



The impact of office spatial aspects on creativity and innovation of architecture and urban design researchers

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Abstract

Innovative research centers need creative researchers who generate new ideas for product or process innovation. Research activities have an extremely significant role in the development of societies whose promotion is strongly dependent on the creativity and innovation. The built environment has a key impact on human behavior. Therefore, this paper at first, evaluates the appropriate plan of offices between open plan and closed plan where increase architecture and urban design researchers' creativity and innovation. Then, the impact of spatial aspects of offices on effective factors of the creative and innovative process is examined. The spatial aspects derived from literatures are privacy, beauty, spatial diversity/flexibility, and proximity/visibility. Also, effective factors on the creative and innovative process are tranquility/physical comfort, creative thinking, motivation, and communication. In the current study, a survey was conducted of 92 faculty members and PhD students of architecture and urban design departments in governmental universities of Tehran, Iran. Results indicate that closed plan offices are more desirable for architecture and urban design researchers with the subject of enhancing creativity and innovation. Moreover, spatial aspects of offices have different influence on effective factors of the creative and innovative process that should be considered in design of research offices. At the end, some architectural design guides are proposed to achieve the appropriate research offices where stimulate architecture and urban design researchers' creativity and innovation.

Keywords: Creativity and innovation, Spatial aspects, Offices, Research centers

1. Introduction

In recent decades, the policy makers of countries have shown an increasing interest in the expansion of knowledge-based innovation and creativity decisions, which are driving forces for the development of countries [1-3]. Creativity and innovation are happening in contexts such as universities and research centers. In a research center, there are lots of factors, such as the built environment, influencing the quality and quantity of creative and innovative outputs of researchers. Studying the organizational behaviors verifies the effect of physical environment on the employees' satisfaction, efficiency, and motivation [4, 5]. Research centers could be assumed as workplaces whose outputs are creativity and innovation and whose main resource is expert employees [6, 7].

So far, no comprehensive study has appeared in the literature about the impact of architectural aspects of research centers on their researchers' creativity and innovation.

To the best knowledge of the authors, the research conducted by Toker [8, 9] is the sole work focusing on the innovation in research centers. Toker concentrated on spatial configurations of research centers and emphasized on the face to face communication, as one of the essential factors in growth of the researchers' innovation. Toker utilized the space syntax and demonstrated the best layout among three various spatial configurations. This research, however, did not account for the researchers' satisfaction. Moreover, among various factors influencing the innovation, only the face to face communication was investigated.

This paper intends to determine the effective spatial aspects of offices with the objective of increasing the researchers' creativity and innovation. Among two classes of areas in a research center, namely private and public areas, private area, which mostly includes the working offices, is considered in this study. First, important factors affecting the creativity and innovation are identified. Then, based on data collected with the survey method, the important spatial aspects in increasing creativity and innovation are extracted. Additionally, the researchers' preference about the open or closed plans offices is evaluated. Various statistical metrics are presented and the obtained results are thoroughly discusses.

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2. Creativity and Innovation

There is a vast domain of research on creativity and innovation spanning from the creativity in problem solving to innovative technologies. Although there are a lot of definitions for creativity and innovation, in this paper the focus is on the definition proposed by Amabile (1996; 1997). That is, creativity is a process leading to novel and useful ideas [10] and innovation is the successful implementation of those creative ideas [11]. Evidently, knowing this process can develop and simplify the creativity and innovation. Graham Wallas has presented one of the first models associated with the creativity process [12] which has the following four stages:

1- Preparation: stand preliminary tasks on the problem which concentrates the researcher's mind on the problem and exploring its miscellaneous dimensions.

2- Incubation: denotes when the problem is internalized into the unconscious mind and externally it seems that nothing is happening.

3- Illumination or insight: implies when the creative idea comes from unconscious mind to conscious mind.

4- Verification: is referred to when the idea is intentionally verified and then applied.

Some other researchers [13] believe that another stage called "implementation" could be added at the end of this process. Implementation means realizing the new idea and creating novel things. By this evolution, the creativity is converted to innovation.

