

# The Impacts of Sustainable Residential Interior Space on Inhabitant's Emotions

Maryam Banaei <sup>1\*</sup>, Abbas Yazdanfar <sup>1</sup>, Javad Hatami <sup>2</sup>, Ali Ahmadi <sup>3</sup>

<sup>1</sup> Faculty of Architecture, Iran University of Science & Technology, 16846-13114 Tehran, Iran

<sup>2</sup> Faculty of Psychology and Educational Sciences, Tehran University, 17469-37181 Tehran, Iran

<sup>3</sup> Faculty of Electrical & Computer Engineering, Khajeh-Nasir Toosi University, 1631714191 Tehran, Iran

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## Abstract

Focusing on inhabitant's climate comfort causes the neglect of personal and aesthetic factors that have effects on emotions and psychological comfort. Blindly adhering to sustainable design principles regardless of the basic architectural design parameters cause similar interior spaces in today's housing of Iran. Interior space form is one the main design factors that has some effects on inhabitant's emotions. It is a correlation research to study inhabitant's emotions towards sustainable interior space by focusing on interior form. It illustrates that form can consider as an influential factor in creating and improving sustainable conditions according to inhabitant's emotions.

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**Keywords:** Sustainable interior design; emotion; shape; PAD

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## 1. Introduction

New developments and principles towards sustainable design cause most of the Iran's dwellings to have some basic sustainable conditions. Iranian National Building Code part 19 has principles for designing in a defined sustainable parameters. Although sustainable principles have the great impact on energy uses it pays less attention to personality, culture, and people's emotions towards spaces (Gifford, 2007). Besides the environmental factors in which architecture is created and exist, the social, cultural, and economic circumstances should never be ignored (Abdel-Hadi, 2012; Pardalos, 2012, p. 236). Sustainability has variety of aspects, and one of its main parts is about social sustainability, health, and mental health (Woodcraft, 2012), however most of the regions in Iran follow the physical sustainability without paying any attention to social life and culture of that region.

Researches show that human's environment has some impacts on emotional state and feeling (Horayangkura, 2012; Kamil & Abidin, 2013; Marcus, 2006; Noiprawat & Sahachaisaeree, 2012). Residential designing is a complex field that needs a variety of proficiencies to cover all aspect of human life to create livable houses and protect inhabitant's health (Pardalos, 2012, p. 236). In

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\* Corresponding author. Tel.: +0-000-000-0000

E-mail address: [banaei@arch.iust.ac.ir](mailto:banaei@arch.iust.ac.ir)

her book, Clare Cooper Marcus (2006) stated the impact of our house on our emotion and identity. Architecture is not only a scientific field but has great artistic aspects that can have some effects on emotional states (Kukhta & Pelevin, 2015). Also, as we mostly live inside the buildings, the interior would play a more effective role on emotional state.

Different parameters are important in interior space designing such as; light, color, form, material and furniture (Haddad, 2014; Sufar, Talib, & Hambali, 2012). Among these parameters form or shape of space is based on architect's idea and desire. While light and color are flexible and can change easily by inhabitant's mood (Wardono, Hibino, & Koyama, 2012), inhabitants cannot change space shape simply unless by using false shapes. Interior space form is one the main design factors that can have special effects on inhabitant's emotions (Karšli, 2015; Yalçin, 2015). It shows the importance of architect's role in designing interior form and its long-term effects on inhabitants.

Moreover, the importance role of the form can be found in nature, divers details in nature have various forms and shapes that are not only for aesthetic value, but they have functional values that are innate in their existence. Architectural design should be integrated with nature, and all its components should improve this integrity (El-Zeiny, 2012; Giurea, 2014).

