Sociopetaloid of architecture space;

Synthesis and synomorphy of humane-physical factors

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Abstract

This research experimentally analyzes the issue of Sociopetaloid of architecture space. Sociopetal represents spaces where people come together or stay away from each other, and when they stay away from each other it is also called sociofugal.

The research methodology was primarily compiled by presenting a pattern with a theoretical standpoint regarding the Sociopetaloid of space using hypothesis testing with a case study with the aid of polling, first on-site presence technique, then a cognition map tool and a questionnaire. 7 public spaces were selected amongst 3 distinguished independent the university of science and technology(IUST) faculty buildings for the case study. The data underwent correlative analysis using the SPSS statistical software and meaningful relations were determined between the variables affecting Sociopetaloid.

The following main results were achieved in this research:

• The psychological-social factors of users directly influenced the Sociopetaloid of the public architecture space and were considered as an establisher.

• Physical-spatial factors influence Sociopetaloid. This influence has two types; one with "direct affordance" and another with "indirect affordance".

• Sociopetaloid of public space is achieved with proper synthesis of the spatial- physical elements of architecture and psychological-social elements of users. This Sociopetaloid increases with a high synomorphy between the space physic and interpersonal behaviors.

Keywords: Sociopetaloid, Architecture, Public space, Synthesis, Synomorphy, Humane- physical factors

1. Introduction

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

The question is whether or not a special physical architectural plan would be able to encourage maintaining positive and constructive social relations between users, and add to opportunities for interpersonal and extra-personal interactions. If the issue is viewed from a physical determinism aspect which was common in early modern architecture, the problem is settled. However, according to many studies conducted throughout recent decades and proposition of the theories of free-willism, possibilism and probabilism which talk about physical impact over behavior, the important and effective role of mental-social characteristics of users in typical interactive behaviors which occur in public architectural spaces should 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 sociopetaloid of architecture space has been evaluated as positive from various aspects. A reciprocal social relation to satisfy the need of man for relationships and sense of belonging is a necessity which helps personal growth. Further clarification of social duties,

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commitments in the generality of the activity and function of the building, further mutual support between users, less self-alienation and preparing the grounds for development of friendships and daily relations are amongst other impacts of the higher sociopetaloid of public architecture spaces of buildings with mere non-functional specifications.

2. Hypothesis

The issue of sociopetaloid in public spaces or "public behavioral settings" as an architectural psychology1 subject, belongs to public buildings such as: cultural, educational, medical and residential buildings where relations between users are considered to be more non-functional or as interpreted "anthropophilic"2 (humane), and social interactions which occur in them are not the result of mere functional and predetermined purposes but are rather unofficial and accidental, gaining more importance3. To this end, the case study of the present research is focused on public spaces belonging to cultural-educational buildings (of the university).

The general hypothesis of the research: Sociopetaloid of architecture space is achieved through proper synthesis of the physical-spatial factors of architecture and mental-social factors of users. This synthesis is the result of synomorphy or coexistence between 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 users of the space. The research hypothesis seeks to identify 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 establishing the hypothesis there were many intervening factors such as meanings, concepts, motivations, imaginations and approaches of the users, therefore, from the two general research methods of psychology, namely, testing of hypothesis and exploration, the first method was selected and from the two methods of testing of hypothesis (laboratory and field), field research for the type of case study was chosen together with surveying and polling techniques and deduction from meaningful correlations for identifying impacts.

3. Definition of sociopetaloid

Use of the terms sociopetaloid, sociophile, sociopetal and sociofugal implies spatial qualities in architecture which either gather people together or disperse them. These terms were 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 features and removable equipment and furniture. He proved the important role of furniture in the sociopetaloid of architecture space [1]. Sociofugal organization causes refusal from social interaction4 contrary to sociopetaloid organization. Edward T. Hall believes that a sociofugal space in one culture may be a sociopetaloid space in another. A sociofugal space is not necessarily a bad space, just as a sociopetaloid space which

may not always be good. What is desirable is the existence of flexibility and compatibility between physical plans of public spaces so that a variety of different spaces exist and people engage in these spaces based on their needs and moods.

