Investigation of the Environmental Factors Affecting the Sociability and Their Importance; Case Study: Architecture Education Environment*

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ABSTRACT

The role of the architecture education environment as an influential model in the mental pattern of the architecture students and their education as future professional architects is of significance. According to the practical nature of the architecture lessons that require the students' presence and their interaction to improve the learning process, it can be supposed that through creating sociability as a qualitative feature of the education environment, the students' learning can be improved. The current research studies the influential environmental factors on the sociability in the architecture education environment that its features can contribute to improving and facilitating the learning process. Therefore, the main research question is which influential factors affect sociability in the physical environment of architecture education, and what are the relationships between them, and how much is their relative weight? Therefore, after identifying the initial concepts, the suggested model of the influential factors was presented through logical analysis and deductive reasoning. Then, the validity of the recommended model in the architecture education environment was measured using Fuzzy Delphi methods. In the next step, the DEMATEL method was applied to measure the relationships between the factors, and using the Analytic Network Process (ANP), the significance and weight of each one of the factors were evaluated. The obtained results presented six groups of the influential factors on the sociability in the architecture education environment that are as follows: physical elements, architectural-spatial factors, aesthetics meanings, sense of security, perceptual-meaning, and activity-functional. Physical elements and architectural-spatial factors were obtained as causal variables among the main factors that have a strong driving power and weak dependence in the design of the sociability in the architecture education environment. Also, activity-functional factors gained the maximum weight and significance among the main factors.

Keywords: Sociability, Architecture Education Environment, Fuzzy Delphi, Fuzzy DEMATEL, Fuzzy Analytic Network Process.

1. INTRODUCTION

The principal purpose of architecture education is to develop and improve the creative talents of architecture students. It requires providing conditions and features that, on the one hand, are related to the educational planning and social and cultural conditions and, on the other hand, are related to the spatial features in which architecture education occurs. According to the effect of the physical environment of the architecture education on the students' learning, it is necessary to recognize the influential factors because if the physical environment cannot provide the required environmental affordance to meet the students' demands, the learning process will be problematic.

The current research investigates the sociability of the education environment, as an influential physical feature, on the architecture education environment. Therefore, the influential factors on sociability in the education environment, their relationships, and the significance of which are identified. Thus, the research structure is classified into four main sections. First, the concepts and theoretical framework of research are explained. Edward Hall studied concepts such as sociability to investigate the collective interactions in the architectural space (Daneshgar Moghadam, Bahreini, & Einifar, 2011). The sociability of the public environment is obtained by the appropriate adjacency of spatial-physical and social- mental factors. This sociability increases with high coordination and adaptation between the body of space and individual and trans-individual behaviors (Salehinia, 2009; Salehinia & Memarian, 2012). Tahmasebi (2012) emphasizes the significance of the role of qualitative components of the built environments in improving social interaction (Tahmasebi, 2012; Behzadfar & Tahmasebi, 2013).

Naghiloo and Falahat studied sociability in urban environments. This research recommended a conceptual model to describe sociability, which is based on three aspects of human, environmental, and perceptual-meaning (Naghiloo & Falahat, 2016). The causes and influential factors on the maintenance and continuity of the collective life and quality of the sociability in the public spaces are studied in a paper conducted by Daneshpour and Charkhchian (Daneshpour & Charkhchian, 2007). Shojaei and Partovvi also identified the forming and improving criteria of sociability in the public space (Shojaei & Partovi, 2015, pp. 99-105). Furthermore, Alitajer et al. investigated the sociability factors in educational environments. They showed that the social and mental characteristics of users have the most impactability on sociability, and the physical features of the public environment have the minimum impactability (Alitajer, Sajadzadeh, & Saati Vaghar, 2016). Also, some studies are conducted on sociability in residential and cultural buildings (Yazdani & Teymuri, 2013; Sajjadzadeh,

Yousefi, & Yousefi, 2016). Thus, the sociability features in the architecture education environment will be studied based on former studies, and the conceptual model of research will be recommended. In the second section, the mentioned model will be screened using surveying elites. Then, the relationship and the effect of the obtained factors and sub-factors on each other are measures, and the significance of each component will be obtained. Finally, the results will be discussed, and the architectural design solutions will be suggested.

The current research aims to create sociability as a physical feature in the architecture education environment through considering the relationship between humans and the environment, and consequently, be influential in the behavior of architecture students and their learning process. It is noteworthy that the analysis method of the current research is of Multiple Criteria Decision-making Methods (including Fuzzy Delphi, Fuzzy DEMATEL, and Analytic Network Process) based on Tseng (Lin, Tseng, & Pai, 2018). Using this method in architecture studies is new and considering its capability of solving complex problems is a novel step in this regard.

