

A Proposed Digital Systematic Introduction to Measure Innovation and Creativity Levels in Interior Parametric Architectural Design

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Research Article

Keywords: Digital parametric architecture, Parametric interior design and furniture, Parametric design software, Innovation levels

Posted Date: February 1st, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1315683/v1>

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A PROPOSED DIGITAL SYSTEMATIC INTRODUCTION TO MEASURE INNOVATION AND CREATIVITY LEVELS IN INTERIOR PARAMETRIC ARCHITECTURAL DESIGN

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Abstract

Background: This paper aims to investigate the extent to which parametric design tools contribute to increasing innovation in interior furniture design. The research methodology measures creativity criteria based on the theoretical background and previous studies in this field. We use Statistical Package for the Social Sciences (SPSS) software with samples (40 professionals) of architects, designers and specialists to analyze the survey outcomes. Our methodology consists of three stages. In the first stage, a questionnaire and a survey on the main concepts, familiarity and applications of parametric design in furniture and interior design is done. Then, the stage of measuring the success and extent of fulfillment of parametric design characteristics criteria and indices in the modern parametric furniture. Finally, comparing the levels of creativity in some proposed types of traditional and parametric furniture (i.e. chairs and tables) in furniture interior design.

Results: The results show that; adoption of parametric design in interior furniture achieves good flexibility and streamlining. Also, it fulfills a good and perfect aesthetic, functional and innovative value, where the highest innovation index of 53% (good) is achieved. For parametric chairs the highest innovation index percentage is 38% (creative), while for traditional chairs is 41% (normal). The parametric tables highest percentage is 40% (creative), and for traditional tables is 57% (normal). Finally, we recommend and suggest applying in a larger scale the applied research study on all parametric interior design elements and not just some types of furniture, and examining the psychological impact on the user behavior.

Conclusions the parametric design tools for interior furniture actually help designers to make significant creative and innovative designs. This because they are more than just traditional engineering design tools. In this paper, we focus on tools, criteria and indices of furniture parametric interior design and their effects on increasing the creativity levels.

Keywords: Digital parametric architecture, Parametric interior design and furniture, Parametric design software, Innovation levels.



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Background:

The design process greatly and strongly affects human feelings and their psychological state. For psychological comfort, it is very important to make diversity, creativity and renewal in all external or internal design elements. Remarkably, the parametric architecture concept may be known to all professionals in the architectural or design activities. The parametric design is the establishment of a parametric model using the computer and by referring to the primary elements that formed each other through a number of clearly defined variables and constraints. Therefore, the parametric model can be changed or modified and re-established within the limits of compliance with the predefined conditions. Also, it can be updated by changing the parameters values while maintaining the relationships between its constituent elements. Continuous development and renewal of specialized engineering parametric design software enables users and designers to work with the parameters of new standard geometric shapes. During the design process, the parametric design passes through important stages, starting from developing ideas about the external construction of the building, as well as the internal design stage. There is much modern software which enabled architects to ease the formation and configuration of furniture. Also, it has provided a range of ideas that were not possible before and enabled mathematicians to reach and understand non-traditional shapes. These shapes have different characteristics from the traditional shapes and form the parametric topology.

Research Problem:

The research problem appears by answering the following question: Does the trend of parametric digital architecture affect the generation and production of new and innovative ideas in the field of furniture and interior design? To what extent is this achieved successfully and flexibly? This is in the absence of clear boundaries and a typical standard methodology about the various and multiple aspects of parametric modeling adopted by digital architecture in interior design and furniture.

Research Hypothesis:

The research assumes that following and adopting the parametric digital architecture in the interior design and furniture leads to the generation and the creation of new and diverse design ideas and methods in the field of the interior design and furniture.

Research Objectives:

- 1- Formulating the proposed numerical methodology for measuring innovation levels in parametric architecture in interior design.
- 2- Monitoring the most important applications of parametric architecture in the field of interior design, whether that includes interior wall cladding or interior design of the space with all its elements, including interior and exterior furniture, and what are the latest used computer programs.
- 3- Monitoring the cultural and cognitive returns of specialists and users of internal parametric architecture concepts in design and their pros and cons and their impact on the beneficiaries.

Research Methodology:

The research followed the descriptive analytical approach in addition to the questionnaire approach by surveying the opinions of specialists and accessing their knowledge of this modern concept and clarifying its most prominent pros, cons and characteristics. Also, it proposes a study of a protocol for measurement and comparison between the parametric design tools and the common traditional design tools. This is to understand the impact of the parametric design tools on the level of creativity, innovation and the extent of the transformation that can be achieved in this field. Therefore, we compare and clarify the differences between parametric and traditional design.

1. Research Theoretical Background

1.1 Parametric Architecture:

It is the architecture that uses information technologies in controlling its parts and in operating its various functions. It converges with the concept of smart architecture. Also, it can be defined as the architecture that results from the reliance on information systems in various life activities, which may be changed in its various aspects, whether in the form,

function or construction. [1].

1.2 Parametric Interior Design:

It is the modern technology emerging in the interior design and furniture software used in the parametric design by the computer (e.g., Generative Components, Rhinoceros, Digital Project, Maya, etc.). [2]. Which depend mainly on the use of a unit repetition system design. This results in impressive and innovative designs that are very complex and save time and effort, which previously seemed unrealistic and inapplicable. [3].

1.3 Parametric Interior Design Features: [4].

- Smooth and flowing lines, like a piece of cloth.
- Lack of decorative elements in the furniture.
- Curved geometric lines.
- Diversity of texture and external appearance of the furniture (e.g., rough, smooth, glossy, matte, etc.).
- Avoid normal geometric beginnings (e.g., squares, triangles, rhombus, etc.).
- Avoid simple duplication of elements.
- Maximum environmental sustainability.
- Enormity in the furniture dimensions compared to the traditional and classic style.
- Practicality and versatility where, at the same time, the piece of furniture can be a chair, table and wall shelves.
- Ease of cleaning the parametric furniture compared to the traditional one that has many details and decorations.