4. Basic theories and related researches

The basic topic of this research is the impact of physical space on behavior. Theoretical stances in this regard may be summarized in the approaches of free-willisim, possibilism, probabilism, and determinism [2]. As it was explained before, physical space is a public behavioral setting or public architectural space. The behavior in mind is also of social interaction or informal and accidental interpersonal type17. Related theories will be generally reviewed from three main design aspects; 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 has in a group [3]. The distance within interaction spaces and the considered 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 desirable social contact between people is different in various situations and even at different times of the day and these changes take place in order to achieve 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 prepare necessary psychological grounds" (Einifar, 2000). Serge Chermayeff and Christopher Alexander also 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).

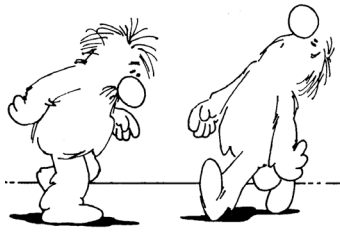According to the view of Jon Lang different architecture

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

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 provide 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 architectural space while the indirect capability includes things such as symbolic concepts that depend on a reference and utility of a pattern [9]. The "non-physical affordances" like "physical affordances" can also affect architectural perception [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 human behavior in the daily life setting. They believe that physical environments impose compulsions on human behavior. According to Roger Barker behavioral setting is active like an organism system and is consisted of components and factors such as "indicative or current pattern of behavior (a reversible, continuous and repeatable activity)", "a specific design of the physical environment (a specific three-dimensional realm or array)", "a specific period of time" and "an adaptable relation

between the sustainable pattern of behavior and place". There is a lot of similarity between individuals who are in a similar behavioral setting [14]. Synomorphy means that without a synomorphic relation between the realm and behavior of man there is 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. He believes that these settings 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 design necessary for further synomorphy and adaptation between space and behavior [2].

5. Research Pattern

According to the findings of relevant researches, a theoretical model has been proposed for these researches in the domain of sociopetaloid of architectural spaces and related designs in order to identify influential factors 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 the humanitarian-physical factor determine the sociopetaly of space (fig. 2).

5.1. Public Space

In this research the public behavior setting or public space6 of architecture has been considered for the assessment of sociopetaloid. There are two major approaches toward public space in architecture and urban development literatures of the recent century: Descriptive and prescriptive. The descriptive approach tries to describe and explain human behavior in the presence of others and times of interaction. The prescriptive approach attempts to find a way for humanistic interaction. Two main layers of 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 Arnedt states that public space gathers people together and also separates them7. Charles Taylor defines public space as a collective space in which members can contact each other by means of different tools or 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 too can see the world from other people's point of views [15].

5.2. Case Study

- *Building sampling:* In order to establish the hypothesis a case study8 was conducted. From amongst humanistic or anthrophilic buildings, cultural and educational buildings the architecture of the university was adopted. The university is
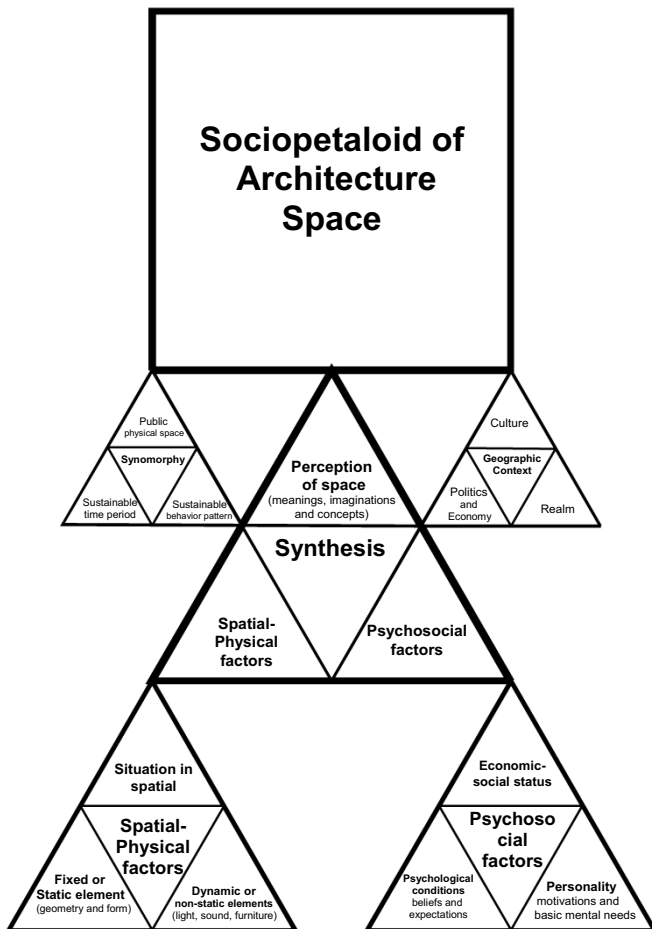
Fig. 2. Proposed pattern of sociopetaloid of architecture space [Authors,2009]

