

Socio-petaloid of Architecture Space; Result of synthesis and synomorphy of humane-physical factors

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Abstract: The research experimentally analyzes the issue of Socio-petaloid of the architecture space. The research methodology was compiled primarily by presenting a pattern with a theoretical standpoint regarding the Socio-petaloid of the space using the type of hypothesis testing with case study through a polling, with on-site presence technique, and with the tool of cognition map and a questionnaire. 7 public spaces from among 3 distinguished independent buildings of the university faculties were selected for the case study. The data underwent correlative analysis in the SPSS statistical software and the meaningful relations between the variables affecting the Socio-petaloid were deducted.

The following results were achieved by the research:

- The psychological-social factors of the users directly influenced the Socio-petaloid of the public architecture space and were considered as an establisher.
- The physical-spatial factors influence the Socio-petaloid. This influence has two conditions, one with "direct affordance" and another with "indirect affordance".
- Socio-petaloid of the public space would be achieved with proper synthesis of the spatial-physical elements of architecture and psychological-social elements of the users. This Socio-petaloid increases with a high synomorphy between the space physic and interpersonal behaviors.

Keywords: Socio-petaloid, Architecture Public Space, Synthesis, Synomorphy, Humane-Physical Factors.

1. Introduction

Modernity has influenced all dimensions and aspects of the life of man today, particularly over the recent century, and amplified individualism, as sociologists and social scientists have interpreted, is one of its influences. In addition to the historical and social backgrounds the physical environments of the buildings and cities have perhaps played a role in this change. Attention to the physical environment as the habitation of neighbors has gained more importance toward their proximity to each other and compensation for part of the social interactions presently lost in the previous architectural and urban buildings and textures.

The issue is that whether a special physical architectural plan would be able to encourage maintaining of positive and constructive social relations between the users, and add to the opportunities of interpersonal and extra-personal interactions. If the issue is viewed from the point of physical determinism which was common early in the modern architecture, the problem is settled. However, according to the researches conducted over the recent decades and proposition of the theories of free-willism, possibilism and probabilism of the physical impact over behavior, the important and effective role of mental-social characteristics of the users in the typical interactive behaviors occurred in the public

architectural spaces may not be overlooked. Knowledge of the process of composition (synthesis) and compatibility (synomorphy) between the humane and physical factors is of double importance in this respect.

A desirable social interaction or socio-petaloid of the architecture space has been evaluated as positive from various aspects. A reciprocal social relation to satisfy the need of man to relationship and the need to a feeling of belonging to place is a necessity which helps personal growth of the man. Further clarification of social duties commitments in the generality of the activity and function of the building, further support of the users of each other, lesser self-alienation and preparing the grounds for development of friendships and daily relations are among other impacts of the higher socio-petaloid of the public architecture spaces of the buildings with mere non-functional specifications.

2. Hypothesis

The issue of socio-petaloid in public spaces or as architectural psychology¹ puts "public behavioral settings", belongs to the public buildings such as: cultural, educational, medical and residential buildings where relations between their users are considered to be more non-functional or as interpreted "anthropophilic"² (humane), and the social interactions

occurred in them is not the result of mere functional and predetermined purposes but it is unofficial and accidental, gaining more importance³. To this end, the case study of the present research has been focused on the public spaces of the cultural-educational buildings (of the university).

The general hypothesis of the research: Sociopetaloid of the architecture space is achieved through proper synthesis of the physical-spatial factors of architecture and mental-social factors of the users. This synthesis is the result of synomorphy or coexistence between the public physical space and inter-personal or extra-personal behaviors in wake of the conditional correlation between these two which is determined by the mental-social factors of the users of the space. The research hypothesis has sought to identify the type of effective physical-spatial factors of architecture and mental-social ones of the users and experimentally assess the extent and manner of synthesis and synomorphy of these factors after explaining them.

In the process of the establishment of the hypothesis there were a lot of intervening factors like meanings, concepts, motivations, imaginations and approaches of the users, therefore, from the two general research methods of psychology, namely, test of hypothesis and exploration, the test of hypothesis was selected and from the two methods of the test of hypothesis (laboratory and field), the field research of the type of case study together with techniques of surveying and polling along with deduction from meaningful correlations for the identification of impacts were chosen.

3. Meaning of sociopetaloid

Use of the terms sociopetaloid or sociophile and sociopetal and sociofugal implies spatial qualities in architecture which gather the people together or disperse them. The terms have been defined by Humphery Osmond accompanied by Robert Sommer during their position as managers of a hospital in Canada. The terms were primarily proposed by Osmond concerning the sociopetaloid or sociofuge of spaces with semi-fixed feature, removable equipment and furniture. He proved the role of furniture in the sociopetaloid of the architecture space [1]. The sociofugal organization contrary to the sociopetaloid one causes refusal from social interaction⁴. Edward T. Hall believes that the sociofugal space in a culture may be a sociopetaloid one in another culture. A sociofugal space is not necessarily a bad space just as a sociopetaloid space which may not always be good generally. What is desirable is the existence of flexibility and compatibility between the physical plans of the public spaces of a building so that a variety of different spaces can exist and people could be engage in these spaces based on need and mood.

4. Basic theories and related researches

The basic topic in this research is the impact of physical space on behavior. Theoretical stances in this regard may be summarized in the approaches of free-willism, possibilism, probabilism, and determinism [2]. The physical space in this research as it was explained is the public behavioral setting or public architectural space. The behavior in mind too is of social interaction or informal and accidental interpersonal type¹⁷. The related theories will be generally reviewed in three main sections of design for social interaction, capability

of physical space in shaping behavior and synomorphy of physical space and behavior.

As for the **correlation of architecture space and social interaction** or based on an interpretation, ecology of social interaction, researches have been conducted within the theories of "design for social interaction". According to the viewpoints suggested by Joseph P. Forgas in the domain of social interaction (inter-personal) psychology, "interaction of social experiences" and specifications of the behavioral setting is the main topic of discussion on social interaction. Architecture space may be considered as an important component in the interaction of man with others. Man, as an organized system, dynamic and apt at learning, is able to modify his behavior in wake of changes in architectural space. Social interaction depends on "social role" and relations an individual have in a group [3]. The distance of interaction spaces and the concerned relation or synthesis in this research is in the social-consultative intervals²⁰ of the theory of "proximity" by Edward T. Hall⁵.

Another research on "How to use man-made environments in inter-personal communication" has achieved "social psychology" by means of experimental methods [4].

Irwin Altman believes that the extent of the desirable social contacts of people is different in various situations and even in different times of the day and these changes take place toward achievement of a desirable level of privacy [5]. "A balance between privacy and social interaction is possible both by physical concepts and by cultural-social concepts which prepares necessary psychological grounds" (Eminfar, 2000). Serge Chermayeff and Christopher Alexander too, consider "privacy and social interaction" as interrelated and close concepts [6]. On the other hand Thorsten Hagerstrand has offered a method for the analysis of activities in the course of time and place which is known as "geography of time". This method addresses behavior in time and place and the physical environment in which social activities are carried out and seeks to examine the impact of physical environment on the daily activities of individuals and groups. [7].

Normal L. Mann believes that "proximity", "congruency", "density", "situation" and "purpose" are the primary and major factors establishing interaction between individuals, and can help cooperation and competition [8] (Fig.1).