As mentioned before, creativity and innovation are the results of a process. Accordingly, in order to raise individuals' creativity and innovation, the factors affecting this process should be boosted. Various and different factors influence each stage of the creativity and innovation process. For instance, in the stage of preparation, tranquility/physical comfort and creative thinking could have significant effects. Due to the impact of tranquility/physical comfort on increasing concentration, this factor could be impressive in stage of reviewing literatures and collecting relevant information. Moreover, creative thinking (or divergent thinking) is the capability of distinguishing differences between various data and exploring the best solution among all available [13]. Motivation is an underlying requirement in all stages of creativity and innovation process, particularly in the incubation stage [14, 15]. In the incubation stage, although individuals may be disappointed because nothing appears externally under happening, motivation helps them to not give up endeavor and to concentrate more on the subject. The most effective factor in illumination stage is tranquility. Transferring an idea from the unconscious mind toward the conscious mind can be done easier if individuals have physical comfort and tranquility. In the verification stage, creative thinking becomes highlighted again since individuals are trying to introduce their idea, achieved in illumination stage, and make it easy to comprehend. The last stage for innovation, namely implementation stage, necessitates group working and communication with other experts to convert the idea to product [16, 17]. Communication is one way of

information flow and transferring knowledge [18-20] which is essential in implementation of a new idea.

As discussed above, several factors influence the creativity and innovation process consisting of creative thinking, motivation, tranquility/physical comfort, and communication. In this paper, these factors are considered as effective factors in creativity and innovation process; thus, the influence of spatial aspects on these factors is going to be studied.

3. Open Plan and Closed Plan Offices

Offices in a workplace can be categorized into two classes: open plan and closed plan. Open plan offices are large rooms in which the employees work. Sometimes, the space of this type of offices is divided by some partitions; however, they still are one hall where employees work together. Closed plan offices are completely enclosed with dry walls and a door. A large body of research activities in the field of open plan offices has been conducted to investigate their pros and also cons.

Many studies have implied the benefits of open plan offices [5, 21]. The main claim of designers of open plan offices is to create a flexible space which can be diversely furnished by changes in size or organizational structure. Furthermore, these kinds of offices can reduce the cost [22]. In open plan offices, eliminating the obstacles increases employees' communication [23]. Based on the new work patterns, which emphasize group working, low-hierarchical organizations, and increased communication [6, 24, 25], open plan offices seem to be appropriate choices in new workplaces.

On the contrary, open plan offices have disadvantages which have been speculated in some studies. Among these points are the low level visual and acoustic privacy as well as more distractions and interruptions [5, 26, 27]. Moreover, reducing employees' efficiencies [4], job satisfaction, and motivation are other disadvantages of open plan offices [16, 28]. Other studies based on subjective reports of employees in open plan offices have illustrated that the irrelevant speeches result in lower productivity, more stress, and dissatisfaction of employees [4, 29, 30]. Nowadays, one of the main challenges of work system designers is to have a workplace in which the satisfaction of employees is guaranteed [31]. A number of solutions, such as implementing standing partitions, in order to solve the problems of open plan offices have been suggested in other works [5]. Partitions in open plan offices decrease distraction and increase privacy; however, they cannot remove all unwanted stimulations [5, 32, 33].

Recently, open plan offices have been broadly used mainly due to their lower cost and other benefits. Felstead, Jewson, and Waters (2003) reported an observation in the growth of development of open plan offices in Britannia, in a three year period. They also predicted that no decrease in this layout of workplace would happen [34]. However, the reality is against this prediction and the tendency is now turning to closed plan offices [35]. Cain (2012) believes that open plan offices decline employees' creativity and productivity because of low privacy. He

declared that the best way of communication is what takes place in the midst of solitude such as the communication through the internet.

Based on aforementioned discussions, these questions arise: Whether for all organizational tasks a unique type of office is appropriate or does it depend on the task? Do the cultural aspects affect the preference? Answers to these questions need comprehensive and further studies. This paper intends to find an answer for a more limited question: Which kinds of offices are preferred for Iranian researchers in an architecture and urban design research center?

4. The Impact of Built Environment on Human Being

Until 1960s, psychologists were mostly ignoring the effects of physical environment on human behavior. Since then, a significantly growing body of literature has appeared in the field of environmental psychology, confessing the relationships between human beings and their built environments [36, 37]. Nowadays, the fact that human behavior is influenced by physical environment is widely accepted [37]. This subject has been studied specifically in the field of workplaces, residential areas, medical places, and educational environments [e.g. 21-24, 38-42]. Consequently, a suitable context for a specific behavior could be provided by designing built environment with especial aspects.

