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Concept as the Activist of Creativity in Architectural Design: Exploring Factors Affecting Concept Formation Using the Structural Equation Model

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Abstract

In the contemporary understanding of architectural design, the concept is essential in that it drives the creative aspect of a designer, provides design a wealth of meaning, and initiates and shapes the design process. Based on the importance of the concept in architectural design, this study aimed to examine the factors affecting the concept formation of architect candidates/architects in design education and practice. For this purpose, a pilot study in the first phase of the study tested a survey distributed to two groups of participants, namely architecture undergraduate students and practising architects in Ankara, the capital of Turkey. The data obtained from the survey were analyzed with the SPSS software and measurement tools were identified and then, weights of the factors were determined using the Structural Equation Model (SEM). According to the analysis results, the factors affecting concept formation in architectural design are the design problem, context, designer-induced values, and user-induced values according to their weighted importance. One of the main reasons the design problem and context are pioneers in determining concept is that these factors hold a strong place in the traditions and teachings of design education. In addition, depending on the way architecture students and practicing architects experience the profession, their attitudes towards creating concepts in their designs may vary.

Keywords

architectural design, concept, design education, architectural practice, structural equation model

1 Introduction

Architectural design, by its nature, is a process that incorporates the element of creativity in it. In this close relationship between architectural design and creativity, an aspect of the concept drives creativity, guides design, supports the idea generation process, and enriches design in terms of meaning. In the design process, the designer reaches the concept based on a central idea and initiates the concept design to create the design product. The concept constitutes the end of development process of the idea and the beginning of the design process, at the point where this process, which mostly takes place in the mind, begins to be embodied for the first time. Therefore, it is the most important part of the design, both as a result and as a beginning (Bilir, 2013:p.46).

The term of concept, commonly used in architectural terminology, takes place in the architectural design process as the representative expression or, in a way, the roadmap of the proposal developed by the designer to solve the design problem. In this sense, the concept is seen as a phenomenon that makes design unique and sense-making in the field of design (Erman and Yılmaz, 2017). A concept in architectural design is an idea that guides the designer through the process from abstract spatial creation to elaborated design product, and it is defined as a key to providing a complete understanding of the designed element (Tigges and Jonson, 2014:pp.70–71). Thus, the concept can be said to inform how the content will be transformed into the style. This stage is also the process by which the designer's design language begins to form. In other words, the concept can be seen as a uniquely formulated form of design-oriented thinking, even its icon. It is the first decision of the design that is undeveloped but reflected in the resulting product. It is therefore the key point of the act of designing (Bilir, 2013:p.58). In this action, the concept developed by the designer regarding the problem stands out as a component of the elements that make the

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design unique and differentiate it from others. An architectural concept is a form of thought conveyed verbally through a few words or visually through sketches that are not yet transformed into the style (Wingårdh and Wærn, 2008:pp.40–44). In this respect, the concept is the whole thought that forms the prominent features of the building in design and can be expressed abstractly or partially concretely (İnceoğlu, 2004).

Following these statements, this study investigates the premise that concept is one of the essential elements that initiate architectural design. Further, it examines the critical factors that affect the concept generation of architecture students and practising architects' designs. The concept is significant as factor in creativity. This subject pertains to the importance and primary focus of the research. Since architecture students lack professional practice, the factors affecting their concept development in the design process remain limited. Because there is a direct relationship between concept development and creativity, this limits students' creativity as well. Design creativity is a phenomenon that can improve by means of various ways of concept development. In this regard, different inputs of concept development should be involved in design education to develop creativity in students of architecture. Introducing architecture students to different problem areas of professional practice (such as user and designer-sourced values) will prepare them for professional practice and eliminate the gap between design education and practice. This study has been tested through a field study examining the concept development attitudes of architecture students and practising architects. In order to collect data in this research process, a total of 298 people, primarily senior architecture undergraduates and those practising architecture, were surveyed. The data obtained from the survey were analyzed with the SPSS software and measurement tools were identified and then, the weights of these factors were determined using the structural equation model. Based on this, it was found that the main factors affecting concept formation in architectural design are the design problem, context, and designer- and user-induced values. According to the architect candidates' and architects' views, the design problem and context are the most referenced factors in the concept formation process. In addition, these two factors constitute a beginning to the design process by also being used together. It is thought that the design problem and context factors were the most referenced factors in the concept formation process mainly due to established teachings and habits from the design education process.