Blindly adhering to sustainable design principles regardless of the basic architectural design parameters cause similar interior spaces in today's housing of Iran. It seems that today houses have climate comfort condition, sufficient lighting, ventilation, and insulation, but they have similar interior space shape or form. Focusing on climate comfort conditions causes the neglect of personal and aesthetic factors that have effects on emotions and psychological comfort (Gifford, 2007). Also, we face the same interior spaces not only in one city but different cities with different climate conditions in Iran. It seems that most of the sustainable residential interior spaces are designed regardless of the shapes or has false shapes with no function. It is needless, to say that structure creates the total shape of the place but by using today's structural technology we can work on new aspects of shapes that can help achieve sustainability. However, Iranian traditional architecture shows that interior space forms can support and improve sustainable conditions (Hensel, 2008).





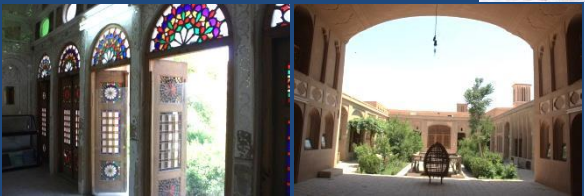
The aim of this research is to study the correlation between inhabitant's emotions and psychological comfort towards their sustainable residential interior space. As psychological comfort is a sustainable parameter, this study tries to figure out which forms in interior space improve inhabitant's emotions and psychological comfort for using in sustainable designing. This study tries to show the hidden aspects and complexity of residential designing and the role of feeling and emotions towards it. Also, to illustrate that focusing on physical comfort should not cause emotionless spaces.

### *1.1. Form in sustainable designing*

Some researchers have studied the form in sustainable designing. Baggs (2004) stated in his "Healthy House" book that pyramid forms have positive effects on growth of plants or even human being and have healing power (Baggs & Baggs, 2004, p. 56). He believed in unseen power of shapes and had some ideas about "golden rectangle", "Fibonacci series" and "Platonic solids" and their effect on health (Baggs & Baggs, 2004, pp. 58,59). Practically it seems that forms are forgotten in today's sustainable architecture (El-Zeiny, 2012). Although there are some cases in large scale that uses the form for their sustainable objectives like the German Reichstag in Berlin, in the smaller scales and routine residential designing, it is ineffective. While, the traditional architecture in Iran had a special form of each region's housing that had sustainable functions too. Interaction between religious, cultural, ethical, and professional features of inhabitants and architect in a social system in the past had brought aesthetical and well-organized samples in which sustainability was implied not only on the surface but also in its structure and inside (Pardalos, 2012, p. 236).

Table.1 shows some examples of Iranian traditional architecture that the interior shape helps the sustainability of the spaces. For example, Ali Qapu Palace in Iran is a masterpiece for acoustical performance that created only by interior forms (Hensel, 2008). Traditional houses of Zavare and Gheshm cause ventilation and climate comfort in the hot region by changing in height and form of interior spaces (Irvani, Etesam, Masoud, & Mofidi, 2009). Also, traditional windows in Iran have great nature relatedness and daylighting with their special design and form(Irvani et al., 2009).

Table 1. Form in sustainable design, examples of Iranian traditional architecture

Sustainable parameters (LEED, 2009)	Documents
Daylight (Dolat Abad, Yazd, Iran)	
Ventilation (Zavareh houses, Zavareh, Iran)	
Thermal comfort (Badgir, Gheshm, Iran)	
Acoustical performance (Ali Qapu, Palace, Isfahan, Iran)	
Nature relatedness (Lary house, Yazd, Iran)	

## 1.2. Form and emotion

Throughout history, architects have used the form to create useful and delightful spaces. There are two different opinions towards form in architecture; one can be in relation towards emotions (pleased, exciting, relaxing and etc.) that can be called “effective forms” and the other one is about structural form that can be called “interpretation form”(Devlin & Nasar, 1989).

