the present study, the dimension of the problem was investigated. For this purpose, the literature and research background were studied and the variables were identified. After knowing the nature, dimensions and scope of the problem and the variables involved in the problem, the behavior of the variables was identified. After controlling and coding the data, data were extracted from the questionnaire and interview. The measurement tools have been used for evaluation, and standard evaluation and theories of the Delphi expert community have been cited to validate the data measurement. Preliminary data extracted from the first stage in seven architectural projects qualified for research were evaluated through Delphi and the related factors were extracted. Finally, using pls software and regression test based on the extracted data, the research hypotheses were proved (Fig 1).

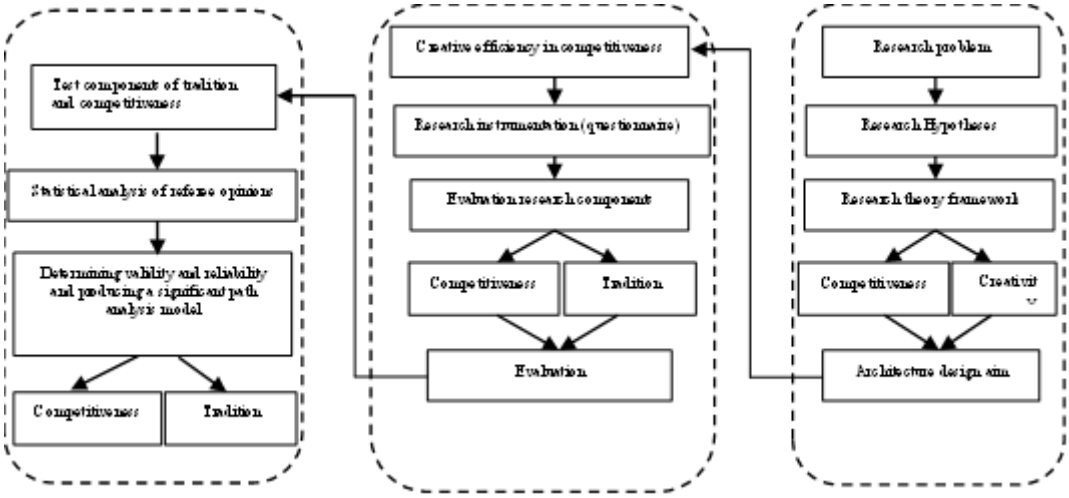


Fig 1 Proposed research method (Source: Authors)

3. Literature Review

To percept the design process many studies have been conducted (Table 2). The researchers for this movement include Christopher Jones, Christopher Alexander, John Lockman in the 1960s, and in the 1970s Horst Rattle and Henry Sanoff. Series of articles by Bruce Archer's in 1963 in Design Magazine presented a new model of designing method. In these articles, he stated that intuition and cognition are combined in the design process, and by structuring this process, it can be expressed scientifically. The processes that drive purposefully generated thought are the most complex cognitive processes that can be studied (Beaty et al., 2016: 85-97). The model that Archer proposes for the design process is needed at different times and for different approaches. In the analysis stage, principled observations and inductive reasoning are needed, and in the creativity stage, subjective and deductive reasoning is needed (Fig 2).