2. RESEARCH METHOD

This research is of applied in terms of purpose, and is descriptive-analytical in terms of data collection and solving problems method is Fuzzy Mathematical modeling. The information collection instrument is taking notes of library studies and the questionnaire. Therefore, the research includes three sections. In the first part, the influential factors on sociability in the architecture education environment were surveyed using the Fuzzy Delphi method from experts (architecture education professors). The statistical population of this step is 20 architecture professors (with teaching record and presence in the architecture environment). The criteria of selecting elites are as follows: being familiar with the architecture education, the academic education level, knowledge, work history and academic occupations (teaching history), experiences and skill, availability, and having the motivation and tendency to participate in research (Modiri, Mirzaiei Khaki, & Karimi Shirazi, 2014). In the second part, the survey was conducted on six elites based on the obtained relationship between the factors and sub-factors of sociability from the previous method. The analysis method in this phase is Fuzzy DEMATEL of the Multiple Criteria Decision-making Methods, which is one of the significant methods in the evaluation of the causal relationships (Tseng & Chiu, 2013; Lin & Pai, 2018). In the third part, using the new mixed method of the Analytic Network Process based on DEMATEL, the influential weight of the criteria and the significance of each one of the effective factors on sociability are investigated in the architecture education environment (Modiri, Mirzaei Khaki, & Karimi Shirazi, 2014).

3. EXPLAINING CONCEPTS AND THEORETICAL FRAMEWORK

According to the problem statement of the research, first, it is required to understand the concepts of social interaction and sociability. Then, the influential environmental factors on them will be investigated.

3.1. Social Interactions

Social interaction is a process that is started by establishing a relationship between actors and provides the formation of the social relationship between them and its flow over time. This process emerges by the interaction effectiveness and impactability between the actors. In this process, each actor's action is the result of his/ her experiences that is variables over time and based on the experiencing process. Therefore, the social interaction means establishing a relationship between two or more individuals that leads to the reaction between them, and this reaction is known for both parties (Daneshpour & Charkhchian, 2007; Rohami, 2014, p. 39). According to Lars Lerup (1972), one of the required factors for creating is an environmental affordance that can welcome different groups and individuals (Daneshpour & Charkhchian, 2007, p. 23). The social interaction brings closer the people's attitudes with subjective backgrounds and different characteristics. This, activities such as interaction with others and observing activities of people contribute to the personal growth of humans by providing socialization and sociability (Lang, 2004, pp.186-187).

3.2. Sociability

Social interaction depends on a sociable space to meet this need. According to Humphry Osmond's definition, the use of the words sociable or sociopetal spaces, collecting and sociofugal spaces, or dispersing spaces, indicates the quality of the space that brings people together or separates them. (Alitajer, Sajadzadeh, & Saadati Vaghar, 2016; Mardomi Qamari, 2011). The quality of interactions (formal and informal) in the architecture education environment can increase the sense of belonging to the place that leads to more satisfaction of users with space and encourages them to spend more time in the space. The students' social interaction in the educational environments is to find a proper place for gatherings, discussions, and team works that occur outside of the formal educational environment and are unorganized, unpredictable, and unofficial (Alitajer & Hajiabadi, 2016).

The physical space has been considered the most influential factor in creating the appropriate environments for the social interaction of the users among the influential factors in creating sociability (Pasalar, 2003). According to Moleski & Lang, the physical environment provides the ground for the behavior events in three levels, including 1. physical elements such as light that determine the physical structure, and provide the necessary facilitations for the space use. 2. physical environment provides the realization of the behavioral patterns by creating the place territories (including dimensions, form, geometry, and spatial relations). 3. the physical environment acts based on the emotions, experiences, and aesthetic perception and contributes to the perception of the users (Moleski & Lang, 1986).

The researchers presented some classification in studying the influential factors on sociability. In this regard, Alitajer and Zarei considered the effective place qualities in the place preferences of students in three aspects of physical, activity, and meaning. Shoajie and Partovi also mentioned the physical, activity, and social dimensions effective in sociability (Shojaie & Partovi, 2015). Daneshpour and Charkhchian also had another classification of the influential factors on sociability. In concluding their studies, they have divided the dimensions affecting sociability into four general dimensions of inviting, security, desirability, and activity responsiveness. (Daneshpour & Charkhchian, 2007). After the logical analysis and deductive reasoning of the opinions of scholars, the suggested model of the environmental factors affecting the sociability in the architecture education environment is presented. According to the classification of Lang and Moleski, as mentioned, physical elements, architectural-spatial elements, and perceptual- meaning aspects were selected (emotional, affective, referencing, and prescriptive meanings) The aesthetic meanings that imply the indicators such as harmony, coordination, and proportions, are considered as the fourth dimension because of its importance. The sense of security, which leads to spatial territories and influences behavior, and contributes to a person's psychological sense of the environment, was another factor. Also, the activity-functional aspect that is related to the relationship between the physical environment and the activity of users mentioned by (Ahmadi, Farhdi, 2016; Shojaei & Partovi, 2015; Alitajer, Sajadzadeh, & Saadati Vaghar, 2016), was considered as another environmental factor. Therefore, the conceptual model, including the factors affecting sociability and its sub-criteria, has been presented in Table 1.