2 Relation between design process – creativity and concept

The first step of the design process is to form the design idea. A new idea is formed by interpreting the existing knowledge and the new information from an external source. The originality of the ideas depends on the designer's ability to interpret, modify, and transform at this point. However, the designer's creative syntheses begin to gain presence along with external representations. The ideas or images in the mind are embodied and form meaningful wholes. A concept is more than a single idea and much more than a spontaneous moment of project inspiration (Kısacık, 1999). Cosme defined the concept as a complex system ofinter-related ideas, carrying strength enough to launch the creation of the architectural project (Cosme, 2008:pp.99–100). Today, conceptual reflection is essential in architectural practice – in the aspect of design process that refers to intellectual dimension of design. Thus, the concept has anessential role in theoretical self – thematisation of architecture and guards the future of thearchitectural profession as an autonomous intellectual discipline (Vesnić and Ćipranić, 2019).

According to Stapenhorst (2016), a concept is visual communication tools explaining the notional dimension of the problems. Concept provides the relationship between mind and perception in the design phase works from the first stage to the next in idea production and development. In Stapenhorst's book (2016), she identifies three primary senses of the term 'concept' as it is used in architectural discourse and provides each with a chapter: Concept as repository of rules, strategies and criteria, concept as generator and communicator, concept as explorer of non-architectural knowledge. There are two other senses of 'concept' in Stapenhorst's book: Concept as result of and guideline for an ideational process and conceptual use of architectural references. She also states that the concept is a mental communication tool between the designer and the design. Moreover, in this process, the concept reflects the identity and main idea of the design product. According to Stapenhorst (2016), concept is a key term in architectural design. However, it is often used imprecisely or merely for marketing purposes. In the changing profession of the designing architect, decisions are increasingly made in multidisciplinary groups.

Concept can serve as a dialogic instrument in the process, making it possible to process heterogeneous information from various spheres of knowledge. The effective presentation of selected information becomes a relevant interface in the design process, significantly influencing the design's quality. Architectural design has always been a practice

that has to deal with an interdisciplinary field of requirements and, at the same time, has the freedom to use its methods to personalise its design processes (Stapenhorst, 2016:p.45). Those "borrowed" approaches from non-architectural disciplines allow for a high degree of personalisation of the design process and can therefore be seen as an important design tool (Zheng et al., 2018).

Lawson's book (2006) *How Designers Think: The Design Process Demystified* is valuable in the context of design, design process and designer. This book explores "design" as a process, how that process works, what we understand about it and how it is studied and performed by professionals. Lawson tries to summarise his various researches with design and designers – both professionals and students. According to him, design can describe the process followed by a professional when coming up with a new product or an improvement of a brand. The word "design" can also be used as an adjective to compare different works by designers. He describes design as a negotiation between problem and solution through the activities of analysis, synthesis and evaluation. He also describes designers as the creators of the future. Designers of any discipline consistently struggle to define their design process. Each profession will tackle this goal differently, and within their given subset of design, will take a different path to their ultimate product. Lawson speaks highly of designers and their seemingly nebulous way of thinking. There is a constant reference to the fact that designers must finely balance scientific and analytical thinking with concerns around beauty and aesthetics. Lawson also touches upon specific types of thinking – the main one he associates with designers being "solution-focused design". The practice of balancing parallel thought processes – analytical and aesthetic, theoretical and practical – is the essence of the design process and one of its most empowering aspects. He states that with respect to thinking processes, hierarchies are non-existent since each design discipline carries its own load of problems to solve through many different facets. Lawson suggests that taking the time to engage the issues comprehensively leads to more well-rounded, and ultimately, better-finished products. As such, developing a solid set of foundation skills and methods are of the utmost importance, permeating into other work and yielding more robust results. Lawson also discusses how various design constraints and the growing gap between designer, client and user affect the final product. He also speaks with the same emphasis on the importance of finding and solving problems. However, he emphasises paying attention to the thought processes necessary to identify and understand design problems and create design solutions (Lawson, 2006). In the creative process, the designer's intention to develop interaction with parameters of communication is crucial. It activates a complex system in creative activity, based on intuition, experience and knowledge. This approach is conditional on developing the complex character of a creative process. In that context design research can be thought of as a form of processing the designer's intention in a particular way further developing design activity, and providing varying forms of expression. In that way, design research operates on the primal stage of creative activity, starting with the aesthetic intention and ending with the concept developed on an ideal level. In that context, design process can be understood as an activity towards the transformation of different design potentials and possibilities, which increase the complexity of various design concepts developed on the stage of creative activity (Mako, 2007:p.274).