Studying the relation between art and emotion is not a new field. About 2500 years ago Aristotle asked why art evokes emotion, so the question still exist, how or why art evokes emotion is a scientific question because emotions can be studied behaviorally and neurologically (Aiken, 2013; Mahdavinejad et al., 2014). We understand our surrounding by our senses and feelings and emotion plays an important role in our interaction with the environment and especially architecture(Krukaset & Sahachaisaeree, 2010; Kukhta & Pelevin, 2015).

Some studies explain the effects of different forms on emotion. Most of the studies discuss the differences between curvature and rectangular forms. Studies show that using too much curve lines can cause more stress (Roelfsema, Scholte, & Spekreijse, 1999). Moreover, another study compared two different environments according to curvature and figured out that old people tend to prefer object-orienting interior spaces (curved walls) more frequently than the spatially-orienting features (squared off walls) (Shepley, 2005). It could be predicted that completely straight lines or too much curvature would be less preferred in an architectural interior setting (Dazkir, 2009, p. 33). Also other studies show that curvilinear forms of architecture have vital

influence on environment-behaviour in terms of promoting communication, encouraging movement, lifting the spirit, aiding orientation, changing perception, enhancing social experience, increasing pleasure, supporting the sense of community, relieving sense of distance and dissolving social boundaries(Adnan & Yunus, 2012).

Totally, studies show that architecture form has some effects on emotional states (Kukhta & Pelevin, 2015). Also, emotion is fundamental in psychological comfort. Sustainable designing neglects emotions in its principles and causes today architecture, especially residential interior to have similar shapes. Hence, it seems that it is vital to study the emotional states of form for creating more sustainable places.

## 2. Materials and methods

### 2.1. Participants

Forty people participated in this pilot study (17 men, 23 women) and the mean age was 24. We referred sample size to Kline (2010) and his studies about minimum sample size (Kline, 2010, p. 12). We used an accidental sampling method to choose participants from architecture students at Iran University of Science and Technology. According to accidental sampling limitations, we cannot generalize the results of this study, and it needs further researches on this topic for generalization. We chose architecture students because they have some basic knowledge about sustainability, and they have the ability to imagine the spaces by watching perspective, plan and section on the visual questionnaire. Participants had a different academic level in architecture field that were a bachelor, master, and Ph.D. students with 53.8, 30.8 and 15.4 percent frequencies respectively. Participants were from different cities in Iran such as Tehran, Shiraz, and Mashhad, that the majority was from Tehran with 62.5 percent frequencies.

### 2.2. Materials and measures

It is a correlation research in Semantic Differential scale. Participants answered to emotional PAD test (Pleasure, Arousal, and Dominance) questionnaire (Russell & Mehrabian, 1977) by using Self-Assessment Manikin (SAM) technique (Fig.1) 9 scales measured between +1 and -1(Bradley & Lang, 1994). Emotional PAD test is one of the main emotional tests for instance feeling that by measuring pleasure, arousal and dominance can evaluate the emotions (Russell & Mehrabian, 1977). The internal consistency (reliability) for the questionnaire was computed by calculating the Cronbach's alpha for 56 items of the questionnaire. The Cronbach alpha was acceptable, being 0.908.

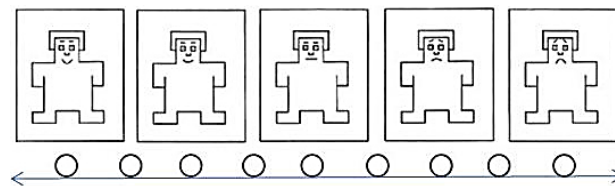


Fig. 1. SAM technique, measuring pleasure (Bradley & Lang, 1994)

We evaluated the house's sustainability by asking participants in 4-points Likert scale to assess the sustainable parameters of the interior space of their house. We used Leadership in Energy and Environmental Design (LEED) parameters to evaluate interior sustainability that has a worldwide certificate for sustainability. According to its indoor environment qualities parameters such as ventilation, daylight, acoustical performance and thermal comfort are important for sustainable interior designing (LEED, 2009, p. 405). To figure out the relation between sustainable parameter, emotions and the effects of forms on emotions we evaluate the Spearman's rank correlation coefficient between sustainability, form and emotion. Then, by using non-verbal questionnaire we found out the total shape of participants' living room interior space and by using SAM technique we studied their emotional state towards their current living room shape. Also, by using another non-verbal questionnaire with SAM technique according to PAD test we evaluated the emotional effects of different forms.

