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In the Name of God

Dear Readers,

I, on behalf of the editorial board, am proud to present this issue of the *International Journal of Applied Arts Studies (IJAPAS)* under the sponsorship of the Islamic Azad University, Yazd Branch. We were driven to found the *IJAPAS* by a noticeable lack of journals, in the Islamic Republic of Iran in particular, devoted to architecture, urban design, urban planning, architectural conservation and restoration, painting, art history, graphic, digital arts, fashion design, performing art, industrial design, aesthetics and semantics. Although the academic world is increasingly driven by cross-disciplinary visions and models, we seek multi-disciplinary views, an attempt to inform researchers, graduate students, and professionals about the trends, ideas and innovations being put forward in applied arts. To this end, in addition to standard articles, in every volume of the *IJAPAS* we hope to provide a special issue related to a respective field with innovation.

We are also sending out a call for papers related to *Applied Arts* to appear in the next issue of *IJAPAS* in Nov – Dec 2021.

Finally, I should mention that we are committed to a speedy refereeing process for every article submitted to us. We effort to reply to all papers submitted within five weeks' time with a response about acceptance or rejection. We also do not require formatting for submissions in our style until *after* the paper has been accepted by us for publication.

I would like to thank our Editorial Board for their work so far in helping to establish the *IJAPAS*. And, finally, I would like to extend my deepest gratitude to Dr. Ali Boloor, the assistant editor of the *IJAPAS*, for all of his hard work to ensure the timely completion of the issue.

I am delighted to invite you to visit us at www.ijapas.org.

Sincerely,

Dr. Abolfazl Davodi Roknabadi
Editor-in-Chief
International Journal of Applied Arts Studies (IJAPAS)
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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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This article is taken from the dissertation of Dr. Neda Asadi Jafari entitled "Explaining the role of changing the components of the problem on the competitiveness of the architectural design" under the guidance of Dr. Iraj Etesam and advisor Dr. Farah Habib in the Faculty of Architecture, Islamic Azad University, South Tehran Branch.

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).

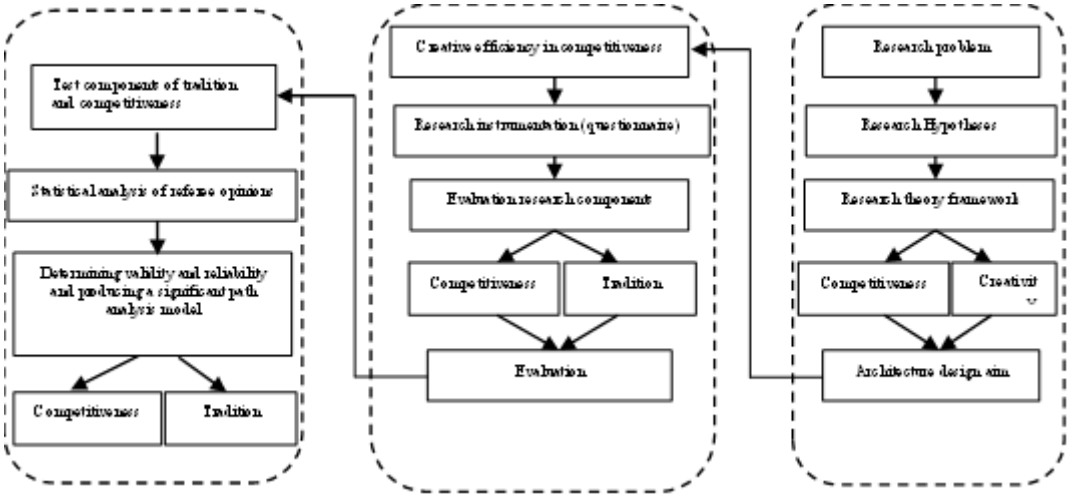


Fig 1 Proposed research method (Source: Authors)

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).

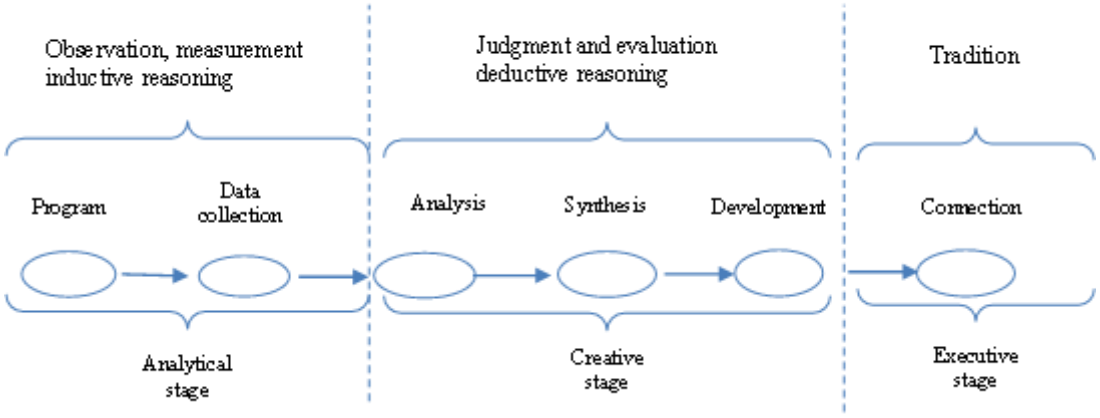


Fig 2 Bruce Acher's proposed chart (Source: El-Khouly, 2015: 34)

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)

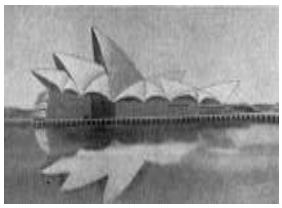
Documents	Rank	Winner
	1	Joren Atzen
	2	Leon Loshter, George Quals, Walter Weissman and Robert Gods
	3	Paul Boycevan and Barbara Osmund

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.

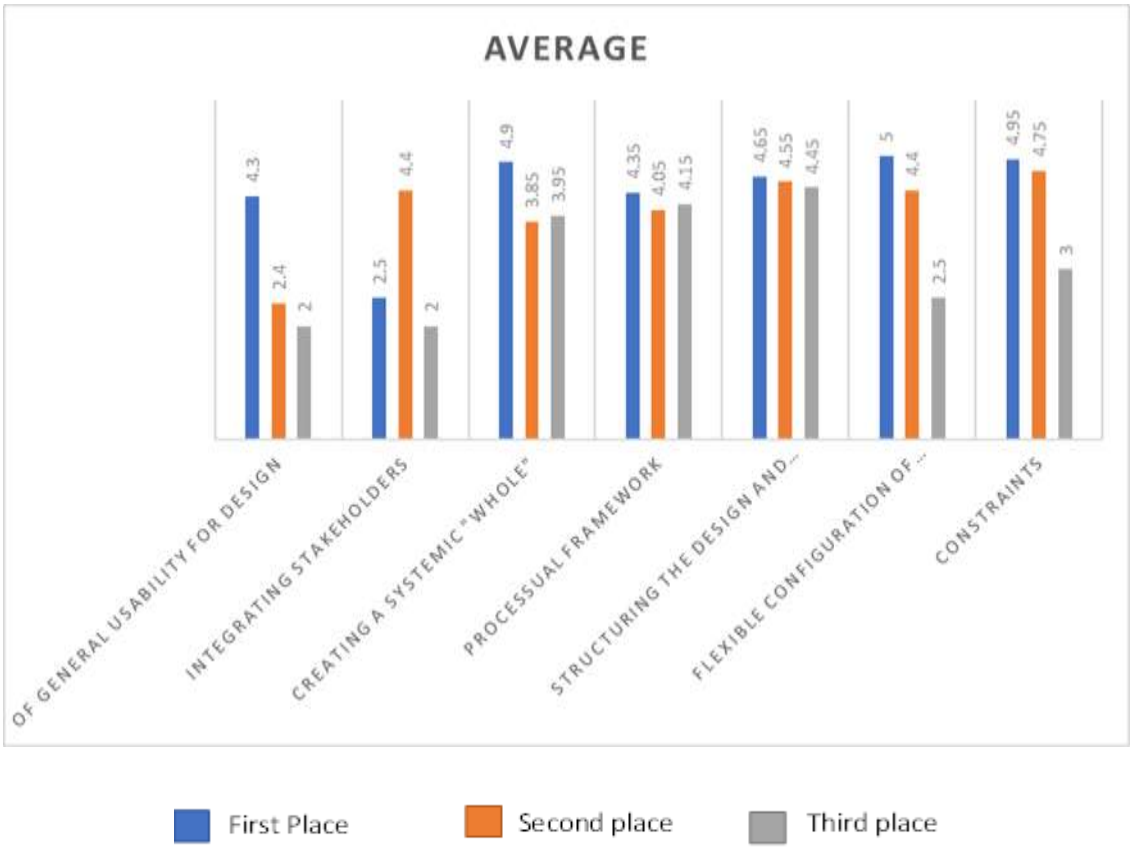


Fig 3 Average data in seven sub-criteria of conceptual tradition (Source: Authors)

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**

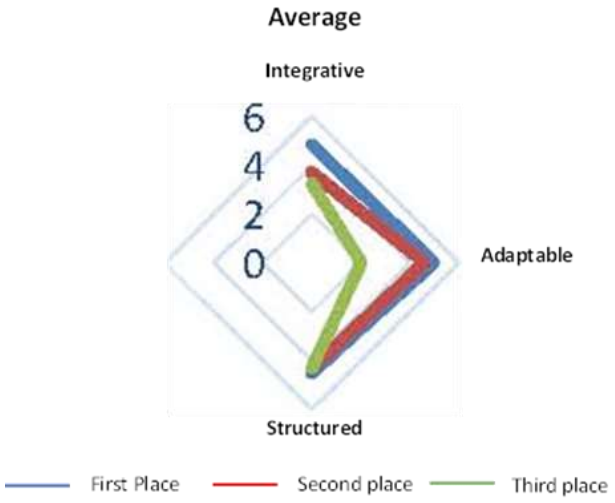


Fig 4 Average of integration, adaptability and structure from the first to third ranking (Source: Authors)

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).

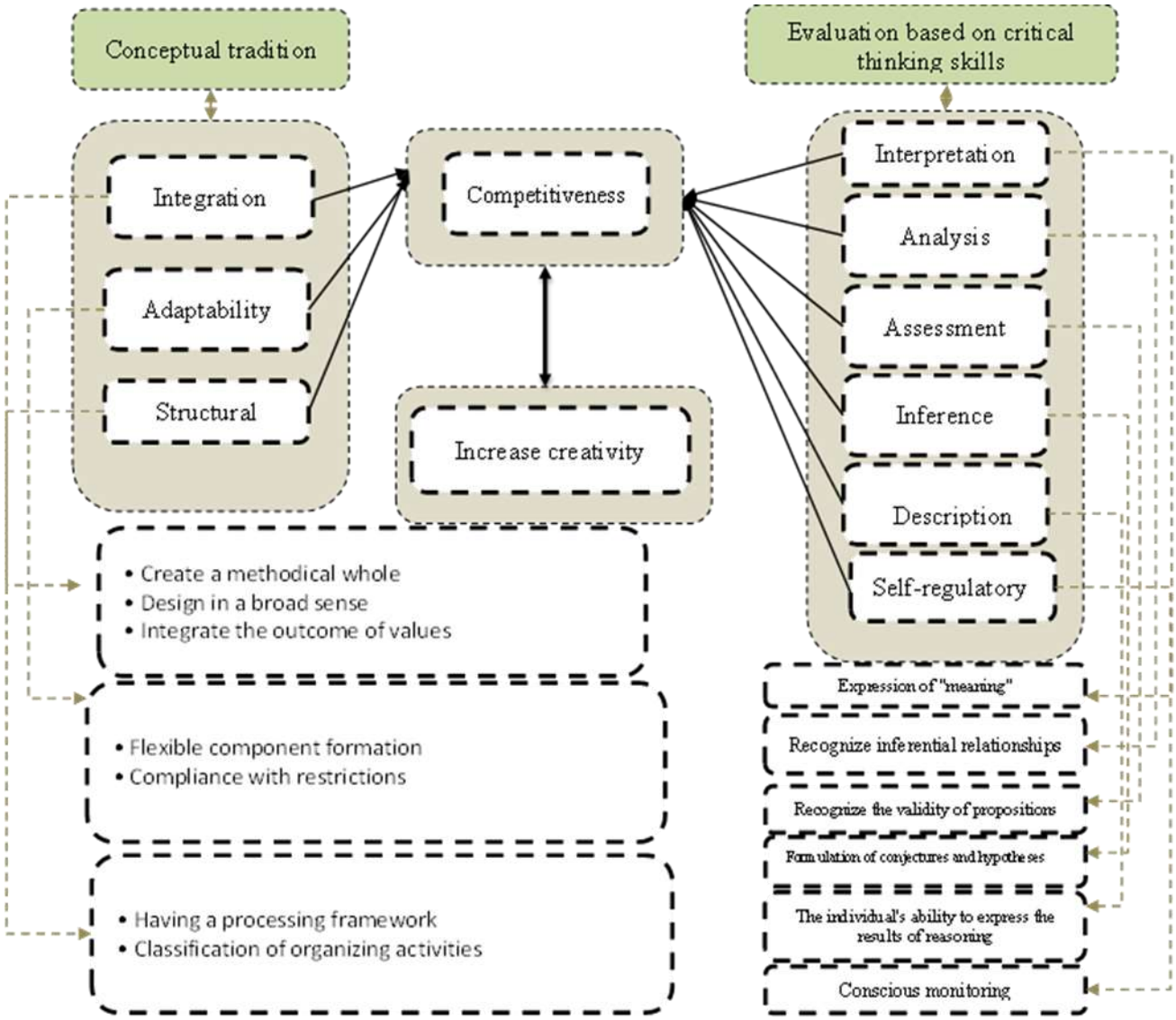


Fig 5 Proposed model

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A Reading on Kalpuregan Pottery Using Petrography

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Research Article

Abstract

The lifespan of Kalpuregan's pottery goes back to 3,000 BC and is probably one of the few areas in the country where the same traditional methods of designing and making pottery are done there now. Recognition of indigenous phenomena is possible by understanding human activities in the environment around them. Laboratory studies for analyzing pre-historic pottery in Iran will give us a better understanding of the production and distribution process. In the meantime, pottery items in Kalpuregan come from technology and firing clay. Clay is abundantly found on the surface of the earth. So far, no reports have been published on the recognition of elements that form containers or potteries in the Kalpuregan, district of Saravan. Most of researches have been done on the motifs and ways of making this pottery. The aim of this study was to identify Kalpuregan pottery using petrographic test. The results showed that Kalpuregan soil is secondary clay. These types of clays include various types such as ballclay, stoneware, red clays, marl, bentonite and refractory clay. The components of pottery comprise the following three major categories: clays, fillers, and fluxes. Clay has other elements such as titanium oxide, potassium oxide, sodium oxide, magnesium oxide, iron oxide and calcium oxide, the percentage of which is different depending on the type of soil. In the process of research, after the petrographic examination, it was found that most of the elements of the clay for pottery in Kalpuregan are Quartz minerals, which are seen as phenocryst and polycrystalline. This type of mineral makes up 20% of the sample volume. In the course of research on the type of fire in Kalpuregan pottery kilns, it was found that the color change of pottery after firing is due to the temperature conditions of pottery kilns in this area.