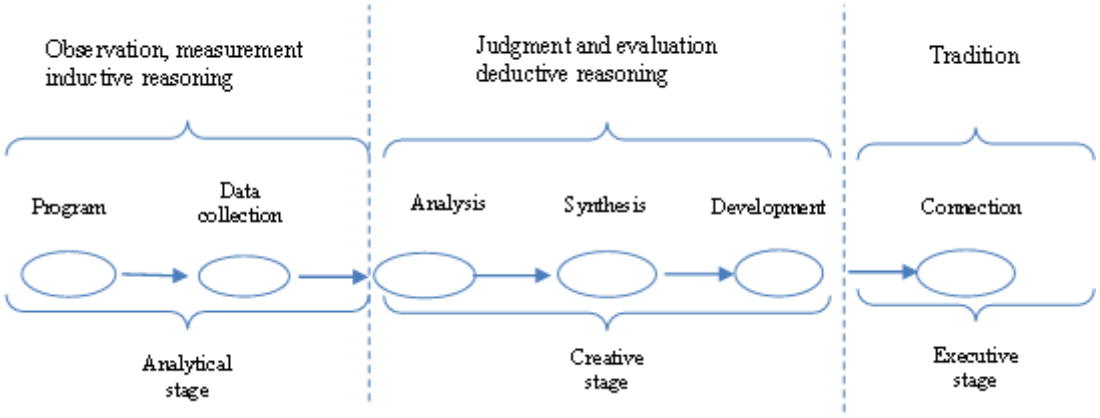


Fig 2 Bruce Acher's proposed chart (Source: El-Khouly, 2015: 34)

In the late 1970s, many articles were written by scholars, including Jeffrey Bradbent and Omer Akin. Scientists from other disciplines have also been involved in helping to better understand design processes. Herbert Simon published a book entitled, "*The Science of Artifacts*", in 1969, and Donal Shon in 1983, with a book entitled, "*The Reflective Specialist*", made a great contribution to understanding education. Brian Lawson, William Mitchell have been influential in better understanding design thinking and the logic of architectural design (Kowaltowski et al., 2010: 453–476). In 1984, Cross created a thematic division of design methods and introduced the main representatives of each field. Thus, the goal of many studies was to "have control over the work process". Design structure problems have always been discussed by Christopher Jones, Peter Levin, Barry Poyner, Melvin Webber, Horst Rittel. In 2002, they reviewed three comprehensive papers on research collaborations, theory, and design operations (Jeamsinkul et al., 2002: 134-155). Goldsmith's convergent and divergent thinking is "divergence of thinking that moves in divergent directions to include different aspects, leading to new ideas and solutions related to creativity, and convergence is a thinking that focuses the data information collection on solving a problem", which is important in the system of thought and design arguments. The processes that target the created thought are the most complex cognitive processes which can be studied (Beaty et al., 2016: 87-95). Geek (1986) combined these and other problem-solving models (Greeno, 1987: 239–270) with a simplified model of the problem-solving process, including the processes creating the problem representation, solution search, implementation, and solution monitoring. Prior to that, Maurice Asimo had come up with a design for the production cycle. This plan starts with the analysis of requirements and then the feasibility studied, and then the initial and complete plan is presented. The next stage is the activities related to production, distribution and consumption. This method is the background of all methods of product development (Julio et al., 2011: 1-18).

LG. March argues that he separated himself from the linear representation of the design process on the assumption that the problem depends on the solution and that inductive-inferential thinking is insufficient to produce a cohesiveness in the design process. March, followed the work of the philosopher Charles S. Pierce to the idea of abductive thinking, which is related to production, while induction and inference are related to research. In other words, "the inference proves that

something must be; induction shows that something is actually practical; and abductive suggests what might be" (Pierce, quoted in Cross, 2008: 3-18). The representation of the March design process is a cyclical model that begins with production (initial conditions and assumptions about the types of solutions to describe the concept of a design), continues with inference (predicts the efficiency of solutions), and experiences induction moments (show changes and corrections in the concept).

Table 1 Studies in architectural design methodology (Source: Authors)

Year	Theories	Description
1933	Devi	Contemplation is as a certain kind of thinking
1966	Jones	Contemplation, combination, analysis
1963	Archer	Evidence and recognition
1964	Alexander	Note on figure composition
1969	Simon	Science of synthetics
1983	Shun	Reflective thinking
1984	Cross	Four fundamental patterns
1986	Gig	Creation process, problem representation, problem solving composition
1990	Goldschmidt	Convergence and divergence thinking
1996	Maher	Parallel thinking between problem and solution
2003	Steinberg	Recognition quality in creative participation

4. Theoretical Foundation

4.1. Defining the Problem and related Approaches

When the current state of a thing is known and also understood by what is the optimal state and goal state of that thing. But there is no understanding of how to go from the current situation to the optimal situation, and here a problem actually arises, in fact solving a problem is part of thinking. Problem solving, which is the most complex part of any thinking operation, and can be defined as an important cognitive approach which requires the integration and mastery of a series of basic and functional skills. The problem-solving process happens when a living entity or system does not know where to go from one situation to another and what path should it take? This is part of the process of a larger problem, in which finding the problem and shaping the problem is part of it (Goldstein and Weil, 1998).