amongst complexes in which interactions and sociopetaloid of public space are mostly the result of cultural and scientific purposes rather than functional and living purposes. Based on the views of users, public spaces within university sites are considered as an unofficial educational supplement to official educational spaces, and their sociopetaloid lead to positive results for students. Meanwhile, students are considered as a congruent group of users of these spaces in which control of intervening cultural-social variables of the research is more easily possible. Amongst different buildings of the Iran University of Science and Technology (situated in Tehran), and from 12 faculty buildings of the university, three independent public spaces were selected by the researcher and with the recommendation of architecture experts from the university. These spaces have a large area, are actively used and have a permanently present population for studying while possessing eligible architecture at the same time.

Amongst the buildings of the university the available space of the faculties were chosen due to the fact that interactions occurring in these public spaces have a higher degree of scientific-cultural themes as compared with other (administrative, service, welfare, laboratory, workshop, research, residential and religious) spaces of the university, and therefore users have 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.

 - *Sampling of space:* Sampling of the public spaces under study was conducted by using the method; "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 previously selected through a "simple random" method, were asked to draw the cognitive map or mental map of their faculty and mark the main point 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. Results were analyzed by comparing the choices and consequently 7 public spaces were obtained for testing the hypothesis by the researcher using a physical-spatial analysis of the complete building organization. Three public spaces were selected from the common structure of various faculties (architecture, civil engineering, mechanics and industries) by analyzing cognitive maps of resident students and three more public spaces from the common structure of other faculties (metallurgy and material, electrical engineering, chemistry and chemical engineering) which were built after the victory of the Islamic Revolution and are architecturally significant. One more public space was selected from the faculty of Islamic Culture and Education which is linked to the basic science classes of the entire university, and is also an architectural heritage within the university (Figures 3 to 9).

The "behavior map and behavior list"10 of each space were prepared without drawing any attention and by means of the observation method. The extent of sociopetaloid and typical social interactions were established by analyzing and interpreting the role of certain physical elements within these spaces. The results of this section of the research will be presented in the supplementary article in order to avoid prolongation of writing. Data was gathered with the aid of on site presence and in the form of questionnaires completed by 103 users (15 students randomly chosen from each space) by polling the variables. The relationship between major variables of the hypothesis was identified and deducted by correlation analysis11 in the SPSS statistical software. The results led to the establishment of the hypothesis. The number of public spaces selected allows the results of the research to be generalized, to some extent, to spaces within universities in Tehran, and universities in Iran. However, sampling should increase for more precise generalization and include other residential, medical, cultural and educational spaces. Generalization of these results to more functional buildings (administrative, commercial, sports, military, etc.) as well as anthroposemic (non-humanistic or industrial) buildings calls for another in-depth research.