1.4 Parametric Interior Design Materials:

The parametric design idea is to protect the buildings and users as much as possible from the harmful effects of unnatural materials, so the main materials for furniture and decoration are often wood and natural stone. They are easy to use and eco-friendly, and their prices are relatively low. There are no additional treatments required due to the diversity of the natural colors and pattern of wood and stone [5]. In addition, plastics, glass, paper, cloth, rubber and other materials are also used in endless combinations and colors. [6].

2. Applied study

The proposed applied study is divided into three parts (Fig. 1). All of its stages are applied to the proposed applied samples (40 professionals) of architects, designers and professionals in the field of architecture and interior design. The statistical software SPSS is used to analyze the outcomes of the survey as follows:

- Part One: The stage of making a questionnaire and survey on the general parametric design concepts, the extent of familiarity and its applications in furniture and interior design.
- Part Two: The stage of measuring the extent of success and fulfillment of the parametric design criteria and indices in modern parametric furniture, which extracted from previous studies.
- Part Three: The stage of comparing the levels of creativity in some proposed types of traditional and parametric furniture (e.g., chairs and tables) in the furniture interior design.

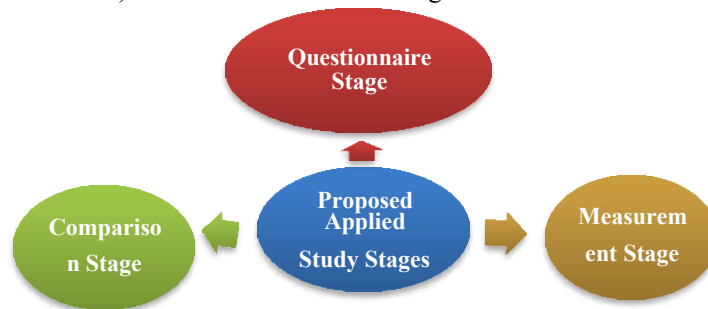


Fig.1 The stages of the proposed applied study, source: the researcher.

2.1 Part One (Questionnaire):

A questionnaire form (see Fig.2) is prepared on the parametric design concept and its applications in furniture and interior design. It is applied to a sample (40 professionals) of architects and specialists in this field, to know their theoretical background, information, awareness, impressions and influence on parametric design concepts:













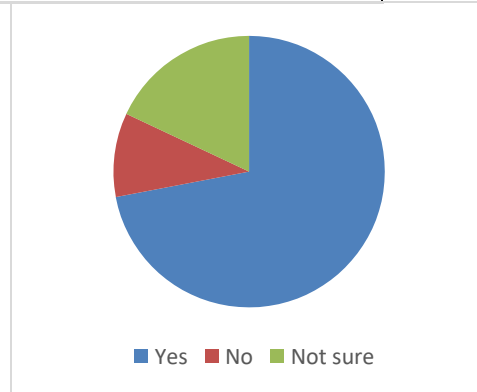
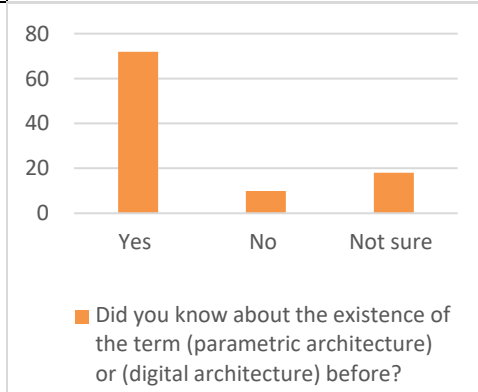
1- Did you know about the existence of the term (parametric architecture) or (digital architecture) before?			
Yes	No	Not sure	
2- What level of informational background do you have about digital architecture and parametric design?			
I have good information	I have simple information	I have no information about that	
3- By looking at some examples of parametric design in the following pictures, what is your impression of this type of design?			
			
Very good	Good	Acceptable	Unacceptable
4- By looking at some examples of parametric design in the following pictures, can you, as a specialist, adopt the concept of digital parametric design and use it, whether in architectural design or interior design?			
			
Yes	No	The possibility of this can be known after studying this architectural trend and its mechanisms.	
5- By looking at some examples of parametric design in the following pictures, do you find that digital parametric design has added more aesthetic and functional values to furniture than traditional design?			
			
Yes	No	To some extent	
6- From the above, in your point of view, what are the pros and cons of the parametric design?			
Pros:-----.		Cons:-----.	
7- Through the information available in the questionnaire, has information been added about the parametric design concept?			
Yes	No	To some extent	

Fig.2 Questionnaire form, source: the researcher.

3-Part one results:

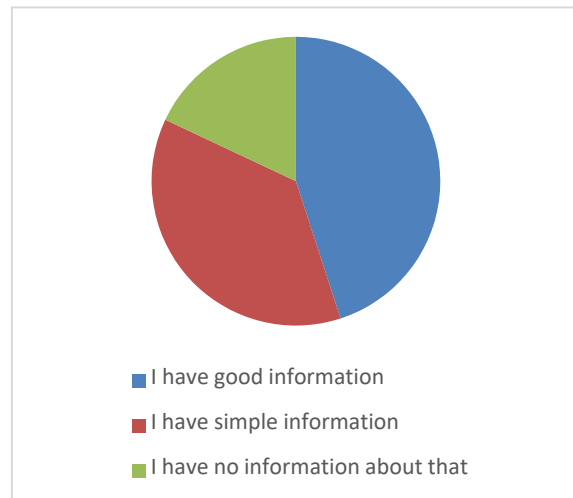
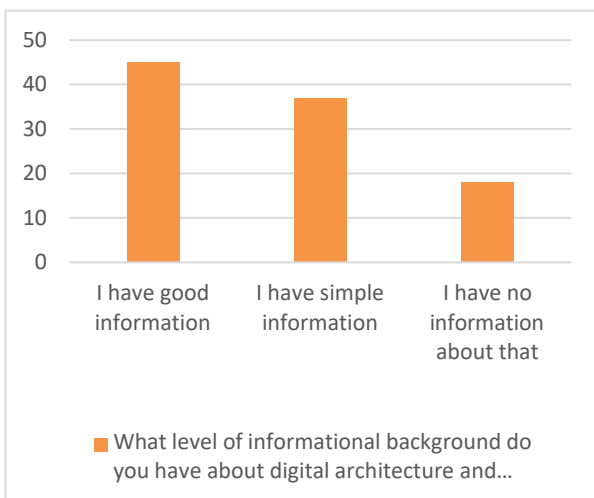
1- Through the proposed sample, it is clear that 72% of the sample knows the existence of the parametric architecture, while 10% does not know, and 18% uncertainly knows.