Keywords: Pottery; Kalpuregan; Saravan; Petrography; Structural Analysis; Instrumental Analysis

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1. Introduction

Potteries are derived from technology and firing clay. Clay is abundantly found on the surface of the earth. This soil is the result of thousands of years of severe erosion of igneous rock and metamorphic rock like granite that abound in the earth's crust. The simplest way to classify soils is to classify them based on their origin, so there are two types of clay. One of the primary clays deposited alongside the parent rocks and remained in its place of origin. These soils have no chance of mixing with other minerals and are pure. The origin of these clays is rocks that have been eroded by contact with surface water, steam, and various gases. This type of soil is found as irregular veins in the rocks that its erosion caused the soil. Other types are secondary clay or sedimentary soils that have been transferred to other environments after decomposition from the main rocks. Secondary clays are much more abundant than primary clays. Type II clays may include iron, quartz, and other impurities. Organic matters are found in type II clays (Basiri, 1363, 23). Understanding 'what substances and minerals were used in making pre-historic pottery and what are the physical and chemical properties of these substances?' leads to an understanding of more complex and useful aspects of prehistoric cultures. For this information, thin sections of pottery can be used in petrographic tests. Petrography is the science in which thin sections of rocks and minerals are studied under an optical microscope. Using thin sections, the stones can be better understood and light, type, texture, grading, and other properties can be found. This technique is the most common scientific method in geological studies (Zare, 2004: 97). It is also widely used in archeology in which it is used to determine the origin of pottery, to examine the minerals in each pottery, and to determine its degree of firing. History of Microscopic studies of pottery thin sections of pottery goes back to the pioneering work of Anna Shepard, who aims to study the microscopic structure of pottery samples using polarizing microscope in four components: clay, adhesives (minerals, rock components and pottery fragments), organic materials and empty spaces. Microscopic study of texture of pottery samples can help 1) determining geological types for clay supply and their changes over time; 2) The nature of the adhesives to the pottery, examining their changes in location and time and their relationship to the technology used to produce the pottery, 3) Identification of local and imported pottery as well as identification and origin of recycled pottery which is added to the modeling clay as adhesives, 4) examining the patterns of behavior. Metallic minerals used to produce glaze in pottery can also be identified by using polished thin-section and reflective polarizing microscope (Amini et al., 2013: 100). Pottery in the village of Kalpuregan has features that distinguish it from other potteries in Iran; one of these features is the color of soils, which they are greenish gray in the Kalpuregan area prior to firing but after firing, they become red in kilns (Nazari et al., 2014: 45).

2. Instruments and Method

The purest type of clay is called kaolin or kaolinite, which is hydrated aluminum silicate. Kaolinite has a regular crystal structure consisting of relatively large (one micron) hexagonal crystals. Clay has other elements such as titanium oxide, potassium oxide, sodium oxide, magnesium oxide, iron oxide, and calcium oxide, the percentages of which are different depending on the type of soil. Chinese or kaolin soil is the most important primary clay type, which has coarse grains and less plasticity in comparison to secondary clays. The most important feature of kaolin soil is its high purity, which makes it white after firing and if it is highly purified, it has a high refractive index (about 1750 degrees Celsius). Secondary clays are displaced by water, wind, or glacier and exposed to severe erosion; their particles are shattering and accumulating elsewhere.

Secondary clays include various types such as ballclay, stoneware, red clays, marl, bentonite and refractory clay. The components of potteries contain three major categories: clays, fillers, and fluxes. What distinguishes clay from other minerals is its extremely small size of particle and chemical ability to absorb water. When the clay is completely wet, each particle of soil is covered with a layer of water. Due to the flatness of the particles, the water gives them the ability to stick together and slip on each other under pressure, which is why the collection of these particles has the properties of ductility and flexibility. The flexibility of the clay depends on the amount of water in it. If the water evaporates, the mud will quickly harden so that it can no longer get a form, because water forms a large volume of mud. As water evaporates, the volume of mud decreases. Depending on the soil type and particle size, the volumetric contraction will range from 5% to 7%. Fillers are designed to prevent body deformation during firing, to provide proper thermal expansion, to control the contraction of wet to dry and dry to firing, and also create a frame-work role in the mud, allowing us to make delicate containers. They have used sand, shell powders, pottery powder (chamotte), straw, chopped vegetables and animal hair such as goats as fillers (Haddadi, 2008: 3).

Fluxes are substances that are added to raw materials to reduce the melting point of the body or glaze. The mechanism of this action is that when the body or glaze is firing, the fluxes melts and forms a glass phase during cooling and in fact creates a solid mass. Potassium oxides, sodium, magnesium, calcium are the most important fluxes. One of the most important steps in making pottery is preparing raw materials and preparing mud with the necessary features. To do this, they pour the clay with water into a pond where its impurities and coarse particles precipitate, and then the slurry in this pond containing clay particles is transferred to another pond. Where small clay particles are deposited and their excess water evaporates over time and the mud reaches the desired stiffness. They are then kneaded and the needed fluxes and lava fillers are added. Once you have the mud with the necessary features, it is the mud-forming stage that is done by hand (in the form of a tubular, a finger, a board or a sheet) or with a pottery wheel. After the process of mud formation, drying and polishing the pottery is one of the most important stages of pottery making. At this stage, before entering the product into the kiln and firing, the water in the body must be removed, either by locating it in natural air which is very time consuming or in a dryer. The pottery firing process is a general one and all the pottery products must be fired at least once, but the glazed products go into the kiln twice. The firing stage includes all that happens from the moment the raw pottery is put in the oven to the extracted fired pottery. It also includes the duration of the kiln cooling down, temperature changes, pottery status, and any climate change that occurs in the kiln. The color of the pottery, its degree of hardness and porosity all depend on the temperature of the kiln, the type of aeration, and the process of cooling the glaze after firing. Sudden changes in temperature lead to high water vapor and the breaking of the item. At room temperature to 120 ° C, the water in the pottery evaporates. When the temperature reaches 200 degrees Celsius, all of its water must be drained. Natural organic matter in the soil is also on the verge of decay. The water contained in the chemical structure of the material molecule is also released from the pottery between 400 and 600 degrees Celsius. At this stage, the temperature rise should be gradual (100 ° C / hr) so that the sudden increase in water vapor does not damage the item (Haddadi, 2008: 4). From 500 ° C onwards, dehydration will be complete. At this stage, the soil becomes ceramic in an irreversible reaction and will no longer dissolve in the water and the water will not penetrate in it. Theoretically, the dry particles of pottery have little contact points with each other and are joined by a method called sintering. At temperatures between 700 and 900 ° C, carbon and sulfur in the pottery soil were removed by the production of the corresponding oxide gas, dioxide and trioxide (Ibid, 2008: 4).

The origin of these gases is carbonate and sulfate impurities as well as carbon residues of organic matter that are not broken down at low temperatures. Each time the pottery is warmed and cooled; a reversible change occurs at 573 ° C. At this point the Quartz within the pottery is altered. This change occurs when the molecules are incorporated into the material's crystal, causing a slight (2%) increase or decrease in volume. Between 600 and 800°C, calcium carbonate is converted to calcium oxide, and till this stage, all the iron in the pottery has been converted to red water-free iron oxide. The pottery at this stage will be red and porous. Full firing will take place between 950 and 1100 degrees Celsius depending on the soil type and resistance, but starting point is at 800°C. At this temperature, the fluxes and free silica are gradually melted in the pottery. At 950°C, Spenils begin to form. They are short-lived and absorb at 1000°C in a glass-like structure.

At 1000°C, mullite (aluminosilicate), such as microscopic needle-like crystals, dissociates into a glass-like environment and merged and strengthens the ceramic structure. At 1100°C the pottery contracts substantially while the primary pores are closed and the clay firing is completed, so that when the temperature reaches 1250°C, there will be no open pores in the pottery and the pottery will be stony at the stage of completion of the firing. At 1300°C, the expanse of mullite stop and at 1400°C no pores remain. Until now, only pottery was examined in the presence of oxygen in the kiln. If oxygen levels decrease, two important factors come into play, first, the kiln fuel may not completely burn and the kiln environment will be covered by smoke, and this smoke will sit on the surfaces inside the kiln like soot. In addition, organic matters in the soil composition due to lack of oxygen may not be completely burned, resulting in remaining carbon or the so-called Black core in the pottery building. Another important phenomenon caused by the lack of oxygen is the revival (chemical reduction) of some of the materials in the pottery. For example, red iron oxide may be converted to black iron oxide until a pottery that was originally red is now completely black (Haddadi, 2008: 4).

3. Research Process

Thin section petrography is a method for studying and classifying clay structures. This method is used in the study of a wide range of materials, including rocks, minerals, pottery, concrete, and brick, plastering (mixture of lime or gypsum). The information obtained from petrography gives insight into some important aspects of pottery studies, including the origin and technique of production. The thin section was made by cutting a small piece of the studied sample, then glued to the flat surface of the glass microscope blade(slide) and its surface polished to a standard thickness (25-30 mm). Finally, the prepared sections are studied by using the polarizing microscope. At standard thickness, the minerals components in the pottery texture which are appeared with different color spectra are identified based on specific optical properties.

The petrographic experiment was carried out here on the object obtained from the Kalpuregan Pottery (Sarvan District) at the Tehran Institute of Cultural Heritage and Tourism on 21/12/97. The test report is as follows (Author).

Fig 1 Smoothing the sample surface (Petrolap device) (Source: Authors)

Fig 2 Preparing Slide (Source: Authors)

Fig 3 Polarizing Microscope (Source: Authors)

Table 1 Kalpuregan's Pottery Building (Source: Authors)

Row	XPL Light Color	Elements of Kalpuregan Pottery
1	White	Quartz (phenocryst and polycrystalline)
2	Red	Iron oxide mineral
3	Black and white like the stars of sky at night	Chert Stone
4	Dark colors like red	Grog
5	Grayscale	Plagioclase
6	Biotite minerals (red, brown) and muscovite minerals (colorless)	Mica
7	Red, pink, green	Amphibole
8	Purple	Pyroxene (partially)

4. Structure Analysis

To understand the structure of the pottery in petrography experiments, we use polarizing microscopes with xpl and ppl light. The desired images are as follows:

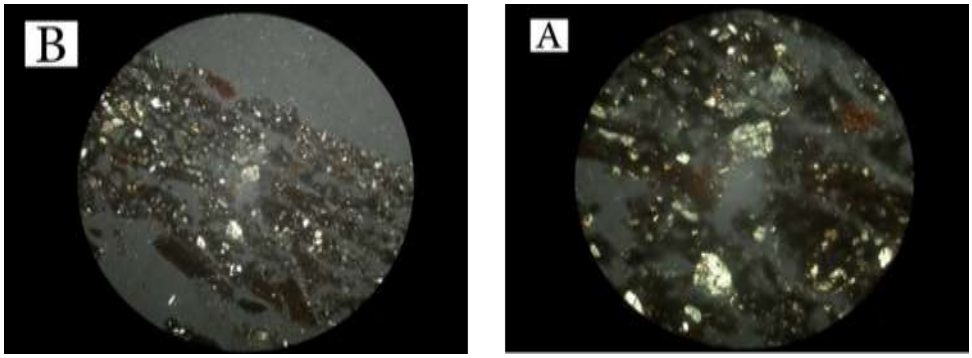

Fig 5 Photography with XPL Light: Image A: photography with XPL light, size 10x: Plagioclase mineral in the center of the image; Image B: Same image, size 4X: Plagioclase minerals and mica minerals (Source: Authors)

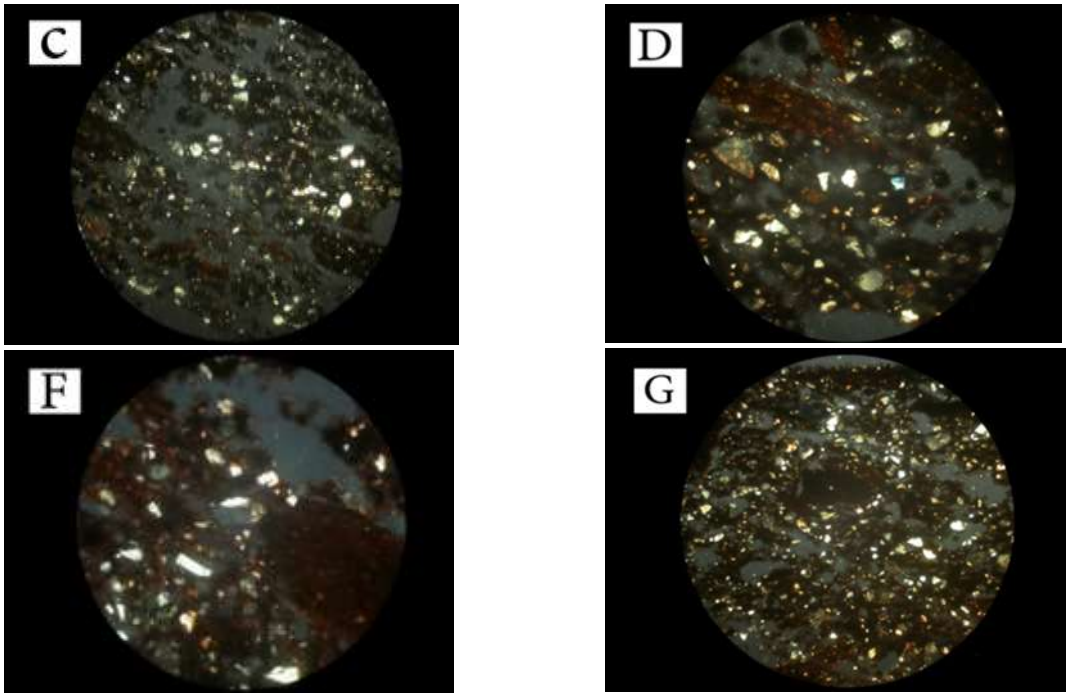

Fig 6 Photography with XPL Light; **Image C**: Photography with XPL light: size 10x: pyroxen Mineral (purple), edge is Chert + Grog fragments; **Image D**: photography with XPL light, size 4X: Quartz (white minerals), Iron oxide (red); **Image F**: Photography with XPL Light: size 4x: Grog in Center of image and Blank Space; **Image G**: Photography with XPL Light: Size 10 X; Polycrystalline Quartz (multicrystal) in the middle of the image (Source: Authors)

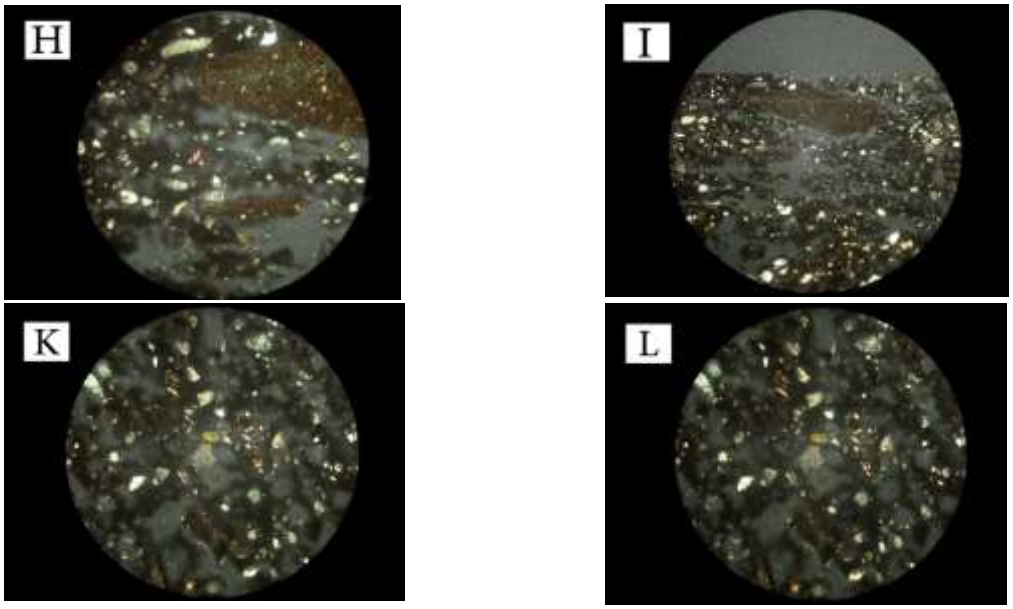

Fig 7 Photography with XPL Light; **Image H:** Photography with XPL Light: Size 4X: modeling clay; **Image I:** Photography with XPL Light: Size 10 x, Amphibole Minerals (Red and pink), Grog (Red in the Corner); **Image K:** Photography with XPL Light: 4x size: Amphibole + Grog + Amphibole abundantly; **Image L:** Photography with XPL Light: Size 10 X. Amphibole Mineral (Green) Next to chert rock Photography with PPL Light (Source: Authors)

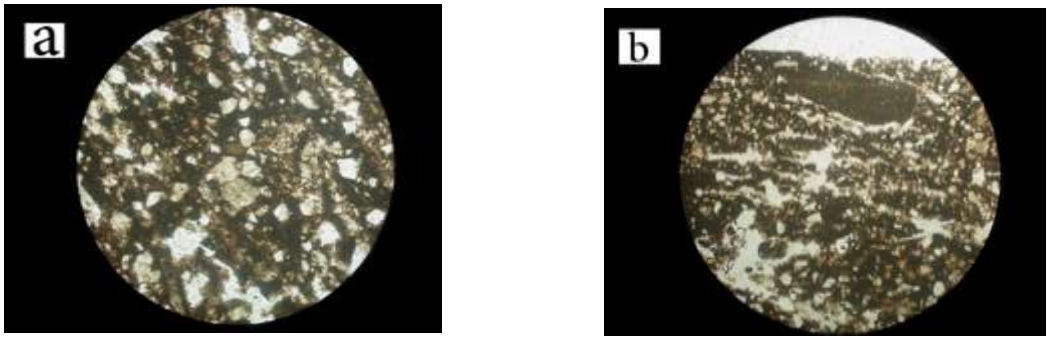

Fig 8 Photographer with PPL Light; **Image a:** in PPL light; **Image b** in PPL light (Source: Authors)