6. Analysis of Sociopetaloid of Public Spaces in Faculties

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

Fig. 3. The interior-exterior public space under study, 1/ground floor of the Faculty of Mechanics [Authors,2009]
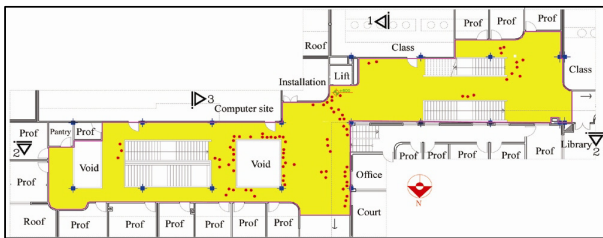

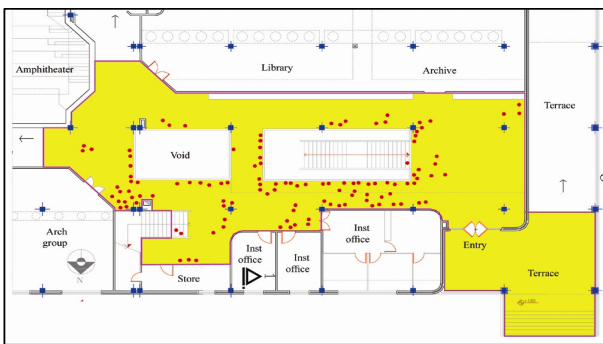**Fig. 4.** The interior public space under study 2/first floor of the Faculty of Mechanics [Authors,2009]

Fig. 5. The interior-exterior public space under study 3/ground floor of the Faculty of Architecture [Authors,2009]

Fig. 5. The interior-exterior public space under study 3/ground floor of the Faculty of Architecture [Authors,2009]
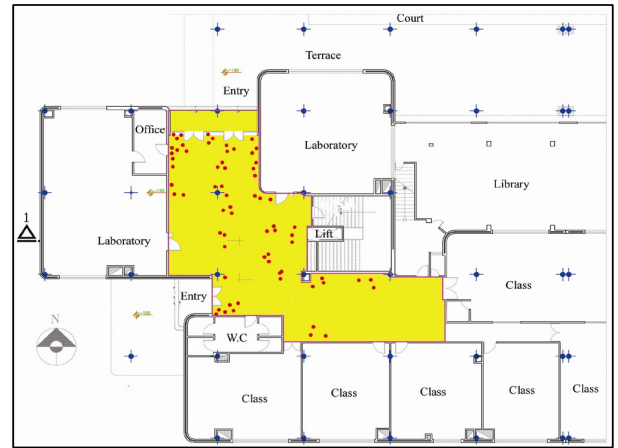
Fig. 7. The interior public space under study 5/ground floor of The Faculty of Chemical Engineering [Authors,2009]
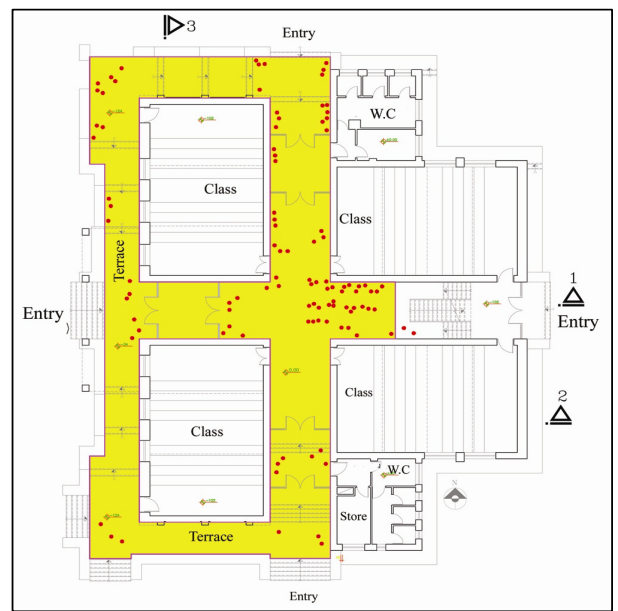
Fig. 8. The interior-exterior public space under study 6/ground floor of the Faculty of Education [Authors,2009]
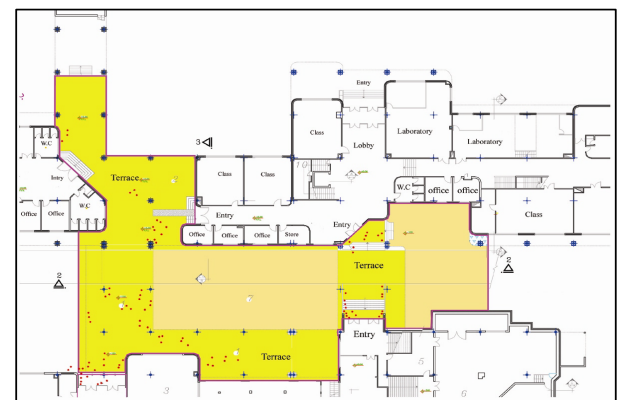
Fig. 9. The interior-exterior public space under study 1/ground floor of the Faculty of Mechanics [Authors,2009]