No.	1- Did you know about the existence of the term (parametric architecture) or (digital architecture) before?	percentage (%)
1	Yes	72
2	No	10
3	Not sure	18



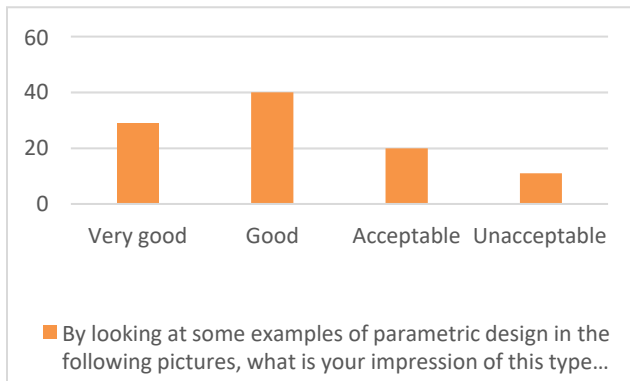
2- The results show that 45% of the sample has good information about the parametric architecture, while 37% has simple information, and 18% has no information about the parametric architecture.

No.	2- What level of informational background do you have about digital architecture and parametric design?	percentage (%)
1	I have good information	45
2	I have simple information	37
3	I have no information about that	18



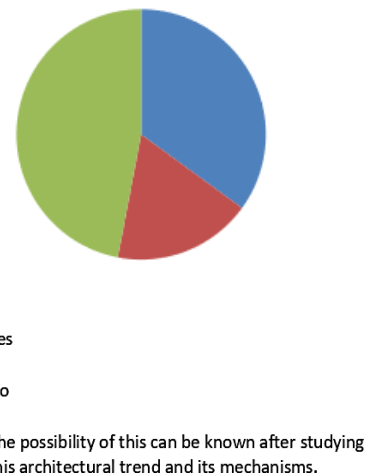
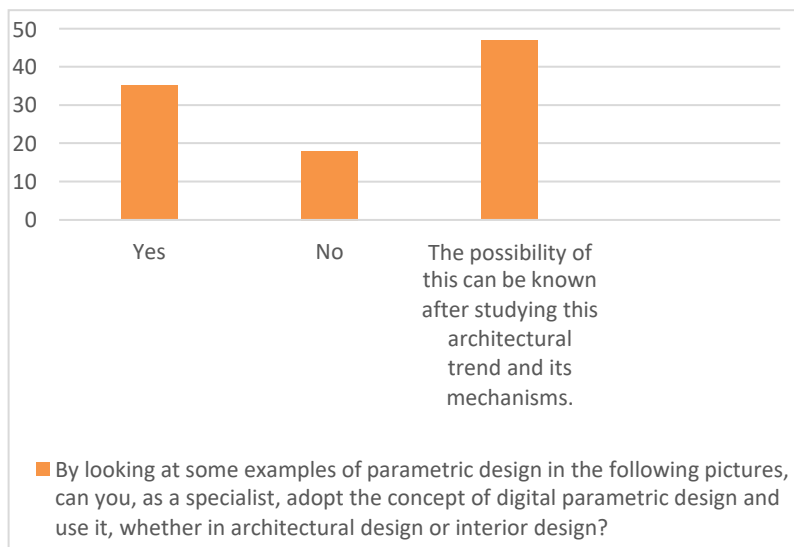
3- We found that 29% of the sample has a very good impression about the parametric architecture, while 40% has a good impression, 20% has an acceptable impression, and 11% has an unacceptable impression.

No.	3- By looking at some examples of parametric design in the following pictures, what is your impression of this type of design?	percentage (%)
1	Very good	29
2	Good	40
3	Acceptable	20
4	Unacceptable	11



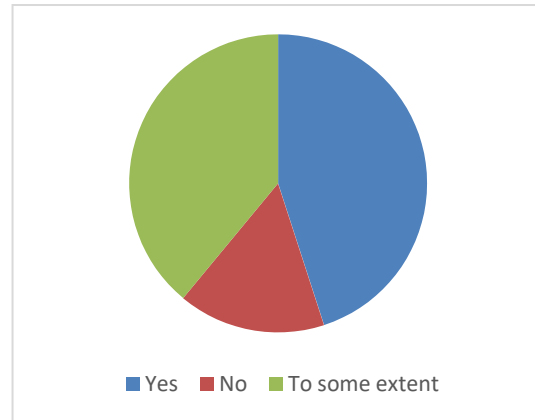
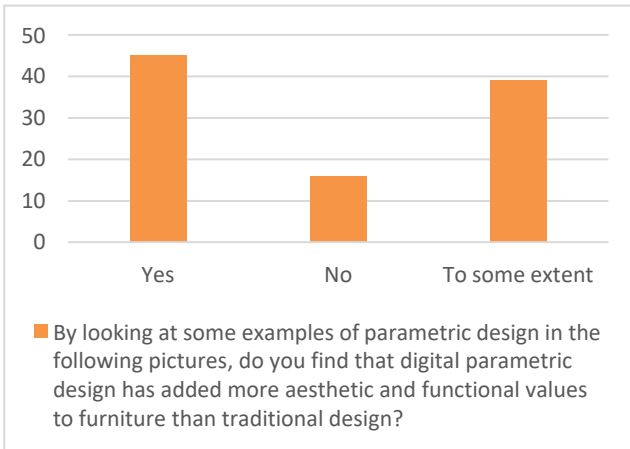
4- It is clear that 35% of the sample can adopt and use the parametric digital design concept as a specialist, while 18% cannot adopt and use this concept as a specialist, and 47% can adopt and use it after studying that architectural field and its mechanisms.