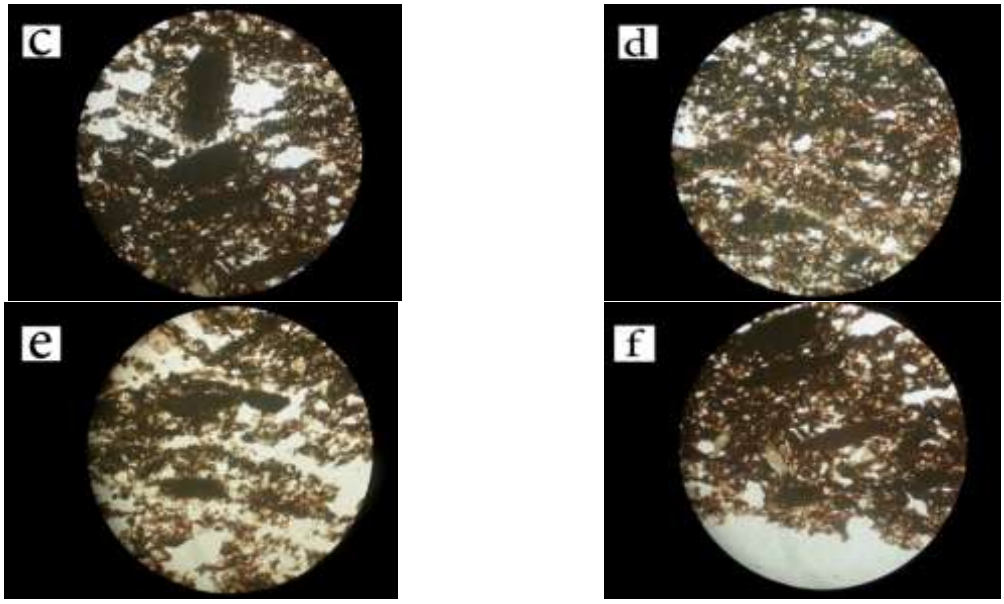

Fig 9 Photographer with PPL Light; **Image c:** Grog parts in PPL light; **Image d:** iron Oxide fragments (Brown and Black) in PPL Light; **Image e:** iron Oxide fragments (dark brown) in PPL light; **Image f:** Grog fragments in PPL Light (Source: Authors)

Table 2 Description of the structure of the Kalpuregan pottery (Source: Authors)

Row	Elements	Percent	Explanation
1	Quartz	2%	Quartz is the most abundant mineral in this sample, forming about 20% of the sample volume. Quartz mineral occurs in two forms: phenocrysts (monocrystals) and polycrystalline (polycrystals). Of course, it is necessary to explain that the fenoquartz (monocrystals) is the most abundant.
2	Grog	3%	These fragments are remnants of earlier pottery or fragments of clay and silt that can be seen separately and coarse-grained in the modeling clay. These fragments are dark brown in color with 1 mm dimensions and 3% abundance.
3	Iron oxide	2 to 3%	Iron oxide is brown to dark in the modeling clay. This mineral forms about 2 to 3 percent of the sample volume
4	Other components	Partial and limited	Amphibole, plagioclase, pyroxene, mica is partially and limitedly present in the modeling clay and there is plenty of space in the sample.

5. Conclusion

Given the purpose of this study and the geological study of the Sarvan as described above and according to the petrographic analysis of the Kalpuregan pottery, it can be deduced that the sample has domestic origin and its production is related to the region itself. The information obtained from petrography will identify some important aspects of pottery information. The thin section has a standard thickness (25-30 mm) by cutting a small piece of the sample under study. Standard sections were studied by polarizing microscope. In this experiment, any component of the minerals in the pottery texture appears with a different spectrum and the properties of the color spectrum and light are examined. Elements of pottery include quartz, iron oxide minerals, Chert rock, grog fragments, plagioclase, mica, amphibole and pyroxene. As mentioned earlier, this experiment shows how the origin and technique of the Kalpuregan pottery production was. Its Origin goes back to the same constituent elements, with the color spectra specified in Table 1. Kalpuregan's potteries come from technology and clay firing, Secondary clays are much more abundant than primary clays. Type II clays may include iron, quartz mica, and other impurities. Organic matters are found in type II clays.

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An Overview of the Traditional Weaving of Sistan and Baluchistan

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Research Article

Abstract

Handicrafts are part of the national arts and crafts of Iran, which in addition to economic production aspects, reflects national culture and values, as well as creativity and philosophical insights and artistic tastes of ethnic groups living in any part of the country. In other words, handicrafts and traditional indigenous arts related to handicrafts, in addition to the economic aspect, express the social history of societies and represent the ethnic cultures and arts of the Iranian people. For many people, the concept of handicrafts and what the handicrafts are called, and where the artistic, cultural and economic values of this part of national activity lie, may not be clear, but it is important to note that today, in many countries of the world, even in the most industrialized countries, the economic activity of handicrafts is considered as a basic source for the production of goods, especially export goods, and an important means of creating employment, exports, and so on. In this article, a review of handicrafts and clothing of the people of Sistan and Baluchistan has been studied and the handicrafts and clothing of this people have been studied.

Keywords: Handicrafts; Traditional Weaving; Sistan; Baluchistan; Needlework

1. Introduction

Clothing, through a set of material signs, establishes a system of cultural communication among the people of the society. Class status Individuals are in different social and ethnic groups. Type of material, color, accuracy, shape and patterns of clothing and culture Vocabulary related to clothing with a set of cultural, moral and spiritual values and criteria such as shame and modesty, dignity and dignity, greatness and humiliation, social and economic importance and religious beliefs and ideals are intertwined. In the following, we will study the hand-woven fabrics of Sistan and Baluchistan.

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1.1. Plus weaving

In Sistan and Baluchistan, they are usually called nomads "Plus Nomads". Tent dwellers prepare their tents in person. Consumables are goat hair and its weaving method is such that the beginning of goat hair is cut with a machine and cut to the desired size diameter. The braided hair is twisted on a horizontal weaving machine and weaved like a kilim, and each time a piece of black tent called a plus is prepared. To make a tent, three pieces of plush are sewn together. A small plus requires about 12 kilograms of goat hair and takes about ten days to weave. Black tents are very resistant to sun and heat and do not ignite in case of fire. Also, due to their high weight and delicate texture, they are not affected by wind and dust. It is also resistant to moisture and in the long run, moisture has no effect on it. These advantages of black tents have allowed them to maintain their position in front of tarpaulin tents and the nomads to use as shelters or shelters hundreds of years ago (Afshar, 1984; Yavari, 2011).

Fig 1 Example of Plus weaving

1.2. Embroidered Coins

This art has a special place in Baluchistan handicrafts due to its decorative and ornamental uses after needlework. In this art, materials such as small and large mirrors, sequins, beads and pearls, shells, fittings, fabrics, coins and shells are used. Its products are mostly used in celebrations, celebrations and weddings. Examples of coin embroidery are placed on the neck of the camel. It is also used in the bride's bed for decoration. This art is also used as a mural (Afshar, 1986; Esfandyari, 1992).

Fig 2 Example of Embroidered coins

1.3. Kalpurgan Pottery

Pottery in Baluchistan is associated with the name of Kalpurgan village. Kalpurgan village is located near the border town of Saravan and has a long history of pottery, which dates back to five to seven thousand years. Baloch women use clay to make utensils around their place of residence. In addition, to decorate it, they use the role that is passed from mother to child. Pottery turns red due to the type of soil in the region after baking, and this feature has distinguished Kalpurgan pottery from other pottery in other regions of Iran. In Kalpurgan pottery women do not use pottery wheels. They make pottery by hand and use special geometric shapes that are several thousand years old to decorate its surface. To decorate the potter with the help of a thin piece of wild palm wood the size of a matchstick, the design is engraved on the pottery. The color of these designs is reddish brown before baking the pottery and turns black due to heat (Afshar, 1992; Mohammadi, 2000).

1.4. Needlework

Needlework is a hand-embroidered work that is immortalized on the field of fabric with the help of capable hands and creative thinking of artists, and what remains is the result of the admirable taste, taste, initiative and talent of the artists of this valley. This art has a long history in Baluchistan and it can be considered as an extract of women's pain and hearts and a reflection of the bitter and sweet memories of an ethnic group throughout history, which itself has become a mental mixture of song and rhythm of hand movement. Types of needlework products are: Tablecloths, rugs, cushions, bedspreads, wedding tablecloths, sharps, backs, etc. (Esfandyari, 2001).

Baloch embroidery is one of those embroideries in which all or most of the fabric is covered with stitches and colored stitches. In this type of needlework, the sewing is in the form of lines that have a geometric design and are of the satin sewing type, in which the diameter of all the lines is the same, and the total products according to the type of sewing they are divided in to high-work, medium-work and low-work. The designs used by Baloch women are completely segmented and geometric, and to visualize them, happy colors are used, among which the bright orange and red colors are more than other colors, and the details of the designs are mostly colors: green, white, Forms black and brown. In fact, bright orange and red are the main colors, and green, blue, white, black, and brown (up to crimson) are the sub-colors of this type of needlework. Needlework does not require more than two types of raw materials and the total material is only yarn and fabric. Needle workers use tail yarn according to their facilities and tastes. It is finely woven and is used for small products in small parts (Keshban, 2010).

Usually, needle workers prepare the product independently, and in case of group work, after implementing the general plan, each needlewoman or girl embroiders one color completely, and for the next part and sewing another color, it is sewn to the next needle is delivered and this process continues until the end of the work and completion of the product. Indigenous women of Baluchistan mostly use embroidered products to decorate the chest, pockets, headgear, collar, trouser slippers, curtain edge and tent cover (Kalte, 2004; Hasanbeigi, 1987).

Baluchi needlework, which is produced in the form of ribbons with different widths, is used to make a variety of complementary products, and the products that are usually produced using these ribbons are women's bag, wallet, glasses cover, cigarette box, key holder, pants. Coat, coat, tie, shoes, belt, lampshade cap, boots, blouse, jacket, album cover, photo frame, etc. (Nikbin, 2005; Farokhseresht, 1994).

Fig 3 Example of Needlework

1.5. Textiles

The history of textile weaving in human civilization dates back to the millennia BC. Cover fabric is one of the basic human needs that has had its ups and downs during different periods of history. In the findings of the burnt city with the discovery of a significant number of different tools of weaving and spinning wood, clay, pottery and metal, which indicates the existence of the weaving industry at that time. The fabrics found are often brown and cream in color, but several two-color fabrics of wool and cotton have also been found. In the art of textile weaving, what has been known and known since the millennia BC is the self-sufficiency of the people of Sistan in the production of raw materials for various industries, especially textile weaving, so that until this last century Livestock until spinning and preparation are all done with traditional and special tools (Afshar, 1984; Wilcox, 2013).

1.6. Embroidered Feathers (Parivar)

It is a kind of embroidery on fabric. Raw materials and tools, like other fields of needlework, thread, fabric and needle. Sewing is sewn directly on the garment and like Baloch needlework, there is no need for a fabric with regular and perpendicular warp and weft. The background is the whole fabric that only parts of the whole background are filled with stitching. This art is common among the natives and is used in the villages of Saravan and Iranshahr. Parivar is mostly used on the fringe of Baloch women scarves and in some areas, it is also sewn on clothes in front of breasts, trousers and sleeves. Also, in some villages, they embroider with silk thread on hats, Chinese sweat, kohlrabi, armbands, prayer covers, etc. (Yarshater, 2003).

Fig 4 Example of Embroidered feathers (Parivar)

1.7. Mat Weaving

The art of mat weaving has had a special place in the lives of the people of Sistan and Baluchistan, an art with a long history of the burnt city and Lake Hamoon. Mat weaving is pronounced in one region in Sistan region with Khulk weaving dialect and in Baluchistan region with Tegerd dialect which are very different in terms of type of raw materials. Pulp weaving is woven from collars and straw is woven from the leaves of wild palm trees. Sistan mat weaving products are: curtains, canopies and Tooten (a kind of wicker boat) and from Baluchistan mat weaving products we can mention ropes (brooms), belts, shoes, underlays, pouches, etc. (Afshar, 1984).

1.8. Tamarisk (Gaz) Weaving

The abundance of Tamarisk trees and wild Tamarisk bushes in Sistan has made all kinds of basket weaving products common in the region. These baskets are woven in various shapes from thin twigs of trees and shrubs. Tamarisk branches are soaked in water for several days due to their dryness and regain their flexibility. Then, using Tamarisk branches, baskets of different sizes are woven, which are used to transport goods and food (Yavari, 1975; Pourbahmani, 2008).

Fig 5 Example of Tamarisk (Gaz) Weaving

2. Methodology

The research method in this research is descriptive based on the nature because it has no involvement in the information obtained and the results have been reported in a realistic way.

The researcher's goal in conducting this type of research is objective description. Real and regular are the characteristics of a situation or a subject. In such research, the researcher tries to express the objective results of the situation. Descriptive research involves gathering information to test a hypothesis or answering questions about the current state of the subject matter (the main focus is primarily on the present tense), and this research describes and interprets what is. In this type of research, the role of the researcher determines the observations and descriptions. Conducting descriptive research can only be to understand the current situation or to assist in the decision-making process. This type of research looks at how a subject works.

One of the main parts of any research work is data collection. Due to the fact that this research is descriptive, in this research, the available information and documents have been used and the data collection tool is filing.

3. Conclusion

In this article, the hand weaves of Sistan and Baluchistan and especially the types of embroidered patterns on women's clothes were reviewed. The designs that have long shone on the women's clothing of Sistan and Baluchistan are very beautiful and delicate and are created by needlework artists. It is important to note that the patterns of Sistan and Baluchistan fabrics have gradually lost their place with the passage of time and the development of the present world. In this article, traditional weaves of Sistan and Baluchistan, including needlework, Plus weaving, Embroidered coins, Embroidered feathers (Parivar), Mat weaving and Tamarisk (Gaz) Weaving, were studied and their application has been analyzed.

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Designing Doll Costume Inspired by "Simorgh" and using the Properties of Harmel and Nano Zinc Oxide

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Research Article

Abstract

The prevalence of various diseases caused by pathogenic bacteria and their resistance to antibiotics has forced researchers to search for healthy and safe methods to produce products suitable for human well-being with the advent of nanotechnology in the present century, nanomaterials such as silver, gold, zinc, copper and titanium dioxide are used as antimicrobial agents. In this study, the antimicrobial efficacy of cotton samples in in reducing two common strains of Gram-positive Staphylococcus aureus, source of eye, skin, bone and joint infections and Gram-negative Escherichia coli, origin of urinary tract infections, nosocomial and blood infections using zinc nanoparticles and harmaline, has been examined for use in children's doll clothes. Small amounts of antimicrobial test of the samples indicate that in the treated samples the average percentage of bacterial reduction for Gram-positive bacterium Staphylococcus aureus was %96 and Gram-negative Escherichia coli %99. Also, in the doll costume design section, an attempt has been made to be inspired by one of the mythological symbols of Iran (Simorgh)and the designs should be based on it. The research method in this article is descriptive based on the nature, because; there was no intrusion into the information obtained and the results were reported realistically. This research is based on the experimental method, because; a laboratory process is required to prepare the fabric with the desired properties.

Keywords: Hamaline; Fabric Design; Costume Design; Doll

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1. Introduction

Although the puppet is a branch of art and theater, in fact the puppet has all the sciences in it. It includes sciences such as philosophy, metaphysics, hermeneutics, anthropology, archeology, sociology, psychological arts, music and especially visual arts. The puppet is a "silent person "who is enlivened by a "moving person "who has a sympathetic mind (Georgian,2016: 75). Empty your psyche. The child trusts his doll so much and sees himself as him, attributing all his feelings and emotions to the doll. This not only causes mental exhaustion, but also leads toa better understanding of him. Then the doll allows the child to grow up without fear of adults and to experience a number of issues out of curiosity (Tehran, 2018).