* Each red dot in the diagrams represents a social interaction occurred between two or more people that has been achieved through the technique of preparing behavioral lists within a certain period of time at a selected space. Reflection of this list on the maps of the spaces results in the establishment of behavioral maps.

6.1. Impact of Social-mental Characteristics of Users on Sociopetaloid of Space

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

The correlation analysis in Table (1) shows that upon increase in educational level and 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 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 increase in the extent of personal space and the resultant need for more isolation for students with higher grades or those taking postgraduate or doctorate programs. These factors cause fewer tendencies toward interactions in the public spaces under study, which host a considerable number of present population and allows less access to desirable privacy and maintaining invisible bubbles of larger personal space. Also, 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 others in the spaces under study compared with users from other fields of study. This is perhaps due to requirements for group cooperation in related fields15.

According to the data presented in Table (2), a meaningful correlation (P- value <0.3) was observed between the extent of interaction tendency of the users of the public spaces under study and their interest in their fields of study as well as their temporary mental moods (temperament) at the time of presence in these spaces and their economic status.

Students with more interest in their fields of study (which were their first choices) have shown more tendencies toward maintaining relations with friends and others in public spaces within their faculties. This meaningful relation may be the result of motivation for presence in these spaces due to high interest in their fields of study. In other words, this interest is followed by forming friendships in spaces and settings in which they learn disciplines. Users who enjoyed a happy or calm mood have both maintained social relations with others for a longer time and had more tendencies toward inter-personal and extra-personal interactions in the spaces under study in comparison with sad and impatient users. Those present in the spaces that were of a higher or lower economic status expressed less tendency toward interaction in the spaces compared to those with an average economic status. The reason as to why these two groups have the same level of tendency toward interaction in the spaces is that the group of students with a higher economic status, do not tend to pass their free time in public spaces of faculties, due to planning a variety of programs in their daily lives.

As for the second group, such as users with higher educational levels (postgraduate and doctorate programs), they require larger personal space than others due to mental reasons and this issue causes them to become distanced and consequently does not establishing relationships with others at a higher level16. Conversely, users with lower and weak economic statuses have a lower tendency toward maintaining constructive interactions with their friends in the spaces under study and fail to reinforce motivations in these places probably due to higher mental burdens, preoccupations, abundance of mind when confronted by problems and lack of sufficient peace of mind.

Table 1. Relationship between sociopetaloid of space and general and educational characteristics (gender, field of study, level of education) of users [Authors,2009]

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

Table 2. Relations between sociopetaloid of space and mental factors: "interest in field of study", temporary mental moods (temperament) of users" and their "economic status" [Authors,2009]

Level of Interaction	Gamma index	P-Value	Level 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	* 0.097	passing grade	0.063	0.747
						field choice priority	-0.247	*0.168

* P-Value< 0.3

6.2. Impact of Physical Characteristics of the Public Architectural Space on its Sociopetaloid

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

Based on viewpoints of the users of public spaces within the university faculties under study, the importance of the physical-spatial factors were obtained and are shown in Table 3. Only two characteristics of the fixed elements of the space can be seen (numbers 6 and 10) amongst the first 10 physical-spatial characteristics which have a high impact on the sociopetaloid of the architectural space according to the views of the interacting persons in these spaces. Conversely, a suitable situation of the space in the spatial order of the whole building has the highest impact as well as semi-fixed elements such as furniture and tableaus. The results of table 3 have been achieved through direct analysis of answers to relevant questions in the questionnaire given by users. According to the correlative analysis (mentioned hereunder) and deduction of meaningful relations between the variables taken by means of comparing relevant questions of the questionnaire using statistical software, the primary results changed to some extent.