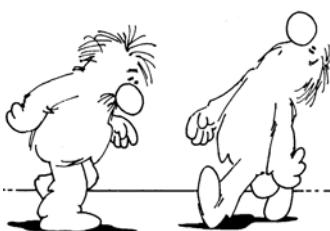


Fig. 1 As Mann interprets, proximity, congruency, density, situation and purpose are the primary and major factors establishing interaction between individuals [8], [3].

According to the view of Jon Lang different architecture spaces may "deter" or "facilitate" people's behavior but they cannot "determine" the behaviors. Therefore, the final result of interaction between man and architecture space is not possible only through "adaptation" of behavior with space but coexistence between behavior and space is the result of a "conditional attunement" between these two by means of the decision and final selection of man based on his physical and intellectual capabilities, his needs, interfaces and social and cultural norms [9]. As Tony Cassidy describes "If people are

congruent in public spaces there is more probability of their reciprocal relations, and non-congruency increases lack of relations between them [10]. Herbert Gans says: "A potential architectural space prepares a vast extent of opportunities for satisfaction of the needs of a person or persons whereas, what is gained by a person every moment is the very result of an effective architectural space". Therefore, the manner of using an architectural space depends on "opportunities" and "their quality" [11].

Capability or affordance of physical architectural space in shaping behavior has been proposed by James J. Gibson as another discussion which is related to the topic of the project. Capabilities or affordances considered by him includes physical configuration of a thing or behavioral place which makes it usable for particular activities. These capabilities also provides for aesthetic concepts and perceptions [12]. Capabilities of the environment may be divided into two direct and indirect groups. The direct capability refers to provision for activities by the architectural space while the indirect capability includes things like symbolic concepts that depends on a reference and utility of a pattern [9]. The "non-physical affordances" like "physical affordances" can also affect perception of an architectural [13].

Physical-behavioral synomorphy is another relevant discussion on which a theory has been made. In order to define and recognize the synomorphy between physical space and behavior we need to study the meanings of "behavioral setting". The meaning of setting or place of behavior has been compiled by a group of behaviorists who are known as "ecologic psychologists" because of their attention to the man's behavior in the daily life setting. They believe that physical environment imposes some compulsions on the man behavior. According to Roger Barker the behavioral setting is active like an organism system and include components and factors such as "indicative or current pattern of behavior (a reversible, continuous and repeatable activity)", "a special design of the physical environment (a special three-dimension realm or array)", "a special period of time" and "an adaptable relation between the sustainable pattern of behavior and place". There is a lot of similarity between the individuals who are in a similar behavioral setting [14]. Synomorphy means that without a synomorphic relation between the realm and behavior of man there could be no possibility for the existence of a sustainable place-behavior. R. Trancik also introduces two important types of behavioral settings, namely, "place" and "connector", which are abundantly seen in the urban space, and believes that these two also exist in architecture [13]. Amos Rapoport also follows and approaches similar views and considers proposition of adaptable and flexible as well as open-ended designing necessary for further synomorphy and adaptation between space and behavior [2].

5. Research pattern

According to the findings of the related researches a theoretical model has been proposed for the researches in the domain of socio-petaloid of architectural spaces and related designs in order to identify the factors involved in developing social interactions in public buildings. This pattern has been tested and examined in the present research and the authenticity of its structure has been confirmed. The two basic triangles in the pattern are considered as establisher and

radical "humanitarian" and "physical" factors. The triangle on the middle stem is the result of the synthesis of these factors. The "synomorphy" triangle and "geographical bed" along with the suitable process of synthesis (composition) of humanitarian-physical factor would determine the socio-petaloid of space (fig. 2).

5.1. Public space

The public behavior setting or public space⁶ of architecture has been considered in this research for the assessment of socio-petaloid. There are two major approaches toward the public space in the architecture and urban development literatures of the recent century: Descriptive and prescriptive. The descriptive approach tries to describe and explain man's behavior in the presence of others and interaction with them. The prescriptive approach attempts to find a way for humanistic interaction. Two main layers of the public space which are recognized in close relation with each other are: Inter-personal space or social confrontation space and extra-personal or public space. Hanna Arnett says the public space gathers men together and separates them⁷. Charles Taylor terms the public space as a collective space in which members can contact each other by means of different tools or a face-to-face communication. Moreover, Shilla Benhabib believes that by presenting himself to others in a public space and expressing himself before the public, man allows other individuals and groups to consider his viewpoints so that he would see the world from the point of view of other [15].

5.2. Case study

- Sampling of building: In order to establish the hypothesis a case study⁸ was conducted. From among the humanistic or anthropophilic buildings, cultural and educational buildings and from among them, architecture of the university was adopted. The university is among complexes where the occurred interactions and socio-petaloid of the public space are mostly the result of the cultural and scientific purposes than functional and living purposes. The public spaces of universities, based on the views of their users, are considered as an unofficial educational supplement to the official educational spaces, and their socio-petaloid would lead to positive results for the students. Meanwhile, students are considered as a congruent group of users of these spaces in which controlling of intervening cultural-social variables of the research are more possible. From among different buildings of the Iran University of Science and Technology (situated in Tehran) and from among 12 faculty buildings of the university, three independent public spaces with a large size, which were active and had a permanently present population for studying while enjoying an eligible architecture were selected by the researcher and with recommendation of the architecture experts of the university. From among the buildings of the university the available space of the faculties were chosen because the interactions occurred in the public spaces of the faculties have a higher degree of scientific-cultural purity as compared with other (administrative, service, welfare, laboratory, workshop, research, residential and religious) spaces of the university, and users have a higher spatial engagement and a more transparent cognitive image toward the space of their faculties. Consequently, the reliability and internal validity of the research increased.