Children usually start having activities with dolls between the ages of two and three. So that if you see a doll, they have the ability to communicate with it. They may do things with dolls, such as; feed the doll, bathe the doll and then place the doll in bed. These types of games represent an important part of their cognitive development. Because of this great connection, the mental and physical health of the child is very important.

The first doll was invented in the pre-Milad period, so it is difficult for historians to go back to an inventor, but in modern times, Ruth handler invented the first doll in 1959 (2019, Milan). Germany and France Early in the production of European dolls, a mixture of paper, sawdust, plaster and glue was made as a cheap alternative to wood, which could be formed under pressure and enabled mass production of dolls.

After wood, a kind of synthetic cellulose was discovered around 1870, which has been used to make dolls since the late 19th century, this material became brittle and flammable with the age of the doll, but due to its low price, it was used for some time in factories in Germany, France, USA and Japan for mass production of dolls. From the second half of the twentieth century, more durable materials. After 1870, kalehgis and glass eyes became popular for dolls. From the begging of 1880, some manufacturers began to produce dolls that could close their eyes.

It was the golden age of doll production from 1860 to 1890 when the demand for dols increased and new and delicate types were constantly produced. Many of the dolls produced at this time were mechanical and had the ability to move, sing and dance (Madehow, 2020).

Given the importance of toys in the developmental process of the child and the need for its health and safety, attention to the quantity and quality of production, distribution and use of toys in the country is necessary. the attitude that toys are just a luxury item should be changed. Creating a new thinking in the toy industry, in order to improve the safety level of domestic products and prevent the import of unsafe toys, will reduce accidents caused by the use of this educational and entertaining device in children (Ibid, 2010: 84).

Doll manufacturers usually design a doll from the original design to the final product, which includes face design and swing, etc., up to packaging. First, a linear etude of the mental design is presented and then a color image of that designer is created. then a model of that design is sculpted with wax. After the design of the sculpture was approved, a sample of it will be made as a production mold (Madehow, 2020).

The important point in toy design is that the child should be able to easily use his toys, touch them and make changes in them if he wishes. Also, the toy should be in harmony with other items in the child's environment; so that the with his real life (Ibid, 2019: 137).

Given the importance of toys in the developmental process of the child and the need for its health and safety, attention to the quantity and quality of production, distribution and use of toys in the country is necessary. The attitude that toys are just a luxury items should be changed. Creating a new thinking in the toy industry, in order to improve the level of safety of domestic products and

prevent the import of unsafe toys, will reduce accidents caused by the use of this educational and entertaining device in children (Ibid, 2010: 84).

One of the medicinal plants; the plant Esfand or Espand, scientifically name harmala Pergamum from the family Zygophyllaceous (Zygophyllaceous), has about 22 genera and more than 250 species (Asgarpanah, and Ramezanloo, 2012: 1573).

It is a magnificent perennial plant that grows spontaneously in arid, steppe and sandy soils, native to the eastern Mediterranean. It is a 3.0-8.0 m tall shrub with short creeping roots, white flowers with green veins and round seed capsules that has more than 50 seeds. this plant contains beta-carboline alkaloids, such as harmalol, harmaline and hemin (Moloudizargari, 2013: 199).

Studies have shown that the two most important alkaloids of pecan, namely harming and harmaline, are found in seeds and roots and are present in small amounts in pecan flowers.

Table 1 Pecan Alkaloids (Rural, 2018: 75)

Pecan alkaloids	Seed	Flower	Leaves	Stem	Root
Harman alkaloids (harmane)	+	–	–	–	+
Harmaline Dehydroamino	+	–	–	+	+
Quinazoline Derivative, de Vasicine (Pegamine)	+	+	–	+	–
2,3 trim ethylene & 4 quinazoline	–	–	–	–	–
1, 2, 3 – Hydroxytrimethlene Quinazoline (Harmalol)	+	–	–	+	–
Ajmalicine B carboline	+	–	–	–	–
Harmaline	+	_	_	_	_
Pegamine	+	_	+	+	+
Vaccines	+	_	+	+	+

Harmaline is an alkaloid found in harmala fruit. P and is not present in its flowers (Iranshahy, 2019: 535). Esfand spherical fruit has a large number of brown or black seeds and prismatic shape and has a penetrating odor and very bitter taste and is used as a general disinfectant) (Ishraqi et al, 2009, 63).

Hamadan (C13H150N2) was first isolated by gobble from the seeds and roots of harmala either is slightly soluble in hot alcohol and completely dilute in acids. Harmaline is almost twice as toxic as harming (Mahmoudian et al. 2002: 2).

Harmaline has pharmacological toxic, fungicidal and bactericidal effects (Zeila et al, 2015: 28). Medical plants in important civilizations of the world, such as ancient Iran, Egypt, the Middle East, ancient Greece, India and China date back to 3000 BC.

In Egypt, for example, the pecan plant is used to treat infectious diseases and is used as a powerful microbicide (ibid, 2018: 74). The use of this plant is different in different countries; Alkaloids derived from harmala seeds. P In traditional medicine in some parts of the world, it has been used as an antifungal and disinfectant. In Saudi Arabia, for example, the use of this plant against fungal infections has been common (Moloudizargari, 2013: 206). this purifying property of Pecan seeds is used in Uzbekistan and Turkey (Ibid, 2013: 201).

Today, toys are not just a means of entertaining children and have found different functions in the social, physical, cognitive and emotional areas of the child. Among the toys, the doll is one of the most useful toys among children, which in fact can be said that the child lives with it. For this reason, paying attention to the child's health when using the doll is very important for the child's parents. In this article, clothes are designed that are creative in terms of design and are appropriate for Iranian culture. On the other hand, the fabrics used in the clothes of these dolls are hygienically upgraded with the natural material available in Espand and strengthened with other materials, and help maintain the health of the child.

2. Materials and Methods

To prepare the fabric, harmaline and nanomaterials (Table 2) were added to the human and enough distilled water was poured on it until the human volume reached 100 ml. the human was then placed in an ultrasonic bath for 10 minutes.

At this stage, a 100% cotton cloths were added to the human and the human was placed in an ultrasonic bath at 50ºC for 40 minutes. The cloth was then washed and dried for 20 minutes at 80ºC.

Table 2 Specifications of materials used

Characteristic	Name of manufacturer	Name of the material
1314131	Sigma Aldrich	ZnO
304212	Sigma Aldrich	Harmaline

3. Discussion and Results

3.1. Investigation of Antibacterial Activity

Quantitative evaluation of antimicrobial activity of completed fabrics against Gram-positive Staphylococcus aureus (25923 ATCC) and Gram-negative Escherichia coli (25922 ATCC) according to AATCC standard method 2004-100. In this method, samples in 10% dimensions 10 mm was placed next to a half-McFarland-based bacterial suspension, followed by 100 Ul of agar soy Tryptic in the culture medium for 24h and then for quantitative microbial analysis. they were placed in a plate culture method. For bacterial growth, the culture media were kept in an incubator at 37 with C for 24h. At the end, the number of bacterial colonies in each container was counted and the percentage of bacterial reduction was calculated. completed with the materials in Figure 1, as well as the small amounts of antimicrobial test of the samples indicate that the raw fabrics have no microbial properties and in the treated samples the average percentage of bacterial reduction for Gram-positive Staphylococcus aureus is 96% and Gram-negative Escherichia coli. 99% is calculated. so, use e Nanomaterials facilitate the breakdown of bacteria. The decomposition of bacteria by the desired materials can be done by destroying the membrane, well and enzymes of bacteria.

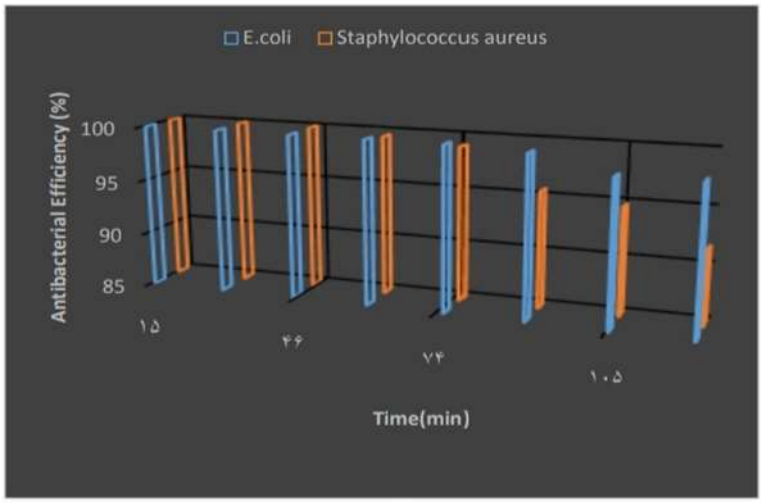

Fig 1 Antibacterial diagram of samples

3.2. Clothing Design Department

The basis of the designs presented in this article is the idea taken from Farshchian Master Simorgh miniature painting, which has symbols and features such as; Narrow neck, curved lines, dalber-like texture on the wings, many arches on the body of Simorgh, many feathers and a layer with wavy and Brocken lines on the edge of Simorgh wings have been conceived in the design of clothes.

Fig 2 Simorgh miniature painting

Simorgh or Sirang is the name of the mythical birds that raised Rostam's father. there is a lot of talk about Simorgh, but the issue that everyone agrees on is that; this chicken in the world, there is a name but there is no sign of it and such birds cannot be hunted. In Arabic, Simorgh is called Angha because they believed that it was a long-necked bird with colorful feathers in the land of the Companions, which lived on a very Hight mountain peak. (Naira, 2006: 216).

Simorgh is one of the most prolific symbols of philosophy, literature and mystical wisdom, which has a special place both in the world of mythology and in the field of revelation, intuition and enlightenment (Ibid, 2006: 231).

In the field of clothing design, using software designer marvelous, three-dimensional and color design of them.

Fig 3 Designs implemented with marvelous software

The basis of the etudes presented in this article is the idea taken from Farshchian Master Simorgh miniature painting, which has symbols miniature painting, which has symbols and features such as; Narrow neck, curved lines, dalberi texture on the wings, many arches on the body of Simorgh, abundant feathers and a floor with wavy and broken lines on the edges of the wings, have been conceived objectively and conceptually in the design of the clothes.

In the conceptual part , the designs are done as follows ; Puffy and pleated sleeves (association of volume created by overlapping wings), multi-layered skirts (inspired by the stratification of Simorgh feathers), cloche sleeves and skirts (take on a soft and special curved shape when worn and show softness Curvature, body of Simorgh), rabbit collar (in addition to being widely used in children's clothes , sharp and long collar, indicating long and sharp wings of Simorgh), use of curved lines in cuts (according to the characteristics of these lines, a better choice for children's and doll designs).

4. Conclusion

The results showed that; Cotton cloth impregnated and supplemented with 2 substances (ZnO) and harmaline have a significant percentage of bacterial reduction, so that the average bacteria are %96 and against Gram-negative bacteria is %99 calculated and confirmed.

In this article, for a fabric designed with this special feature of resistance against two common types of bacteria, 5 clothing designs were presented with an idea from the Iranian mythological element (Simorgh) to a design in accordance with Iranian culture and a step was taken to preserve this culture.

Since the child needs play to grow and learn, and given that most of the activities of childhood play, two important criteria of the standard or physical and mental health should be considered in choosing toys. the fabrics and clothes designed in this study were aimed at considering the two dimensions of mental and physical health of the natural needs of the child.

Due to the fact that toys are one of the effective factors in the development and learning of children and the child due to his young age and weak body, is exposed to many dangers both physically and mentally. that is why the standard of the toy is so important. In addition to physical health, a suitable toy should provide general and external structure (and mental health) and internal reflection. Because the child communicates a lot with his doll and actually lives with it, so that in his dream he cares about feeding the doll or even takes it to the bathroom and most of the time he has it with him and even he takes it with him to bed and due to this high tactile connection, it is suggested that the results of our research be used in the design of fabrics and the design of doll clothes.

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Hossein Esfahani Aghajani Mural Restoration Practices

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Research Article

Abstract

The present study explores the life and work of Hossein Aqajani-Esfahani with a descriptive and analytical approach. The aim of this study was to review the works and cultural services of an artist, who has a significant position in the field of restoration of the monuments and buildings, and on the other hand, in the domain of academic education, as well as in the domain of management in cultural position, his role is highly considerable. But unfortunately, based on the available resources, no research yet has been conducted about this artist. The approach of the research in the analysis of the works of this artist was based on statistical population, consisted of various works in the field of restoration. The result of the research is that Hussein Aghajani-Esfahani in his restoration projects tried to consider historical authenticity and stylistic features of the works with his extensive knowledge and command of the field of restoration, and in developing this attitude he would have a determining role. Documentation and following the executive authenticity in reconstruction is one of the important points of his works of restoration in various fields.

Keywords: Restoration; Iranian Painting; Mural; Hossein Aghajani-Esfahani

1. Introduction

Murals are a category of historical works, which their aesthetic aspect can be, evaluated as important as equal to their historic value. For this reason, all sciences, related to the field of painting and illustration are involved in it. The sensitivity of the issue finds its most importance, when the historic aspect and irreversible direction of elapsed time over the historical work, impose some constraints over balancing. In fact, achieving an acceptable balance between these two main aspects, always has forced restorers to strive in various branches of science in this field that has led

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to create a new branch called ‘Foundations of Restoration of Painting’. In fact, the goal of each balancing method is to achieve a goal that the theoretical foundations define. The principle is to practice theoretical principles, not necessarily everywhere in the world and in all cases, should balancing of the murals have been conducted with just one particular method. With the beginning of the 1960s and for the first time, painting works and decorative motifs in buildings such as Zanjan’s Dome of Soltaniyeh and paintings of various palaces and mansions in Isfahan attracted the attention of Italian restoration specialists. Technical and technological studies were conducted on a number of damaged murals and after obtaining an understanding of the technology and the technique used in them according to the laboratory and scientific methods, the mentioned paintings were restored by IsMEO board of experts, based on particular conservation and restoration principles. In places such as Ali Qapu and Chehel Sotoun, there are works in which multiple layers of paint has been painted. Their approach with such a technique resulted in restoration of some of these paintings, and removal of annexed layers from the old painting, but a small number of them have remained as sample proofs and with the same technique. Restoration is an act that defines the relationship between the work and restorer. Restorer is an expert, an artist, who looks deep into history, and more important than that he is a modern and contemporary person. The attraction of love to history, art, and above all the love of human is pulled him toward this profession. He is not an apathetic person and looks at the historical work with knowledge and love, and it is this love that plays as a motivation for him to know and to connect with the work, a relationship which is romantic, wise and artistic. In addition to be a profession, restoration is the self-gratification of soul and is the seeking of God’s satisfaction. According to a unanimous intellectual, “restoration is a mission that rather than talent, requires cognition, rather than fertility, requires patience, it needs conscience more than emotion, it requires dignity more than acquirement of benefit, in this domain one should not pursue business, but he should devote himself”. Restoration requires humility, selfishness and egoistic attitude is a pest for this profession. The day that restoration is finished and when the intention of restorer is being reflected and colored in it, the work loses its character. Restorer has to act in such a way that his work must express history to and sustain it. His job is to sustain history and bestowing continuation to it. More than anything, restorer is a righteous trustee. The thing that is in his hand is a trust that must be transferred with honesty and integrity to the next generation. This article analyzes the works of one of the most sublime restorers, Hossein Aghajani, who spent many years of his life with the IsMEO board of expert to repair and restore, historic monuments of Isfahan; and then he and his colleagues started to restore other monuments in Isfahan and other cities. In the present research the restoration methods of Hossein Aghajani are evaluated. His education was in the field of Restoration of Historical Monuments. The features of restoration work of Aghajani are in such a way that the restoration of the paintings is mostly done by oil painting technique and tempera on the wall, and the restorations of decorations of the building were done on tiles and plasterworks and mirror works of the historic building. Therefore, here, the activities of Aghajani are evaluated to understand what methods he has used in his works? What are the components of the restoration methods and techniques of murals by Hossein Aghajani? What are the subdivision categories of restored works of Hossein Aghajani?