Table 1. Influential Environmental Components on Sociability

Aspect	Criteria	Sub-criteria
Influential Environmental Components on Sociability	Physical elements	Appropriate and desirable lighting
		Audio conditions (peace and silence)
		Desirable temperature
		Smell
	Architectural-spatial elements	Space dimensions and size (pleasant and open space)
		Form
		Geometry (geometrical centrality)

Aspect	Criteria	Sub-criteria
Influential Environmental Components on Sociability	Architectural-spatial elements	Spatial relations (visual relationship and spatial integration)
		Natural and architectural elements
	Aesthetics meanings	Novelty and diversity (unity, continuity, complexity)
		Harmony
		Color and construction materials
		Advertisements and motifs
		Spatial proportions (Form and order)
	Sense of security	Solitude (crowd)
		Private space and territory
		Friendly atmosphere
		Sense of belonging
		Legibility
	Perceptual- meaning	Sense of invitation
		Flexibility
		Permeability
		Desirability
		Vitality
	Activity- functional	Proper facilities for sitting
		Activity accountability
		Active occupation (different activities at different times)
		Passive occupation
		Space participatory and publicity (conversation and interaction space)

4. MEASUREMENT AND SCREENING OF THE INFLUENTIAL FACTORS ON SOCIABILITY IN THE ARCHITECTURE EDUCATION ENVIRONMENT

In this phase, a weight limit has been applied in the model due to a large number of variables identified, and to identify variables, reduce inputs, to determine the importance of inputs relative to each other and, and to the localization of variables. A questionnaire with 29 questions was designed (each question indicates a variable) to do this phase. 20 questionnaires were distributed among the respondents, and all the questionnaires were received completed and comprehensive. These questionnaires were qualitative and based on the five-point Likert Scale from considerably significant to insignificant. After distributing and collecting the questionnaire, the Fuzzy Delphi method was utilized to determine the most significant components. According to the results obtained from three phases, the components, whose non-fuzzy average expert opinion was less than eight, were removed (Fig. 1). Therefore, out of 29 components, seven components were removed from the final conceptual model, and the final model had 22 components (Fig. 2).
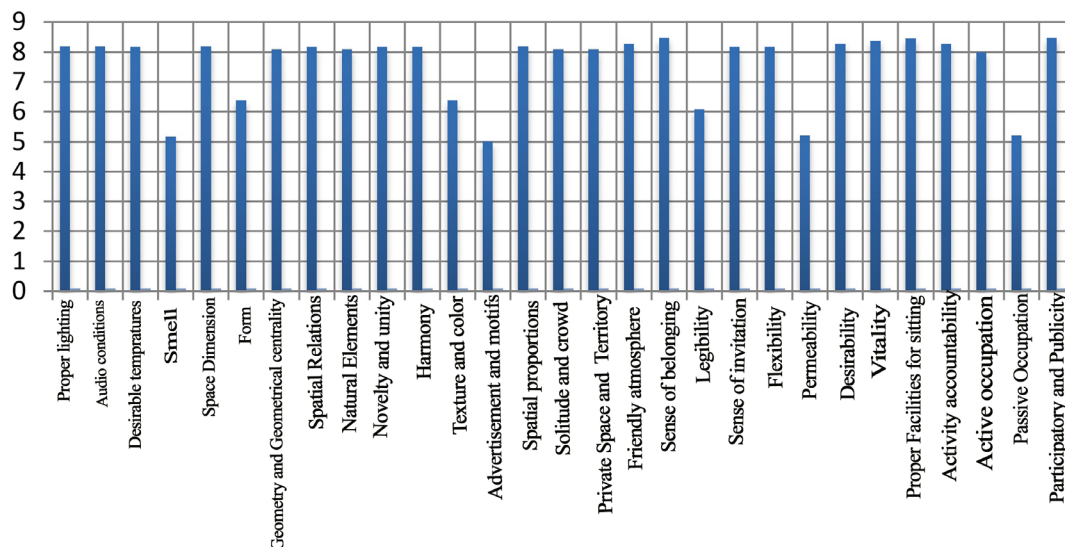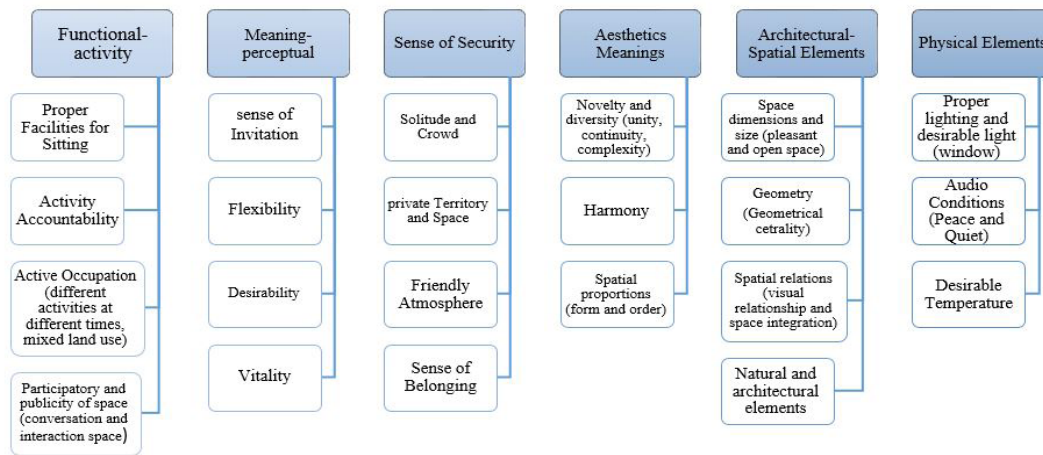