4.2. Creative Thinking

From the cognitive psychology point of view, creative thinking can be considered as a set of tendencies and abilities that lead a person to create new and innovative thoughts, ideas. Creative action requires the emergence of a certain mental ability that depends on the mental processes and the behavioral and personality characteristics of the creative person. Scholars have expressed the aspects of creative thinking including fluency and fluidity, flexibility, originality or novelty, development, analysis, combination of organization, complexity, transformation and change (Seif, 1999: 45; Mirkamali, 1999: 100; Hosseini, 1998: 54).

4.3. Adequate understanding of the Thinking issues in Design

Generally, understanding a subject involves three general aspects. These three aspects include the understanding the subject, what is being understood or the subject itself, and finally the

scientific observation that connects the first two aspects. Regarding architectural design, the issue of design needs to be recognized and understood (Daneshgar Moghadam, 2009: 59). However, in design situations, rarely the problem is clearly defined at the beginning of the work, but many experienced designers have considered the need for a clear problem to be necessary to start creative work (Lawson, 2005: 175). Therefore, starting the design process as a creative or critical work, or in other words, creative problem solving by a designer, requires a sufficient understanding of the design problem, which goes back to the initial stage and preparation in the series of steps explained in the process of creativity and architectural criticism. In fact, creative understanding of the problem is one of the most important capabilities of the designer, which provides the designer with a sufficient understanding of the design problem in order to find the answers with a critical approach. The importance to motivate creative and critical thinking in the process of architectural design is undeniable (Hojjat, 2002: 51).

4.4. Tradition

In the Oxford Encyclopedia, the word "transformation" is the literal meaning of alteration, and in art, transformation means change of a simple form to a more complex form or, conversely, a change from a concrete form to an abstract form. One aspect of changing the components of a problem in order to achieve creativity is tradition. Tradition means change in the space of the problem. In conceptual design, the production of an idea or a range of ideas is developmental and purposeful. The structure of thinking in the design process is how design actions and ideas relate to each other. Design movements (stage, action, creation) of the structural units of design include argumentative movement. The "stages" of design change the position of the design compared to its predecessor (Goldschmidt, 1990: 291-298).

Conceptual tradition as a sub-branch of conceptual change, thinking strategy is to provide a creative interaction of conceptual transformation to develop the architectural design process. The three main approaches to achieving conceptual tradition are to develop, a way of knowing and acting on the findings of thinking (Table 2). In the process of critical movement evolution, sudden mental insight is the stimulus response that occurs suddenly in the brain after an idea is ignited. This leads to the discovery of amazing phenomena in knowledge. There is a lot of debate about what constitutes sudden mental insight. One of the arguments put forward is the emergence of sudden insights, a process of transformation in which creative insights are the result of rethinking (Weisberg and Alba, 1981: 169-192).

Table 2 Conceptual tradition main factors (Source: Authors)

4.5. Sydney Opera House Competition

Generally, to select the study sample, two steps were considered in the selection stage: one is evaluating and judging the work with the designer's cognitive model (critical thinking) and the other is evaluating and judging the designer's idea using the judges' cognitive model, which is usually critical. And if it has both aspects among the valuable world works, a work was randomly selected and the competition process from call to delivery and feedback was analyzed in the international community.