As discussed in the literature review, there are lots of environmental aspects affecting the important factors of the creativity and innovation process which could be categorized in four spatial aspects of privacy, beauty, spatial diversity/flexibility, and proximity/visibility. In this paper "proximity" means physically being next to each other. For instance, researchers' offices locate next to each other or they work in open plan offices. "Visibility" means that it is possible to see other researchers during the work. For example, imagine a window on the door of the closed plan office through which other researchers coming and going can see inside the office; or the layout of researchers' desks in an open plan office are in an order let workers see each other during the work). In the following, the effects of each special aspect on important factors in creative and innovative process are briefly reviewed:

- "Privacy" provides individuals' tranquility and physical comfort. Also, it eases the concentration which can lead to the creative thinking [16, 43, 44].
- "Beauty" of a place promotes tranquility and could lead to more physical comfort as well [37]. Moreover, beauty can increase individuals' motivation to stay longer in the place [43].
- "Spatial diversity/flexibility" can afford various contexts for creative thinking [16]. Owing to the differences among individuals, such a place can provide more people with satisfaction and also flexibility of places let individual reconfigure the furniture. Additionally, the spatial diversity can increase individuals' motivation to stay longer in the office according to answer larger domain of their needs.

"Proximity/visibility" (of people is the best way to increase their communication [43, 45]. Accordingly,

consideration of this spatial aspect can be effective in the creativity and innovation process. Moreover, the researchers' motivation may increase by being informed of another's condition.

5. An Appropriate Office for Increasing the Creativity and Innovation in Architecture and Urban Design Research Centers

Based on preceding discussions, it is assumed that spatial aspects of an office can influence the researcher's behavior working there. This paper is going to find answers to below questions:

1- Which types of offices (open plan or closed plan) are preferred by Iranian architecture and urban design researchers?

2- Whether or not and in what order the effective factors in the creativity and innovation process (tranquility/physical comfort, motivation, creative thinking, and communication) are influenced by spatial aspects of privacy, beauty, spatial diversity/flexibility, and visibility/ flexibility?

5.1. Research method

Self-report is one of the reliable ways for measuring creativity [46-48] and innovation [49] and it is very often fulfilled via questionnaire [50]. Accordingly, the questionnaire-based survey method is adopted in this paper to collect the data. The statistical population in this research is architecture and urban design researchers. The sample group was 92 faculty members and PhD students of architecture and urban design departments of governmental universities in Tehran. The questionnaire was designed by authors in the four-point Likert scale (In four-point Likert scale, strongly disagree is scored 1, disagree is scored 2, agree is scored 3, and strongly agree is scored 4.)and has two parts: first part asking the researchers' preference about open plan offices or closed plan offices; and second part has 25 questions around the impacts of spatial aspects on effective factors in creativity and innovation process. For analysis of the data, the statistical method called RM-ANOVA (Repeated Measures Analysis of Variance: RM-ANOVA) in the SPSS environment was employed.

5.2. Data analysis and discussion

The analysis of first part of questionnaire shows that architecture and urban design researchers are not satisfied in open plan offices (mean=2.13, SD=.90) and they prefer closed plan ones. They believe that close plan offices are more effective in increasing their creativity and innovation.

In order to study the impact of spatial aspects on effective factors in creativity and innovation process, four sets of analyses are fulfilled in the following. These analyses are based on multivariate test and significant differences; a summary of software outcomes are outlined as well. Hereafter, the factors affecting the creative and innovative process are called effective factors for short.

1. The influences of “privacy” on effective factors: The results shows that effective factors are impacted significantly differently by the spatial aspect of privacy because $F(2.28, 207.70) = 6.61$, $p = .001$, and $\eta_p^2 = .068$. Based on the numerical results given in tables “Descriptive Statistics” (Table 1) and “Pairwise Comparisons” (Table 2), the impact of “privacy” is significantly greater on tranquility/physical comfort (mean=3.31, SD=.39) compared with motivation at $p < .001$ but not compared with the communication (mean=3.29, SD=.66 at $p > .05$). In

the comparison of the tranquility/physical comfort with the creative thinking, a tricky point exists due to $p = .056$. This value is so close to the assumption of .05. Thus, it is decided to account for it as a moderate factor leading to a moderately higher impact of “privacy” on tranquility/physical comfort compared with creative thinking. Therefore, the creative thinking (mean=3.47, SD=.54) and the motivation (mean=3.08, SD=.85) are affected most and least by “privacy”, respectively.