Oxman (2004) and Goldschmidt (1997) interpret this as an evolution from the mental process to physical configuration and treat it as the expression of internal representations with external representations. The act of designing is transformed into the design product by the influence of creativity, and each design process points to mental activities. The creative activity required in the architectural design process is mainly cognitive. As Smith et al. (1995) puts it, creativity involves the stages of producing and discovering within the framework of an individual's mental activities, and this process is also intuitive thinking. This creation process, based on production and discovery, involves the generation of creative structure, discovery and interpretation, creative thought, creative discovery and interpretation, and product development. The individual and cultural components of the designer also join the creative process that develops with these mental activities. In other words, the personal and cultural components of the designer are interpreted and encoded by the mental activities that the individual has. This process enables the formation of the cultural scheme of the individual and this interaction system enables the shaping of the design process (Önal, 2010).

It is seen that the creative process is also described in the definitions made about creativity. Each individual is psychologically equipped with perceptual systems that emerge creatively. Through this system, the world is perceived, and information is obtained. This information storage process defines the essence of creative problem-solving to create an integrated whole (O'Neill and Shallcross, 1994).

Creative activity occurring in the architectural design process has a cognitive structure. As Smith et al. (1995) state, creativity involves the production and exploration steps in the framework of an individual's mental activity. This process is also intuitive thinking. This creation process, based on production and exploration, includes the phases of pre-creative exploration and interpretation, the production of creative thinking, creative exploration and interpretation and product development. In the creative process, developing through these mental activities the designer's own personal and cultural components are active, at the same time. Concept, in this process, plays a key role in developing the solution idea and formulating the unidentified problems. Concepts are means for designers to create and solve problem. Thus, concept is defined as the ability to find various possible answers to the determined problem (Erdoğan and Boztepe Erkıs, 2014).

On the other hand, two different views have been put forward in studies on the mechanisms involved in creative activity. Newell and Simon (2018:p.57) argue that creativity is a specific problem-solving behaviour. On the other hand, they argue that the critical aspect is problem finding and that the most challenging part of creativity is realising the solution (Benami, 2002:p.103). Treffinger et al. (2008:p.44) mention that creativity and problem solving is a model that involves the three-way structure of the relationship of the fundamental theories about the psychology of an individual with cognitive style formation based on learning and psychological characteristics. With this model, they argue that each component is effective in the individual's perception of problems, making choices, making decisions, and generating solutions. Problem-solving and creative thinking is the same cognitive activity. (Akın, 1984). Creativity is formed by the cognitive mechanisms that arise between a designer and the product. All personal, social, cultural, and psychological components belonging to the individual within this mechanism are effective (Önal Ketizmen, 2011).

Creativity and concept development are also an essential part of the design education process in architecture. Intertwined with abstract concepts, design education has a complex and contradictory structure which, by its structure, is far-reaching, not very obvious, difficult to define, understand, classify and form (Yürekli and Yürekli, 2004). The creative problem-solving abilities of designer candidates are strengthened through teaching creative thinking techniques and experiencing the design process in studios (Onur and Zorlu, 2017). Through all these experiences, individuals' creative personality traits are strengthened and this creative process, together with the creative individual, serves to reveal the potential of the creative product (Erman and Yılmaz, 2017).

Oxman (2004) states the necessity of conceptual processes and knowledge structuring while discussing design thinking in a cognitive context. He explains the information representation in design with cognitive mapping, consisting of the issues, concept, and form, which he calls ICF (issues, concept, form). Based on this, the issue refers to the connection with the problem, the concept refers to a particular idea of the whole, and the form refers to the formal correspondence of the idea. In this way, organisation, sharing, and transfer of information are also provided externally. As conceptual knowledge (concept) drives the process of generating ideas, it forms the basis, i.e. the essential input, of design thinking. Conceptual information is structured by different methods, both mentally and formally, in the design process.

Tschumi (2012) and Libeskind (2002) have employed verbal means to draw the limits of linguistic expression when speaking of architectural works. Their statement testifies more to the potential of architectural form. A deficiency of words that occurs and spreads before an architectural object on account of the impressiveness of its structure, additionally and decisively legitimates its status as a work of art. The ineffable or the immeasurable gives a sense of wonder that forms the difference between building and architecture (Libeskind, 2002). Concept, not form, distinguishes architecture from a mere building (Tschumi, 2012:p.41). From here, it can be concluded that without a concept as a means for understanding reality, architecture cannot be defined as a form of knowledge (Tschumi, 2012:p.741). Tschumi stated that there would be no architectural product without a concept, and defined the concept as an element that differentiates the structure from any structure, helps to make sense of the structure, and gives the structure identity (Tschumi, 2005:pp.11–16). Therefore, the concept is made sense through a constructed form (Tigges and Jonson, 2014). The concept in architectural design is, in a sense, a road map that the designer refers to as a guide in this process (Balkan, 2005). The main idea that defines the concept is a thought in which different ideas, principles, rules, patterns, forms, and environmental relations converge in or around to form a whole. Although there are stages in design that can sometimes be resolved quickly, the process elapses until the concept formation is at the point where the highest importance should be given to study and research.