Fig. 1. Non-Fuzzy Mean of the Elites' Opinions and their Differences

Fig. 2. The Influential Environmental Factors on Sociability in the Architecture Education Environment with Network Structure

5. IDENTIFYING THE RELATIONSHIPS BETWEEN INFLUENTIAL FACTORS ON SOCIABILITY

Multiple Criteria Decision-Making Methods (MCDM) are among the most applied method of decision makings due to their superior to other methods in evaluating different options. These methods are capable of qualitative and quantitative evaluation of the criteria that cannot be measured by the traditional methods. Fuzzy logic was used to solve the decision-making problems due to the unbalanced scale in judgments, uncertainties, and inaccuracy of the comparisons (Modiri, Mirzaei Khaki, & Karimi Shirazi, 2014). There are various methods to solve the multiple criteria decision-making problems that ANP[1] and DEMATEL[2] are of the most applied methods (Lin, Tseng, & Pai, 2018). These methods divide a complicated problem into its hierarchal components, in which the decision options are at the lowest level, and the main purpose is at the highest level. The middle levels are related to the main criteria and secondary criteria. DEMATEL technique developed by Gabus and Fontela investigates the internal structure of the criteria and tries to solve the problem and improve it. (Gabus & Fontela, 1972). The complex interaction between the components of a system can be modeled by DEMATEL (Lee, Tzeng, Yeih, Wang, & Yang, 2013).

ANP was presented by Saaty (Saaty, 1999), and its purpose was to solve problems of interdependence and feedback between criteria and options. In this phase, the Fuzzy DEMATEL method was used to identify the relationship and effectiveness and impactability of the factors.

After surveying and analyzing the data, the effectiveness and impactability of each influential factor on the sociability in the architecture education environment were obtained according to Table 2 and Figure 3. Similarly, the positive values indicate the effectiveness, and the negative values indicate the impactability. Therefore, among the main factors, physical elements had the most effect with the value of 0.87, and activity-functional had the most impactability with the pure impactability of -0.94. Accordingly, the factors of physical elements and architectural-spatial elements are considered causal variables that have strong driving power yet weak dependence in designing the sociability in the architecture education environment. Thus, these factors must be focused on first to start to design the sociability in the architecture education environment. The aesthetics meanings, sense of security, perceptual-meaning, activity-functional are the variables that have low driving power yet severe dependence in designing the sociability in the architecture education environment. These variables are mainly the results of the causal variables in designing the sociability in the architecture education environment. They also are involved in creating sociability in the architecture education environment.