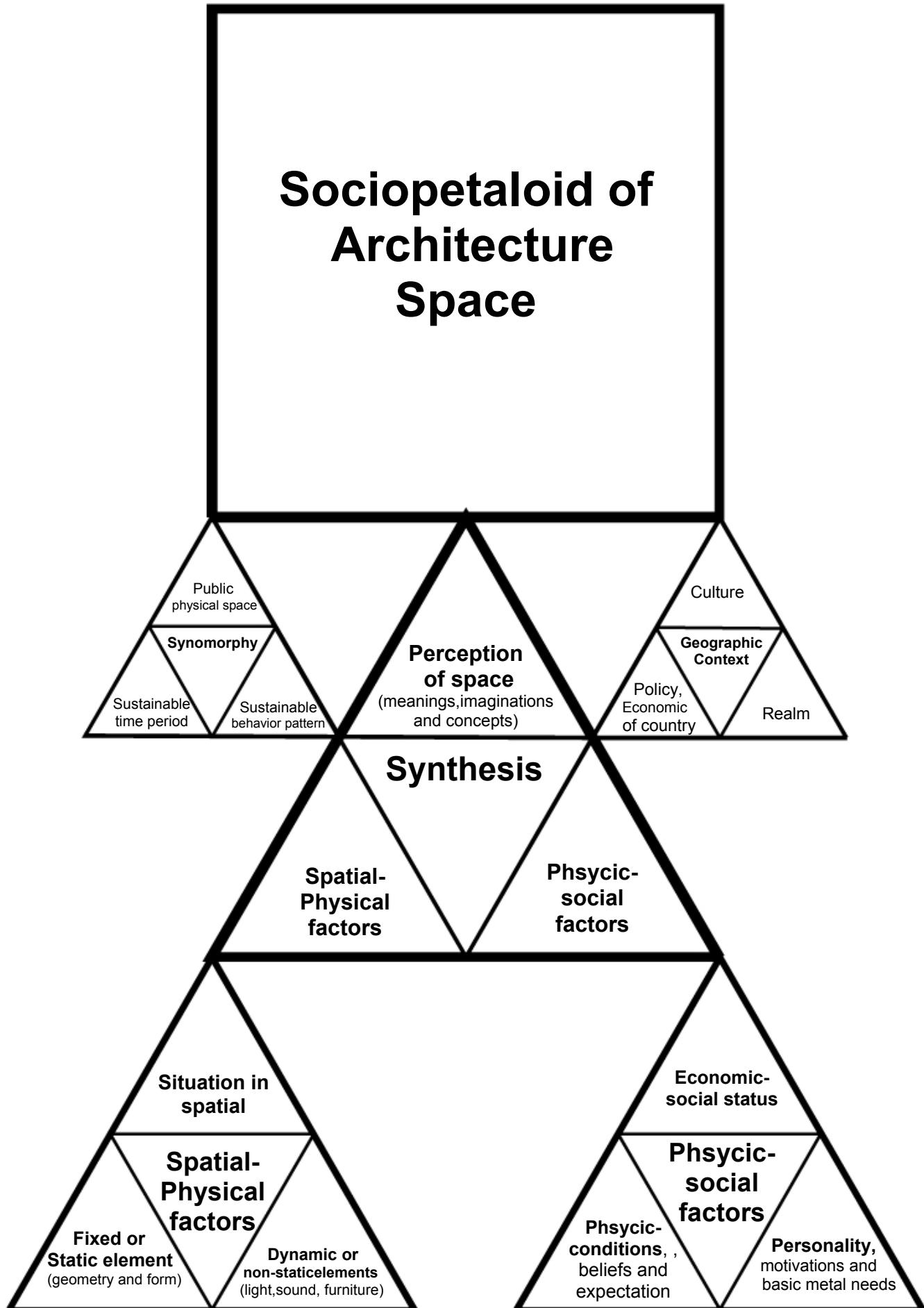
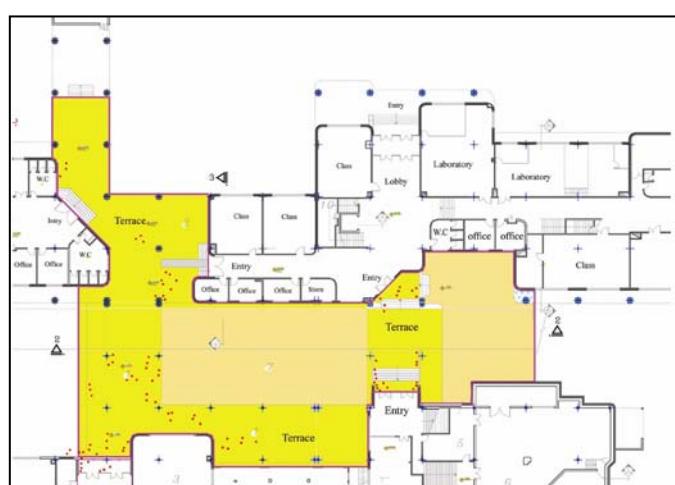
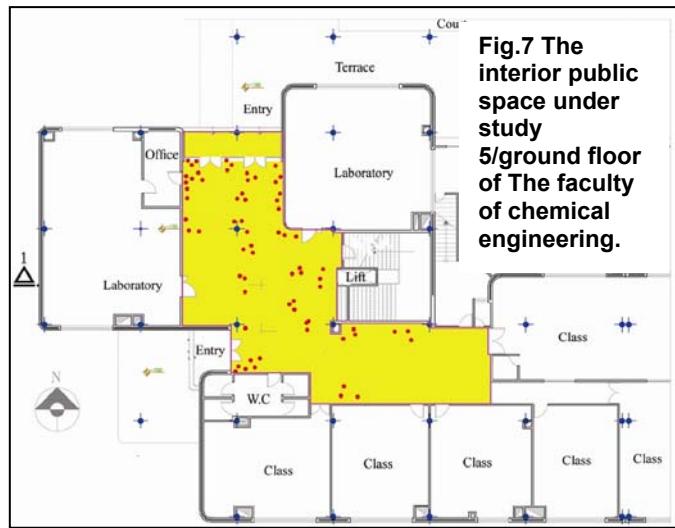
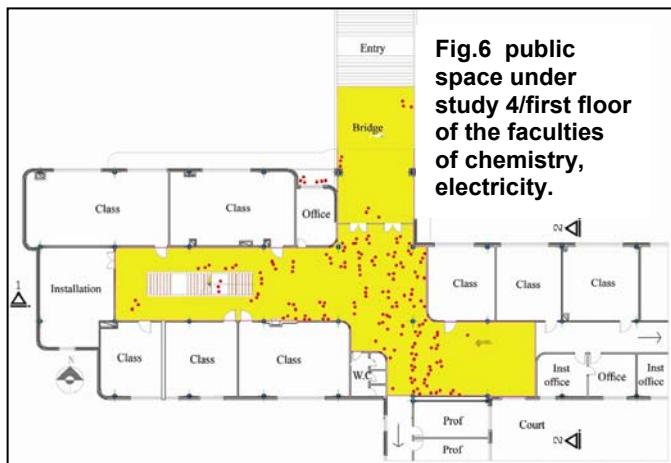
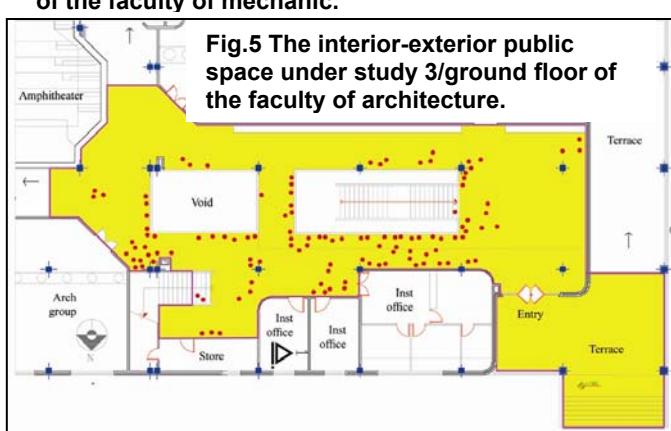
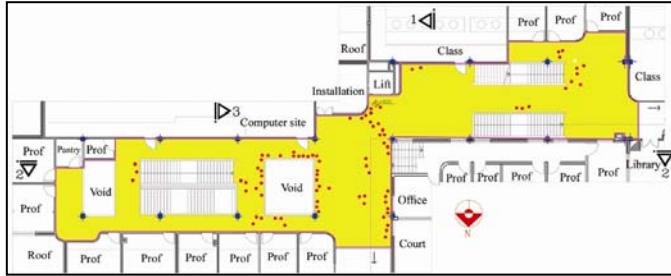
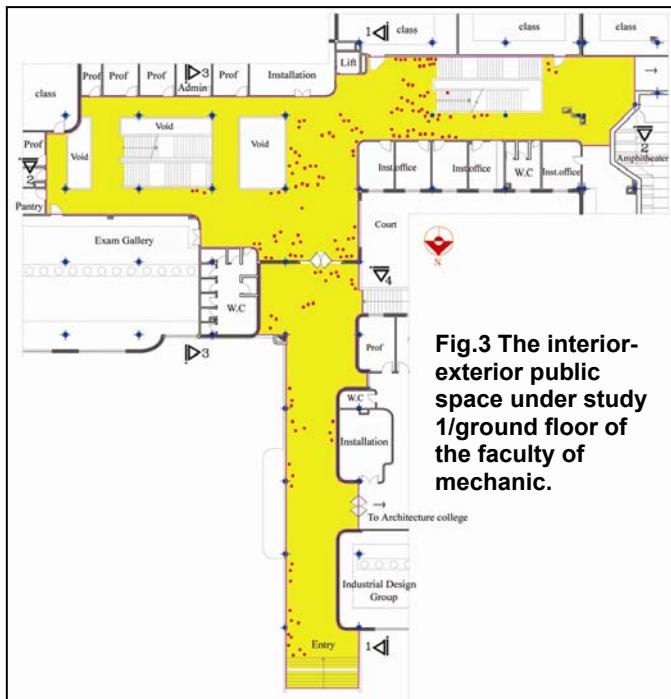