2.1 Components that form the concept in architectural design

While the concept consisted of concrete things such as layout, structure, form, plan, and facade layout and was shaped in a more general character and independent of the place within the history of architecture, it has changed and become more abstract expressions that feed on context and content today (Tschumi, 2005:pp.11–16). With this statement, Tschumi (2005) describes some concept components as context and content. The context can be extended to all features and conditions of the location, while the content can be extended to the design program and subject. Based on this, it can be stated that the concept today focuses on context and design problems. In parallel with this view, Onat (2006:pp.106–124) also defines every major element that affects and is affected by the design process as a value and treats these values as elements that support the original and creative aspect of the design product. The values expressed by Onat (2006) can be said to be the elements that make up the concept. Architectural design is an activity of creative thinking, and elements related to the concept gathered under the name of values trigger creativity and form the original side of architecture. Concepts that can be associated with creative thinking can arise from the environment as well as from the problem itself. Onat lists these values, which are thought to play a role in creating the concept, as follows (Onat, 2006):

- design problem-induced values;
- place/environment-induced values (context);
- designer-induced values;
- user-induced value.

These components may form the concept by coming together in different combinations. However, the concept can only be formed by an architect's original idea. Onat states that in such a case, the relationship between concept and context may be blurred and the concept cannot readily make sense (Onat, 2006). While the concept components can sometimes create the whole design alone, it can sometimes be predicted that all the components can be involved in the concept generation process. In addition, it is necessary to include investors in the user-induced values because the designer is responsible to the investor of the project as well as to the user.

2.2 Process of concept development

The concept development phase requires the designer to absorb considerable together, make appropriate connections between them and, most importantly, explain or establish them all in a single structure.

A visual image or a conceptual structure, brought up by taking advantage of past experiences and perceptions, can be reinterpreted during the examination phase, or multiple images transferred from memory can take place under pre-design structures with their new forms created through ascription (Ertürk, 1981). In this sense, the concept development process describes the most basic productive processes, making certain structures ready for use in the design process by transferring what is in memory (Turan, 2002:p.54).

In this sense, concept formation becomes possible by combining the ideas identified in the previous stage in a way determined by the designer, by preparing them to interact with each other. The conscious and purposeful action of forming a concept paves the way for producing a large number of pre-design structures. The different items are arranged in various formats and reformatted; the visual layout does not reach a specific result until the desired format is found. The ideas, which are abstracted and interpreted together with the designer's analysis of important problems in design and the measure of self-externalisation and have reached a certain stage, provide clues to the method of design (Murphy, 1988:p.89).

Concept selection affects the product design and development process due to its impact on the quality, cost, and desirability of the final product (Mattson and Messac, 2005), as well as its impact on the development time and cost of later design stages (Pahl et al., 2007). During this process, concepts generated earlier in the design process are evaluated, selected and synthesised into a final solution for further development to address the design goal (Nikander et. al., 2014; Ulrich et al., 2011).

The images of thought will, over time, transform into design sketches and begin to form a sequence of design, that is, construct (Goldschmidt, 1997). In space design, in orienting to information, one's connection to the environment becomes possible by establishing current and future-oriented relationships including past experiences. Logical and intuitive knowledge is a product of the encounter of categories and sensory content that were previously found but formed during the experience. Space design, which can be defined as the activity of access and orientation to information and transforming information, is a process by which all factual things about the design can be seen (Sayın, 2007).

To reconcile and summarise the development process from idea to concept with Descartes' interpretation; "First,

with the help of instant, imagery, sense perception and memory, we need to intuit simple propositions clearly; second, we need to gather all we know about the subject we are investigating; third, we need to find out what needs to be compared to one another in order to make full use of our power" (Turan, 2002:pp.44–47). The concept development process is directly proportional to the process of attaining ideas at the initial stage of design. The ideas that have reached a certain stage by abstracting and interpreting, along with the designer's analysis of important problems in design and the measure of self-externalisation, provide clues to the design method.

3 Methodology

In this study, the Structural Equation Model (SEM) was used to examine the factors affecting concept formation in architectural design. SEM is a comprehensive statistical method used to determine the linear relationships between independent variables and dependent variables and estimate the effect of all variables on one another, and tests the relationships between observed (measurable) and hidden (unmeasured) variables (MacCallum and Austin, 2000). The most significant difference between SEM and other statistical methods is that it analyses the relationship between many variables as a whole (Ayyıldız and Cengiz, 2006). Thus, the error rate that increases in other methods due to the number of analysis steps is low (Şahin and Taskaya, 2011).

