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THE IMPACT OF SUSTAINABILITY FACTORS ON THE USABILITY OF RESIDENTIAL SPACES

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ABSTRACT

Usability studies are a cultural phenomenon to understand user's experience. It is a part of human behavior activities to value the user's satisfaction. Social sustainability has a strong relationship with ecological and economic conditions of the society, improving the quality of life within urban communities.

Recently Kurdistan region witnessed rapid developments which led to expanding of urbanization and increasing housing complexes around main cities. These complexes have been applied without any consideration to the social sustainability aspects. This study objective is to evaluate the impact of social sustainability factors on the usability of residential spaces through a detailed questionnaire in order to improve previous suggested models.

This study investigates the significant correlation between factors affecting the usability of residential spaces and to predicate the usability of residential spaces from independent variables of social sustainability, which includes responsiveness to social needs, quality of life, comfort and wellbeing, spatial organization, social interaction, and flexibility. In view of that; correlation analysis (Pearson Product Moment Correlation Coefficient Test) was used to explore the relationships among the variables as well as to describe the strength and direction of the liner relationship between variables. Moreover, the multiple regression analysis was conducted to formulate an equation that represent the best prediction of the usability of residential spaces from several independent variables of social sustainability. Based on the hypotheses testing, this study reveals a positive association between social sustainability factors and the usability of house space. The results concluded that "flexibility", "social interaction", "responsiveness to social need" are the significant factors that have direct impact on the usability of house space.

1. INTRODUCTION

The concept of usability has been presented throughout the history by different classifications such as functional, technical, aesthetic and economic architectural qualities. According to ISO 9241-

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11, usability means the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use[1].

On the other hand, sustainability is an important issue to consider in design, not only due to environmental concerns but also due to economic and social matters, promoting architectural quality and economic advantages [2]. Among the three stated pillars, social aspect of sustainability is the least studied and, only has been seriously considered after the year 2000. Social and cultural sustainability is about combining the design of the physical environment (spatial layout and form) with the social needs of users[3]. In other words, social sustainability means satisfaction of basic human needs, continuation of culture, well-being, improvement and maintenance of current and future well-being and improvement of quality of life by reducing social inequality [4-5-6]. Hence, among different approaches, the approach of social sustainability was selected to be as a factor which respects the residents' culture, social, models and values, and people's belief and traditions and leads to residents' satisfaction, sense of belonging, security, social order and eventually social interactions [7].

Growth population and expanding of urbanization will continue increasing the buildings construction. In the same context, the needs for the safe and good life of future generations are also important. To reach this goal there is vital requirement to control urban planning, design and construction [4-8]. The architecture has the power to change the society in a positive way through better forms of productions related to social quality, especially in residential areas. Thus, this livable future can be formed through a radical awakens in terms of social sustainability[2]. Housing is more than a place that solves basic human needs such as sleeping, eating etc. It is a place that enhances our lifestyle [9- 2-10-8].

In the age of globalization and continuous urbanization, architects have a greater responsibility to design residential buildings with comfortable and sustainable environments. However, sustainable solutions should not concern themselves only with utilizing technology, but also with creating interactions amongst a community's social, cultural, historical, and environmental aspects [3]. This rapid change can be perceived in social life, structures and cities. Technology has started to control people and this has resulted in an increasing imbalance between nature, human and technology. Today, there are significant problems confronting the building sector, such as globalization, industrialization, the imbalance between nature and humanity. These problems determine the quality of life that will have in the future.

1.1 Usability Concept

The study of usability emerged from a diverse field and based on different perspectives, it was first developed in the 1950s in which applied widely in Information Communication Technology. However, the usability research in built environment is associated with the International Council for Research and Innovation in Building and Construction. The CIB group is established to apply usability concepts and provide a better understanding of the user experience in buildings and workplaces. Usability is determined by three key factors: [10]

- Effectiveness – whether users can achieve what they want to do with the space.
- Efficiency – how long it takes them to achieve it.
- Satisfaction – their feelings and attitude towards the product.

In the field of Architecture, the usability concept has in principle been well known for centuries. It was mentioned by Vitruvius in his book De architectura, as he clarified that there were three principles of good architecture: Firmitas, Utilitas and Venustatis. For Vitruvius Utility should be useful and function well [11].