No.	4- By looking at some examples of parametric design in the following pictures, can you, as a specialist, adopt the concept of digital parametric design and use it, whether in architectural design or interior design?	percentage (%)
1	Yes	35
2	No	18
3	The possibility of this can be known after studying this architectural trend and its mechanisms.	47



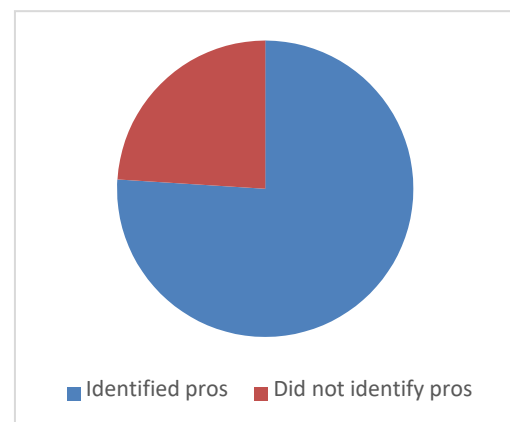
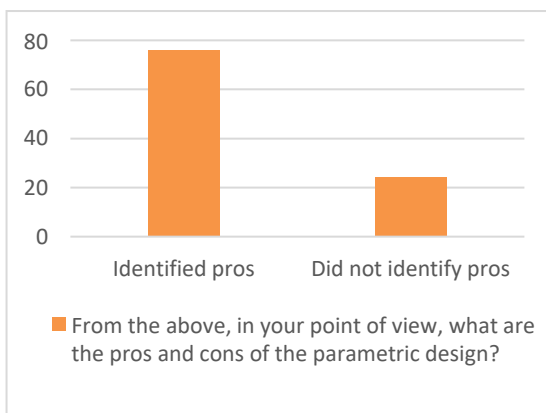
5- Through the proposed sample, it is clear that 45% of the sample finds that the digital parametric design has added more aesthetic and functional values to the furniture than the traditional design, while 16% does not find that, and 39% find that to some extent the parametric digital design has added more aesthetic and functional values to the furniture than the traditional design.

No.	5- By looking at some examples of parametric design in the following pictures, do you find that digital parametric design has added more aesthetic and functional values to furniture than traditional design?	percentage (%)
1	Yes	45
2	No	16
3	To some extent	39



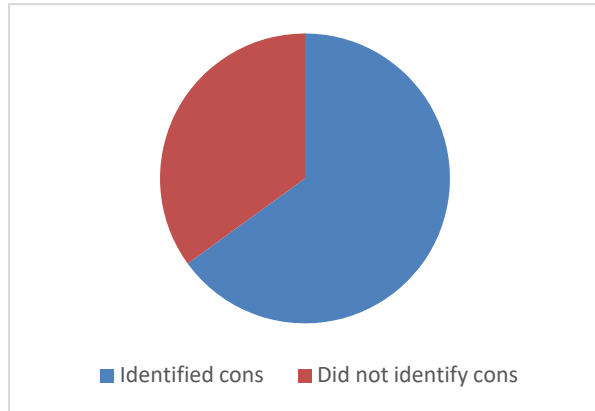
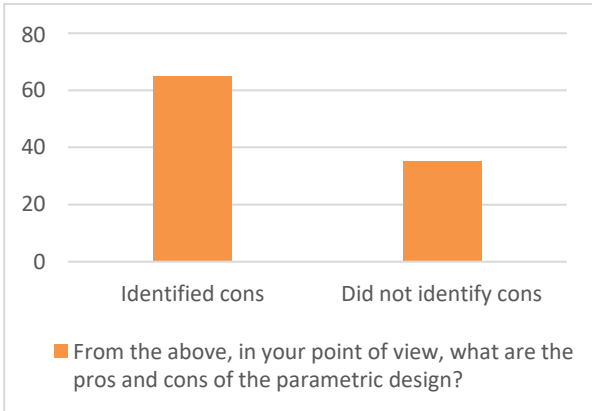
6- The results show that 76% of the sample could identify specific pros for using the digital parametric design, while 24% did not specify pros because they did not fully know the concept, its determinants and problems.

No.	6- From the above, in your point of view, what are the pros and cons of the parametric design?	percentage (%)
1	Identified pros	76
2	Did not identify pros	24



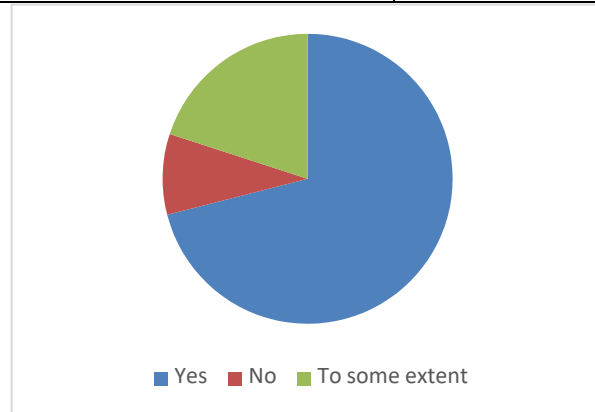
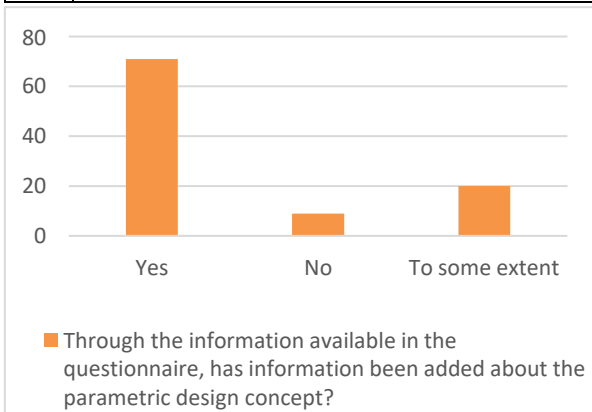
- Also, 65% of the sample could identify specific cons of using the digital parametric design, while 35% did not specify cons due to their lack of full knowledge of the concept, its determinants and problems.