Table 2. The Effectiveness and Impactability of the Influential Factors on Sociability

Factors	D	R	D+R	D- R	Results
Physical Elements	3.29	2.42	2.72	0.871	The Most Effective
Architectural-Spatial Elements	3.24	2.46	5.69	0.78	Effective
Aesthetics Meanings	2.86	9.2	5.76	-0.04	Impactable
Sense of Security	2.55	2.91	5.46	-0.37	Impactable
Perceptual-Meaning	2.7	2.99	5.69	-0.3	Impactable
Activity- Functional	2.43	3.73	5.81	-.0.94	The Most Impactable
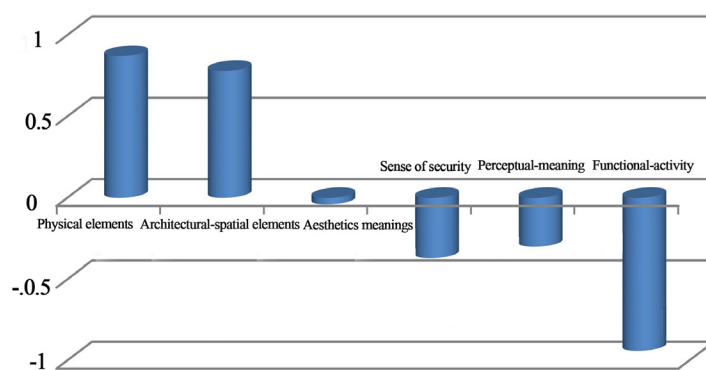
Fig. 3. The Effectiveness and Impactability of the Main Influential Factors on Sociability

The effectiveness and impactability of the sub-factors were presented in Figure 4 and Table 3. As can be seen, the proper facilities for sitting have the most effect, and participatory and publicity of the space have the most impactability.
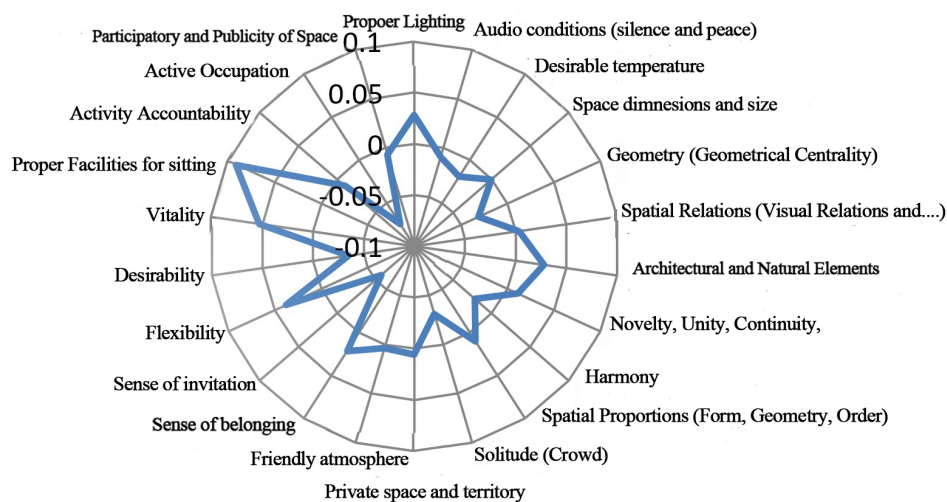
Fig. 4. The Effectiveness and Impactability of the Sub-factors on Sociability

Table 3. The Effectiveness and Impactability of the Influential Factors on Sociability

Aspect	Sub-Factors	The Value of Effectiveness	Results
Physical Elements	Proper and Desirable Lighting and Light	0.0281	Effective
	Audio Conditions (Silence and Peace)	-0.009	Impactable
	Desirable Temperature	-0.019	Impactable
Architectural-Spatial Elements	Dimensions and Size of Space (Open and Pleasant Space)	-0.0002	Impactable
	Geometry (Geometrical Centrality)	-0.031	Impactable
	Spatial Relations (Visual Relationship and Spatial Integration)	0.0035	Effective
	Natural and Architectural Elements	0.028	Effective
Aesthetics Meanings	Novelty, Unity, Continuity, Complexity, and Diversity	0.013	Effective
	Harmony	-0.022	Impactable
	Spatial Proportions (Form and Order)	0.0105	Effective
Sense of Security	Solitude and Crowd	-0.031	Impactable
	Private Space and Territory	0.0057	Effective
	Friendly Environment	0.0036	Effective
	Sense of belonging	0.0214	Effective

Aspect	Sub-Factors	The Value of Effectiveness	Results
Perceptual-Meaning	Sense of Invitation	-0.057	Impactable
	Flexibility	0.0382	Effective
	Desirability	-0.035	Impactable
	Vitality	0.053	Effective
Activity- Functional	Proper Facilities for Sitting	0.0916	Effective
	Activity Accountability	-0.01	Impactable
	Active Occupation (Different Activities in Different Times)	-.074	Impactable
	Participatory and Publicity of Space (Interaction and Conversation Space)	-0.007	Impactable