To perform this study we needed to categorize different forms of interior spaces. Ching (2012) categorize interior space to point, line, surface and volume (Ching & Binggeli, 2012, p. 3) that can produce an unlimited number of samples for analyzing.

So, we worked on surfaces according to rectangular and curvature shape to have a smaller number of samples that are more realistic. Fig.2 shows our categorizing that produce 14 different samples.

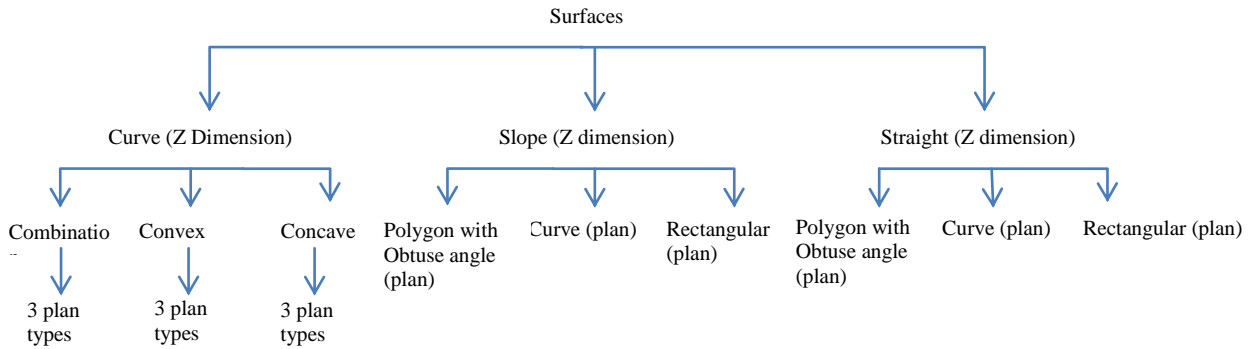


Fig. 2. Categorizing interior forms according to surfaces

### 3. Result

Table.2 shows the One sample t-test result of sustainable parameters in interior spaces, according to participants scores. We used 4 points Likert scale to evaluate the sustainability of the houses. The mean frequencies show that houses have appropriate sustainable conditions based on inhabitant's desire. Fig.3 shows the histogram of sustainability that has a peak in appropriate condition.

Table 2. One sample t-test results for sustainable parameters

	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Mean Difference
Daylight	39	3.0769	.66430	.10637	28.926	38	.000	3.07692
Ventilation	40	2.9000	.67178	.10622	27.303	39	.000	2.90000
Thermal comfort in winter	40	2.2250	.76753	.12136	18.334	39	.000	2.22500
Thermal comfort in summer	40	2.1250	.75744	.11976	17.744	39	.000	2.12500
Acoustical performance	40	2.8500	.83359	.13180	21.623	39	.000	2.85000
Nature relatedness	40	2.7000	.88289	.13960	19.341	39	.000	2.70000