No.	6- From the above, in your point of view, what are the pros and cons of the parametric design?	percentage (%)
1	Identified cons	65
2	Did not identify cons	35



7- It is clear that 71% of the sample finds the information in the questionnaire add information about the parametric design concept, while 9% finds that it did not add information about the parametric design concept, while 20% finds that it adds to some extent information about the parametric design concept.

No.	7- Through the information available in the questionnaire, has information been added about the parametric design concept?	percentage (%)
1	Yes	71
2	No	9
3	To some extent	20



2.2 Part Two (Measurement)

At this stage, we measure the extent of application and fulfillment of parametric design criteria and indices in modern digital parametric furniture. The same previously proposed sample of architects and designers is used. These indicators are extracted from previous studies in this field. By looking at example pictures of parametric interior furniture (see Fig. 3):

Parametric Design Indices [7]:

1. Aesthetics Index.
2. Elegance Index.
3. Originality Index.
4. Innovation Index.
5. Functional Index.

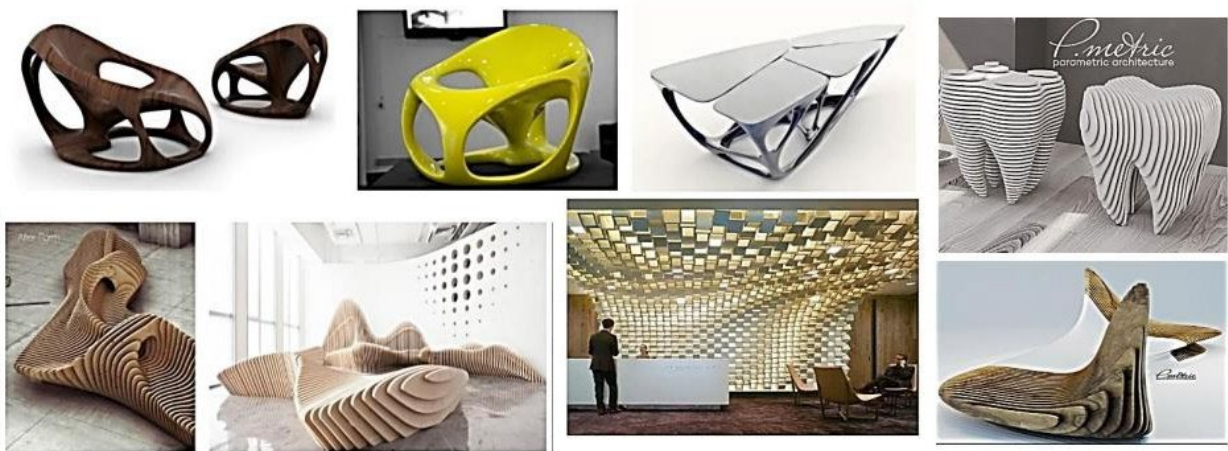


Fig.3 Examples of parametric digital interior furniture.

4-Part Two Results:

The participants in the proposed sample evaluated the parametric furniture according to the previous indices, and their opinions are requested to be limited between (very good - good - acceptable - unacceptable) for each index separately, and the results are as follow:

1- Aesthetics index: It is clear from the proposed sample that, (see Fig. 4) 18% decides that the level of aesthetics in parametric furniture is very good, while 47% decides that the level is good, 22% decides that the level is acceptable, and 13% decided that the level is unacceptable.

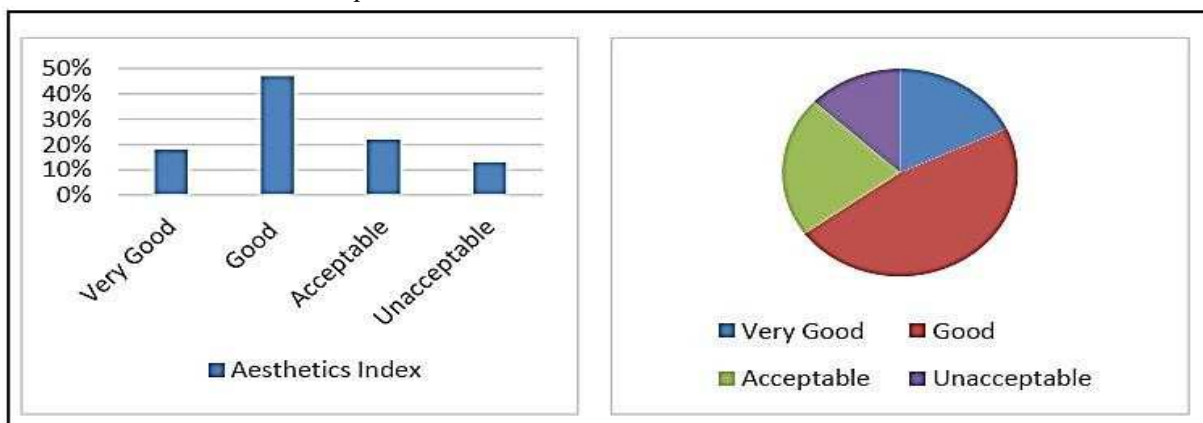


Fig.4 Percentages of Aesthetics index results.

2- Elegance Index: The results show that (see Fig. 5), 17% finds the level of elegance in parametric furniture is very good, while 45% finds the level is good, 30% finds the level is acceptable, and 8% finds the level is unacceptable.