2. Research Method

In general, scientific research can be divided into two categories of descriptive research and experimental research based on how to obtain the required data (research design). In this paper methods - descriptive case study was used. Descriptive research includes a set of methods that aim to describe the conditions of the conditions or phenomena under study. Conducting descriptive

research can be more about understanding the current situation or helping the decision-making process. Conducting research using a case study method consists of four stages: stating the problem and selecting the "case" (analysis unit), conducting field operations (data collection), organizing data and compiling a report. The researcher's focus in the case study is on a "case". But this unit may consist of multiple events and different people or it may be composed of different processes.

3. Research Background

Based on the available existing sources, the background studies, which were found to this time, are as follows. An article by Hamid Frahmand-Boroujeni, Hossein Ahmadi, and Reyhaneh Qasemabadi (2011) under the title of "A Review on Theorizing of Restoration of Mural in Europe", published in the first volume of 'Restoration of Historical Works and Buildings' magazine, which dedicated to theoretical bases of murals and the method for restoring and retouching them. Aslani, Hessam (1998), conducted research on the principles of conservation and restoration of historical–cultural murals with a special attitude to the mural of Persian Miniatures in Safavid Era, in Isfahan; his supervisor was Rasool Vatan Doost at University of the Arts (Isfahan Campus). In this thesis after briefly stating the basic principles of restoration of murals, he compares the murals of Brankachy chapel with the murals of Qeysarie Gate. Haji Alian Mohammad Ismail (2009), 'Analysis of Fifty Years of Restoration of Safavid Murals of Chehel Sotoun Place in Isfahan', Supervisor doctor Samad Samanian, Isfahan University of Art. In this thesis he analyzes the principles of restoration of murals of Chehel Sotoun Palace in Isfahan, which have been done by Italian restoration board of IsMeo and Iranian restoration groups.

4. Theoretical Foundation

4.1. History of Restoration

In general, in order to present the history of restoration one cannot introduce a starting point, because repair and restore and reconstruct of the works, is a subject that has been existed in different times and different places and other people have used this creativity, in various methods, in order to satisfy their daily needs. This practice is as old as the history of tool-making human; meaning that, when primitive people learned how to make useful tool by materials around them, they naturally forced to learn how to repair worn-out or broken objects. For example, many people were using residential buildings and objects belonged to their ancestors, and certainly in certain conditions, repair was being performed over them. So, one of the primary sources of useful information about primary restoration are the very objects of that time (Mirfakhrai'e, 2008: 5).

4.2. Approach of Painting Restoration

Restoration of monuments and historical buildings is very important for restores. But what is essential in this regard, is paying attention to conserve and maintain the original work. Restorers restore the damaged parts and leave the rest of the work intact. It is in this case that its painter and creator of the work is respected and when the viewer examine the restored work, he/she realizes that to what extent the original painter has created artistically and beautifully his own work, as well as value is given to the restoration work. Since the beginning of restoration, as one can get from old inscriptions, dealing systematically and careful concluding, are among the cases of interest and concerns of all people, who are interested in conserving artistic works (Azadeh Tafreshi, 2016: 112).

Some of the early writers, quite surprisingly have been agreed with modern ideas in this field. (Reconstruction) of surface coloring (painting) or interior of the works, as it is called today, has to be limited to the replacement of the damaged parts without hiding the primary color and improvement of the work without new coloring. Authors have proposed different ways to interpose color. For valuable artistic works, it is desirable that the painting be restructured in such a way that the restored part is not clearly discernible, rather, the restored parts have to be tracked down by close examination. The next method is the method of a different brush stroke in contrast to the surrounding color. (Like hatching and other methods), or placed the filled solution at a lower level of the original. Precise painting with different colors or characteristics from the surrounding environment or leaving these parts in a flat manner and slightly colored, and with same level of color next to it, are among the methods that can be mentioned. Besides preventing further decay and disintegration, the purpose of the correct restoration, is to provide an appropriate and acceptable appearance of an artistic object. So that, it can be studied with intervention of disturbing factors as a complete set. So, the fake reconstruction of the original is not the goal of restoration (Vatandoost et al, 2013: 80).

Damage on the body of a human figure or pale transparent sky in contrast to the dark background that creates less inconvenience to the viewer, can take much longer time on the color and texture or the skill of the painter. The task of the restorer is to restore paintings that are more valuable for its owner as a decoration on the wall or the image of a visage that is valuable due to a reason rather than historical or artistic values. Restoration in the sense of recreation is concluded as repairing without damaging the original. In some cases, which the contemporary works are damaged, especially when the original painter fixes it or supervises its restoration, the same flawless perfection is desired (Hesami, 1998: 44-52).

4.3. Importance of the Conservation of Historical Works

Artistic works and historical monuments are subjected big and small damages over time, which sometimes human has role in that damage or sometimes they are damaged naturally and without human intervention. What is important here is to maintain and conserve these works, because, in such works the age-old culture of a country lies, and its restoration helps to the durability of the art and the civilization of that culture. Clearing is considered as an essential part in the process of preservation and maintenance, and it is the aesthetic factor of the object and increases its lifespan and improves its structure. It also specifies the conditions and the actual situation. In such a way, that with appropriate measures, we can be ensured that it can be preserved for future generations. In the recent years countless critiques have been stated about the traditional methods of cleaning buildings and historical–cultural and artistic objects. Inappropriate application of techniques and technologies carelessly, including cleaning with pressure of air and steam can cause severe damages to the surface. The loss of surface detail and subtleties due to overall cleansing and throughout the surface, can corrupt the strength of the surface and even in some cases, exacerbate the destruction process. Chemical techniques also have problems of their own, and sometimes the leftovers of the chemical materials, after the cleaning process remain on the surface and will reveal its effect in the future, principally they have uncontrollable reaction (Azadeh Tafreshi, 2016: 100-120).

4.4. Features of Reconstruction and Restoration of Murals

One of the most important debates on restoration of historical works, is the restoration of murals that is considered important for restorers, due to the diversity of techniques and methods of coloring, compositions, different artistic styles, adequate knowledge. Because insufficient information on the painting results in incorrect restoration, that in turn results in deterioration of restored work, therefore, the restorer by Knowing this information start to restore the historical works especially murals, with precision and delicacy and a pinpointing look. Before 1960s, the performed activities in the field of conservation of the murals in Iran have not been congruent with the modern restoration principles, which have been put forward by the Italian board of experts IsMEO in the years after this decade. Although shedding or chipping the damaged murals and covering them with plaster, by painters, that have been done in different periods and with the aim of restructuring of the painting, is a conservative approach, but it is a method, which is accepted as a reconstruction and renovation method of the paintings, without conserving the originality of the work and in contrast to the type of performance in the early year of scientific and modern restoration. Many examples of murals, especially works in Isfahan, and Shiraz and . . . are observed, which are restored with multiple layers over each other. Works, which were restored by eminent experts such as Mosavor Al-Mollk, Javad Rostam Shirazi and.... At the beginning of the 1960, and for the first time, the paintings and decorative motifs in buildings such as Dome of Soltaniyeh in Zanjan and murals of the palaces in Isfahan and Shiraz attracted the attention of Italian experts of restoration. Technical and technological studies were performed on a number of damaged murals, and after obtaining an understanding of technology and technique used, according to the laboratory and scientific methods, the mentioned murals were restored based on the principles of conservation and restoration, particularly via using scientific methods, by the restoration board of IsMeo; however, the examination of how the conservation and restoration, the methods used and the strengths and weaknesses in the performance of IsMeo board does need another study. Before the presence of the mentioned experts, conservation and restoration of mural had a distinct definition from scientific restoration (Arzhmand and Aminpoor, 2014: 110).

In palaces, like Ali Qapu and Chehel Sotoun, in which there are several layers of paint over each other that underlie many questions. The performative instance of multi-layer murals can be seen in the works of other cities as well, but the presence of Italian restorers in Isfahan and Shiraz and deal with such a technique caused the restoration of a number of these paintings and removal of additional layers on the old painting, in next periods, but a small number remained with that technique as the proof sample. The works that have been done before this decade on the wall paintings by master painter, can be considered as a reconstruction or renovation of the old paintings; thus, the master painter in facing the damaged painting work caused by the passage of time or other erosive factors, with purposes such as maintaining the aesthetic aspect of the work, altering a part of the architectural space or changing the period of the history of the painting, they shed (destruct) the painting or they were chipping them, then in order to reconstruct it, they cover the painting with a layer of plaster. This type of restoration approach has not been based on the principle that emphasizes on the volubility and originality of the work (Vatan Doost, Beheshti, and Neiery, 2013: 71-82).

5. Method and Technique of Iranian Oil Painting with a Red Preparatory Layer in the Works of Hossein Aghajani

The use of oil paint in order to create works of art goes back to ancient times; the ancient Greeks and as well as the Romans were aware of this important method and sometimes a combination of canvas and oil paints was used for paintings. In Iran, and it perhaps can be said in the Middle East and Asia, this method was not used much. Perhaps, the main reason is the consideration of the important factor of climate, which due to dry weather, in most parts of Iran; water color was mostly used (color + water soluble base). In Iran, in most of the works in buildings and mosques, often watercolor techniques were used for creation of artistic paintings, and in order to create big paintings on the wall or murals, this technique was used. In this study, the aim is to find methods, tools, and materials that have had been used in certain period and time of the history of Iran's art (Safavid Era) in creation of painting masterpieces and wall decorations, and this is conducted in this way that with the information that is made available the repairing of these works will be carried out using modern scientific and technical facilities with full knowledge and originality. Carrying out these investigations, one should benefit from the following three options. Evaluating the works and the techniques used to create them through the remaining writings and documents from the intended time period utilizing the experiences and expertise of contemporary masters and skillful traditional experts, close objective examination of works by laboratory studies. One way of proper laboratory study, is the small cuts of paintings (paint layers and its base) and observing it with microscopes. In this way, the fashion of the use of paint and the placement of layers, despite of its small thickness in the paintings can be studied very well. Oil paintings with slightly Iranian style and some signs of Hindi elements, oil paintings in Isfahan of Safavid era were created by a wide variety of different method and techniques, and often painted by Iranian, European, Armenian, and probably Indian painters. These features are as follows: 1. these works regarding, technique, style and size were unique per se and are considered as the largest paintings in Iran under the Safavid era. 2. Paint layers regarding their conservations, are in a pretty good condition. In such a way that after elapsing almost four centuries, the layers of paint have not change physically or chemically. 3. They are among of the first examples of oil painting murals on the real sense, which have been painted by Iranian master of painting. 4. Although, in these painting, the influence of European paintings can be seen, but Iranian masters have proven that after being influenced by European paintings, they have changed it to their wish, and gave it Iranian soul and characteristic (Field studies and researcher interview with Professor Aghajani, 2016).

Preparing the primer layer and the surface according to the usual time, the primer layer was mostly mud and straw and the surface was polished plaster. The first practical work by master painter carried out was canvassing (saturation of the surface of the plaster to be painted, with baked linseed oil, or other diluted vegetable oils or diluted isinglass. After the canvassing the surface of the plaster, in some cases, they were attempting to cover a red paint on the entire of the plaster surface, and this is the same preparatory layer red that is apparent in some of the painted image of Safavid era with other color layers on it (the paintings of ceremonial parties in Chehel Sotoun and etc.), the base of this color is likely as same as the vegetable oil that has already been cooked and prepared, and later the painter attempted to draw a design that has already been studied and then he will complete the painting is completed. Meanwhile, in a design, which was being prepared, first the positions of individuals in painting were set regarding official positions and rank. Preparing the layers in predetermined places attaching gold to ornate clothing and garment makings also were done, that this operation was performed after dropping color of garments and clothes in an oily manner. And finally, portrait makings and the hands and feet were painted and polished, after

completing the details; the painting was abandoned in order to be dried. After relative drying of the paint layer, they were covering the painting with the protective oil layer, which has been previously prepared (Aghajani, 1982: 165-186).

6. Painting Method and Technique on the wall with a Red Preparatory Layer (Enlarged Miniatures) in the Works of Hossein Aghajani

The stages of painting are as follows; wetting the intended wall that usually was made of brick or clay, leveling the surface of the wall with screed of plaster in the corners of the wall, in order to guide and keep the layer of primer in its place and creating a smooth surface. Coating the primer, primers were usually made of straw and mud and sometimes made of plaster that has been covered by hand on the wall. A sample is in the highest floor of Ali Qapu palace (at the level of plaster sometimes they were scratching it by hatchet so it would find a better adhesion) in fresco painting technique (lime base) in Europe, most of the painters were drawing on the primer layer, which was a mix of lime and sand instead of straw and clay, and they were studying the design with the architecture of the intended building that has been known as the preparatory design. The upper layer was mostly made of plaster, which was performed after preparation of the solution of the plaster and after wetting. This layer has been composed of several parts that gradually became softer and tenderer. In such a way that with tools and equipment of plasterwork the scratched layer was completely removed and they easily turn it to the shape and form they wish. And then dividing the body of work in the dimensions of the frame of paintings and lining up the levels until the top layer is still wet. The frames of these paintings are often square or rectangular. As well as, blocking the parts without plaster layer and that was being polished by warm plaster and special trowels. After that the surfaces of wall became completely dry, in order to making a canvas out of it they did cover the surface of the wall with a solution of tragacanth plus sugar or a diluted solution of tragacanth and gum Arabic or too thin animal glue. In carried out tests, it was observed that the use of tragacanth and sugar for canvas was the most popular methods in comparison to the other methods, because tragacanth does not dissolve in water and it is less harmful to the surface of plaster. In some cases, a small amount of red paint was added to canvassing fluid in order to create a red surface. The thickness of this red layer is inconsiderable, and this is this preparatory red layer which can be seen in some mural paintings of Safavid era wall picture, which paint has been covered on it (Field studies and researcher interview with Professor Aghajani, 2016).

Fig 1 Chehel Sotoun Palac, Two Lovers, tempera on plaster, on red preparatory layer, restorer: Hossein Aghajani. (Source: Safavid Era Murals in Isfahan, 2015)

Fig 2 Chehel Sotoun Palac, Rabbit Hunting, tempera on plaster, on red preparatory layer, restorer: Hossein Aghajani. (Source: Safavid Era Murals in Isfahan, 2016)

7. Design Preparation Method for Painting in the works of Hossein Aghajani

A design, which was studied beforehand, was the same size of the intended frame to be draw on, and punched in order to make holes then it was placed on the canvassed surface, the it was copied on the canvas with black powder in thin textile that made the black powder to be sprayed, so the design would become visible in form of black dots on the wall. B. By a very thin black paint, they drew the dotted design. C. The first act of painting in this category of paintings includes the preparation and creation of the preparatory layer of gold and red layering and then attaching gold folio. D. On the surface that its design and its gliding is determined, the colors that have been previously tested and remained perfectly are painted on the desired parts in a body and flat manner, so the flat painted surfaces were created. The material that has been used the base of color was most likely egg yolk or warm gum Arabic with special wax. The mixture of Arabic gum and wax as the base for color, would give a beautiful and special state to the outer layer that is similar to the surface of the eggshell. The color of the face and body parts, was generally pink-white, and was made of a mixture of hot Sheikh Jawahar Water. In order to create bright colors a mixture of Macro colors and Sheikh Water was used; grass greens were generally a mixture of indigo dye and orpiment. E. After painting the pictures, respectively, the painters began to complete the sky and clouds, trees, mountains and flowers relating to it, and then continue to paint the clothes. F. A very important step in paintings was the outlining the shirts and caps and turbans and trees and limbs, this technique perfectly depicts and manifests the main appearance and wrinkles in clothing and body parts of the painting and generally it became practical with a darker color than the underlying color. In the last stage hands and face and all parts of the body that has been painted with pink color

that tended to white, was painted by warm red ink, and eyebrows and hairs and the line above the eye were outlined with black paint and in order to highlight the outlining in addition to red, black was also used, in such a way that under the red line, a black line was drawn so, the intensity the red line has been multiplied. When the painting and decorating of clothes and so on were finished, to protect the paint layer a solution of tragacanth and sugar would be covered on the painting (Aghajani, 1981: 160-178).

8. Conclusion

In this study, the works of Hossein Aghajani-Esfahani were analyzed and evaluated, apart from his works, his life was also studied. In regard to, who and what have led to his successes. Therefore, the biography of Aghajani was observed then his restoration works of paintings in historical buildings were discussed. In other words, each biography has two layers, one layer is a narrative individual and personal events and another layer is the narrative of historical and social events. In a sense, biography is a hole that each reader can observe through it a wide range of historical and social and cultural invents of a period, and evaluates it. Then, the importance and necessity of restoration and its approaches and restoration of painting works and the restoration of decorations of the building were discussed, because he was majoring in the field of Restoration of Monuments. The features of restoration work of Aghajani are in such a way that the restoration of the paintings is mostly done by oil painting technique and tempera on the wall, and the restorations of decorations of the building were done on tiles and plasterworks and mirror works of the historic building.