The Sydney Opera House architecture competition was selected as a sample study. Because the selected work of the competition, according to the international community, is considered an innovative and creative work which has been accepted in the critique and evaluation stage. Since the design problem defined in the design submitted by Atzen, for this purpose, it was researched again to be compared with the other two designs submitted to the competition. The following factors such as problem solving how to construct and justify the curved roof shells designed by the designer, process of convergence to the problem space and solution space in the design has led to the selection of this universal work. According to studies conducted in the design process, the research competition leads to the research issue. Competition documents such as the call in the brown book and the top design documents in the red and yellow books are also available, as well as the second and third place design documents are available. The Sydney Opera House was completed in 1973, and in 2007 was registered on the World Heritage List as the most valuable architecture of the Twentieth century, along with numerous paths for creativity and innovation in architecture and structural design. This is the design result by Joran Atzen, an unknown Danish architect, completed in 1956. The building has a significant impact on modern architecture and is known as one of the earliest examples of important buildings. According to the Sydney Opera House website, in a book entitled "The Brown Book", the terms and conditions of the Sydney Opera House International Design Competition were announced. This program includes: terms of competition, black-and-white photographs of the site, a summary of the relevant rules to be considered, site description, site conditions, building requirements, and schedule for submitting documents and holding the jury session (Bruke, Macdonald, 2014: 31). The book was published in 1955 by Dr. A. H. Pettifer in Sydney. In general, the organizers of the Sydney Opera House were pursuing specific goals. For example, the Sydney Opera House is a landmark for cultural activities which influence growth and change of culture in Australia and even internationally. One of the highlights of its construction has been the unexpected and an artistic and imaginative theme. In general, these multiple goals can be named (Murray, 2003: XI-30).

1. Build a strategic building for development and promotion, 2. World-class performance art, 3. Providing cultural services in a building worth the audience, 4. Creating multipurpose spaces that can simultaneously covers a wider range of visitors, 5. Creating an effective and innovative building, 6. Creating a cultural feature and symbol in the world, 7. Creating economic prosperity and optimizing Sydney's economy.

According to the Sydney Opera House website, 200 design works were submitted in this global competition, and in the end, Joren Atzen was able to win the first place. The Philadelphia team were second and Paul Boycevan and Barbara Osmund were third. The top three entries are given in (Table 3). In (Table 4) shows the process of competition and making of the first ranked design work.

Table 3 Sydney Opera House Design Competition (Source: Authors)

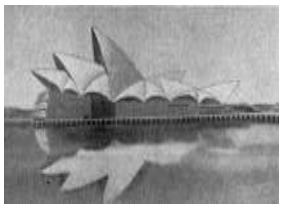
Documents	Rank	Winner
	1	Joren Atzen
	2	Leon Loshter, George Quals, Walter Weissman and Robert Gods
	3	Paul Boycevan and Barbara Osmund

Table 4 Important dates for the competition, judging, design and construction of the Sydney Opera House (Source: Authors Quoted (Murray, 2003: XI))

1957	Announcement of the final result of the competition and Atzen's migration to Sydney
1958	Compilation of the red book includes executive plans by Atzen. Start of project and scheduled in three phases, platform execution, execution of roof shell and interior walls.
1961	Problem solution of how to build and justify curved roof shells
1962	Compilation of the Yellow Book
1965	Establish project financial management constraints for Atzen
1966	Atzen moves out of the project and is replaced by Hall.
1973	Opening of the Opera House
1978	Atzen receives the Gold Medal of British Architects from the Royal Institute.
2003	Atzen receives the Nobel Prize in Pritzker Architecture.

5. Research Findings

5.1. Analysis of Descriptive Characteristics

The three selected works in the Sydney Opera House competition were analyzed and descriptively evaluated based on the factors extracted from Delphi research and conceptual tradition. Seven factors of conceptual tradition (Integrating the outcome of values, creating a methodological integrity, processing framework, classifying organizational activities, adapting constraints, integrating), based on expert opinion result and the six cognitive skills are analyzed as described in Table 7. Based on the questionnaire, the questions were assessed and the results

indicate the significance of the components extracted from the research. In (Table 5), descriptive indicators for the main dimension of structured integrative and adaptable are presented as the main criteria in conceptual tradition and in (Fig 3) the average data are expressed in seven sub-criteria of conceptual tradition.