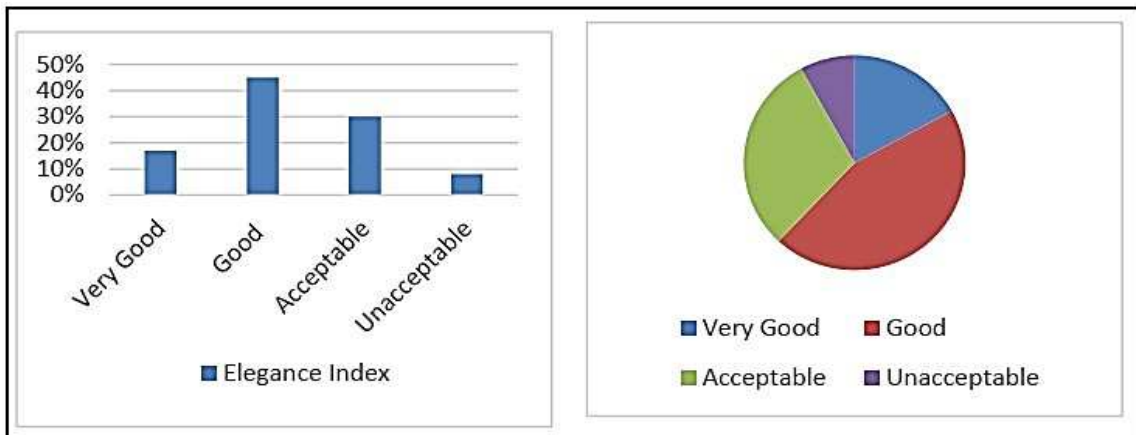


Fig.5 Percentages of elegance index results.

3- Originality Index: The proposed sample shows that (see Fig. 6), 16% decides that the level of originality in the parametric furniture is very good, while 27% decides that the level is good, 45% decides that the level is acceptable, and 12% decides that the level is unacceptable.

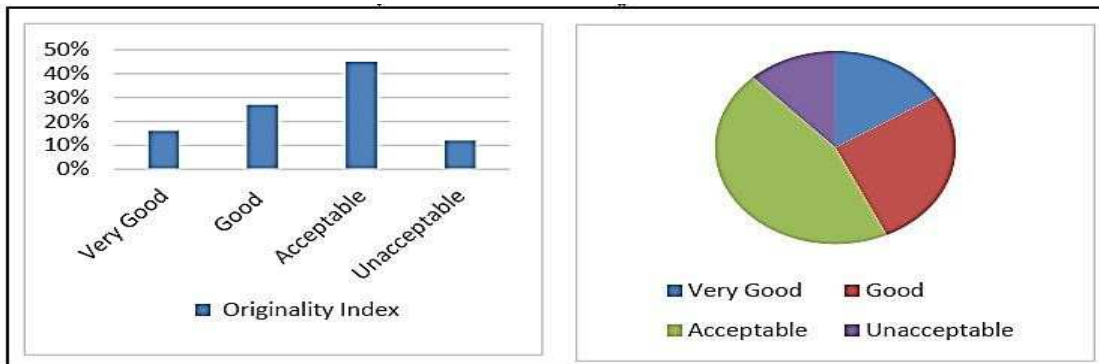


Fig.6 Percentages of originality index results.

4- Innovation Index: It is clear from the proposed sample that (see Fig. 7), 23% finds that the level of innovation in parametric furniture is very good, while 53% finds that the level is good, 15% finds that the level is acceptable, and 9% finds that the level is unacceptable.

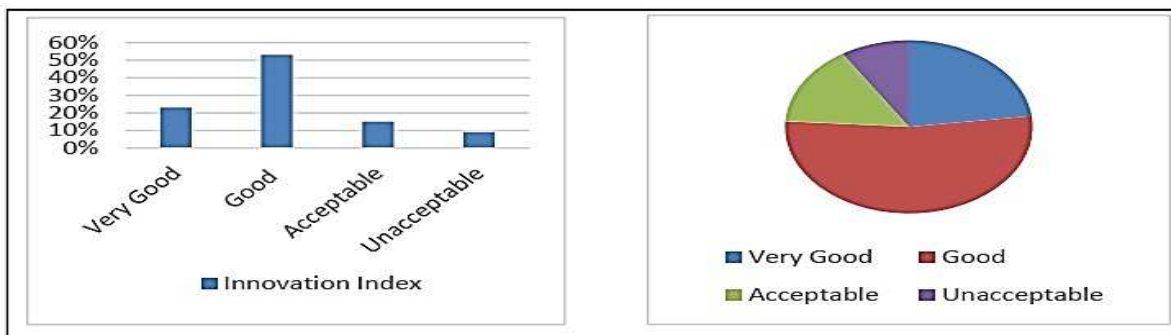


Fig.7 Percentages of innovation index results.

5- Functional Index: The results show that (see Fig. 8), 37% decides that the functional level in parametric furniture is very good, while 42% decides that the level is good, 14% decides that the level is acceptable, and 9 % decides that the level is unacceptable.

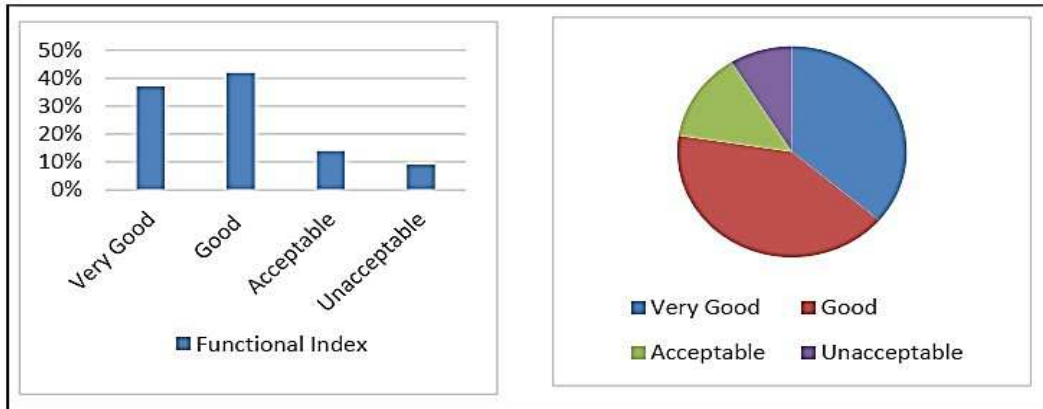


Fig.8 Percentages of functional index results.