Figure 5 presents the causal graph and network map of the relationships between the main factors. In this figure, the horizontal axis represents the significance of the criteria, and the vertical axis shows the impactability or effectiveness of the factors. The interactions between the main factors and their effectiveness are also presented by the arrow. Among the main factors, the physical elements affect the architectural-spatial elements, aesthetics meaning, sense of security, perceptual-meaning, and activity-functional aspects to create sociability in the architecture education environment, but is not affected by any of these factors.
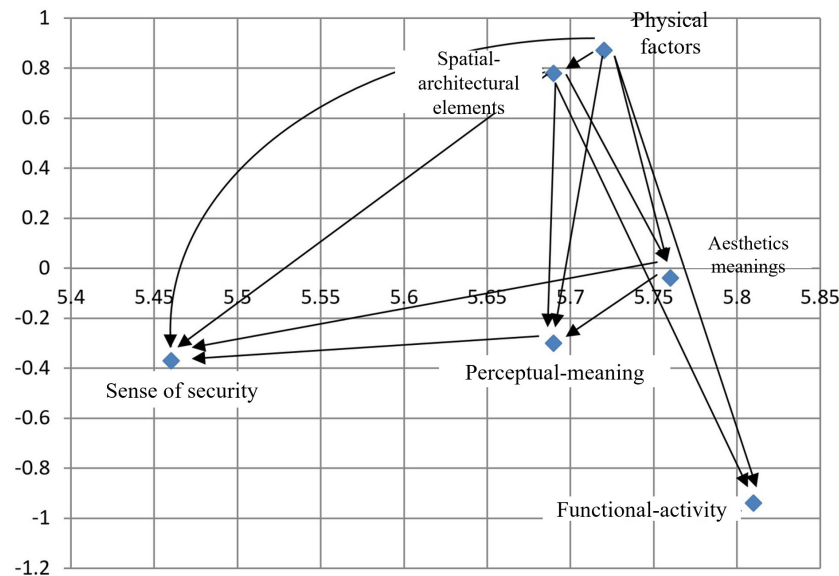

Fig. 5. The Causal Graph and Network Map of Relationships between the Main Factors

6. MEASURING THE SIGNIFICANCE OF EACH ONE OF THE INFLUENTIAL FACTORS ON SOCIABILITY

The fuzzy ANP was used to obtain the significance and weight of each one of the factors. Therefore, the weight and significance factors and sub-criteria are obtained according to the network structural model presented in Figure 6.
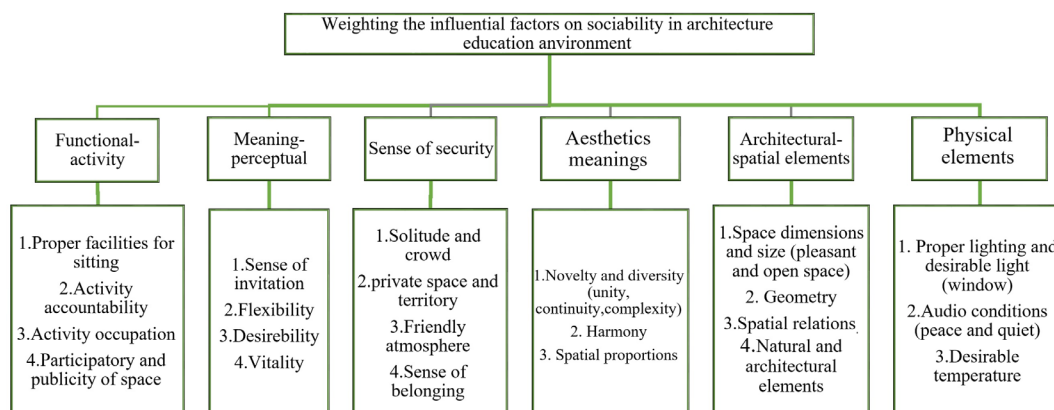