Fig. 2 Proposed pattern of socio-petaloid of architecture space



- Sampling of space: The sampling of the public spaces under study among the three buildings of the faculties was conducted by using the method of “preparation of a cognitive map”⁹. By referring to the site of all three faculties that host a total of 9 educational departments, some 15 resident students from different genders and educational levels of each group or field of study who had been selected through a “simple random” method, were asked to draw the cognitive map or mental map of their faculty and mark the main site of social interactions on the map. A total of 85 cognitive maps were gathered from three faculties and the spaces emphasized and marked commonly by all the students of a faculty were analyzed by comparing the choices and consequently 7 general spaces were achieved for testing the hypothesis by the researcher from physical-spatial analysis of the organization of the whole building. Three public spaces from the common structure of the faculties (architecture, civil engineering, mechanic and industries) and three more public spaces from the common structure of the faculties (metallurgy and material, electricity, chemistry and chemical engineering) which were built after the victory of the Islamic Revolution and were significant architecturally were selected through analysis of the cognitive maps of their resident students. One more public space from the building of the faculty of Islamic Culture and Teachings which is related to the basic science classes of the whole university, and is also considered among the architectural heritage of the university was selected (Fig. 3 to 9).

Without drawing any attention and by means of the observation method the “behavior map and behavior list”¹⁰ of each space were prepared and by analysis and interpretation of them the role of certain physical elements of the spaces in the extent of sociopetaloid and typical social interactions were established. The result of this section of the research will be presented in the supplementary article in order to avoid prolongation of writing. By means of polling the variables data were gathered by questionnaires and by on site presence

from 103 users (15 students from each space on a simple random basis). The relationship between major variables of the hypothesis was identified and deducted by correlation analysis¹¹ in the SPSS statistical software, and the results have led to the establishment of the hypothesis. The number of selected public spaces allows generalization of the results of the research to the spaces of the universities in Tehran, and the universities in Iran so some extent. However, sampling should increase for the higher generalization and include other residential, medical, cultural and educational spaces. Generalization of the results to more functional buildings (administrative, commercial, sport, military and etc.) as well as anthroposemic (non-humanistic or industrial) buildings would call for another research.

6. Analysis of sociopetaloid of public space of faculties

The sociopetaloid variables of the space have been examined in three general groups of mental-social elements, physical-spatial elements and the synthesis-synomorphy between these two groups¹².

6.1. Impact of social-mental characteristics of the users on sociopetaloid of space

The hypothesis in this section is: Mental-social factors of the users have a direct impact on the sociopetaloid of the public architectural space and is considered as a creator. Meaningful correlations¹³ were achieved between certain social-mental characteristics of the users¹⁴ of the public spaces of the university faculties and their sociopetaloid, and based on these meaningful relations the “direct impact” was deducted. This correlation exists between gender, level of education, field of study, temporary mental moods, extent of interest in the field of study and economic status of the users, and the extent of tendency toward interaction in the spaces.

Table 1. Relation between sociopetaloid of space and general and educational characteristics (gender, field of study, level of education) of users

General & educational	Gender	Gamma index	P-Value	Field of study	Gamma index	P-Value
Level of education	Female	-0.412	* 0.237	Tech-engineering	0.101	0,609
	Male	0.153	0.478	Art	-0.5	0.364
Educational semester	Female	-0.152	0.153	Tech-engineering	0.05	0,974
	Male	-0.110	0.489	Art	-0.407	* 0.211
Age	Female	-0.101	0.691	Tech-engineering	0.05	0,970
	Male	-0.084	0.604	Art	-0.617	0.438

* P-Value< 0.3

Correlation analysis of Table (1) shows that upon promotion of the educational level and increase in the number of passed semesters, the extent of social interactions decreases in females and increases in males. Moreover, upon aging and increase in the number of education passed semesters the extent of tendency toward interaction in all female and male students decreases with a considerable negative correlation coefficient (P- value <0.3). One of the reasons involved is perhaps the increase in the extent of the personal space and the resultant need to more isolation of the students of the higher grades or those of the master and doctorate programs. These factors cause their tendency toward interactions in the

public spaces under study, which host a considerable number of present population and allows less access to desirable privacy and maintenance of the invisible bubbles of the bigger personal space, to reduce. In the meantime, the users who study in the fields of architecture, urban development and art revealed more tendencies toward interaction and establishment of inter-personal and extra-personal relations with other in the spaces under study as compared with other fields of study, which is perhaps due to the requirements of the group cooperation in the related fields¹⁵.

According to the data of Table (2), a meaningful correlation (P- value <0.3) has been observed between the extent of

Table 2. Relations between socio-petaloid of space and mental factors: “interest in field of study”, temporary mental moods (temperament) of users” and their “economic status”

Accuracy of Interaction	Gamma index	P-Value	Accuracy of Interaction	Gamma index	P-Value	Interest in field of study	Gamma index	P-Value
Economic status	0.257	* 0.062	Temporary mental moods	0.465	*	passing grade	0.063	0.747

* P-Value< 0.3

tendency to interaction by the users of the public spaces under study and the extent of their interest in their fields of study as well as their temporary mental moods (temperament) at the time of presence in the spaces and their economic status.

The students attending the space who are more interested in their field of study (their fields of study were their first priorities of choices) have shown more tendencies toward maintaining relations with friends and others in the public spaces. This meaningful relation may be the result of their motivation for presence in the spaces of their faculties due to their more interest in their fields of study. In other words, the interest in the fields of study has been followed by friendship in the spaces in whose setting they learn their interested disciplines. The users who enjoyed a happy or thoughtful and calm mood have both maintained social relations with others for a longer time and had more tendency toward inter-personal and extra-personal interactions in the spaces under study as compared with sad and impatient individuals. Those present in the spaces who were of a higher or lower economic status expressed less tendency toward interaction in the spaces comparing the those with a middle economic status. The reason why these two groups have the same level of tendency toward interaction in the spaces is that the group with a higher economic status, in the first state, due to its proper economic status, tranquility and prediction of a variety of programs in its daily life does not probably tend to pass

their leisure time in the public spaces of the faculties. In the second state, this group, like the users with higher educational levels (master and doctorate programs) has a bigger personal space than other due to the mental reasons and the issue causes them to keep more distance and consequently does not tend to establish relations with others at a higher level¹⁶. Conversely, users with lower and weak economic status have a lower tendency toward maintaining constructive interactions with their friends in the spaces under study and have failed to reinforce the motivations in them probably because of a higher mental burden and preoccupations and abundance of their minds with the confronted problems and lack of sufficient mental calmness.