Part Three (Comparison):

At this stage, we compare between the innovation and creativity levels in some proposed examples of traditional and parametric furniture (e.g. chairs and tables) in furniture interior design, using the previous proposed sample. It is requested to limit their opinions between (very creative - creative - normal - uncreative - very uncreative) for each type of furniture separately.

5-Part Three Results:

1- Chairs:

I. Parametric chairs (see Fig. 9):

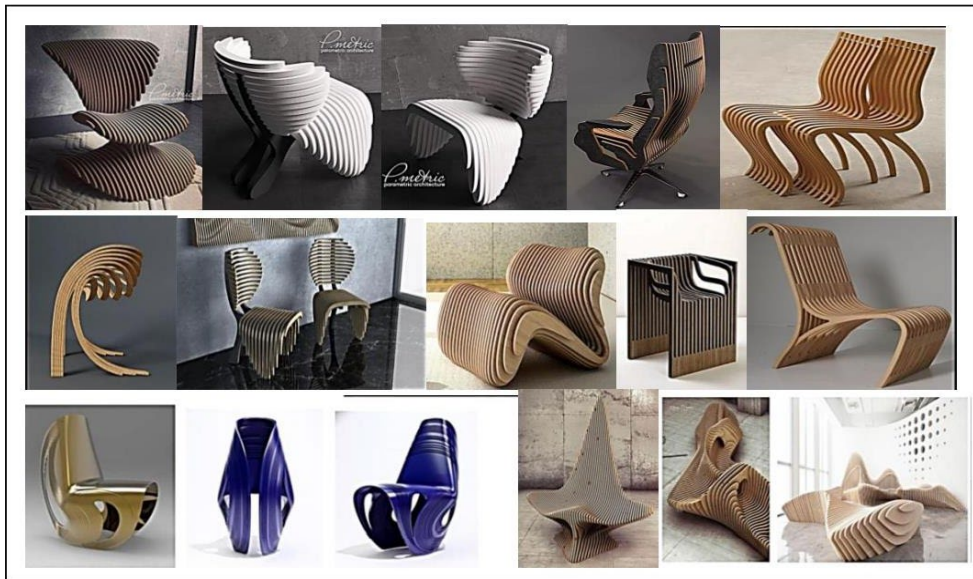


Fig.9 Digital parametric chairs

It is clear from the proposed sample that (see Fig. 10), 31% decides that the level of creativity and innovation in parametric chairs is very creative, while 38% decides that the level is creative, 16% decides that the level is normal, 6% decides that the level is uncreative, and 9% decides that the level is very uncreative.

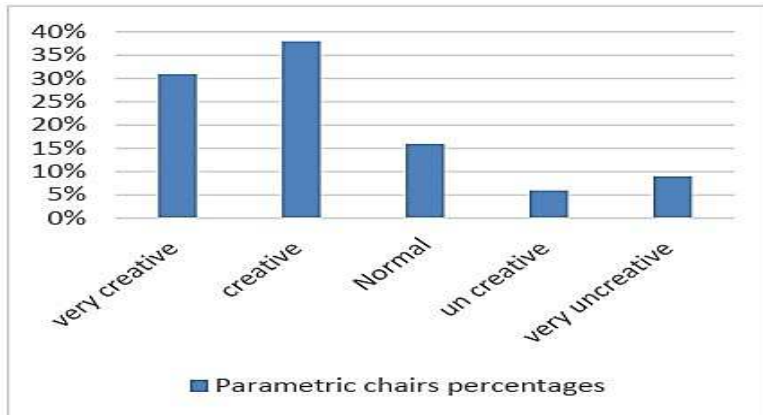


Fig.10 Parametric chairs percentages

II. Traditional chairs (see Fig.11):



Fig.11 Traditional chairs

The results show that (see Fig. 12), 12% finds that the level of creativity and innovation in traditional chairs is very creative, while 18% finds that the level is creative, 41% finds that the level is normal, 19% finds that the level is uncreative, and 10% finds that the level is very uncreative.

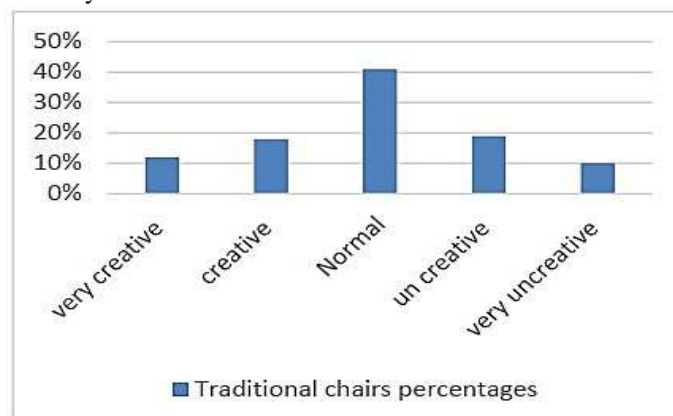


Fig.12 Traditional chairs percentages

2- Tables:

I. Parametric tables (see Fig. 13):



Fig.13 Parametric tables

Through the proposed sample we find that (see Fig. 14), 31% decides that the level of creativity and innovation in parametric tables is very creative, while 40% decides that the level is creative, 14% decides that the level is normal, 10% decides that the level is uncreative, and 5% decides that the level is very uncreative.