Table 1 Descriptive Statistics of the influence of spatial aspects on effective factors

Spatial aspects	Factor	Mean	Std. Deviation
Privacy	Tranquility/physical comfort	3.3098	.39113
	Motivation	3.0761	.85464
	Creative thinking	3.4674	.54372
	Communication	3.2935	.65529
Beauty	Tranquility/physical comfort	3.7011	.46916
	Motivation	3.3261	.56663
	Creative thinking	3.2935	.80572
	Communication	2.6196	.73891
Spatial diversity/flexibility	Tranquility/physical comfort	3.0815	.65999
	Motivation	2.6848	.91302
	Creative thinking	2.8297	.64714
	Communication	2.1304	.90441
Proximity/visibility	Tranquility/physical comfort	2.1304	.87978
	Motivation	2.7174	.90573
	Creative thinking	2.0326	.76246
	Communication	2.9601	.53416

Table 2 Pairwise Comparisons of the influence of privacy on effective factors

Objective (I)	Objective (J)	Mean Difference (I-J)	Std. Error	Sig.*
Tranquility/physical comfort	motivation	.234	.086	.047
	Creative thinking	-.158	.059	.056
motivation	Tranquility/physical comfort	-.234	.086	.047
	Creative thinking	-.391	.089	.000
Creative thinking	Tranquility/physical comfort	.158	.059	.056
	motivation	.391	.089	.000

*Mean differences are significant in .05 and sig. shows P value. Also, just significant component are shown in table. The “Bonferroni correction” is considered the adjustment for multiple comparisons

2. The influences of “beauty” on effective factors: According to $F(2.37, 216.01) = 54.47$, $p < .001$, $\eta_p^2 = .37$, “beauty” affects significantly differently the effective factors. Referring to Table 1 and Table 3 (Pairwise Comparisons of the influence of beauty on effective factors), the impact of “beauty” is significantly higher on the tranquility/physical comfort (mean=3.70, SD=.47) compared with the motivation, creative thinking, and communication (all $ps < .001$). In addition, the effect of “beauty” is significantly lower on the communication (mean=2.62, SD=.74) compared with all tranquility/physical comfort, motivation, and creative thinking (all $ps < .001$). However, “beauty” does not have significantly different effects on the motivation (mean=3.33, SD=.57) and creative thinking (mean=3.29, SD=.81) at $p = 1.00$.

3. The influences of “spatial diversity/flexibility” on

effective factors: According to the result, “spatial diversity/flexibility” affects significantly differently the effective factors, as $F(2.64, 240.49) = 27.03$, $p < .001$, $\eta_p^2 = .23$. The Tables 1 and Table 4 (Pairwise Comparisons of the influence of spatial diversity/flexibility on effective factors) show that, in researchers’ viewpoints, “spatial diversity/flexibility” has a significantly higher impact on the tranquility/physical comfort compared with all motivation ($p < .05$), creative thinking ($p < .05$), and communication ($p < .001$). Moreover, the importance of “spatial diversity/flexibility” is significantly lower in communication compared with motivation and creative thinking (both $ps < .001$). However, no significant difference is observed between the motivation (mean=2.69, SD=.91) and creative thinking (mean=2.83, SD=.65) at $p > .05$. Thus, the highest impact of “spatial

diversity/flexibility” is on the tranquility/physical comfort (mean=3.08, SD=.66) and it has almost no effect on

communication, according to its mean.

Table 3 Pairwise Comparisons of the influence of beauty on effective factors

Objective (I)	Objective (J)	Mean Difference (I-J)	Std. Error	Sig.*
Tranquility/physical comfort	motivation	.375	.060	.000
	Creative thinking	.408	.075	.000
	Communication	1.082	.088	.000
motivation	Tranquility/physical comfort	-.375	.060	.000
	Communication	.707	.087	.000
Creative thinking	Tranquility/physical comfort	-.408	.075	.000
	Communication	.674	.110	.000
Communication	Tranquility/physical comfort	-1.082	.088	.000
	motivation	-.707	.087	.000
	Creative thinking	-.674	.110	.000

*Mean differences are significant in .05 and sig. shows P value. Also, just significant component are shown in table. The “Bonferroni correction” is considered the adjustment for multiple comparisons

Table 4 Pairwise Comparisons of the influence of spatial diversity/flexibility on effective factors

Objective (I)	Objective (J)	Mean Difference (I-J)	Std. Error	Sig.*
Tranquility/physical comfort	motivation	.397	.113	.004
	Creative thinking	.252	.082	.016
	Communication	.951	.113	.000
motivation	Tranquility/physical comfort	-.397	.113	.004
	Communication	.554	.131	.000
Creative thinking	Tranquility/physical comfort	-.252	.082	.016
	Communication	.699	.110	.000
Communication	Tranquility/physical comfort	-.951	.113	.000
	motivation	-.554	.131	.000
	Creative thinking	-.699	.110	.000