Fig. 6. The Model with the Research Structure Network

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Based on the results obtained by the ANP method of the resulted matrices from the previous phase (DEMATEL), the weight and priority of factors and sub-factors are presented in Figures 7 and 8. Accordingly, activity-functional gained the most weight among the main factors. Also, the maximum weight is related to the spatial proportions (Form, geometry, and order) that achieved the first rank among the sub-factors. The participatory and publicity of space (conversation and interaction space) was ranked the second priority, and the active occupation (different activities at different times, land use mix) was ranked the third priority. Also, the novelty and diversity had the fourth priority, and the activity accountability and desirability obtained the fifth and sixth priorities among the 22 sub-factors. These sub-factors were allocated 34% of the total weight of the sub-factors, indicating the significance of these sub-factors.
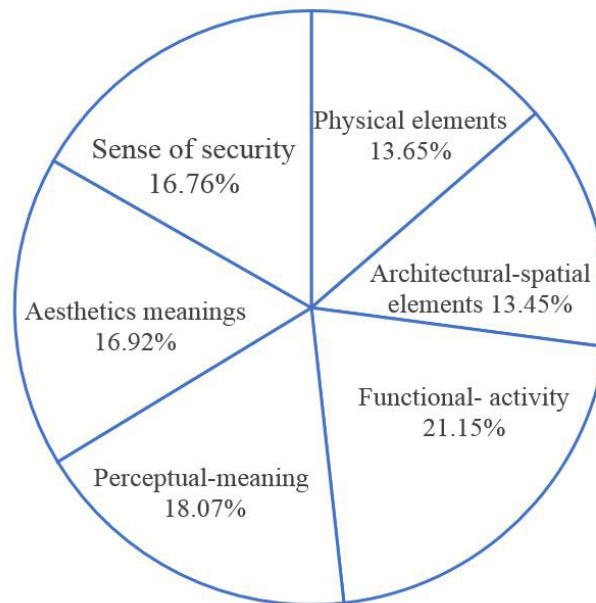

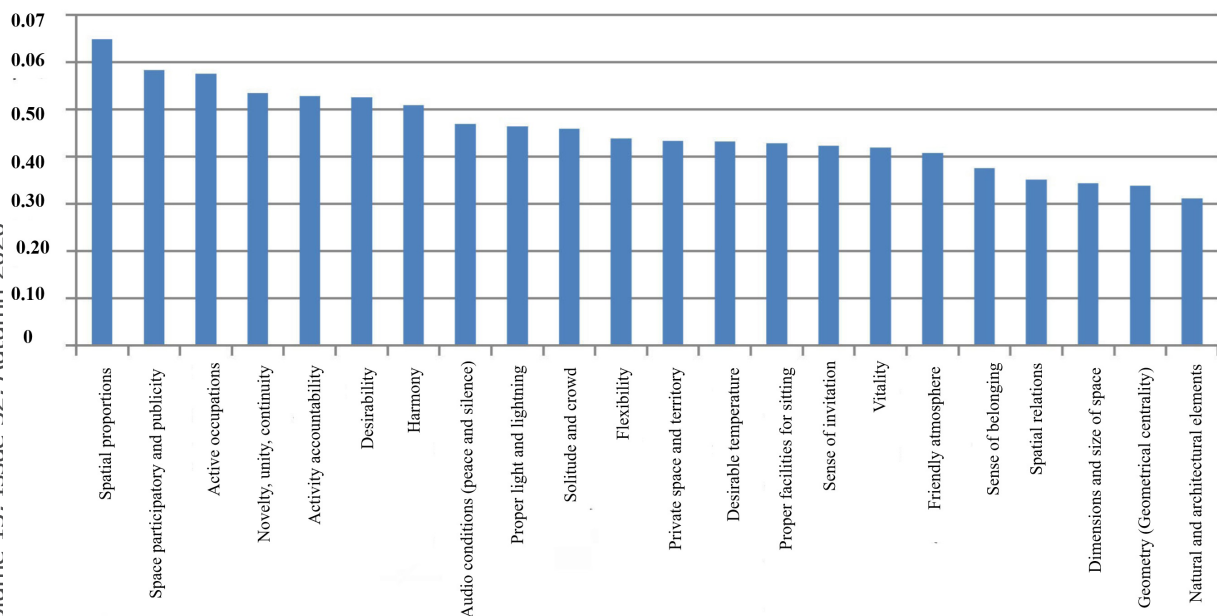**Fig. 7. The Graph of the Relative Priority of the Main Factors**

Fig. 8. The Graph of the Final Priority of the Sub-Factors

7. DISCUSSION AND CONCLUSION

The influential factors on sociability in the architecture education environment are classified into six main groups. Table 4 shows the comparison between these factors and the results of the previous studies. As can be seen, and since the obtained components were based on the conclusions and analysis of other studies, the

current study can be considered in line with other studies. Also, the results obtained from the Fuzzy Delphi method for the architecture education environments were confirmed by the experts. On the other hand, the analysis of the interaction and the relationship between the influential factors and sub-factors on the sociability is a novel step in the architecture studies using the Multiple Criteria Decision Making Models (MCDM). Studying the relationship between the components and their effectiveness can provide a way to present the design solutions.