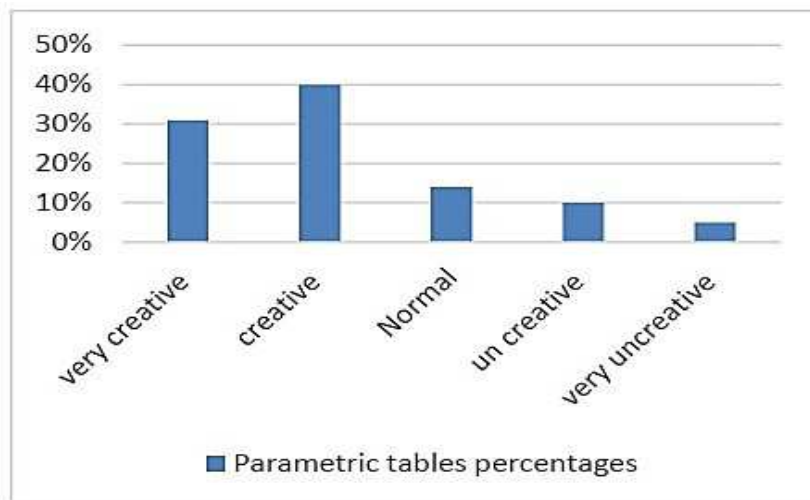


Fig.14 Parametric tables percentages

II. Traditional tables (see Fig. 15):



Fig 15 Traditional tables

It is clear that (see Fig. 16), 8% finds that the level of creativity and innovation in traditional tables is very creative, while 13% finds that the level is creative, 57% finds that the level is normal, 10% finds that the level is not uncreative, and 12% finds that the level is very uncreative.

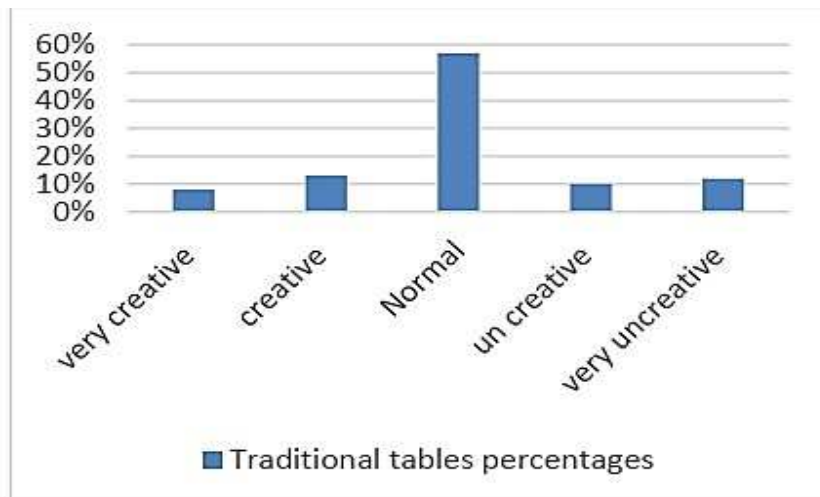


Fig.16 Traditional tables percentages

6-Discussion:

The parametric design has many pros and cons as follows:

I. Pros:

- The adoption of parametric design in interior furniture achieves flexibility and streamlining. Also, it fulfills a good and perfect aesthetic, functional and innovative value.
- The parametric design saves and reduces the time and effort required in the traditional design process.
- Achieves softness and quality during the design process stages, and this becomes evident when modifying a specific part of the design, which is automatically applied to the rest of the design.
- In line with the principle of sustainability through the principle of recycling building materials.
- Succeeded in designing many activities (i.e. exterior and interior design and furniture) with flexibility, innovation and creativity.
- Ease of implementation and manufacturing due to the use of repetitive units (proto type).
- The possibility of adding the fourth dimension (movement) by controlling the composition and formation of the interior furniture.

II. Cons:

- Parametric design in interior furniture needs a high skill in using designing software (e.g. Generative Components, Rhinoceros, Digital Project, BIM Revit, Dynamo, DS Max3, Inventor, Marionette, Maya Modular).
- High implementation cost due to the development and use of automated cutting technology and robots in manufacturing.
- Some specialists see it as boring, repetitive and unusual compared to the traditional interior design.
- Compatible with modern designs, while it slightly compatible with ancient and popular legacies.
- Heavy reliance on computer software in design weakens the designer's ability to innovate manually.

7-Conclusions:

1- The survey is prepared and distributed to the proposed study sample (40 professionals) of architects, designers and specialists to assess the extent to which the parametric design criteria and indices are met. The maximum percentages for each index separately are as follows:

- In the Aesthetics index, the highest percentage is 47% (good).
- In the Elegance Index, the highest percentage is 45% (good).
- In the Originality index, the highest percentage is 45% (acceptable).
- In the Innovation index, the highest percentage is 53% (good).
- In the Functional index, the highest percentage is 43% (good).

2- The survey is prepared to compare the levels of innovation and creativity in some proposed examples of traditional and parametric furniture (e.g., chairs and tables) in furniture interior design, the highest percentages are as follows:

I. Chairs:

- For parametric chairs, the highest percentage is 38% (creative).
- For traditional chairs, the highest percentage is 41% (normal).

II. Tables:

- For the parametric tables, the highest percentage is 40% (creative).
- For traditional tables, the highest percentage is 57% (normal).

From the above, we conclude that the parametric design tools for interior furniture actually help designers to make significant creative and innovative designs. This because they are more than just traditional engineering design tools. In this paper, we focus on tools, criteria and indices of furniture parametric interior design and their effects on increasing the creativity levels.

8- "List of Abbreviations"

Not applicable"

9- Recommendations:

- 1- The research suggests applying the applied research study on a larger scale on all the parametric interior design elements, not just some types of furniture, and examining the psychological impact of that on the user behavior.
- 2- The need to increase the cultural and scientific awareness among designers on such new concepts in design through new parametric design computer software.
- 3- The inevitability and necessity of taking advantage of pros derived from the parametric design questionnaire and avoiding the cons that were reached through the research study.
- 4- The necessity of applying and including parametric design systems within the academic curricula in specialized colleges (e.g. engineering and applied arts) so that students can keep pace with the requirements of the modern market in the field of parametric interior design.

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11- Figure legend

Not applicable