6.2. Impact of physical characteristics of the public architectural space on its socio-petaloid

In this section the hypothesis is: Physical-spatial factors have an impact on the socio-petaloid of the space. This impact has two states, one with “direct capability”, which facilitates the physical occurrence of inter-personal and extra-personal interactive behaviors in the space, and the other with “indirect capability”, which as a perceptive and conceptual factor and by establishing mental images based on the mental backgrounds, defines, facilitates, increases and generally changes the previous belongings and experiences of the users.

Table 3. Priority of physical-mental factors that impact the socio-petaloid of the spaces under study from the point of view of users

Order of physical-spatial factors that impact the socio-petaloid of the spaces from point of view of users	
Priority	Physical- spatial characteristic
1	Situation of space to the entrance/closeness to main entry and exit of the building
2	Availability of furniture motivating the stop/presence of benches, platforms, tableaus, other equipments
3	Availability of furniture for sitting
4	Location at the point of intersection of main corridors of building/space would facilitate access to all spots of the building
5	Temperature/degree of (heat and cold) in different seasons of the years which should be suitable and human friendly.
6	Big size/enlargement, vastness and openness of space
7	Suitable light/more and proper light of the place compared to other spaces
8	Functional centrality/location of functions with frequent references around the space
9	Sound/ proper acoustic space with no reflection of murmuring
10	Lightness of visual mass of floor/presence of openings and voids on the grounds with easy sight to upper and lower stories
11	Geometrical centrality of the whole building/located on a special and strategic place
12	Low density of space/emptiness of the body of space and low number of columns in space to help the range of vision
Priority	Physical- spatial characteristic
13	High altitude
14	Smell/sensing a desirable scent
15	Special decoration, design and figures on floor, wall and ceiling
16	Color, type and texture of materials of wall, floor and ceiling
17	Ceiling duct
18	Square shape of geometry of space
19	Markings, symbols and special signs
20	Shape of the ceiling
21	Rectangular shape of space
22	Vertical window
23	Horizontal window
24	Circular shape of geometry of space

Based on the viewpoints of the users of public spaces of the university faculties under study, importance of the physical-spatial factors have been achieved as per the data of the Table 3. From among the first 10 physical-spatial characteristics which according to the views of the interacting persons in spaces have a high impact on the socio-petaloid of the architectural space, only two characteristics of the fixed elements of the space are seen (numbers 6 and 10). Conversely, the suitable situation of the space in the spatial organization of the whole building as well as the semi-fixed elements of the space such as furniture and tableaus had the highest impact. The results of the table 3 have been achieved through direct analysis of the answer to related question in the questionnaire by the users. According to the correlative analysis (mentioned hereunder) and deduction of the meaningful relations between the variables taken by means of comparing the relevant questions of the questionnaire in the statistical software, these primary results have changes to some extent.

There is a meaningful correlation (P-value <0.3) between "extent of interaction in space" by the users and "physical characteristics" of the spaces under study. The extent of interaction in space which is a sign of socio-petaloid is measured by means of scales such as: Frequency of referral to the space, frequency of using and duration of stop. That is, the more the frequency of inter-personal and extra-personal interactions is, the higher the grade of socio-petaloid of the space will be. The correlation data of the Table 4 show that socio-petaloid of the space is interrelated with variables of the "dynamic physical elements of the space", "fixed and static physical elements of the space", "semi-fixed physical elements of the space" and "situation of the space in the spatial organization of the whole building" and these correlations are explained by factors such as "frequency of referral", "duration of stop" and "frequency of use" by the users of the public spaces under study. Details of the physical variables with meaningful correlation with the criteria that increase socio-petaloid are seen in the table.

Table 4. Relation between socio-petaloid and "physical characteristics" of public spaces of university faculties

Physical-Spatial Components		Frequency of referral	Duration of stop	Frequency of use	Physical-Spatial Components		Frequency of referral	Duration of stop	Frequency of use
Suitable light	Gamma	0.233	- 0.002	- 0.002	Access to all spots of building	Gamma	0.269	0.168	- 0.212
	P-Value	* 0.060	0.986	0.986		P-Value	* 0.034	* 0.958	* 0.065
Enlargement, vastness	Gamma	0.085	0.064	- 0.159	functions with-high referrals	Gamma	0.075	- 0.175	- 0.075
	P-Value	0.522	0.654	* 0.183		P-Value	0.517	* 0.176	0.522
High altitude	Gamma	0.065	- 0.081	- 0.024	Low of Columns, empty space	Gamma	- 0.154	- 0.118	- 0.144
	P-Value	0.611	0.528	0.848		P-Value	* 0.235	0.347	* 0.200
Color, texture of material	Gamma	0.157	- 0.087	- 0.111	Silence	Gamma	- 0.106	0.101	- 0.132
	P-Value	* 0.196	0.483	0.352		P-Value	0.409	0.425	* 0.265
Smell	Gamma	- 0.018	- 0.079	- 0.005	Proper temperature	Gamma	0.060	0.219	- 0.157
	P-Value	0.885	0.524	0.967		P-Value	0.607	* 0.082	0.182
shape of Ceiling	Gamma	- 0.024	- 0.132	0.029	Facility for sitting	Gamma	- 0.113	0.049	- 0.087
	P-Value	0.885	0.317	0.809		P-Value	0.362	0.703	0.450
horizontal window	Gamma	- 0.1	- 0.229	0.028	Circular shape	Gamma	- 0.162	- 0.180	0.020
	P-Value	0.425	* 0.078	0.826		P-Value	* 0.229	* 0.197	0.877
vertical window	Gamma	- 0.085	- 0.067	0.040	Square shape	Gamma	0.021	0.141	0.074
	P-Value	0.525	0.611	0.757		P-Value	0.870	* 0.291	0.534
ceiling Duct	Gamma	- 0.051	0.007	0.017	Rectangular shape	Gamma	- 0.329	0.009	0.068
	P-Value	0.682	0.958	0.887		P-Value	* 0.010	0.943	0.595
Presence of void	Gamma	0.044	- 0.058	- 0.253	Signs and symbols	Gamma	- 0.150	- 0.017	- 0.047
	P-Value	0.717	0.632	* 0.023		P-Value	* 0.261	0.890	0.695
Decorations	Gamma	- 0.066	0.071	- 0.036	Geometrical centrality of building	Gamma	0.072	0.142	- 0.070
	P-Value	0.595	0.584	0.760		P-Value	0.565	* 0.235	0.556
Proximity to entrance	Gamma	- 0.110	0.033	- 0.191	Availability of furniture for sitting	Gamma	0.018	- 0.085	0.376
	P-Value	0.377	0.799	* 0.087		P-Value	0.880	0.484	* 0.001

* P-Value< 0.3

6.3. Manner of synthesis and synomorphy of human-physical factors in space socio-petaloid

In this section the hypothesis is: The socio-petaloid of the architectural space increases by a high synomorphy and adaptation between physical space and inter-personal and

extra-personal behaviors. The synthesis or composition of certain human-physical factors with each other, which leads to the formation of interactive behavior, strengthen this synomorphy.