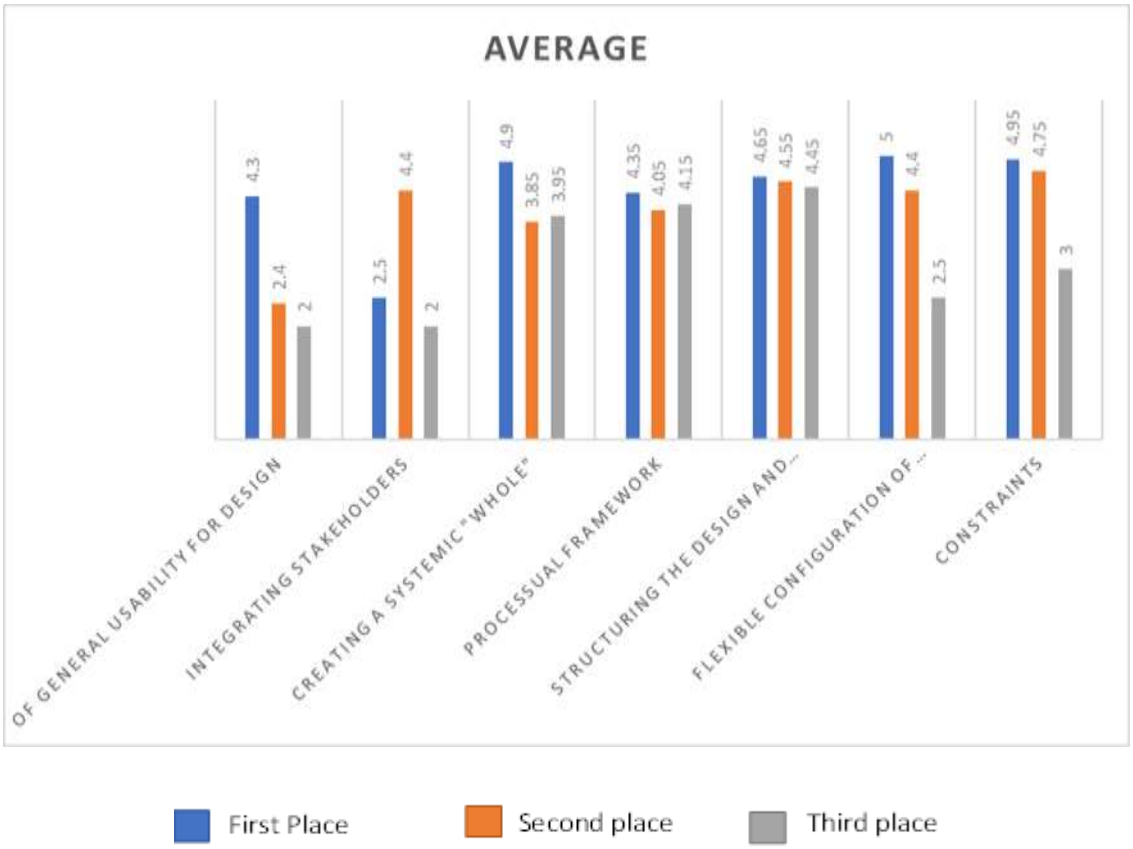


Fig 3 Average data in seven sub-criteria of conceptual tradition (Source: Authors)

Table 5 Descriptive indicators for the main dimensions of structured integrative and adaptable (Source: Authors)

		Min	Max	Mean		Standard Deviation	Variance	Skewness		Tension	
		Statistic	Statistic	Statistic	Error Coefficient	Statistic	Statistic	Statistic	Error Coefficient	Statistic	Error Coefficient
Integrity	**1st rank**	**2.67**	**5.00**	**4.8333**	**.11970**	**.53530**	**.287**	**-3.897**	**.512**	**15.916**	**.992**
	2nd rank	**2.00**	**4.67**	**3.7000**	**.18716**	**.83701**	**.701**	**-1.366**	**.512**	**.554**	**.992**
	3rd rank	**1.33**	**4.67**	**3.2500**	**.21882**	**.97857**	**.958**	**-.185**	**.512**	**-.540**	**.992**
Structural	**1st rank**	**3.00**	**5.00**	**4.5000**	**.16623**	**.74339**	**.553**	**-1.174**	**.512**	**-.257**	**.992**
	2nd rank	**2.50**	**5.00**	**4.3000**	**.20326**	**.90902**	**.826**	**-1.025**	**.512**	**-.414**	**.992**
	3rd rank	**2.50**	**5.00**	**4.3000**	**.19668**	**.87959**	**.774**	**-.990**	**.512**	**-.269**	**.992**