In this method, relationships are established between the variables that the researcher considers and this model, established as a result of the research, is tested through research data (Cheng, 2001:p.656). There are different goodness-of-fit indices used to evaluate model fit. These indices also have limits on whether the model can be accepted. The proposed acceptance range of the criteria used to evaluate the model's fit with the data and the accuracy of the established theory is found in Table 1 (Schermelleh-Engel et al., 2003).

There are different fit indices used in Structural Equation Model analysis and statistical functions that these indices have. The most commonly used indices among the recommended ones are Chi-Square, RMSEA (Root-mean-square error approximation, GFI (Goodness-of-fit index), CFI (Comparative Fit Index), NFI (the Normed Fit Index), and TLI (Jöreskog and Sörbom, 2001:p.51; Tucker and Lewis, 1973). The CFI, NFI, and TLI, which are the commonly used criteria of goodness-of-fit, take values ranging from 0 to 1, and the proximity of the values to 1 indicates that the model's suitability is better. For RMSEA, the value equal to or less than 0.05 is a perfect fit, the values between 0.08 and 0.10 are acceptable, and the values greater than 0.10 correspond to a poor fit (Hayduk, 1987; Jöreskog and Sörbom, 2001). After the model prediction in SEM, it should be investigated how much the model fits sampling. First, the relationships determined in the model are examined to whether they are significant and as expected. If each relationship specified by the model comes out as expected, in this case, it is investigated whether the model produces the desired value in terms of the fit values. The results are interpreted if the desired values are obtained (Şimşek, 2007).

Table 1 Standard goodness-of-fit indices (Schermelleh-Engel et al., 2003)

Goodness-of-fit indices	Acceptable fit
RMSEA	$0.05 \leq \text{RMSEA} \leq 0.100$
SRMR	$0.05 < \text{SRMR} \leq 0.100$
NFI	$0.90 \leq \text{NFI} \leq 0.95$
NNFI	$0.95 \leq \text{NNFI} \leq 0.97$
CFI	$0.95 \leq \text{CFI} \leq 0.97$
GFI	$0.90 \leq \text{GFI} \leq 0.95$
AGFI	$0.85 \leq \text{AGFI} \leq 0.90$

3.1 Hypothesis and research model

The study aimed to examine the factors affecting concept formation in the architectural design process, which is a crucial element of architectural education and practice. To achieve this goal, the central hypothesis to be tested is as follows:

- *Hypothesis:* in architectural design education and practice:
  - design problem,
  - context,
  - user-investor induced values,
  - and designer-induced values significantly affect the creation of the concept, and as a result, the architectural product in the architectural design process.

Moreover, the design problem factor, one of the factors affecting concept, is more effective in the concept creation process for architecture students and practising architects than the context, user-investor-induced values and designer-induced values factors as a ratio. It has been assumed that the design problem factors may have a role of approximately 50% in the concept formation process for both groups. As a result of the literature review, the research model created based on variables involved in the research is shown in Fig. 1.

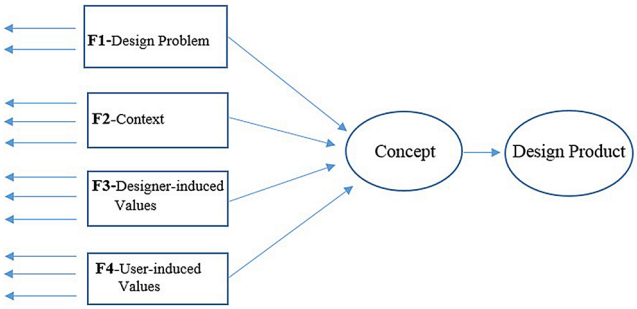

Fig. 1 Research model

3.2 Participants and measurement tool

In the first phase of the study, a pilot study tested a questionnaire distributed to two groups of participants consisting of architecture undergraduate students and practising architects. The study was conducted in the capital city of Ankara, which was selected as the pilot region in Turkey and gives access to a vast number of architecture students as well as practising architects, and solely represents this area in the context of the research problem.

The survey was forwarded online to 157 undergraduates and 141 practising architects. The existence of participants who design is important in this survey. Undergraduate students and practising architects were selected for the survey because they constantly experience the design process in architectural education and practice. Therefore, these two groups have been chosen for the survey. It was assumed that the 298 participants identified by the snowball sampling method accurately represented the universe. The socio-demographic characteristics of the participants are shown in Table 2.

The measurement tool used in the study is a questionnaire administered to architects and students working or studying in Turkey. In the survey form, of the scales developed by Onat (2006), the design problem scale was measured with two independent variables, the context scale was measured with three independent variables, the user impact scale was measured with three independent variables, and the designer factor scale was measured with three independent variables.