The synomorphy of physical-human factors increases under the influence of constant and continuous use of the space by the users and sustainability of the current patterns of inter-personal and extra-personal interactions which results in the increase in the experience of space by the user and enrichment, reinforcement and refinement or alteration of the quasi designs and mental image which guide the him (her). Certain physical characteristics in composition with mental characteristics of the users such as interest in the field of study, temporary mental moods, motivation of stop in the space, previous mental backgrounds and so on, would affect this grace and capability of space. The criteria for assessment of the process of synthesis and synomorphy of human-physical factors which have resulted in sociopetaloid in the present research include: Maintaining interactions between non-friendly individuals, tendency toward interaction in the space, duration of presence in the space and frequency of referring to it, feeling of need to interaction, dependence of place to space, duration of stop in the space, and space as a

factor for more communication. Now, the meaningful correlation of the afore-mentioned variables of composition are analyzed and identified.

There is a meaningful correlation ($P\text{-value} < 0.3$) between "maintaining interactions between non-friendly individuals" and certain "physical characteristics" in the spaces under study. Keeping social distances (personal distance, seclusion and territory safeguarding) and the extent of the social interactions are influenced by the factor of friendliness. That is friendly individuals (for example two classmates who are friends in the case study of this research) would become closer to each other with more interactions. Therefore, if physical characteristics in a space should be able to take the place of the effects of friendliness to some extent and play the same role in increasing the inter-personal and extra-personal interactions, then we can say that physical space in a more effective space in sociopetaloid of the space with more capability.

Table 5. Relation between "maintaining interactions between non-friendly individuals" and "physical characteristics of the space"

Maintaining interactions between non-friendly individuals	Gamma index	Accuracy of meaningfulness (P-Value)	Maintaining interactions between non-friendly individuals	Gamma index	Accuracy of meaningfulness (P-Value)
Physical-spatial components			Physical-spatial components		
Suitable light	0.073	0.588	Possibility of communication	0.046	0.733
Enlargement ,vastness of place	- 0.021	0.885	Place of functions with high referrals	0.341	* 0.007
High altitude	- 0.007	0.958	Low density of space (low number of columns)	0.056	0.677
Color and texture of materials	- 0.155	* 0.225	Silence	- 0.094	0.456
Smell	- 0.303	* 0.012	Suitable temperature	- 0.005	0.970
Special shape of ceiling	- 0.271	* 0.037	Facility of sitting for a short period of time	0.059	0.665
Presence of horizontal window	0.175	* 0.219	Circular shape	-0.040	0.792
Presence of vertical window	- 0.038	0.784	Square shape	0.137	0.315
Presence of ceiling duct	- 0.121	0.330	Rectangular shape	-0.066	0.645
Presence of void	0.056	0.643	Signs and symbols	0.094	0.471
Decorations	- 0.103	0.397	Location at geometrical centrality of building	0.074	0.563
Proximity with entry of building	0.063	0.653	Presence of benches, place for sitting and equipment	-0.030	0.833

* P-Value< 0.3

As it is deduced from the provision of correlation Table 5, from among the "dynamic physical elements of the space" suitable smell, and from among the "fixed and static elements of the space" color and texture of the materials of the surfaces, particular shape of the ceiling and horizontal window, and also from among the characteristics of "location of space in the building organization", functional centrality of the space (situation of the functions with high referrals around it) had the highest impact in occurrence of social interactions between non-friendly people present in the space (non-friendly and strangers) as compared to other physical-spatial characteristics in the opinion of the users. In other words, certain static and dynamic elements and situation of the spaces under study in the organization of the building have replaced part of "elements of friendliness" in maintaining

inter-personal and extra-personal social interactions between strangers and students of the lower grades and those of the higher grades at the faculties and increased the extent of these interactions. The reason probably is that the afore-mentioned physical characteristics have caused the probability of accidental confrontations to increases and more tranquility to be created in the space to have the people stay more in the space, therefore, interactive probabilities between strangers or non-friendly rise due to various mental and motivating reasons.

There is a meaningful correlation ($P\text{-value} < 0.3$) between the "extent of presence in the space" and "feeling of need to interaction" in the spaces. A high feeling of need to inter-personal and extra-personal social interactions would cause longer presence of the users in the public spaces with

Table 6. Relation between “feeling of need to interaction” and “extent of presence in the space”

Feeling of need to interaction	Gamma index	Accuracy of meaningfulness
Extent of presence in the space	-0.326	* 0.017

* P-Value< 0.3

increase in the number of interactions and rise of the sociopetaloid of the space. As it is seen in correlation Table 6, there is a harmony and congruency between the answers to these two questions. That is, individuals who have had a high feeling of need to interaction have frequented the public spaces of their faculties once to several times per day.

There is also a meaningful correlation (P-value <0.3) between the “duration of stay in the space” and “reason of stay in the space” in the spaces under study. Motivations of stay in the space have overshadowed the duration of stay of the users and if these motivations become strong the duration of stay would increase and therefore extent of inter-personal and extra-personal social interactions would possibility increase. Upon the increase of interactions, the sycopetaloid of the space also increases.

Table 7. Relation between “duration of stay in the space” and “reason of stay in the space”

Duration of stay in the space	Gamma index	Accuracy of meaningfulness
Reason of stay in the space	0.254	* 0.021

* P-Value< 0.3

Based on the data of Table 7 students who stayed in the space with the motivation of talking to their friends and spending the breaks between their classes have had a longer stay, sometimes more than half an hour, than those with other motivations. Those with other motivations (waiting for friends, enjoying the crowd and current activities, receiving scientific news, using the surrounding facilities) did not reveal a meaningful correlation with the increase in their duration of stay. Therefore, we see that mental motivations (reason of stay in the space) with a synthesis by physical factors would affect the longer stay in the space thus increasing the interactions and socioetaloid.

Table 8. Relation between “crowded space” and “demanded privacy” of users

Crowded space	Gamma index	Accuracy of meaningfulness
Demanded privacy	0.2	* 0.300

* P-Value< 0.3

If the typical feeling of presence in the space is positive and brings about satisfaction, it will primarily cause the person to stay longer in the space, and secondly, his ((her) tendency to establish inter-personal and extra-personal interactions increase. People who feel that a public architectural space is crowded show a need toward privacy. That is, sufficient private space for refreshment and regain of energy for maintaining social interactions is not prepared as it is needed. Such users would seriously lose their tendency toward inter-personal and extra-personal social interactions with other due

to this negative feeling of presence in the space. That is why the socioetaloid of the space decreases. According to the data of Table 8 there is a meaningful correlation (P-value<0.3) between “feeling of a crowded space” and “demanded privacy” of the users of spaces under study. Users who considered the physical dimensions of the space to be small and the population of the space to be excessive have a feeling of crowded space. They prefer a subsidiary, solitude and low-populated public spaces for interaction with friends. Conversely, those who considered the physical dimensions of the space to be suitable for social interactions with the present population prefer main, big and crowded public spaces for interactions with others. This meaningful correlation shows that the physic of the spaces under study can predict solitude spots with limited sight from the surrounding space in the sideline of the main space in order to provide a desirable level of privacy next to the highly interactive and crowded place at the center of the space for some of the users, so that they would too have more tendency toward joining others as a result of this physical background.