Usability is one of the most important, but most often neglected aspects of building performance. During the last 10 years there has been a new development of research in usability of buildings and workplaces. Recently researchers have identified additional key concepts to usability: Context, culture, situation and experience. Understanding those might be achieved by involving users [12]. The usability concept is usually known and often translated as functionality. However, some researchers prefer to make a distinction between functionality and usability [14-11-13], where functionality in the building industry is objectively measurable, while usability introduces the subjective views of the users. Consequently, usability can be assessed differently by different groups of users. Furthermore, researchers had suggested that usability can be considered differently depends on the context, culture, situation and experience [13].

1.2 PREVIOUS MODELS ABOUT USABILITY AND SOCIAL SUSTAINABILITY IN ARCHITECTURE

Social sustainability has a strong relationship with ecological and economic sustainability of the society according to the established principles of sustainability. This relationship is important in the process of improving the quality of life within urban communities. Today, there are significant problems confronting the building sector, such as globalization, industrialization, the imbalance between nature and humanity. These problems determine the quality of life we will have in the future.

Bittencourt *et al*. [11] suggested a model for usability which include following categories: Accessibility, Readability, Orient ability, Safety, Environmental comfort, and Functionality. The study shed the light on definitions and principles of different knowledge areas regarding the concept of usability in Architecture. Moreover, the suggested model categorizes the key factors that should be considered in the design of architectural spaces, and explain the relationship between users' needs and their satisfaction as shown in Figure 1.

Figure 1: Bittencourt's model of Usability.[11]

Hatipoğlu [2] presented another model which focused on the social sustainability within architecture quality in residential sectors. Several indicators of social sustainability were identified like (Needs-oriented design and participation, Accessibility and circulation, Efficiency of planning, Flexibility, Safety, Health, well-being and comfort, Common rooms and facilities, Open spaces,

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Children´s playground, Proportion of buildings, diversity of living units, Storage, parking and waste services). The model applied on two buildings have different concepts but similar constructions and seem in harmony without copying one another. The result showed that one of the buildings "demonstrates a successful design and practice process, in terms of social quality and sustainability and housing quality while the other is not. Furthermore, the study provided a guideline for developing housing projects towards social quality and sustainability [2].

In another study that conducted by [14] a model includes factors affecting social sustainability in architecture is established Figure 2. The study was based on the perspective of the professional community of architects and urban developers, in which their analysis can help to extract the effective indicators of social sustainability in architecture. Therefore, the social sustainability indicators in architecture can include social security and trust, quality of life, social participation, social interactions, architectural identity in accordance with popular beliefsand finally, flexibility. The study summerized that the most effective indicaters that affecting social sustanability are Quality of life and social interactions.

Therefore, with increasing social interaction, the citizen satisfaction can be significantly increased by enhancing the sense of place through the three sub-indicators of "place attachment belonging to place and commitment to place", which can be particularly considered by architectural designers and urban developers [14].

Figure 2: Moztarzadeh 's Model about factors affecting social sustainability. [14]

In Eriksson's model about social sustaniabilty,four dimenssions were proposed which are : equity, awareness of sustainability, participation and social cohesion constitute .The study reveald that equity dimension means that each resident have a well functioning living space, adaptable to different life phases. The study concluded that flexibility is an effective factor of social sustainability in process of residential design which can provide a larger range of usable space for diffrent users. It is a factore that act in response to useres needs and make adaptaion to their demographic changes. The research method has been based on qualitative research with observed studies in order to develop knowledge of how residential design relates to social sustainability and to find a working model promoting the social sustainability aspects within the design practice with residential floor plans to promote a future sustainable housing design [15].

Similarly, Capolongo in 2016 conducted a research to examine social sustainability issues as

shown in Figure 3 through a tool which evaluates users' perception from the quality and well-being perspective. The study presented a hierarchical structure composed of a criteria and indicators system which is organized through calculated by using the Analytic Network Process. The output of study was the definition of a tool which evaluates how humanization, comfort and distribution criteria can affect the social sustainability of a building. The model's first parameter: humanization have four indicators includes safety and security, the social aspect, well-being, and health promotion, comfort includes day lighting, social thermal comfort, and acoustic. Finally, an indicator of distribution contain access and paths, hospitalization blocks, space flexibility, and spatial organization[16] .