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Table 4. Comparing the Results of the Influential Factors on Sociability with Other Studies

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Main Factors	The Previous Studies Confirmed the Factors as Sociability Factors.	The Result of the Current Research
Physical-Spatial Elements	Alitajer & Zarei, 2016; Daneshpour & Charkhchian, 2007; Mardomi & Qamari, 2011; Salehinia & Memarian, 2012; Alitajer et al., 2016; Bigdelizadeh, 2013; Moleski & Lang, 1986	This factor is of a lower priority (fifth priority). However, it does not mean the low impact of this facto on other factors so that it is considered as the most effective factor.
Architectural-Spatial Elements	Alitajer & Zarei, 2016; Shojaei & Partovi, 2015; Moleski & Lang, 1986; Memarian, 2012	This factor is the sixth priority. However, it does not mean that it has a low impact on other factors so that it is the second effective factor in sociability.
Aesthetics Meanings	Alitajer & Zarei, 2016; Moleski & Lang, 1986	This factor has the third priority and is among the main factors. Therefore, following the functional-meaning and the aesthetics meanings factors, it has significance in designing the sociable education environment that is created under the influence of physical elements and architectural-spatial factors and affects the sense of security, perceptual-meaning factors, and activity-functional factors.
Sense of Security	Daneshpour & Charkhchian, 2007; Behzadfar & Tahmasebi, 2013; Shojaei & Partovi, 2015; Ghanbaran & Ja'fari, 2014; Naghiloo & Falahat, 2016	It is the fourth important factor in creating sociability of the architecture education environment that is affected by the physical elements and architectural-spatial elements.
Perceptual-Meaning	Alitajer & Zarei, 2016; Moleski & Lang, 1986; Naghiloo & Falahat, 2016	It is the second important factor in sociability, and therefore, must be considered in the architecture design as a significant factor.
Activity-Functional	Alitajer & Zarei, 2016; Shojaei & Partovi, 2015; Mardomi & Qamari, 2011; Bigdelirad, 2013; Alitajer et al, 2016	This factor is known as the most significant factor in creating sociability of the architecture education environment. Therefore, it can be said that providing the required environmental affordance for facilitating the activities in the environment is the first factor that must be considered in architectural design.

In general, the results show that the most significant factor in forming a sociable environment is the activities and functional quality of the individuals, followed by the meanings that are perceived from the environment and, eventually, the physical and spatial factors. According to the relationships and the effectiveness of these factors, the architectural-spatial elements and physical elements are the most effective factors on other factors. These factors form the perceptual and aesthetics meanings and sense of security and provide the opportunity for the realization of different activities.

According to the obtained results from research, the following cases can be considered in designing the architecture education environment to have the proper affordances of sociability:
- Observing the proportion between the current behavior patterns and the geometry and form of the educational environment in which the activity occurs.
- Observing the proportion between the activity features related to the learning (demands of teacher and architecture students) with the dimensions and size of

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the physical environment of education.

- Providing appropriate furniture with the needs of architecture students helps create the interaction and conversation space for them and the teacher and provides the possibility of occurring the activities related to learning (through observation) and participatory of doing activities (participatory learning) for students.

- Providing an environment that makes it possible to enjoy in different conditions, considering the proper scale of activities in place (in terms of behavioral and emotional effects in space) and the visual attractions.

- Variability and relocation of the semi-fixed and mobile elements (furniture) of the environment by the students that are effective in creating a sense of belonging and conducting their activities.

- Considering sense of invitation including different aspects of physical and visual access, functional position, diversity of activities, and accessibility for different social groups in the architecture education environment.

- The proportion between the content meanings (aesthetics and referencing meanings) of the environment with the activities that occur in that through applying the aesthetics elements and harmony

and the desirable coordination between the components in the physical environment

- Creating the desirable privacy through controlling and regulating the relationship between the architecture students and their desired interaction that are effective on the sense of security of the physical environment of education, and resulting in the effect on their behaviors by creating the private space and behavioral territories.

- Creating the environmental affordance (through flexibility, privacy, and friendly environment) to improve the sense of belonging and ownership of the students and teacher to the education environment that leads to increasing the presence of students in the educational physical environments, and creating a friendly atmosphere among them and increasing the interaction.

- The use of natural and spatial elements in designing the architecture education environment along with the proper design of spatial relations, geometry, dimensions and size, and natural and architectural elements that can provide the required environmental affordances for the collective activities and exchanging ideas between the students and teacher in the architecture education environment, resulting in facilitating the learning process of students[3].

END NOTE

1. Analytic Network Process.
2. Decision Making Trial and Evaluation Laboratory.
3. The effect of sociability of the architecture education environment on the students' learning has been studied in the Ph.D. thesis of the first author and will be addressed in another paper.

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