7. Conclusion

The present research has experimentally examined the impact of the semi-static and dynamic physical elements as well as the situation of the space in the organization of the whole building, separately and in combination with each other, in addition to assessing the impact of the static physical elements of the space on socioetaloid in the public spaces of the educational buildings of the scientific-cultural centers like universities. Moreover, the impact of certain mental-social factors on socioetaloid has been evaluated and their impacts have been proven as far as we could afford.

The results show that:

1. Physical characteristics of the public architectural space affect the extent and type of inter-personal and extra-personal social interactions occurred in the space. Extent of these impacts, provided that they increase the number of occurred interactions, reveals the high socioetaloid of that space. Correlative analysis showed that there had been a meaningful relation between “fixed elements of space” containing characteristics such as: Opening on the floor (lightness of the visual mass of the floor) and location at the center of the public space, high altitude in parts of the space, low density of space (low number of columns as well as vastness) in other parts of the spaces and presence of the semi-open space in front of the entrance door of the building and before the public space, and the extent of social interactions between those who are present in the public space. Meaningful relations have also been observed between other physical characteristics such as color, quality, design and texture of the materials, shapes and forms of the walls and ceiling, symbols and signs and Carshio geometrical shape (plan) of the space, and the extent of the interactions and its endurance, however this meaningfulness was slight and considered of the second and third classes. Meanwhile, presence of “semi-static elements of the space” particularly the sitting furniture (bench and platform) as well as public and private signboards in the public space caused longer stay of the users in the space, hence increasing the probability of occurrence of inter-personal and extra-personal relations. “The non-static and dynamic elements of the space”, especially appropriate and sufficient natural light is an important characteristic in the

space which encourages the users for further stay in the space and add to their interactions. The temperature, sound and smell elements are also important. They are related to the modern technologies of construction in the contemporary architecture and their technical aspects should be taken into consideration for a positive effect. All the above findings are congruent with and confirm the theoretical models of probabilism proposed for the typical effect of physic on behavior (see basic theories).

2. The case study and analyses showed that spatial characteristics (location of space in the spatial organization of the whole building) such as proximity to the main entrance and exit of the building, location in the geometrical center of the building, acting as the functional centrality of that part of the building, and also location at the intersection of the two main interior routes of the building are considered as "sociopetaloid hardware" through providing "interaction infrastructure" like guidance of most individuals toward public architectural space and increase of the accidental passages and informal confrontations. This finding is congruent with the experimental model of "functional centrality, functional distance, and spatial proximity"¹⁷. Special physical characteristics are considered as "sociopetaloid software" through providing "interaction superstructures" such as tranquility and satisfaction, creation of "direct and physical capability" of stay and creation of "indirect capability" of tendency for stay and pause and prolongation of its time. This result conforms with and confirms the theoretical model of environment (see basic theories).

3. The desirability of sociopetaloid has been clarified in the polling and interview with users of the public spaces under study at the university faculties. Most of them believed that public spaces with sociopetal characteristic were an important supplement to the formal educational spaces such as classes, laboratories, workshops, libraries and so on since students use them in almost half of the period of their education. Moreover, in their opinion, the sociopetaloid of the public spaces would result in development of friendships, maintaining of enduring ties, increasing of the feeling of belonging to the university environment, improving individual growth, socialization, closeness of the students with mental backgrounds and varied characteristics, further support of students for each other in the educational and living areas, less self-alienation and more self-confidence, creation of unforgettable memories for the post-graduation days and finally affects the metal feeling of security and safety in the faculty settings.

4. Sociopetaloid of the public architectural space is the outcome of the intermediary links arising from the process of synthesis and synomorphy of between physical-humanitarian characteristics. This process and its extent have been assessed by means of several criteria including: Maintaining interactions between non-friendly individuals, extent of tendency toward interaction in the space, extent of stay in and referral to the space, feeling of need to interaction, dependence of place on space and duration of stay in the space, deduction of meaningful correlations between these criteria of synthesis and synomorphy with each of identified physical-humanitarian factors, thus leading to the recognition of the extent of effect and type of physical-spatial and mental-

social characteristics involved in the sociopetaloid of the architectural space.

5. Based on the findings, a theoretical model for determining the factors affecting sociopetaloid of the architectural spaces has been suggested in order to be included in the design of the public behavioral setting of the public buildings. The model has been examined and tested in the present research. Designers of the public buildings in general, and those of the more humanitarian ones like residential, educational, cultural, and medical buildings in which the soul of the human being is addressed by the space, in particular are recommended to employ the physical-spatial characteristics mentioned in this research in designing public architectural spaces in order to make the buildings humanitarian, improve productivity of residing personnel, and secure satisfaction and mental tranquility of the people who refer to them.

Footnotes

1. Environment psychology is the study of behavior psychology in the physical environment of the daily life. Architectural psychology is considered as a subsection of the environment psychology in which "environment" has been addressed more specifically and with more details and interpreted as "structural physics and architectural spaces". Environment and architectural psychology domain includes theories of space and shape perception, social psychology, anthropology, study of social relations and study of culture.

2. Kiyo Izumi believes that some buildings have been designed more for correct function of the machine and equipment rather than the people who work with these equipments (anthroposemic or non-humanitarian buildings). There are other buildings in which more importance is attached to the needs of the users (anthropophilic or humanitarian). In the anthroposemic type people have to cope with the physical conditions and construction proportions however in the anthropophilic type equipments and construction proportions and physics should cope with the humanitarian conditions [9].

3. Public behavioral settings are corridors for movement and hesitation, halls and lobbies, yards and other common spaces in the public buildings. Public spaces which are considered as special behavioral setting and are used by a defined group of users for a limited period of time, possess a pre-determined organization and social system and strict control and monitoring is maintained on them are not discussed in the present research. Classroom, conference hall or amphitheater, workshop, laboratory and so on in the university complexes that serve as a case study in this research, are examples of these public spaces which are considered as special behavioral settings with a formal definition by the organization of the faculty and university, and controlled by instructors and personnel and a special program is performed on them.

4. Back-to-back benches are an example of the sociofugal organization. Some spaces provide a discouraging atmosphere for interaction between people. Disperser is referred to a quality of space architecture that hinders maintaining of social relations. Like long and narrow corridors of a prison which prevent people from gathering [16]. Sociopetal spaces usually contain a place for sitting, an edge for leaning, a shelter from sun and rain and a cozy place for chatting, in a manner that even those who are not acquainted much with each other find a plausible reason for attending these places with a small greeting [17].

5. Edward Hall has used "social anthropologic orientation" approach under the topic of proxemic theory in order to study the role of distance and space in the humanitarian interactions toward description of different cultural rules that regulate the using of space. He believes that every individual divides the social environment into distinguished regions that encompass his (her) body like invisible bubbles. He categorized these distinguished regions into four types of boundaries of personal space: Friendly region, personal region, social region and public region. Each one of these interaction regions are specified by a variety of norms, expectations and behaviors. Transit from a region to the other usually accompanies a specific change in the behaviors [18].

6. The word "public" in English has been taken from the Latin root *Populus*, meaning people. The word includes a wide range of meanings in Oxford English Dictionary such as: Accessibility, visibility, openness, belonging to all the people, having a non-private possession, controlled by the state, and organizer of society and community.