Adaptability	**1st rank**	**4.50**	**5.00**	**4.9750**	**.02500**	**.11180**	**.013**	**-4.472**	**.512**	**20.000**	**.992**
	2nd rank	**3.50**	**5.00**	**4.5750**	**.11627**	**.51999**	**.270**	**-.952**	**.512**	**-.254**	**.992**
	3rd rank	**1.00**	**4.00**	**2.7500**	**.26532**	**1.18655**	**1.408**	**-.407**	**.512**	**-1.480**	**.992**

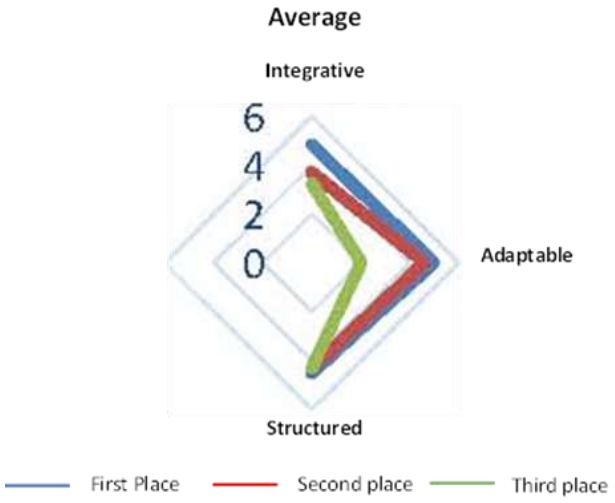


Fig 4 Average of integration, adaptability and structure from the first to third ranking (Source: Authors)

5.2. Investigating the Correlation between Research Components

a. Investigate the Relationship between Structured, Integrative and Adaptability

According to the result of Spearman correlation test, there is a significant relationship between the two variables of adaptability and integration with the rate of increase of adaptability by one unit, the rate of integration by 57.8 and with the increase of adaptability by one unit, the rate of structurally increases by 57.2 percentage. There is a significant relationship between the two variables of structured and integration, with the structural rate of increase by one unit, the rate of integration increases by 52.1 percent (Table 6).

Table 6 Indices of correlation between structured, integration and adaptability (Source: Authors)

Correlation test					
Structure	Integration	Adaptability			
0.572	0.578	1.000	Correlation coefficient Gi	Adaptability	Spearman Correlation test
0.008	0.008	0	Significant level		
20	20	20	Total		
0.521	1.000	0.578	Correlation coefficient Gi	Integration	
0.018	0	0.008	Significant level		
20	20	20	Total		
0.572	0.521	1.000	Correlation coefficient Gi	Structured	
0.008	0.018	0	Significant level		
20	20	20	Total		

b. Investigating the Relationship between Competitiveness and Structured

According to the test result, if the significance level is less than 0.05, it is concluded that there is a significant relationship between the two variables. As structured increases by one unit, competitiveness increases by 72.9 percent (Table 7).

Table 7 Investigating the relationship between competitiveness and structured (Source: Authors)

Competitiveness	**Correlation relationship**	
0.729	Correlation coefficient	Structured
0.000	Significance level	
20	Number	

c. Investigate the Relationship between Competitiveness and Integration

According to the Table 9, it is clear that if the rate of integration increases by one unit, the rate of competitiveness increases by 44.7 percent (Table 8).

Table 8 Investigating the relationship between competitiveness and integration (Source: Authors)

Competitiveness	**Correlation relationship**	
0.447	Correlation coefficient	Integration
0.048	Significance level	
20	Number	

d. Investigate the Relationship between Competitiveness and Adaptability

Spearman correlation test was used to verify this relationship. The correlation intensity of this relationship is equal to 78.5 percent with positivity. In other words, with the rate of increase of adaptability by one unit, the rate of competitiveness increases by 78.5 percent (Table 9).