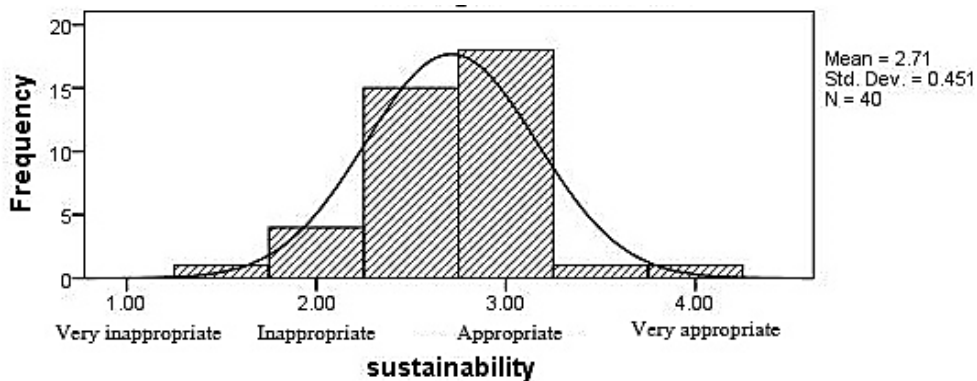


Fig. 3. Sustainability histogram

Among ten different interior space shapes for the living room, two shapes have the major frequencies with 62.5 and 22.5 percent (rows 1& 2 on Table.3 respectively). Table.3 shows the emotional state (pleasure, arousal, and dominance) towards the most frequent shapes of participant's current living rooms. PAD test analysis shows that the first shape emotional state is +P-A-D (A is significant) and the second one is +P+A+D (P & D are significant). According to PAD test analysis +P-A-D feeling means quiet, protected, sleepy and tranquilize, and +P+A+D means admired, bold, creative, powerful and vigorous (Valdez & Mehrabian, 1994). Also, Table.4 shows the one-sample t-test for emotional state towards all forms of current living rooms that is +P-A+D (P & D are significant) which means comfortable, leisurely, relaxed and satisfied (Valdez & Mehrabian, 1994).

In this study, only some parts of PAD test are significant. So, it is only significant that first shape in table.3 is non-arousal and second shape is pleasant with dominance. Also, Table.4 shows a significant result that the total living room shapes were pleasant (p=.001) and non-arousal (p=.022) that would be acceptable because of a long time of living in that place.

Table 3. Emotions towards most frequent living room shapes (\* P<0.05)

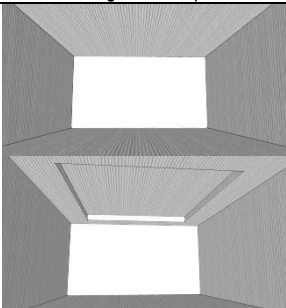
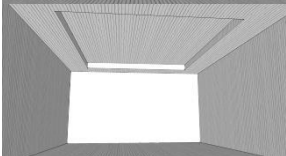
living room shape	PAD	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Mean Difference
	Pleasure	.1700	.41908	.08382	2.028	24	.054	.17000
	Arousal	-.3100	.39713	.07943	-3.903	24	.001*	-.31000
	Dominance	-.0800	.43732	.08746	-.915	24	.369	-.08000
	Pleasure	.4722	.15023	.05008	9.430	8	.000*	.47222
	Arousal	.0556	.42898	.14299	.389	8	.708	.05556
	Dominance	.2222	.26352	.08784	2.530	8	.035*	.22222

Table 4. Emotions (pleasure, arousal & dominance) towards all form of current living rooms (\* P<0.05)

	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
							Lower	Upper
pleasure	.2563	.42925	3.776	39	.001*	.25625	.1190	.3935
arousal	-.1750	.46410	-2.385	39	.022*	-.17500	-.3234	-.0266
dominance	.0500	.42817	.739	39	.465	.05000	-.0869	.1869

Table.2 and Fig.3 illustrate that living rooms have an acceptable level of sustainability. Also, Table.4 shows inhabitant's emotional state towards their living room shapes. So, we can examine our hypothesis about any relation between sustainability and emotional state of inhabitants by using Spearman's rank correlation coefficient. Table.5 shows the correlation results that among all sustainable parameters only daylight and nature relatedness have a significant correlation with pleasure and arousal. Also, total sustainability has a significant correlation with pleasure. Besides, the living room shape has a significant correlation with pleasure, arousal, and dominance that shows the strong effect of forms on inhabitant's emotional state. Table 5 illustrates the weak relation between current sustainable parameters and emotions.