In Iran, oil painting technique has been used; due to the dry climate in most parts of Iran watercolor was mostly used (color + water soluble base). In Iran, in most of the works in buildings and mosques, often watercolor techniques were used for creation of artistic paintings. The other feature of his restoration works is that the mostly used motifs are traditional motifs and sometimes it was a combination of tradition and modern. For example, in the restoration of the Shrine of Sukayneh Bint Huseyn (peace be upon her) the motifs are traditional and coloring is modern, but in his personal works he is inspired by modern motifs and has combined with his method and traditional motifs. Restoration activities have been carried out on the restoration of historical buildings and paintings, and architecture and decoration of the building. Most of the restored subjects of historical buildings in Isfahan or in other cities are the paintings on the walls or murals, such as Chehel Sotoun, Alig Qapu, Qeysarie Gate, and Eight Paradises, in which the tempera technique plaster and oil paint have been used. In Hussaynias and tombs, most of the restored subjects are done on tiles that are traditional motifs and the colorings are either traditional or modern; in some of these tombs, there have been some paintings that have been restored, for example Haronie tomb, which inside the monument there are some floral and birds' motifs as well. Most of the motifs of the historical buildings relate to the Safavid and Qajar eras. Some of the buildings, building constructs, and motifs used in buildings belong to Qajariyyeh era, and some of the architectural buildings belong to the Safavid era but the paintings relate to the Qajariyyeh, like Chehel Sotoun Palce, this palace was created in the time that Safavid government were transferring its administrative offices to Isfahan. But the Persian Miniatures were painted by Reza Abasi in the Qajariyyeh era; these paintings were also restored and repaired by Qajar style. The main goal here is to introduce this artist to the art community; this study has evaluated his works from young age to the present time, and since there was no document of his works, some of his works has been collected in this research.

Table 1 Documents of the Restored works in Isfahan, Restorer: Hossein Aghajani-Esfahani, (Source: Author, 2016)

Location	Technique	Time Period	Subject	The works of Historical Buildings	
Chehel Sotoun Palace	Oil paint on Plaster	Safavid	Banquet Party		
Eight Paradises Palace	Tempera on Plaster	Safavid	Muqarnas		
Ali Qapu Palace	Tempera on Plaster	Safavid	Vase Cutting		
Qeysarie Gate	Oil paint on Plaster	Safavid	Hunting		
Ashraf Hall	Dead Plaster	Safavid	Mi’raj		
Jameh Mosque	Plasterworks and Tile Restoration	Safavid and Seljuk	Geometric Motifs		
Imam Mosque	Painting on Tile	Safavid	Forrest		
Shahshahan Mausoleum	Tempera on Plaster	Timurid	Geometric Motifs		
HAronie Boqeh	Tempera on Plaster	Safavid	Gerefteh Gir		
Ezhei’e House	Tempera on Plaster	Qajar	Still Life of Landscape		

Ali Qoli Aqa Bathroom	Tempera on Plaster	Safavid	Hunting		
Kamal Zoorkhaneh	Tempera on Plaster	2015	Shamseh		
Hossaynieh Imam Ja'far Al-Sadiq	Tempera on Plaster	2011	Arabesque Motifs		
Shafti's Hitsorical Hose	Tempera on Plaster	Qajar	Flower Motifs		
Sokias' Hsitorical House	Tempera and Mirror Working	Safavid	Foreign Christian		
Haratian'S Historical House	Oil Painting	Safavid	Hunting		
Imam Ali Mosque	Tempera on Plaster	Safavid	Rasmi-Bandi		
Imam's Door Mosque	Tile Restoration	Safavid	Arabesque Motifs		

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A Systematic Review of Fractal Theory and its Application in Geography and Urban Planning

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Research Article

Abstract

Fractal has been considered as an optimized structure of nature and an effective tool for depicting spatial complexity. A city can be deemed as a fractal system with self-similarity, and are, therefore, ideal candidates for fractal analysis. Recent decades have witnessed great strides in research on fractal cities in various aspects of urban forms and structures as well as urban development dynamics. Considering the deep and wide-ranging applications of fractal theory in explaining local and spatial complexities, this study aimed at conducting a systematic review and content analysis of research conducted on fractal in order to pinpoint practical and theoretical frameworks they can provide to specialists in the fields of geography and urban planning. To this end, a systematic review was carried out in three general stages of study selection, evaluation, and synthesis of findings. Results showed that developing and emerging concepts in theoretical and experimental studies, which has sought to explain the roles and applications of fractal theory in research and simulations of the built environment could be classified in 10 areas of psychology, architecture, urban design, urban form and structure, urban boundary shape, land use, urban traffic, urban growth modeling, urban hierarchy, and benefits of fractals. Studies related to urban form and structure (N= 37) accounted for the largest share of studies. In addition, key methods leading to the development of fractal studies in the existing literature were use of fractal dimension and Hausdorff dimension (34%), boundary dimension (24%), and network or box-counting dimension (14%) followed by power law (PL) distributions, power laws, and power-scale law (7%).

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Keywords: Fractal Theory; Systematic Review; Content Analysis; Measures and Measurement Method; Urban Planning

1. Introduction

Euclidean geometry has had a decisive role in shaping our perceptions of nature and space for more than two thousand years. It has been influential to the extent that it has turned into an ideology, which imposes a logical pattern on nature, instead of proving a realistic description thereof. The revolutionary nature of fractal geometry lies in providing a more accurate description of nature. In fact, Mandelbrot coined the word fractal from the Latin word Fractus, meaning broken, irregular, and fractured. Mathematicians using fractal geometry focus on describing nature instead of governing it (Blanco Rivero, 2019). Examining the world around us, one can see a certain regularity in the complex system of nature and the human mind, which is necessary for the establishment of order and balance in life. Therefore, decision-making in different situations requires the mental simplification of complexities to find a kind of regularity in order to identify and remember patterns, which in turn, can lead to conscious discovery of design patterns (Sharif and Mohammad Ali Nejad, 2: 1). The fractal dimension is a measure of the extent to which a self-similar figure is “complicated” (El-Darwish, 2019).

Fractal theory emerged after the theories of "complexity" and "chaos" in the 1970s (Kiani and Amiriparyan, 2016). The shape of the fractal geometry originates from growing and developing or dividing recursive geometric series (Vaughan and Ostwald, 2016). Today, fractal geometry is a powerful tool that has long been used by researchers in the field of urban studies (Arlinghaus, 1985; Arlinghaus and Arlinghaus, 1989; Batty, 1995; Batty and Longley, 1994; Benguigui and Daoud, 1991; Thomas et al., 2010). Fractals have fractional dimensions with self-similar properties (Falconer, 1997).

Fractal is an optimized structure of nature and an effective tool for depicting spatial complexity (Liu and Chen, 2007). Fractal geometry is a powerful tool in spatial analysis and can be seen as a new look at urban and regional systems (Batty, 2008). It is argued that a city can be considered as a fractal system with self-similar properties (Batty, 2008; Batty, 2005; Benguigui et al., 2000; Chen, 2010; Feng and Chen, 2010; Thomas et al., 2007; 2008). Research on fractal cities can improve the effective use of urban geographic space (Chen, 2005). Analysis of urban forms and structures can reveal important geographical information about urban spatial development and regional urbanization. Fractal dimensions of urban form as stated in fractal theory have attracted much attention leading to many related studies. Fractal dimensions are effective measures for fractals because they can compact large amounts of spatial data into simple numbers to uncover the hidden spatial information behind the city (Chen and Huang, 2019).

Fractal city studies can lead to a new urban theory. Urban geography studies should explore simple and complex aspects and the relationship between complexity and simplicity of places (Chen, 2017). Given the deep and wide-ranging applications of fractal theory in explaining local and spatial complexities, this study aimed to answer the following question: “What practical and theoretical frameworks useful for specialists in the fields of geography and urban planning can be achieved via a systematic review and content analysis of research conducted on fractals?”

2. Literature Review

2.1. Systematic Review Steps

This section comprises a systematic review of previous studies on the research topic. This method allows for summarizing, interpreting and understanding the patterns in previous research findings as well as the possibility for objective representation of data (Lipsey and Wilson, 2001). Thus, steps of a systematic review are:

- Specification of the research topic;
- Statement of a research topic or question and explanation of the importance of using a systematic review;
- Detailed statement of study selection criteria; and
- Systematic search for related studies

which together constitute the "collection" stage.

The above steps are followed by:

- Assessment of the eligibility of studies (to exclude low quality studies and publications and those that are biased);
- Preparation of a summary of findings; and
- Systematic extraction of data through a content analysis approach;

which together constitute the "appraisal" stage.

Then, the review continues with:

- Descriptive analysis of studies (classification of studies based on different criteria via descriptive investigation);
- Narrative analysis and interpretation of studies; and
- Graphical and tabular presentation.

which together form the "synthesis" stage (Figure 1).

Fractal research in urban planning and design has a long history. In this part of research, a systematic review of studies in this area was performed. The word Fractal was searched in the Science Direct database resulting in more than 87,000 articles as of October 10, 2020. Other keywords and phrases searched were: "fractal", "fractals", "fractal in city", "fractal in planning" and "fractal in urban design". After limiting the searched terms, the number of studies reduced significantly and the focus shifted to geography and urban planning. It should be noted that other databases used in this part of research were: Web of Science, Science Direct, and Scopus. In addition, Iranian databases of SID, Magiran, and Noormags were searched. As expected, a large proportion of these studies were those in other disciplines and sciences

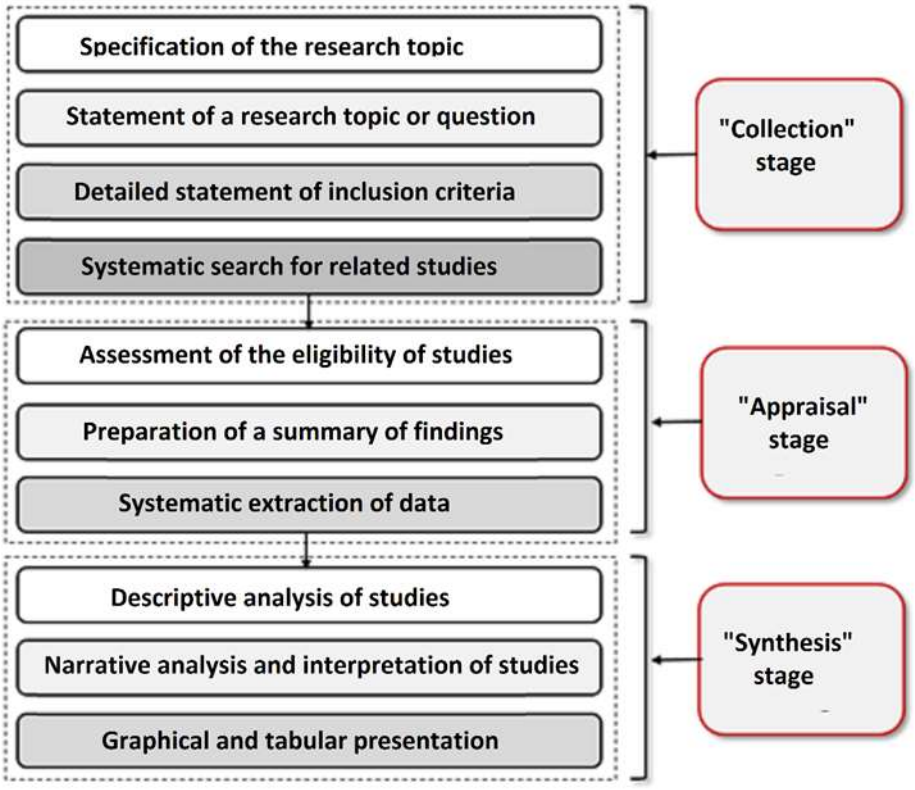

Fig 1 Stages of systematic review of fractal research in urban planning (Source: Authors)

2.2. Systematic Review Questions

Questions had been formulated before the systematic review strategy and study selection criteria were stated. Two research questions were asked during the review:

1) What are the emerging concepts in theoretical and experimental studies that explain the role of application of fractal theory in the study and simulation of built environments?

2) What key theories and methods have led to the development of fractal studies in the literature on architecture and urban design and planning?

In the following sections, an attempt has been made to give comprehensive and appropriate answers to the mentioned questions.

2.3. Systematic Review Strategy and Study Selection Criteria

As studies can be selected from published and unpublished journals, reports, books, dissertations, technical reports, conference presentations, etc., the researcher did not have limitations in selecting studies in the first step. Therefore, inclusion criteria were theoretical and practical studies related to the searched keywords, and exclusion criteria included publications that did not have a valid and academic database, such as news, periodicals, non-English language publications, articles in which bias was observed, and articles that did not use up-to-date data. In addition, studies that were outside the scope of the research and articles that were not available in full text were also excluded from the review at this stage (Lipsey and Wilson, 2001).

In the first step, all studies related to the subject were searched as explained in the mentioned databases (1079 studies). In the next step, the study titles were reviewed and articles that were not related to the fields of architecture, urban geography, and urban planning, design, and management were excluded from the sample (352 studies). Afterward, studies whose full texts were not available were excluded leading to a drop in studies (179 studies). After that, abstracts of the remaining studies were studied and those that were not valid were excluded (143 studies). The final selection was done by studying the full texts of selected studies (102 studies, including 91 external studies and 11 domestic studies). In the following sections, the most important studies are discussed with emphasis on their methodology, criteria and indices, as well as their findings and results (Figure 2).

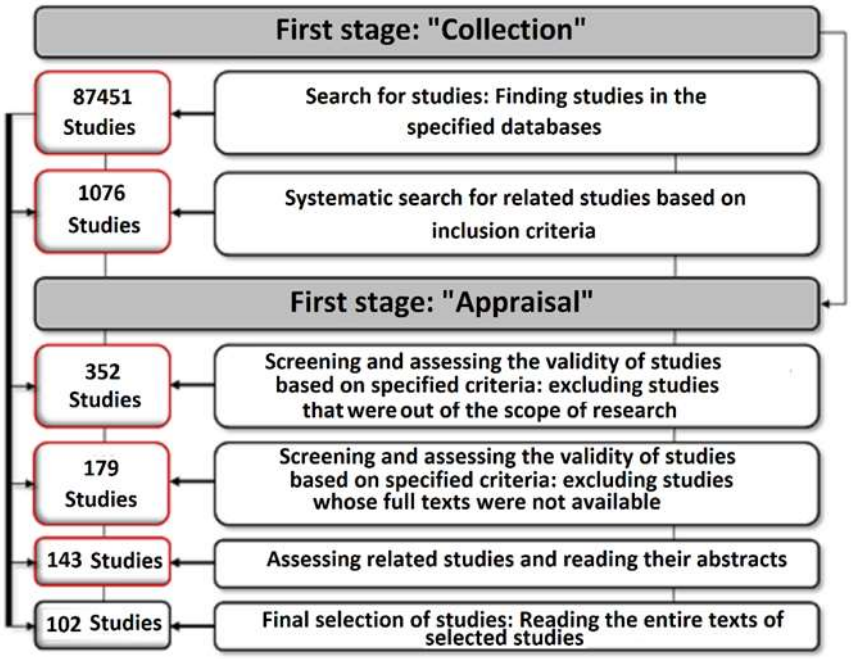

Fig 2 Systematic Review Strategy and Study Selection Criteria (Source: Authors)

In a study entitled "Multi-fractal measures of city-size distributions based on the three-parameter Zipf model", Chen and Zhou (2004) investigated the relationship between urban hierarchies and self-organized multi-fractal networks. To this end, they uncovered the multi-fractal nature of the urban hierarchy, which is related to the rank-size distribution of cities in an area. Putting the questions of "how can we interpret the multi-fractal structure of urban hierarchies, or where is the underlying rationale of the multi-fractal measures of urban systems?" (p. 793), they tried to clarify the underlying logical relationships (Chen and Zhou, 2004). In "Connecting the Fractal City", Salingaros (2004) describes distinct types of cities through connective geometry, which includes different degrees of urban life, and defines fractal, scale, and connection in more technical terms. He examines the relationships between urban components and offers a fundamentally different definition of a city, to clarify what type of city is fractal (Salingaros, 2004). In an article entitled "Comparing the morphology of urban patterns in Europe: a fractal approach" Frankhauser (2004) concludes that fractal model is a proper way to compare the diverse morphology of European cities. In the study, the model is used to identify the morphology of Brussels, Lyon, Stuttgart, Helsinki, Bergamo and Strasbourg (Frankhauser, 2004).