Table 9 Investigating the relationship between competitiveness and adaptability (Source: Authors)

Competitiveness	**Correlation relationship**	
0.785	Correlation coefficient	Adaptability
0.000	Significance level	
20	Number	

According to the analysis performed between the three research components, there is a correlation of integration, adaptability and structured. On the other hand, there is a competitiveness correlation between each of the components, which is meaningful which proofs the research hypothesis.

5.3. Model Fit

To examine the fit of the model in partial least squares, the global quality criteria has been used which is proposed by Amato et al. in 2004.

$$GOF = \sqrt{\overline{communality} \times \overline{R^2}}$$

$\overline{communality}$ is the average of each variable and measures the model external quality. $\overline{R^2}$ is the mean of the coefficients of determination related to each endogenous latent variable and measures the internal quality of the model and has been calculated for each endogenous variable

according to the latent variables that explains it. Three values of 0.01, 0.25 and 0.36 have been introduced as weak, medium and strong values for GoF (Wetzels, 2009).

Table 10 Calculation of internal model fit

Variable	**Communality**	**R2**	**Average Variance Extracted (AVE)**
Competitiveness	0.687	0.612	0.543
Increase creativity	0.641	0.179	0.657
Tradition	0.609		0.629
Fit goodness index	GoF = 0.54		

Convergent correlation: indicates the relationship of criteria or different references to each other. In fact, if the correlation between the scores of the tests that measure unit attribute is high, the test has convergent correlation. In this research, the mean values of the extracted variance (AVE) for all structures it is higher than 0.5, i.e., the items explain more than 50% of the variance of their respective structures, it indicates the existence of convergent correlation in the tests used (Table 10).

According to the value of the goodness index, the fit is equal to 0.54, which indicates a high average fit for the structural model. That is, the internal model has enough power to test the hypotheses and the test results can be considered 100% statistically reliable. Also, the R2 criteria or coefficient of determination indicates the effect that exogenous variables with endogenous variable. This criterion is calculated only for endogenous structures and its value is zero for exogenous structures. The higher the coefficient of determination of a model, the better is the model fit. Three values of 0.19, 0.33 and 0.67 have been introduced as criteria for weak, medium and strong values.

6. Conclusion

The hypothesis of the research is to develop the design method in a quantitative and qualitative analytical framework which aims to describe and obtaining the structure of the process occurred in the design methodology. It is also a study that aims to interpret how innovative concepts are formed using procedural and contextual components in the development of creative ideas and mental insights through cognition. The reshaping of events in the solution space versus the recognition of the design problem indicates the role of creative insight in the process of reasoning to achieve creativity. Considering the main hypothesis of the research, which examines the effect of conceptual tradition on the competitiveness of architectural design, it shows that the tradition of design is effective in increasing the creativity in architectural community. In fact, the tradition of the design problem in the convergence space of the problem, increases the number of innovative solutions. The relationship between the two categories in the design process has been thought to be effective for the emergence of innovative methods, which includes the use of emerging and innovative ideas, creative solutions by designers, promotion, planning to create new ideas, the above mentioned is to make architectural designs competitive. Since the conceptual tradition has mentioned the strategy of thinking to provide a creative interaction of conceptual evolution for the development of the architectural design process, therefore, the Sydney Opera House architectural competition process was evaluated. In this research we can refer to these results;

1-The results of statistical data analyze extracted from the sample study indicate that the high average of all criteria in the first place has caused the competitiveness of the design. The average of descriptive indicators shows, the research variables are significant and increasing the descriptive

indicators in the three criteria of conceptual tradition has been effective in increasing the creativity of the architectural design.

2- "Systematic model" is very similar to the analytical method due to the central role of research. In this model, the idea is a means to convey design problems, the design method tends to be formulated: problems are identifiable, standard solutions are used, and problems are re-analyzed. This approach looks at the design from the perspective of the problem-solving process. Therefore, the model was extracted using path analysis model software. Descriptive indicators derived from the research process is based on the Spearman correlation test and has shown that there is a correlation between conceptual tradition in the design process and competitiveness. This correlation can promote creativity in the field of architecture.