*Mean differences are significant in .05 and sig. shows P value. Also, just significant component are shown in table. The “Bonferroni correction” is considered the adjustment for multiple comparisons

4. The influences of “proximity/visibility” on effective factors: The RM-ANOVA results in $F(3,273) = 48.87$, $p < .001$ and $\eta_p^2 = .35$ which means that there is significant difference between the impact of “proximity/visibility” on effective factors. Referring to Table 1 and, Table 5 (Pairwise Comparisons of the influence of proximity/visibility on effective factors),

“proximity/visibility” has significantly a greater effect on communication (mean=2.96, SD=.53) compared with tranquility/physical comfort (mean=2.13, SD=.88 at $p < .001$), creative thinking (mean=2.03, SD=.76 at $p < .001$), and motivation (mean=2.72, SD=.91 at $p = .05$). However, there are no significant differences between tranquility/physical comfort and creative thinking ($p > .05$).

Table 5 Pairwise Comparisons of the influence of proximity/visibility on effective factors

Objective (I)	Objective (J)	Mean Difference (I-J)	Std. Error	Sig.*
Tranquility/physical comfort	motivation	-.587	.090	.000
	Communication	-.830	.095	.000
motivation	Tranquility/physical comfort	.587	.090	.000
	Creative thinking	.685	.098	.000
Creative thinking	Communication	-.243	.090	.051
	motivation	-.685	.098	.000
Communication	Communication	-.928	.076	.000
	Tranquility/physical comfort	.830	.095	.000
	motivation	.243	.090	.051
	Creative thinking	.928	.076	.000

*Mean differences are significant in .05 and sig. shows P value. Also, just significant component are shown in table. The “Bonferroni correction” is considered the adjustment for multiple comparisons

In fact, according to the means “proximity/visibility” does not affect on creative thinking and roughly on the tranquility/physical comfort.

6. Conclusion

Based on the conclusions drawn from the present study, closed plan offices are desirable for Iranian architecture and urban design researchers with the aim of increasing creativity and innovation. In this type of offices, a built environment defines territories belonging to each researcher and offers more privacy. Additionally, researchers can avoid unwanted interaction and conversation by closing the door of offices.

Moreover, the results declared that spatial aspects have different impacts on effective factors of creativity and innovation process. In this case, privacy of offices significantly increases researchers' creative thinking as well as their physical comfort and tranquility. Privacy of offices includes acoustic, visual, and social privacy. It means that the offices should be acoustic in order to eliminate disturbing noises. Besides, view from outside to inside of offices should be controllable. In other words, the view of windows between inside of room and outside of building or inside of room and corridors should be controllable by curtain or something else. Furthermore, the offices should not be located in junction of corridors and crowded places. Personalizing the office is critical to enhance the sense of privacy. It could be done by letting the researchers put their own stuffs in the offices. Generally speaking, the sense of ability to control the place increases privacy of researchers.

Beautiful offices significantly increase architecture and urban design researchers' tranquility and physical comfort. There are some primary ways to augment the beauty of offices such as usage of plants, pretty pictures, and pleasant furniture. Employing natural material such as wood and stone in finishing and interior design could be suitable too. Moreover, the window in the office, especially good view one, is effective in this way. Another matter is scale. The appropriate scale of the office and furniture could increase beauty of place and also tranquility of researchers.

Similar to beauty, spatial diversity and flexibility of offices significantly increase researchers' tranquility and physical comfort. This spatial aspect is achieved by variety in colors, light, and created spaces. Usage of plants could be effective too. It should be considered that variety has to be accompanied by harmony to lead to a unique space. Therewith, diversity in view through the way toward offices could be helpful and this feature could be achieved by decorated corridors with colors, pictures, and good view windows. Indeed, spatial diversity and flexibility of offices are provided when the office is rearranged according to researchers' (user) needs and variety in different parts of the office could be seen. This spatial aspect lets researchers respond to their various requirements during the day ranging from sitting behind the desk and concentrating on the research to relaxing on the sofa.

Proximity/visibility of researchers' offices has the most

effect on communication. With attention to researchers' preference for closed plan offices, the researchers' proximity should be afforded by designing the offices next to each other. Thus, researchers can see their colleagues by passing in front of their rooms, without distracting their privacy. Moreover, designing a common place near to the offices in where researchers could talk, relax, or have a tea or coffee could encourage communication. This place could be a room with glass wall where inside is easily seen but the noise is not heard from outside.

Accordingly, depending on various occasions, spatial aspects of researchers' offices in architecture and urban design research centers should be intentionally used as a set of means to elevate their creativity and innovation.

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