There is a meaningful correlation (P-value < 0.3) between "extent of interaction in space" by users and "physical characteristics" of the spaces under study. The extent of interaction in space, which is a sign of sociopetaloid, is measured by means of scales such as: frequency of referral to space, frequency and duration of use. That is, the more the frequency of inter-personal and extra-personal interactions, the higher the grade of sociopetaloid of the space. The correlation data in Table 4 shows that sociopetaloid of the space is interrelated with variables of "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 order of the whole building" and these correlations are explained using factors such as "frequency of referral", "duration of stop" and "frequency of use" by users of the public spaces under study. Details of the physical variables with meaningful correlation with criteria that increase sociopetaloid are presented in the following table.

6.3. Manner of Synthesis and Synomorphy of Human-Physical Factors in Sociopetaloid of Space

In this section the hypothesis is: The sociopetaloid of architectural space increases with high synomorphy and adaptation between physical space and inter-personal and extra-personal behaviors. The synthesis or composition of certain human-physical factors, which in turn leads to the formation of interactive behavior, strengthens this synomorphy.

Synomorphy of physical-human factors increases under the influence of constant and continuous use of space by users and also sustainable current patterns of inter-personal and extra-personal interactions which in turn results in further experience of space and enrichment, reinforcement and refinement or alteration of quasi designs and the mental image which guides users. Certain physical characteristics as well as psychological characteristics of the users such as interest in their studies,

Table 3. Priority of physical-mental factors that impact the sociopetaloid of the spaces under study from the user's viewpoints [Authors,2009]

Order of physical-spatial factors that impact the sociopetaloid of public spaces from the user's viewpoints			
Priority	Physical- spatial characteristic	Priority	Physical- spatial characteristic
1	Situation of space from entrance/closeness to main entry and exit of the building	13	Height
2	Availability of furniture motivating the stop/presence of benches, platforms, tableaus, other equipment	14	Smell/sensing a desirable odor
3	Availability of seating furniture	15	Special decorations, designs and figures on the floor, wall and ceiling
4	Being located at the point of intersection of main corridors /space would facilitate access to all spots of the building	16	Color, type and texture of materials of wall, floor and ceiling
5	Temperature in different seasons of the year which should be suitable and human friendly.	17	Ceiling duct
6	Size/area, vastness and openness of space	18	Square shape geometry of space
7	Suitable light/adequate light of the space compared to other spaces	19	Markings, symbols and special signs
8	Functional centrality/location of functions with frequent visits around the space	20	Shape of the ceiling
9	Sound/ suitable acoustic space with no reflections of murmuring	21	Rectangular shape of space
10	Lightness of visual mass of floor/presence of openings and voids on the grounds with easy views to upper and lower storeys	22	Vertical window
11	Geometrical centrality of the whole building/located on a specific and strategic place	23	Horizontal window
12	Low density of space/emptiness and low number of columns in the space to help the range of view	24	Circular shape geometry of space

temporary mental moods, willingness for stopping in the studied space, previous mental backgrounds and so on, affect this capability of the space. The criteria for assessing the synthesis and synomorphy process of human-physical factors which have resulted in sociopetaloid in the present research include: maintaining interactions between non-friendly individuals, tendency toward interaction, duration of presence and frequency of presence, the need for interaction, dependence of place to space, duration of stopping, and area 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-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 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) become closer to each other with more interactions. Therefore, if physical characteristics in a space are to some extent able to take the place of the effects of friendliness and play the same role in increasing inter-personal and extra-personal interactions.