Table 2 Socio-demographic characteristics

Variables	n	%
Gender		
Female	162	54.4
Male	136	45.6
Profession		
Practising architect	157	52.6
Student of architecture	141	47.4

3.3 Data collection method

The data were collected through the survey. "The concept formation scale in design" designed by Onat (2006:p.106) was used in the survey to determine the factors affecting designers' concept formation. This scale combines the four dimensions of concept formation in design (design problem, context, designer-induced values, and user-induced values). On the scale; five options, i.e. Strongly agree, Agree, Neither agree nor disagree, Disagree, and Strongly disagree, were given using a 5-point Likert scale and the students were asked to choose the one that best suits them. The scale was utilised with the study group to develop a valid and reliable tool.

3.4 Validity-reliability and data analyses

The structural validity of the scales used in the research was tested by single-factor confirmatory factor analysis. LISREL 8 was used for Confirmatory Factor Analysis. The fit indices reached in consequence of the modifications are shown in Table 3.

Since the fit values of the measurement models in Table 3 are observed within the desired limits, it is possible to say that the single-factor structures of all variables are confirmed. The survey data were analysed with SPSS (IBM, 15.0) and LISREL 8. Confirmatory factor analysis was performed for the validity of the 40-item scale, which was created using the relevant literature, expert opinion, and student opinion. According to the analysis results, those with factor loads of 0.35 or greater than 0.35 were selected for the second analysis; 11 items appeared to be functioning. The consistency of the scale used in the study was determined, the results achieved, factor loads of the scales and Cronbach Alpha coefficients of their reliabilities calculated with the SPSS are given in Table 4.

The internal consistency coefficients based on the Cronbach Alpha values in Table 4 show that the reliability levels of the responses to the concept formation scale used in the study are above 0.70 (Nunnaly and Bernstein, 1994:p.69), which is the acceptability limit. This study

Table 3 Fit values of the research variables

	X^2	df	X^2/df	GFI	CFI	RMSEA
Design problem	2.946	2	1.364	1	1	1.00
Context	17.236	4	4.257	0.99	1	0.56
Designer-induced values	20.465	4	5.166	0.99	0.99	0.35
User-investor values	12.078	4	4.060	0.99	0.99	0.17
Goodness-of-fit values*			≤ 3	≥ 0.90	≥ 0.97	≤ 0.05

Table 4 Factor loads and Cronbach alpha coefficients of the scales

Factors		Items	Questions	T values	Factor load	Cronbach Alpha
F1	Design problem	*The subject of design is effective in the concept generation process.	q1	11.76	0.88	0.90
		**The architectural program is effective in the concept generation process.	q3	10.87	0.89	
F2	Context	*Physical environmental conditions are effective in the concept generation process.	q6	9.83	0.91	0.88
		**Socio-cultural and economic conditions are effective in the concept generation process.	q7	9.90	0.88	
		***Environmental compliance and non-compliance factor is effective in the concept generation process.	q11	8.96	0.87	
F3	Designer-induced values	*The way the designer perceives the problem is effective in the concept generation process.	q12	9.91	0.72	0.86
		**The experience and style of the designer are effective in the process of producing the concept.	q17	10.11	0.81	
		***The designer's priorities for the problem are effective in the concept generation process.	q19	11.23	0.91	
F4	User-investor induced values	*The socio-cultural and economic conditions of the user are effective in the concept generation process.	q21	8.62	0.84	0.82
		**Ideas and requests of the user are effective in the process of producing concepts.	q32	8.71	0.79	
		***The physical and psychological needs of the user are effective in the concept generation process.	q38	8.42	0.81	

used the Structural Equation Model (SEM) to determine the factors affecting concept formation. The Structural Equation Model was used to determine whether the items in the "Concept Formation Scale" are valid in measuring the concept formation methods of architecture students and architects and determine the factors affecting concept formation in design. For this, the measurement model must be tested to determine whether the 11 items in the concept formation scale are significant in defining the concept formation process. After a valid measurement model has been reached, a structural model must be tested to determine the factors affecting the concept formation of architecture students and architects in the second phase. Therefore, in this study, the SEM was used. In this model, first, the measurement model was tested with the confirmatory factor analysis method, and then, the cause-and-effect relations between these variables were tested through path analysis. The measurement model of the study was determined through confirmatory factor analysis based on the highest likelihood method. The study defined the concept through four hidden factors and 11 items under these variables. Of these 11 items that make up the measurement tool, two were used to describe the design problem, three were used to describe the context, three were used to describe user-induced values, and the last three were used to describe designer-induced values, and these constituted the observed variables of the research.

4 Findings

The findings obtained from the analysis of the data collected in the research on concept determination factors in architectural design are explained below.