In the study, "Fractal characteristics of soils under different land-use patterns in the arid and semiarid regions of the Tibetan Plateau, China", using the fractal dimension of particle-size distributions, Wang et al. (2006) found a relationship between land use and fractal dimension of PSD in the said areas in China (Wang et al., 2006). Thomas et al. (2007), in their study entitled "Fractal dimension versus density of the built-up surfaces in the periphery of Brussels", compared fractal-based parameters and different methods of fractal calculations used in Brussels to explain spatial variations using geographical variables and urban economics and land use planning (Thomas et al., 2007). Jehnsen et al. (1994) reported the results of applying fractal methods and patterns in inner urban structures. In addition, in the article "fractal based design model for different architectural languages" Gozubuyuk et al. (2008) used box-counting method to analyze urban design and traditional buildings in the two historical regions of Istanbul and Mardin in Turkey in order to determine their Fractal dimensions.

"Thomas et al. (2008) in the article entitled "Is there a link between fractal dimension and residential environment at a regional level?", studied the statistical relationship between fractal dimension and residential satisfaction. The study showed theoretical relationships and statistical relationships between some fractal indices and built environment quality (Thomas et al., 2008). In the article "derivation of the functional relations between fractal dimension of and shape indices of urban form", Chen (2011) points to the relationship between size, scale, shape, and dimension of urban settlements as basic problems that should be solved in near future and hopes his study can help provide an achievable perspective for understanding those problems. Therefore, the relationships between the fractal dimension of urban boundary and the compaction ratio of the urban shape were investigated in the study using a simple geometric measure. Compression ratios were shown to be exponential functions of the reciprocal of the boundary dimension. The results could be generalized and applied to common shape indices including circularity ratio, ellipticity index, and form ratio as defined by urban area, perimeter, or Feret's diameter. It can be concluded from the said study that certain functional relations exist between the shape indices on the one hand and the boundary dimension on the other. In addition, within certain range of scales, ratios of size measurements can be used to estimate fractal parameters indirectly in order to reflect the features of urban shapes (Chen, 2011). Batty (2011), in a study on the new science of cities, evaluated and compared similar dimensions of cities such as London, Tottenham and Birmingham based on satellite images. In his view, self-similarity is a decisive factor in urban morphology. He used satellite images taken in 1991-2000 and concluded that the old parts of the cities under study were more complex than the checkered and newly built sections.

Chen (2013) in his article "Fractal analytical approach of urban form based on spatial correlation function" states that though urban form has been empirically proven to be invariant in terms of scaling, can be described by fractal geometry. However, the rational range of fractal dimension value and the relationships among different fractal indicators in cities are not theoretically uncovered yet. He used mathematical transform and found that fractal concepts were associated with scaling analysis, spectral analysis, and spatial correlation analysis and can be incorporated into a novel approach to fractal analysis of cities. He called the method, '3S analyses' of urban form, and used it to obtain a set of fractal parameter equations, to find the relationships among different fractal parameters of cities. Each fractal parameter has a reasonable range of values, and, according to the fractal parameter equations, the intersection of such ranges of different fractal parameters suggests the proper scale of the urban patterns' fractal dimension, ranging from 1.5 to 2. Geographers benefit from 3S-analysis-based fractal dimension equations and the numerical relationships between different fractal parameters to understand urban evolution and future city

planners can possibly use them in their future planning (Chen, 2013). Feng and Liu (2015) in their article "Fractal dimension as an indicator for quantifying the effects of changing spatial scales on landscape metrics" state that though geographers and ecologists are aware of the scale effects of landscape patterns, quantifying such effects is still required. They used the fractal method to appraise the scale (grain or cell size) of landscape metrics at landscape and class levels. To this end, they changed the polygon data of the original land use into raster data at eleven aggregate scales to evaluate the fractal dimensions. They witnessed a fractal law consistent over a range of scales for most landscape metrics in the area and edge, shape and the aggregation groups. Moreover, the scale effects were more complex at the class level compared to those at the landscape level. Using the fractal method for quantitative evaluation of the scale effects can be used as a basis for studying landscape patterns at the time of upscaling or downscaling and is also useful in understanding landscape patterns (Feng and Liu, 2015).

In their article, "Fractal behavior of traffic volume on urban expressway through adaptive fractal analysis", He et al. (2015) point to fractal analysis as a widely used tool in a variety of fields such as finance, physiology, precipitation, biological systems, language and culture, geophysics, etc. They aimed at applying adaptive fractal analysis to traffic volume. In their paper, the autocorrelation function adopted on traffic volume data showed a long-range correlation behavior in two situations investigated (He et al., 2015). In their study "fractal dimensions of urban border as a criterion for space management", Jevric and Romanovich (2016) state that today, the residents of large cities tend to be in the vicinity of open spaces for various reasons, e.g., reducing stress, noise pollution, traffic, etc. and such tendency even exists in Podgorica (Montenegro). This claim was confirmed by the results of questionnaires completed in their study. Information on the fractal dimensions of urban boundaries and urban areas can be used as a parameter for making decisions related to spatial development. In this way, suburban areas that form urban boundaries can be compacted but this should not be done at the expense of their contact with open or green space (Jevric and Romanovich, 2016). In a study entitled "the role of city size and urban form in the surface urban heat island", Zhou et al. (2017) investigated the effect of urban form and size on heat islands and found that the intensity of heat islands among 5,000 large cities was directly associated with city size and urban fractal dimensions, but was inversely related to the anisometry logarithm of the cities. City size had a significant effect on heat islands; therefore, small towns had fewer heat island cores than did stretched and scattered cities (Zhou et al., 2017).

In the study, "spatial analysis of cities using Renyi entropy and fractal parameters", Chen and Feng (2017) divide spatial distribution of cities into two groups: 1) simple distribution with characteristic scale such as exponential distribution; and 2) complex distributions without uncharacteristic scale like power-law distribution. The second case belongs to scale-free distributions that can be modeled using fractal geometry. However, the fractal dimension is not suitable for the first type of distribution. In contrast, spatial entropy can be used to measure any type of urban distribution. Thy aimed at using the dual relation between Euclidean and fractal geometries to generalize multi-fractal parameters. They used mathematical derivation and empirical analysis as their main methods, and used the fact that the normalized fractal dimension is equal to the normalized entropy, as their theoretical foundation. On this basis, they defined spatial indexes called “dummy multifractal parameters” for geographical analysis. Such indexes could be used to describe both simple and complex distributions. They applied dummy multifractal indexes to investigate the population density distribution of Hangzhou city, China. The results showed the spatio-temporal evolution of urban morphology in Hangzhou. The study indicated the usefulness of combining fractal dimension and spatial entropy to achieve a new method for spatial analysis of

city development. An objective of the study was to link the traditional ‘scale-based spatial analysis and future scaling-based spatial analyses of cities to create a methodological framework for urban studies (Chen and Feng, 2017). In a study entitled "Temperature-Humidity Index described by fractal Higuchi Dimension affects tourism activity in the urban environment", Ana Maria et al (2018) used fractal index to investigate the effects of these indicators on tourism. The study area was Focşani City in Romania studied from 2001 to 2016. The results of studies showed that high temperature and humidity directly affected tourism and Higuchi Dimension (DH) could best show the monthly and annual effects of temperature and humidity on tourism. The study also identified indicators with direct negative effects on tourism (Ana-Maria et al., 2018).

In the study, "spatial-temporal fractal of urban agglomeration travel demand", He (2020) specified spatial-temporal networks for travel demand through spatial-temporal analysis and explicit analysis of network characteristics. The results showed that the degree distributions of the networks of spatial–temporal travel demand follow power laws, which decreased with the growth of the square cells used to ‘divide an urban agglomeration to aggregate travel demand’. However, following power laws was not affected by ‘the spatial–temporal granularity of network construction’. This showed that urban agglomeration travel demand had a spatial–temporal fractal nature. These findings can help us understand the nature of travel demand as well as human movement across an urban agglomeration (He, 2020). Gong et al. (2020) carried out a study entitled "Research on the complexity of form and structure of green spaces based on fractal models" state that the fractal nature of urban green spaces is the product of the self-organizing evolution of complex urban systems into higher levels and patterns. The regular and complex structures of urban green space emerge after a certain stage of development. Based on GF1 satellite data collected in 2019 and three fractal models, the complexity of the shapes and structures of a green space system in downtown Dalian, China were examined. The results showed that the boundary dimension measured by the perimeter-scale model was 0.64-1.40 and the boundary dimension measured by the area-perimeter model was 1.79-1.99. These indicated a high degree of human disturbance in the boundaries of green space, and a poor stability of green space spatial structures (Gong et al., 2020).

Among studies carried out in Iran, Mohajeri (2007), in a study entitled “fractal city, the language of nature in urban design”, studied the city of Yazd based on the laws governing fractals and showed the city's compliance with fractal laws. In the dissertation entitled "Fractal geometry, complexity and the nature of urban morphological evolution: developing a fractal anaylsis tool to assess urban morphological change at neighborhood level", Haghani (2009) showed the failure of Euclidean geometry in understanding the city geometry and the need for applying the theory of complexity and fractal geometry in measuring city morphology, and using the fractal dimension as a decisive characteristic to depict the complexity of urban contexts. He examined the context of District 1 in Tehran and specifically analyzed the experimental changes over time using fractal dimension. Based on fractal dimensions obtained via Benoit 1.3 for the neighborhood units in the region, he demonstrated the reduction of complexity over time in the context and concluded that the fractal dimension, as a unique characteristic, should be considered as a determining factor in zoning urban contexts. Madani Isfahani (2011), in a study entitled "Urban space design, an intervention in a complex system with emphasis on geometric fractal dimensions in the urban landscape", investigated three samples of Isfahan Bazaar, Chaharbagh Abbasi Street as the main structure of Isfahan, and Olfat Street is the main axis of the new city of Baharestan in terms of fractal geometry. Then, according to characteristics of organic structure of markets, the actual and potential characteristics in its perspective were analyzed and compared with two other samples. Finally,

using the results obtained from the geometric analysis of market bodies, visual frameworks and patterns were provided for new designs or arrangements.

In a study entitled "a comparative study of morphology of old and new urban contexts based on fractal model: the case of selected neighborhoods in old and new contexts of Zanjan" Heidari (2016) introduced the fractal model and its role in the study of the old context and the new city of Zanjan. Findings showed that the fractal model was a real and accurate tool for understanding the form of cities and that the old context of Zanjan is more fractal compared to the new one. In another study entitled "Study of urban context dispersion using fractal geometry model and complexity theory to find urban development patterns in Tehran's 20th district", Goodarzi et al. (2015) attempted to find the urban sprawl pattern taking into account the indicators of density, area of built environments, etc. The study investigated horizontal development and urban growth, and then measured fractal dimension using GIS techniques along with statistical indicators and aerial photographs. The results showed that among the areas of the southern part of Tehran, District 20 sprawled towards the surrounding villages in the south getting close to Shahriar and Shahre Quds to the west. The study of the degree of sprawl and complexity of the district using satellite images of 2006 and 2011 and fractal dimension calculations showed a direct relationship between the amount of complexity and urban sprawl. Mirkatouli et al. (2014), in their study entitled "explaining different aspects of using fractal geometry in geographical analysis and urban planning", introduced fractal geometry and the effects of fractal dimension on the city as a whole and its elements. In addition, the relationship between fractals in geography and its sub-disciplines (physical and human geography) was discussed and the role and application of fractals in geography and urban planning were presented. In the meantime, the characteristics and typology of cities with fractal structure built and formed throughout history and the effects of fractals on the development of cities were pointed out, and finally the implications for planning and designing urban spaces based on geometry of fractals with a focus on geography. In a dissertation entitled "the effects of external constraints on the overall shape and internal geometric patterns of cities", Mohajeri (2012) examined city growth over time by focusing on the network of roads and the direction of their expansion, and showed the geographical and natural factors limiting and controlling the city growth using Georient software. The results proved that the size and direction of the road network and consequently the shape of the city were affected by geographical factors. Then, using power-scale law and dividing the road network into specific categories based on cumulative frequency, the compliance of the road network with the power-scale law was shown. According to the obtained results, there was a significant relationship between the length of the road network and the typology of the network of passages based on their functions (local, collector and distributor, main arterial roads, etc.) in a scientific way. Based on what was mentioned in this section, the results and findings of studies related to urban fractals will be discussed below.

2.4. Classification of Previous Studies

In this section, in order to answer the questions raised at the beginning of the systematic review, a comprehensive classification of various dimensions was done based on the thorough search presented in the previous section. In response to the first question, i.e. "What are the developing and emerging concepts in theoretical and experimental studies that can explains the role and applications of fractal theory in the study and simulation of the built environment?", different studies were classified in 10 categories including 1) psychology, 2) architecture, 3) urban design, 4) urban form and structure, 5) urban boundary shape, 6) land use, 7) urban traffic, 8) modeling urban

growth, 9) urban hierarchy and 10) fractal benefits. Each category includes more detailed research sub-fields (Table 1).

Table 1 Classification of articles by different fields of study (Source: Authors)

Field of study	Research sub-fields	Researchers	Number	Share of the total
Psychology	Psychological effects of fractal forms on individuals	Abboushi et al., 2019 Taylor, 2006 Chalup, et al., 2008 Pihel, 2011 Lorenzos et al., 2017 El-Darwish, 2019	6	4.7
	Investigating the relationship between fractal dimension and residential environment satisfaction	Thomas et al., 2008 Cavailhès et al., 2009	2	1.6
	Tourism activities in urban areas	Ana-Maria et al., 2018	1	0.8
Architecture	Identifying the applications of fractal forms in architecture (layout and order, hidden structural advantages)	Sakai et al., 2012 Burkle-Elizondo, 2001 Burkle-Elizondo and Valdéz-Cepeda, 2006 Gozubuyuk et al., 2008 Capo, 2004 Rian and Asayama, 2016	4.7	6
Urban Design	Identifying applications of fractal forms in urban design	Lu et al., 2012a, 2012b Robertson, 1995 Batty and Longley, 1994 Bovill, 1996 Cooper, 2005 Mohajeri, 2007 Madani Isfahani, 2011	8	7.9
	Relationships among urban components	Salingaros, 2004	1	0.8
	Investigating the concept of compactness ratio and fractal dimension	Wang et al., 2006	1	0.8
	Urban Morphology	Frankhauser, 2004 Batty, 2011 Tannier and Thomas, 2013 Weber, 2001	4	3.2
	Investigation of the relationship between fractal and urban density	Thomas et al., 2007 Batty, 1995 Frankhauser, 1998	3	2.3
Urban form and structure	Studies of urban and regional form and structure and urban distribution	Batty and Longley, 1994 Chen, 2011, 2013, 2017 Jevric and Romanovich, 2016 Batty et al., 1989 Jehnsen et al., 1994 Cort, 2013 Alam, 2018 Sogo et al., 2018 Gong et al., 2020 Heidari, 2016 Goodarzi et al., 2015 Mohajeri, 2012	14	11.1

	Urban scale studies	Chen, 2013 Jehnsen et al., 1994 Zhou et al., 2017	3	2.4
	Urban rank-size distribution	Chen and Zhou, 2004 Dendrinos and El Naschir, 1994	2	1.6
	Investigating the concept of entropy ratio and fractal dimension	Chen, 2012, 2017, 2020 Chen et al., 1991, 1993 Feder, 1988 Ryabko, 1986 Feng and Chen, 2010 Batty, 2010 Batty et al., 2014 Hong et al., 2017 Kornejady and Pourghasemi, 2019	12	9.5
	Qualities of symmetry, self-similarity and diversity and difference in scale	Kiani and Amiriparyan, 2016 Sala, 2003 Chen, 2011	3	2.4
	Investigating the concept of complexity in fractal forms	Rian and Asayama, 2016 Batty et al., 1989 Liu and Chen, 2007 Chen, 2017 Kacha et al, 2013 White and Engelen, 1993, 1994 Batty, 2005 Gong et al., 2020 Jevric and Romanovich, 2016 Kornejady and Pourghasemi, 2019 Sezer, 2010	12	9.5
Urban boundary shape	Boundary dimension and urban border shape	Tannier and Thomas, 2013 Jevric and Romanovich, 2016 Gong et al., 2020 Batty and Longley, 1987, 1994 Longley and Batty, 1989 Frankhauser, 1994 Longley et al., 1991 Chang, 1996 Chang and Wu, 1998 Chen and Wang, 2016 Chen, 2013 Olsen et al., 1993	13	10.3
Land use	Urban land use studies	Batty and Longley, 1994 Gong et al., 2020 Barr and Barnsley, 1997	3	2.4
Urban Traffic	Fractal behavior of urban traffic volume	He et al., 2015	1	0.8
	Intra-city travel demand	He, 2020	1	0.8
Urban Growth	Remote sensing and urban growth models for understanding urban	Herold et al., 2001, 2003 Chen, 2013	5	3.9

Modeling	development	Jiang and Jia, 2011 Rozenfeld et al., 2008		
	Spatial development decision making	Jevric and Romanovich, 2016	1	0.8
Urban hierarchy	Urban and regional hierarchy	Batty et al., 1989 Matsuba, 2003 Chen and Zhou, 2004 Tannier and Thomas, 2013	4	3.2
	Searching for fractal geometry at different levels	Kiani and Amiriparyan, 2016 Chen and Zhou, 2004 Feng and Liu, 2015 Kaye, 1989 Wong and Fotheringham, 1990 Arlinghaus, 1985	6	4.8
Benefits of fractal	Identifying the properties and benefits of fractal forms	Rian and Asayama, 2016 Batty and Longley, 1994 Mandelbrot, 1983 Frankhauser, 1994 Chen, 2005 Chen and Huang, 2019 Anas et al., 1998 Lagarias, 2007 Cooper and Oskroch, 2008 Crompton, 2001 Kim et al., 2003 Mirkatouli et al., 2014	12	9.5

According on what has been said about the research fields extracted from the studies conducted on fractals, the percentage of the share of each of the 10 fields according were determined (Figure 1).