As it can be concluded from the correlation presented in Table 5, in the opinion of the users, from amongst "dynamic physical elements of the space" suitable odor, from amongst "fixed and static elements of the space" color and texture of surface materials, particular shape of the ceiling and horizontal windows, and also from amongst the characteristics of "location of space in the building organization", functional centrality of the space (situation of the functions surrounded by high referrals) had the highest impact on the occurrence of social interactions between non-friendly people present within the space (strangers) as compared to other physical-spatial characteristics. In other words, certain static and dynamic elements and the situation of the spaces under study in the building replaced "elements of friendliness" in maintaining inter-personal and extra-personal social interactions between strangers and students with lower grades and those with higher grades at the faculties and increased the extent of these interactions. The reason could be that the afore-mentioned physical characteristics increased the probability of accidental confrontations and created more tranquility in the space which in turn, caused people to stay in the space for longer durations, hence, interactive probabilities between strangers due to various psychological and motivating reasons.

There is a meaningful correlation (P-value < 0.3) between the

Table 4. Relation between sociopetaloid and "physical characteristics" of public spaces of university faculties[Authors,2009]

Physical-Spatial Components		Frequency of referral	Duration of stop	Frequency of use	Physical-Spatial Components		Frequency of referral	Duration of stop	Frequency of use
Adequate light	Gamma	0.233	- 0.002	- 0.002	Access to all spots of building functions with-high referrals	Gamma	0.269	0.168	- 0.212
	P-Value	* 0.060	0.986	0.986		P-Value	* 0.034	*0.958	* 0.065
Area, vastness	Gamma	0.085	0.064	- 0.159		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
Odor	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

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Table 5. between non-friendly individuals" and "physical characteristics of space" [Authors,2009]

Maintaining interactions between non-friendly individuals	Gamma index	Level of Significance (P-Value)	Maintaining interactions between non-friendly individuals	Gamma index	Level of Significance (P-Value)
Physical-spatial components			Physical-spatial components		
Suitable light	0.073	0.588	Possibility of communication	0.046	0.733
Area ,vastness of space	- 0.021	0.885	Place of functions with high referrals	0.341	* 0.007
High altitude	- 0.007	0.958	Low density of space (small number of columns)	0.056	0.677
Color and texture of materials	- 0.155	* 0.225	Quietness	- 0.094	0.456
Odor	- 0.303	* 0.012	Suitable temperature	- 0.005	0.970
Specific shape of ceiling	- 0.271	* 0.037	Seating furniture (for a short period of time)	0.059	0.665
Horizontal window	0.175	* 0.219	Circular shape	-0.040	0.792
Vertical window	- 0.038	0.784	Square shape	0.137	0.315
Ceiling duct	- 0.121	0.330	Rectangular shape	-0.066	0.645
Void	0.056	0.643	Signs and symbols	0.094	0.471
Decorations	- 0.103	0.397	Situated at geometrical centrality of building	0.074	0.563
Proximity to entrance	0.063	0.653	Benches, seating areas and equipment	-0.030	0.833

* P-Value< 0.3

"extent of presence in the space" and "need for interaction" in the spaces. A high feeling of need for inter-personal and extra-personal social interactions would cause longer presence of users in public spaces with increase in the number of interactions and a rise in the sociopetaloid of the space. There is harmony and congruency between the answers to these two questions. That is, individuals who had a high level of need for interaction have frequently (once to several times per day) visited the public spaces of their faculties. This correlation is shown in Table 6.

There is also a meaningful correlation (P-value <0.3) between the "duration of stay" and "reason of stay" in the spaces under study. Motivations for staying in the space overshadowed the duration of stay of users. If these motivations become stronger, the duration of stay would increase and therefore the extent of inter-personal and extra-personal social interactions would possibly increase. With increase in interactions, the sociopetaloid of the space also increases.

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

If the typical feeling of being in the space is positive and brings about satisfaction, it will primarily cause the user to stay longer, and secondly, his/her tendency to establish inter-personal and extra-personal interactions increase. People who

feel that an architectural public space is crowded show a desire for privacy. In other words, sufficient private space does not exist for refreshment and regaining energy for maintaining social interactions. Such users would seriously lose their tendency toward inter-personal and extra-personal social interactions with others due to this negative feeling within the space. Therefore, the sociopetaloid of the space decreases. According to the data given in Table 8, there is a meaningful correlation (P-value < 0.3) between "feeling of crowdedness"

Table 6. Relationship between "need for interaction" and "extent of presence in the space" [Authors,2009]