4.1 Descriptive statistics and correlational findings

Table 5 shows descriptive statistics and correlational findings for concept formation factors in architects' designs in architectural education and practice.

Regarding the mean values of the variables, it is seen that the variable of designer-induced values has the highest mean value and the variable of user-induced values has the lowest mean value.

According to these findings, it can be stated that the rates of participation in the design problem, context, and designer-induced values were higher than the mean value in general.

In the Structural Equation Model, created to test the hypothesis based on the research model, the factors that determine the concept formation processes of architect candidates/architects in architectural education and

Table 5 Factors that affect concept formation

		Average	Standard deviation
F1	**Design problem**	**2.98**	**0.86**
q1	The subject of design is effective in the concept generation process.	2.99	0.84
q3	The architectural program is effective in the concept generation process.	2.97	0.88
F2	**Context**	**2.14**	**1.08**
q6	Physical environmental conditions are effective in the concept generation process.	2.08	1.25
q7	Socio-cultural and economic conditions are effective in the concept generation process.	2.12	1.23
q11	Environmental compliance and non-compliance factor is effective in the concept generation process.	2.22	1.36
F3	**Designer-induced values**	**2.10**	**1.34**
q12	The designer's perception of the problem is effective in the concept generation process.	3.45	1.23
q17	The experience and style of the designer are effective in the process of producing the concept.	3.52	1.32
q19	The designer's priorities for the problem are effective in the concept generation process.	3.44	1.37
F4	**User-investor induced values**	**3.50**	**1.04**
q21	The socio-cultural and economic conditions of the user are effective in the concept generation process.	1.97	1.26
q32	Ideas and requests of the user are effective in the process of producing concepts.	2.21	1.33
q38	The physical and psychological needs of the user are effective in the concept generation process.	2.29	1.30

practice are included. As a result of the analysis, the design problem, context and user-induced values were significant in creating a concept. The Structural Equation Model (Path Diagram) created with the LISREL 8 software is shown in Fig. 2. Regarding the effects of path coefficients of the diagram on concept formation, it was observed that their order of magnitude was the design problem (1.00), context (0.56), designer-induced values (0.35), and user-induced values (0.17). Fig. 2 shows that the fit values of the model are within the acceptable limits (Chi-Square = 168.90; df = 73; X^2/df = 2.31; GFI: 0.94; CFI: 0.98; RMSEA: 0.052).

The path diagram (see Fig. 2) shows that the design problem (1.00) is the factor that most affects the concept formation processes of architecture students and practising architects. The design problem is followed by context (0.56) and designer-induced values (0.35). It was determined that the user-induced values (0.17) were the factors that had the least impact on the concept formation process. Besides, there is also a significant correlation between the design subject (q1) and architectural program sub-factors under the design problem factor. Some of the architect candidates and architects have stated that they produced a concept by using these two sub-factors together. A significant correlation has also been revealed between the physical environmental conditions (q6) and the environmental non-compliance and compliance under the context main factor.

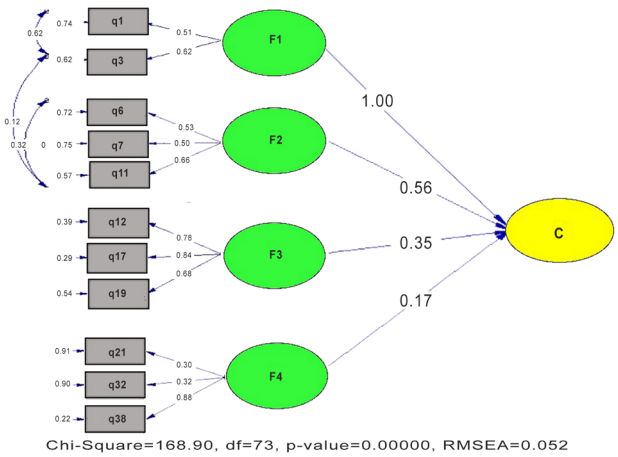

Fig. 2 The path diagram of the model (LISREL 8)

Finally, according to the SEM result, it was determined that the architectural program and the environmental non-compliance and compliance were the factors that helped to create a concept for architects by taking them into consideration together. The validity coefficients in Fig. 2 shows that the scales are valid (r > 0.30). Regarding the scales in terms of t values and error variances, no problems were found in the scales. Furthermore, a significant positive relationship was found between the design problem and context. The evaluation results of the Structural Equation Model obtained from the Path diagram are shown in Table 6.