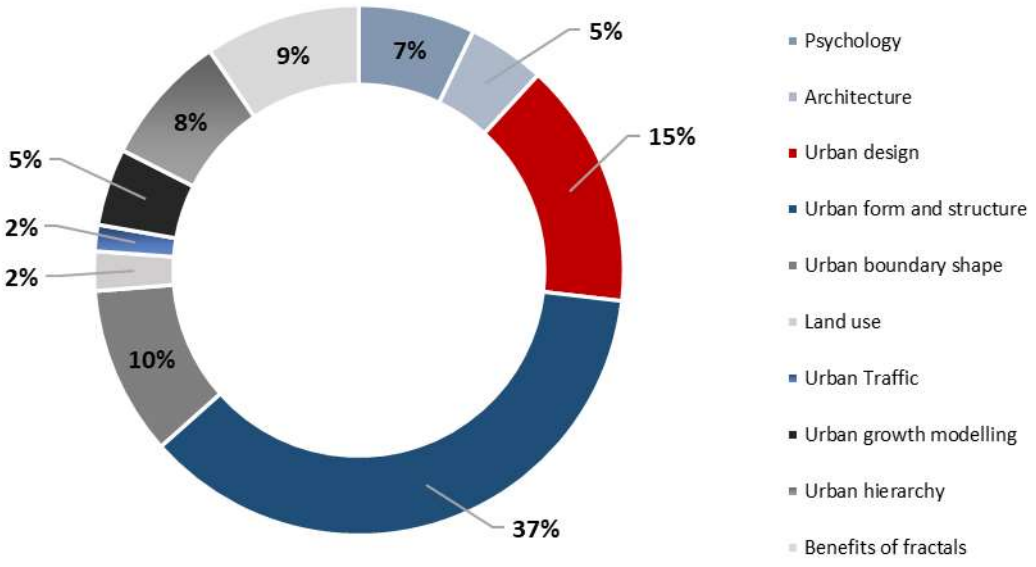

Figure 1: The share of each of the 10 fractal research fields extracted from the systematic review, Source: Authors

As shown in the diagram, studies related to the field of urban form and structure had the highest share of studies with 37%, followed by urban design (15%) and urban boundary shape (10%) and benefits of fractals (9%) as the most studied areas, respectively. In contrast, urban traffic (2%) and land use (2%) have been less studied compared to other areas. In the following, the share of each research sub-field is shown graphically (Charts 2 to 7).

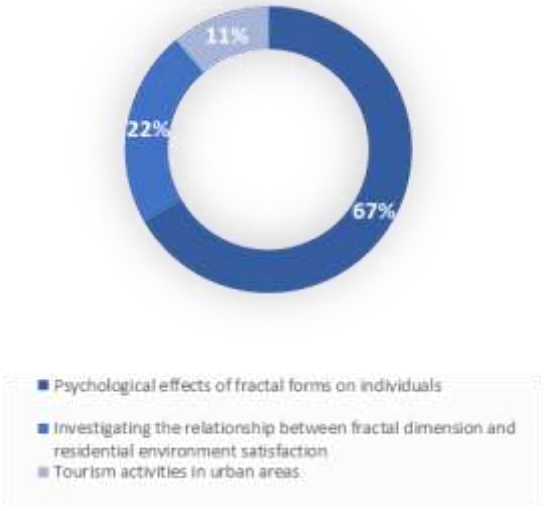

Fig 2 Share of research sub-fields in psychology

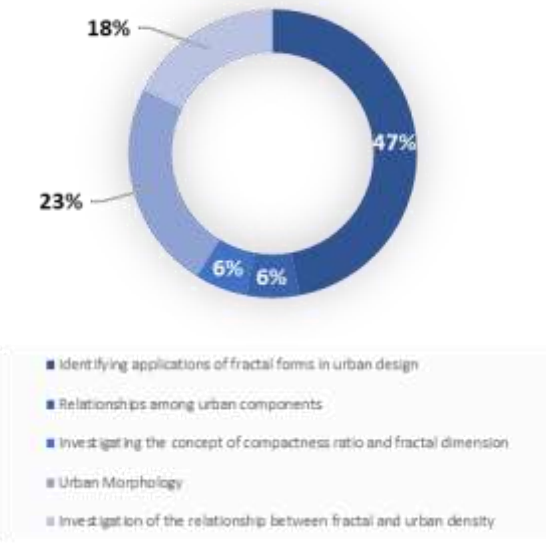

Fig 3 Share of research sub-fields in urban design

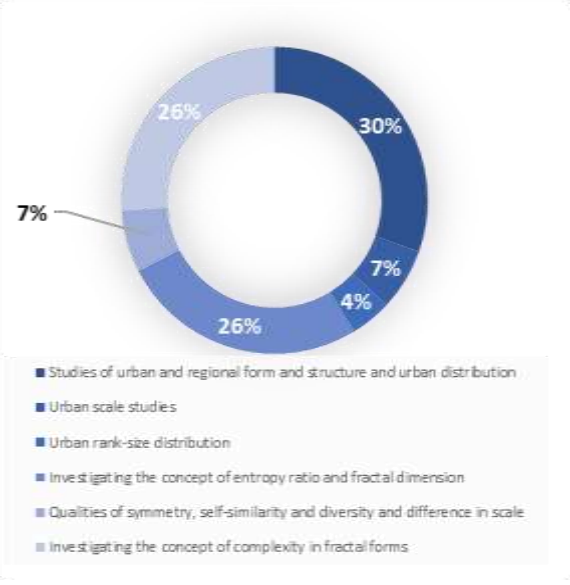

Fig 4 Share of research sub-fields in urban form and structure

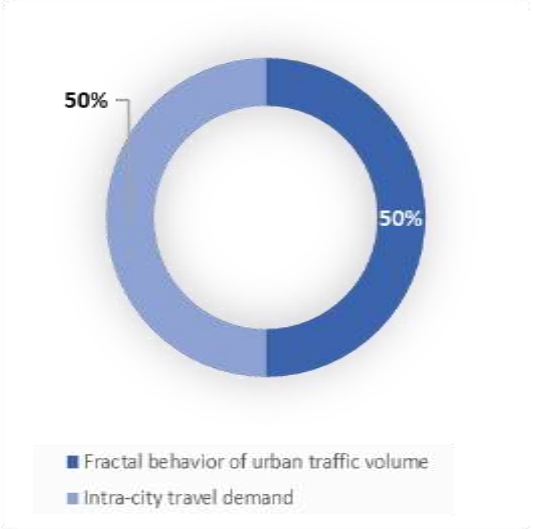

Fig 5 Share of research sub-fields in urban traffic

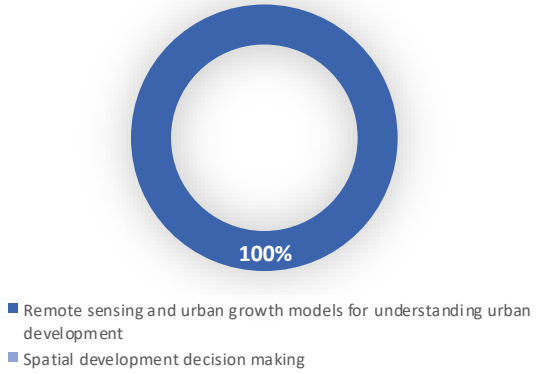

Fig 6 Share of research sub-fields in urban growth modeling

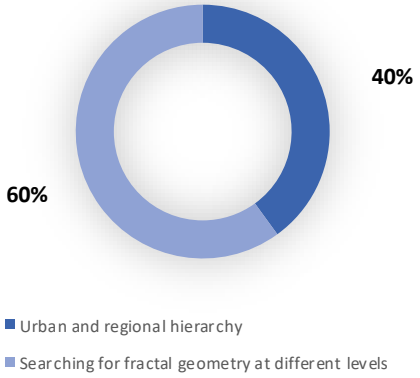

Fig 7 Share of research sub-fields in urban hierarchy

In response to the second question posed in the systematic review, i.e. "What are the key theories and methods that have led to the development of fractal studies in the architecture, design and urban planning literature?", the review of methods, measures and dimensions used in the studies showed that fractal dimension and Hausdorff dimension (34%), boundary dimension (24%), network or box counting dimension (14%) and power-law distribution, power-law and power-scale laws (7%) had larger shares (Table 2).

Table 2 Classification of methods, measures and dimensions used in the systematic review (Source: Authors)

Methods, measures and dimensions	Researchers	Number	Share out of the total
Circularity coefficient, ellipticity index and form ratio defined by urban area, perimeter or Feret's diameter	Chen, 2011 Kacha et al, 2013	2	3.6
Fractal and Hausdorff dimensions	Thomas et al., 2008 Bovill, 1994 Wang et al., 2006 Thomas et al., 2007 Tannier and Thomas, 2013 Chen, 2013 Feng and Liu, 2015 Jevric and Romanovich, 2016 Zhou et al., 2017 Chen and Huang, 2019 Anas et al., 1998 Lagarias, 2007 Balankin, 2020 Jimenez et al., 2019 Abboushi et al., 2019 Haghani, 2009 Madani Isfahani, 2011 Goodarzi et al., 2015 Mirkatouli et al., 2014	19	34.5

Standard circle and radius dimension	Chen, 2011 Frankhauser and Sadler, 1991 Chen et al., 1991	3	5.5
Self-similarity	Sala, 2003	1	1.8
Three-parameter Zipf model	Chen and Zhou, 2004	1	1.8
Grid dimension (box dimension), box counting method or raster analysis	Gozubuyuk et al., 2008 Benguigui et al., 2000 Chen et al., 1991 Chen, 2013 Gong et al., 2020 Frankhauser, 1998 Kacha et al, 2013 Sezer, 2010	8	14.5
3S Analysis	Chen 2013	1	1.8
Sprawl and complexity	Goodarzi et al., 2015	1	1.8
Adaptive Fractal	He et al., 2015	1	1.8
Power law (PL) distributions, power laws, and power-scale law	Chen, 2017 Chen et al., 1993 He, 2020 Mohajeri, 2012	4	7.3
Spatial Entropy	Chen, 2017	1	1.8
Boundary dimension	Gong et al., 2020 Tannier and Thomas, 2013 Jevric and Romanovich, 2016 Batty and Longley, 1987 Longley and Batty, 1989 Batty and Longley, 1994 Frankhauser, 1994 Longley et al., 1991 Chang, 1996 Chang and Wu, 1998 Chen and Wang, 2016 Chen, 2013 Olsen et al., 1993	13	23.6

The share of each of the methods, measures, and dimensions used in the studies examined is shown in the Figure 8.

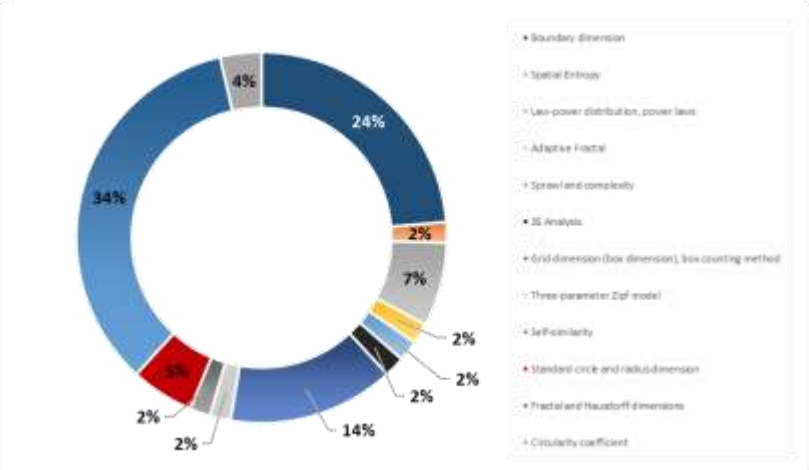

Fig 8 Share of each of the methods, measures, and dimensions used in studies included in the systematic review (Source: Authors)

3. Conclusion

As stated, new knowledge about complex systems has given rise to a new perspective to cities that might no longer be seen as a simple, organized system with linear geometry and structure, but as a complex organism demonstrating a special regularity through its shape at different scales. Fractal geometry is a powerful tool in geographical modeling and spatial analysis and has long been used in urban studies. Research shows that "cities are ideal candidates for fractal analysis", indicating that cities are formed through the gradual influence of local factors that create organized urban patterns.

Urban systems literature involves pioneering studies on the development and use of fractal geometry to understand and plan the physical shape and spatial network of cities. Fractal theory enables the mathematical modelling and computer simulation of urban systems. Different studies have shown how cities grow in ways that seem irregular at first glance, but show an underlying order demonstrating their complexity and diversity, when examined in terms of fractals. Research on fractal cities has witnessed a significant progress in various aspects, including urban forms, structures, transportation, and the dynamics of urban growth. Therefore, given the deep and wide-ranging applications of fractal theory in explaining local and spatial complexities, this study raised the question of what practical and theoretical frameworks useful for specialists in the fields of geography and urban planning can be achieved via a systematic review and content analysis of research conducted on fractals? With the aim of summarizing, interpreting, and understanding the patterns of findings in previous research, this study systematically reviewed and performed content analysis of existing studies in the selected field of research.

To this end, in the first stage, i.e., collection, the research problem or question was defined and criteria for study selection and systematic search of related resources were specified. The second stage, i.e., evaluation, involved reviewing the validity of studies, summarizing findings, and extracting data systematically. In the third stage; i.e., synthesis, descriptive analysis of studies, analysis, and interpretation of studies via descriptive methods and graphic tools were carried out. In addition, during the study, two research questions were posed. The first question was: What are the developing and emerging concepts in theoretical and experimental studies that can explains the role and applications of fractal theory in the study and simulation of the built environment? In order to answer this question, different research fields were classified in 10 categories including 11) psychology, 2) architecture, 3) urban design, 4) urban form and structure, 5) urban boundary shape, 6) land use, 7) urban traffic, 8) modeling urban growth, 9) urban hierarchy and 10) benefits of fractal, each containing more detailed research subfields. Among them, studies related to urban form and structure had the highest share of studies with 37%, followed by urban design (15%) and urban boundary shape (10%) and benefits of fractals (9%) as the most studied areas, respectively.

The second question was: "What are the key theories and methods that have led to the development of fractal studies in the architecture, design, and urban planning literature? In response, based on the methods, measures, and dimensions used in the reviewed studies, it can be concluded that fractal dimension and Hausdorff dimension, boundary dimension, grid dimension or box counting dimension, and power law (PL) distributions, power laws, and power-scale law had larger shares of application in the studies, respectively.

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