Feeling of need to interact	Gamma index	Level of Significance
Extent of presence in the space	-0.326	* 0.017

* P-Value < 0.3

Table 7. Relationship between "duration of stay" and "reason of stay" [Authors,2009]

Duration of stay in the space	Gamma index	Level of Significance
Reason of stay in the space	0.254	* 0.021

* P-Value < 0.3

Table 8. Relationship between "crowded space" and "demanded privacy" of users [Authors,2009]

Crowded space	Gamma index	Level of Significance
Demanded privacy	0.2	*** 0.300**

* P-Value < 0.3

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 had a feeling of crowdedness. They prefer 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 large and crowded public spaces for interactions with others. This meaningful correlation shows that the physique of the spaces under study can predict solitude points with limited views from surrounding spaces on 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 users in order for them to have more tendency toward joining others as a result of the physical environment.

7. Conclusion

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

The results show that:

1. Physical characteristics of a public architectural space affect the extent and type of inter-personal and extra-personal social interactions which occur in the space. The extent of these impacts shows the high sociopetaloid of the space provided that they increase the number of interactions. Correlative analysis showed that there was a meaningful relationship between "fixed elements of space" possessing characteristics such as: opening on the floor or ground (lightness of the visual mass of the floor/ground) and being situated at the center of the public space, varying height of the space, low density of space (low number of columns as well as vastness) in other parts of the spaces, presence of a semi-open space in front of the entrance door of the building 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 materials, shapes and forms of walls and ceiling, symbols and signs, Carshio geometrical shape (plan) of the space, and the extent and duration of interactions. However this meaningfulness was slight and considered of the second and third classes. Also, "semi-static elements of the space" particularly seating furniture (benches and platforms) as well as public and private signboards caused longer stay periods of users in the public space, hence increasing the probability 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 which encourages longer durations of stay for users in the space and adds to their interactions. Temperature, sound and odor-related elements are also important. They are related to modern technologies of construction in contemporary architecture and these technical aspects should be taken into consideration in order to obtain positive effects. 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 the 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, being situated in the geometrical center of the building, acting as a functional centrality of the building, and also being at the intersection of the two main internal routes of the building are all considered as "sociopetaloid hardware" by providing "interaction infrastructure" such as guiding most individuals toward public architectural space and increase of 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" by providing "interaction superstructures" such as tranquility and satisfaction, creation of "direct and physical capability" of stay and "indirect capability" of tendency and prolongation of stay. 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 characteristics were an important supplement to the formal educational spaces such as classrooms, laboratories, workshops, libraries etc. since students use them for almost half of their education periods. Moreover, in their opinion, the sociopetaloid of the public spaces result in development of friendships, maintaining long-time relationships, increase in sense of belonging to the university environment, improving individual growth, socialization, closeness of students with mental backgrounds and varied characteristics, further mutual support of students in educational and living environments, less self-alienation and more self-confidence, creating valuable memories for the post-graduation days and finally the psychological feeling of security and safety in faculty settings.

4. Sociopetaloid of public architectural space is the outcome of the intermediary links arising from the process of synthesis and synomorphy between physical-human characteristics. This process and its extent have been assessed by means of several criteria including: maintaining interactions between strangers, tendency toward interaction in the space, duration of stay and number of visits to the space, need for interaction, dependence of place on space and extraction of meaningful correlations between these criteria of synthesis and synomorphy with each of the identified physical-human factors. This led to the recognition of the effect and type of physical-spatial and mental-social characteristics involved in the sociopetaloid of architectural space.

5. Based on the findings, a theoretical model has been suggested for determining the factors affecting sociopetaloid of architectural spaces in order for them to be included in the

design of public behavioral settings of public buildings. The model has been examined and tested in the present research. Designers of public buildings in general, and those of residential, educational, cultural, and medical buildings, in particular in which the soul of humans are being addressed by spaces, are recommended to employ the physical-spatial characteristics mentioned in this research when designing public architectural spaces in order to make these buildings user-friendly, improve productivity and functionality of residing personnel, and secure satisfaction and mental tranquility of the people who visit 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 inter-personal 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 nor 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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