Since, X^2/s.d. = 168.90/73 = 2.31 < 5 it has shown that the model has an adequate fit and that the results of the proposed model's fit are generally acceptable. The independent variables in the model are examined, and there is a positive correlation between the design problem and context. Regarding the hypothesis proposed in the study, it can be argued that there is a significant correlation between the design problem, project context, designer-induced

Table 6 Structural equation evaluation results

Goodness-of-fit indices	Acceptable fit	Recommended model
RMSEA	$0.05 \leq RMSEA \leq 0.100$	0.052
SRMR	$0.05 < SRMR \leq 0.100$	0.049
NFI	$0.90 \leq NFI \leq 0.95$	0.90
NNFI	$0.95 \leq NNFI \leq 0.97$	0.93
CFI	$0.95 \leq CFI \leq 0.97$	0.94
GFI	$0.90 \leq GFI \leq 0.95$	0.95
AGFI	$0.85 \leq AGFI \leq 0.90$	0.93

values, and user-investor-induced values in the concept formation processes in the designs of architecture students and architects in practice.

5 Results and discussion

This study, with the premise that the concept is an essential factor that initiates and shapes the architectural design process, was based on the hypothesis that the factors that determine concept formation in the design are the design problem, context, designer-induced values, and user-investor-induced values. In line with the hypothesis in the study, the sample group of 298 architecture students and practising architects who were actively involved in the architectural design process were surveyed on the factors affecting concept formation in design. However, in line with the proposed hypothesis, the Structural Equation Model (SEM) was used to confirm that factors mentioned above and the factors that helped create a concept in the design were measured.

According to this model, regarding the concept and the factors determined, it was found that there were significant and positive correlations between the concept and design problem, concept and context, concept and designer-induced values, and concept and user-investor induced values. In other words, all four factors put forward in the hypothesis have been confirmed and were observed to support the concept formation process in architectural design. In addition, it was determined that the factor that most affected the concept formation process was the design problem factor. This is the most important finding. The design problem factor was selected by both groups by around 50% in the concept creation process. Thus, the hypothesis was verified. This was followed by context factor, designer- induced factor and user-investor induced factor, respectively. A part of the sample group that was surveyed also produces concepts by using the factors of design subject-architectural program, physical environmental conditions-environmental non-compliance and compliance, and architectural program-environmental non-compliance and compliance together in concept formation processes. In this study, it has been concluded that the factors affecting the concept development can vary based on the designer's identity. In architectural design education, it has been observed that students develop the concept predominantly on the design problem and context, as they lack professional practice. When determining a concept, that constitutes the design philosophy, the design problem and context factors are expectedly the primary determinants for architect candidates. Design subject and context are used as the determinants, as a premise of architectural design, especially in the design education process. In this process, the architecture students create their analyses based on the design subject and contextual data and embody the design by proceeding to the concept generation process. It is thought that the reason for the relatively low level of the designer-induced and especially user-investor- induced factors is that these factors are not often used in the design education process. At the core of this thought lies the idea that designer- and user-investor-induced values may influence concept generation and are mainly preferred by practising architects. Since the practising architects have professional experience and are constantly in touch with users, the factors of the designer- and user-investor- induced values were more preferred by this group.

On the other hand, architecture students maintain concept formation attitudes within the framework of the habits they acquired during the design education process. The structural equation model in the study proved this by finding a significant and positive correlation between the design problem and context. Moreover, the approach of concept determination for architect candidates has the potential to change when they discover subject-designer identities and interact with users upon their active participation in the profession.

As a result, to enable architecture students to adapt to the profession more easily in the future, it is recommended in the design education process to introduce professional practice and have them perform applications oriented towards the user factor. Thus, they will become familiar with various factors that nourish their creativity and develop it different directions. A structure that ensures proper communication between the designer and the user is achievable by performing the concept development process, which is one of the most important stages of design, in a more conscious

manner. In architectural design, more creative and rational solutions can be achieved by forming interactive, versatile, and meaningful combinations of factors affecting concept development, such as the design problem, context, designer-sourced values, and user-sourced values.

6 Limitations

This study had limitations due to its context. The research required a context in which the participants were accessible but still could perform the concept development processes under their usual circumstances. Therefore, in this study, merely the prospective architects in design education and architects working at an architectural office were questioned. Within the professional architectural practice, however, architects working in the public sector were excluded from the scope of work since they are less active in the design process.

The study was conducted in the capital city of Ankara, which was selected as the pilot region in Turkey and gives access to a vast number of architecture students as well as practising architects, and solely represents this area in the context of the research problem. Thus, it was not possible to address the necessity of a worldwide change regarding design education. In the initiation and execution of the design process, design knowledge, principles, professional ideology, and similar factors also play a role along with the concept development. However, this study focuses exclusively on the issue of concept development, exploring the common ethos of concept creation and denotes its boundaries accordingly.

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