7. As Arnedt interprets, public space has two interrelated meaning: The first meaning is space of presence, that is, presence before others which forms the basis of objective reality. In other words, whatever which appears in public, can be seen and heard by the public, therefore, it has the most extensive possibility of dissemination and propagation. The interface space, the second meaning, refers to the universe; Arnedt uses the idea of bio-universalism by Heidegger; the universe referred by Arnedt is not the natural universe, but a universe which makes the human. What makes tolerance of others in the modern public spaces is not the large number of the individuals involved, or at least it is not so at the beginning, but it is that the interface universe between them has lost its power to gather them together and join them with each other and separate them from each other. If the public space is seen as an interface space which facilitates simultaneous presence and adjust interpersonal relations, both of the afore-mentioned meanings would be unified [15].

8. The case study is among the combined research methods with a high application in psychological and social science studies. It is usually applied when there are questions about how and why an issued is raised and all-out control on the events would not be possible [19].

9. Preparation of a cognitive map is a process in which man acquires information about relative situation and condition of the physical space, codify them, store them, recall them and decode them. These image or map includes structure or appearance of space, its relative situation and its values. The cognitive map of the architecture space is not an accurate copy of the reality but it is a model of the reality. There is a correlation between the social-economic status and cognitive maps. The higher the motivations of the users of the architectural space is the more extensive the importance of the space will be. In some cultures users explain their general perception, some others emphasize on the details, some others consider the open spaces and some others pay attention to the limits and edges. As Donald Appleyard suggests some people imagine the environment through a route finding method whereas others do this as a spatial distribution [9]. From the two main stages of human interaction with the environment, namely, sensual perception and intellectual perception (Cognition- Through put), purporting of meaning to the environment and creation of the cognitive map and mental map are the products of the intellectual perception stage that according to Robert Hershberger may carry both the "representative load" and "Responsive load".

10. The behavioral map is a map that shows the place and type of the current behaviors in the spaces under study. Here inter-personal and extra-personal interactions occurred have been taken into consideration. The behavioral list is a registry of the specifications of current behaviors in the space.

11. Correlation research or analysis seeks to register a relation which is naturally occurred between the variables and it is useful when the variables cannot be controlled for a particular reason. Two major sub-groups of relationship and causal-comparative may be identified within the general framework of correlation research. Relationship studies are based on the nature and power of prediction of relations [19]. The present research has mainly used correlation analysis of the relationship type. According to Linda Grout since correlation research can accompany most of the measured variables in many cases, the strategy would be particularly useful when researcher seeks to perceive the situation or conditions extensively rather than deeply. In other words, capability of studying a wide range of variables is among the important advantages of this strategy.

12. The social characteristics of the users who have been questioned and researched include common characteristics (gender and age), educational characteristics (field of study, level, semester) economic status (occupation of parents, monthly income of the family and the student, place of residence of the family and student, educational costs of the student) and micro-cultural status (mother tongue, place of residence of the family). Mental factors in the questionnaire have been adjusted to achieve the following: Temporary moods of the users, presence and implication of previous memories and backgrounds (scheme), feeling of need to interaction, general personal character, motivations for presence in the space and finally extent of interest to the field of study.

The "physical characteristics" of the spaces under study has been questioned, studies and analyzed within the following categories: Fixed or static elements (geometry, shape and form, color, texture, materials...) semi-static (furniture) and non-static or dynamic (light, temperature, sound and smell). "Spatial characteristics" are referred to the specifications and location of the space in the organization and skeleton of the whole building whose impacts have been investigated through the following questions from users of the spaces under study as well as those using them or interaction: Location near or attached to the main entrance and exit of the building, location on the intersection of the main corridors and centrality of the building (geometrical center of the building), location of the functions with frequent referrals in the surrounding

(functional centrality in that part of the building), location of establishing of relation with all parts of the building.

Questions about assessment of the process "synthesis of (composition of humanitarian-physical)" have been raised within three major topics:"Dependence of place to space and building" (including questions about: Space as a factor of familiarity with building, amicability of the building), "concepts and imaginations" (including questions about: Feeling of multitude, assessment of the need to a desirable privacy, role of space in the structure of the building, extent of desire to refer to the space, and finally "meanings perceived from the space" (including questions about: meaning difference of spaces with bipolar techniques, need to establish a public space for more relation, type of the feeling resulting from the presence and interaction in the space, implication of existence of a public space).

Questions about assessment of the process "synomorphy (compatibility of physic with interactive behavior) were raised as: Suitability and elegance of the space for social interactions, reason for stay in the space (issued exchanged during interaction in the space), extent of interaction with non-friendly individuals (strangers and senior students); extent of interactions occurred in the space (by questions about: Frequency of referring to the space, duration of stay, compliance of the place of gatherings of the faculty with space, repetition of using and stay per day and week, number and type of the interactions occurred in space in the unit of time).

13. In the "ordinal data" the "non-parametric correlation coefficient" is used, that is, these coefficients are estimated irrespective of the function of data distribution. The coefficients which are available for this group of data are: Goodman and Kruskal Gamma, Spearman Rank Correlation, and Kendal Tau a, b. These coefficients primarily show the direction of movement of the two variables under study on levels, that is, if X and Y variables should have levels 1,2,3 and 4, it is studied that if variable X moves from 1 to 4, the variable Y will also move from 1 to 4 or not, this movement may be a sign of increase or decrease. If both of the variables move from 1 to 4, then it is said that there exist a C (concordance), otherwise, there is a D (discordance). If the zero hypothesis is rejected, it is said that the two variables are interdependent and if it is not rejected, the two variables would be dependent. Rejection or approval of zero hypothesis is indebted to the level of reliability or accuracy which is considered for the research. The level of reliability of this research has been considered to be 70 percent. Therefore, α should be considered as 0.3. Now α is compared with meaningful accuracy or P-value. If P-value $< \alpha$, then the zero hypothesis or dependence of the two variables is rejected and the two is said to be correlative. This is the same relation between the two variables. In the correlation tables offered in the research there are two columns of Gamma scale and meaningful accuracy (P-value). More attention should be paid to the column P-value. If the value is almost 0.3 or less than 0.3 the relation between the two variables may be accepted but if the value is more than 0.3, any relation in the accuracy of 70 percent is negated. Complete calculations of the correlations mentioned in this research have been provided in the outlet of the SPSS.15 software.

14. Whereas this research is presented in the domain of physical environment design and its subsidiary, namely architecture, it did not intend to fully identify the whole mental-social factors, because they are beyond the affordance and realm of the present research and call for a separate opportunity and research based on the accurate scientific methods in the psychological and social researches. Here only a few numbers of mental and social factors from the group under the study at the university spaces have been assessed through simple techniques.

15. This factor may be equal with the job variable in them by extending it to other non-academic buildings.

16. The issue has been confirmed by similar researches conducted through the world between the personal space of the wealthy and the poor and the medium class. Some of the wealthy classes are proud that they do not know their neighbors. This reveals their low tendency toward interaction with others. Meanwhile, other researches show that people with a better social and economic status occupy more space and therefore they are more privacy-seeking and more crowd-phobia.

17.M.Powell Lowton believes that the functional distance of the units (rooms and buildings) and the functional centrality of the common services (entrance, corridors and waiting lounges of the buildings affect the patterns of the social interaction of the residents of the residential spaces and people working at the departments, organizations and institutes. Functional distance is attributed to the extent of hardship of relation between different spots. Routes and corridors that maintain the direct relation between the activities reduces this distance. Longer distances, density of traffic and intervention of activities of a single route increase the functional distance of the spots. Functional centrality is referred to the facility of access to the common group facilities, frequency of using them and time of using the behavioral settings or places [9].

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