Table 5. Spearman's rank correlation coefficient (\*Correlation is significant:0.05 level (2-tailed).\*\* Correlation is significant:0.01 level (2-tailed))

		pleasure	arousal	dominance
Daylight	Correlation Coefficient, (Sig. (2-tailed))	.413**, (.009)	-.010, (.950)	.117, (.479)
	N	39	39	39
Nature relatedness	Correlation Coefficient, (Sig. (2-tailed))	.323*, (.042)	.388*, (.013)	.075, (.645)
	N	40	40	40
living room shape	Correlation Coefficient, (Sig. (2-tailed))	.341*, (.031)	.351*, (.026)	.355*, (.024)
	N	40	40	40
Total sustainability	Correlation Coefficient, (Sig. (2-tailed))	.334*, (.035)	.116, (.474)	.194, (.229)
	N	40	40	40

Table.5 shows the correlation between forms and emotional state. Also, tables 3&4 illustrate the participant's feeling towards their living room. So, we can study different forms to figure out which forms improve the emotional state to use them in sustainable designing.

Table 6. PAD test for different shapes (\*Sig. (2-tailed) <0.05)

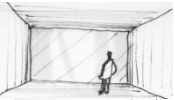

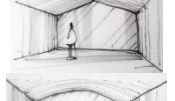

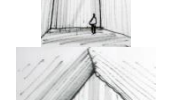

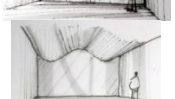

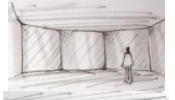


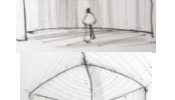


		pleasure	arousal	dominance	Total emotion	shape
N Valid, (Missing)		40, (0)	40, (0)	40, (0)		
1	Mean, (Std. Deviation)	-1.063, (.45954)	-4.188, (.47159)	-.2313, (.49156)	-P-A*-D*	
	t, (Sig. (2-tailed))	-1.462, (.152)	-5.616, (.000*)	-2.975, (.005*)	Bored	
2	Mean, (Std. Deviation)	-.2188, (.46059)	-.1375, (.51872)	-.2000, (.46754)	-P*-A-D*	
	t, (Sig. (2-tailed))	-3.004, (.005*)	-1.676, (.102)	-2.705, (.010*)	Bored	
3	Mean, (Std. Deviation)	-.0813, (.39786)	-.1250, (.47027)	-.1188, (.50633)	-P-A-D	
	t, (Sig. (2-tailed))	-1.292, (.204)	-1.681, (.101)	-1.483, (.146)	Bored	
4	Mean, (Std. Deviation)	.1438, (.54856)	-.0438, (.46989)	.0938, (.50220)	+P-A+D	
	t, (Sig. (2-tailed))	1.657, (.105)	-.589, (.559)	1.181, (.245)	Comfortable	
5	Mean, (Std. Deviation)	-.3625, (.48354)	.0375, (.50176)	.0313, (.63848)	-P*+A+D	
	t, (Sig. (2-tailed))	-4.741, (.000*)	.473, (.639)	.310, (.759)	Cruel	
6	Mean, (Std. Deviation)	-.4000, (.54243)	.1375, (.70245)	-.0688, (.65776)	-P*+A-D	
	t, (Sig. (2-tailed))	-4.664, (.000*)	1.238, (.223)	-.661, (.512)	Distressed	
7	Mean, (Std. Deviation)	-.2625, (.47687)	-.0313, (.53765)	-.1000, (.52745)	-P*-A-D	
	t, (Sig. (2-tailed))	-3.481, (.001*)	-.368, (.715)	-1.199, (.238)	Bored	
8	Mean, (Std. Deviation)	-.0813, (.64148)	.1438, (.61729)	.0250, (.54243)	-P+A+D	
	t, (Sig. (2-tailed))	-.801, (.428)	1.473, (.149)	.291, (.772)	Cruel	
9	Mean, (Std. Deviation)	-.2750, (.51515)	-.1688, (.50124)	-.2063, (.52467)	-P*-A*-D*	
	t, (Sig. (2-tailed))	-3.376, (.002*)	-2.129, (.040*)	-2.486, (.017*)	Bored*	
10	Mean, (Std. Deviation)	-.0688, (.59911)	.0375, (.54758)	-.0625, (.56259)	-P+A-D	
	t, (Sig. (2-tailed))	-.726, (.472)	.433, (.667)	-.703, (.486)	Distressed	
11	Mean, (Std. Deviation)	.1625, (.63939)	.1750, (.48437)	.2375, (.53394)	+P+A*+D*	
	t, (Sig. (2-tailed))	1.607, (.116)	2.285, (.028*)	2.813, (.008*)	Admired	
12	Mean, (Std. Deviation)	-.3688, (.48697)	-.0313, (.47430)	-.1625, (.53274)	-P*-A-D	
	t, (Sig. (2-tailed))	-4.789, (.000*)	-.417, (.679)	-1.929, (.061)	Bored	
13	Mean, (Std. Deviation)	-.0705, (.49321)	.2375, (.49013)	.0000, (.51887)	-P+A+D	
	t, (Sig. (2-tailed))	-.893, (.378)	3.065, (.004)	.000, (1.000)	Cruel	
14	Mean, (Std. Deviation)	-.1688, (.56723)	-.1563, (.56808)	-.0125, (.53694)	-P-A-D	
	t, (Sig. (2-tailed))	-1.882, (.067)	-1.740, (.090)	-.147, (.884)	Bored	