3- The proposed model shows the relationships between the mentioned topics (Fig 5).

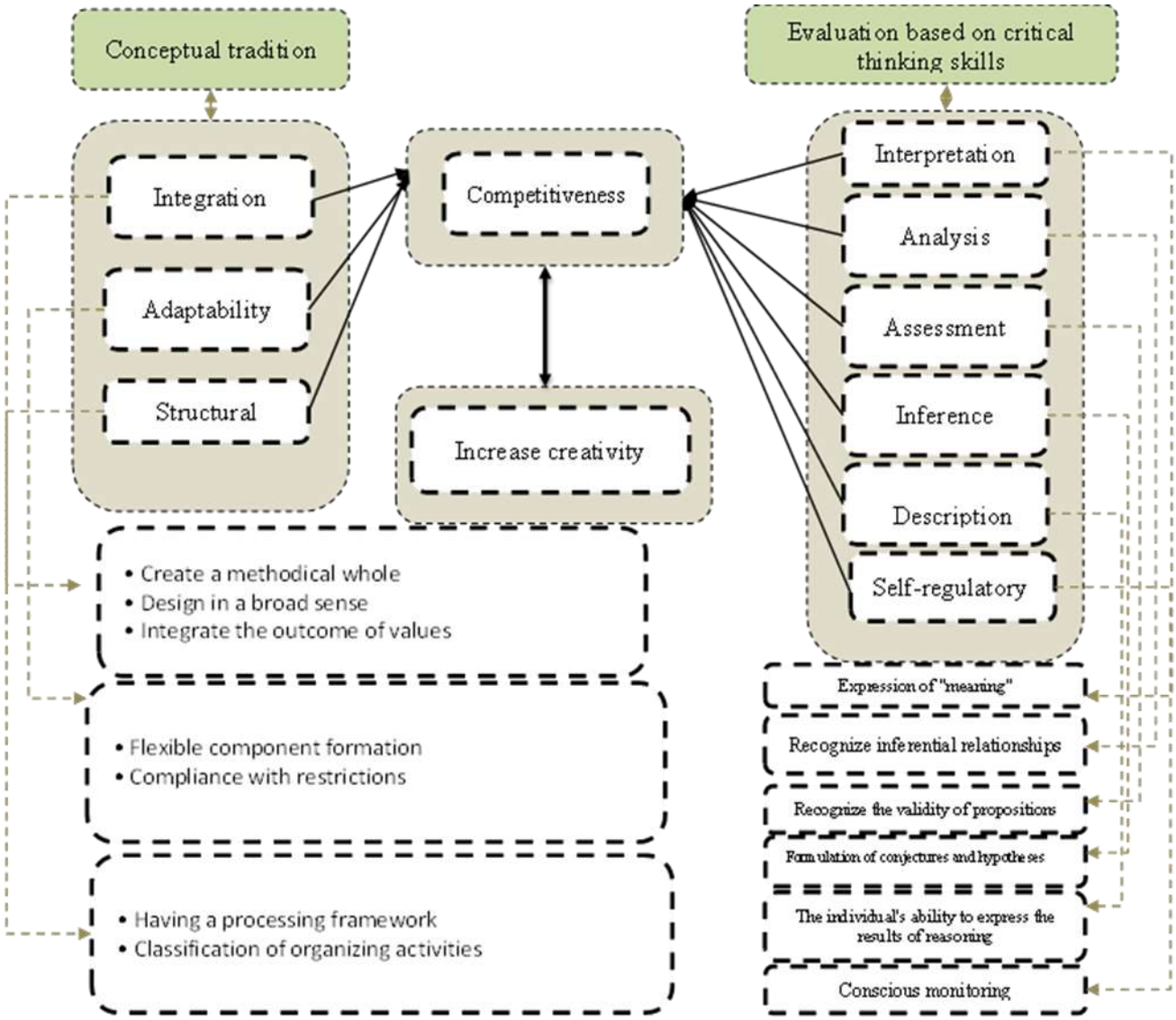


Fig 5 Proposed model

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