Table.6 shows the PAD test results for 14 different shapes that we've created (Fig.2). According to a limited number of participants only some parts of PAD test were significant, for instance, shape number 9 is significantly boring, and number 2 has unpleasant and submissiveness feeling.

#### 4. Discussion

Results show the significant correlation between sustainable interior space form and inhabitant's emotion. In this study participants were from different cities in Iran but the results show no differences in their house's interior space form. We've discussed that Iranian traditional architecture had different shapes from inside and outside of the houses according to climate and sustainability (Table.1). So it shows that these days' architects do not pay that much attention to the forms. Although, results show (Table 2 & Fig 3) that the level of sustainability is acceptable, the emotional state is not appropriate (tables 3&4). We show that interior space form has some effects on emotions while sustainable parameters do not have enough correlation with emotional states (Table.5). It seems that today sustainable designing becomes emotionless by paying too much attention to climate comfort and forget psychological comfort. Also, on the surface there is a conflict between results of Table 3 & 6. Both tables have the same interior form with different PAD results. This conflict can be as a result of participant's long time of living in their current living room and used to living in it with good memories.

We try to evaluate different forms in interior spaces by using PAD test (Table.6). Although there are some significant results that prove previous studies such as; rectangular shapes are unpleasant (table.6, shapes number 2& 5) but showing complete significant effects of different forms on emotional state needs further researches.

#### 5. Conclusion

This study tries to link the basic architectural design parameters such as a form with emotional states towards sustainability. Sustainable designing is mostly focused on climate comfort (Gifford, 2007), and this tend to neglect of design parameters such as form and their effects on psychological comfort. Although there are some researches about the effects of form on emotional states and psychological comfort (Baggs & Baggs, 2004), this topic needs more scientific studies according to sustainability. This pilot study shows the importance of considering psychological factors in sustainable designing. It illustrates that aesthetical and functional considering of different forms in sustainable interior designing can improve emotional states of inhabitants. Our results suggest forms as an influential factor in creating and improving sustainable conditions. According to a limitation in our sample size and method further experimentation is necessary to more definitively determine the effects of the interior form on emotional state in sustainable places and to consider form as a parameter in sustainable designing. Further researches can be specifically done on how to improve interior form according to sustainable designing.

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