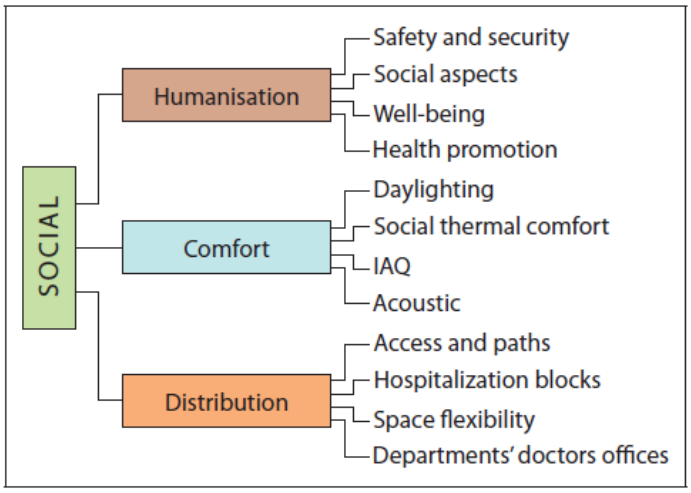

Figure 3: Capolongo's Model [16].

Furthermore, Ahmed assessed another model that structured a framework which include eight main principles for socio-cultural sustainability into: responsiveness to social needs, responsive to cultural values, quality of life, adaptability, safety, security, participation, and accessibility (inclusive/universal design). The study revealed that four out of the eight principles of the socio-cultural sustainability in houses have been significantly achieved. These principles are: 'Responsiveness to social needs', 'Responsiveness to cultural needs', 'Adaptability' and 'Accessibility'. Two other principles have been found to be partially achieved: the 'Quality of life' and 'Security'. The two remaining principles, namely, 'Safety' and 'Participation' have been found to be poorly achieved [17].

Another study that conducted by, Al-Jokhadar&Jabi, aimed to benefit from potentials of such horizontal clusters for generating socially-sustainable tall residential buildings that trace the cultural values of the society. Spatial analysis of various traditional neighborhoods was adopted as a rigorous method for understanding the layout complexity and discovering logical topologies that have social or experiential significance. The study relayed on a model which include five variables: (1) security; (2) social interaction; (3) crowding; (4) visual privacy; and (5) Accessibility, spatial organization, Safety, and Security. The study concluded that social sustainability can be carried out through a comprehensive process of spatial qualities that influence the social life of users[3].

Based on the above-mentioned models, the most influence factors on the social sustainability show in Figure 4 can be specified as follow: (Responsiveness to social needs, Quality of life –comfort and wellbeing, Spatial organization, Social interaction, and Flexibility).

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Figure 4: Social Sustainability Parameters.

2. METHODOLOGY

Using survey as a flexible research approach a comprehensive questionnaire have been applied as a tool for data collection. The aim of this study is to investigate the significant correlation between factors affecting the usability of residential spaces in addition to test the relationship between variables to formulate an equation that represent the best prediction of the usability of house spaces from five independent variables of social sustainability. The design of the questionnaire is relying on the factors that extracted from previous literature studies. Different types of questions are used for different purposes and different types of data are used for analyses. In view of that; Correlation analysis (Pearson Product Moment Correlation Coefficient Test) is used to explore the relationships between variables then multiple regression analysis is applied to predicate the relationship between social sustainability variables and usability of residential spaces.

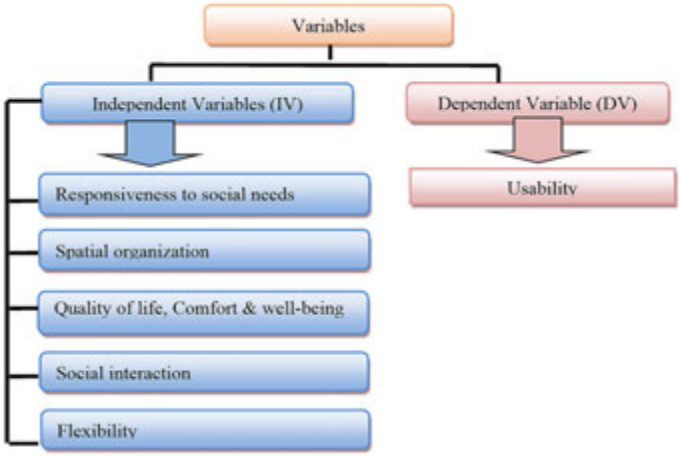

Figure 5: Theoretical Model of social sustainability (IV) vs. usability concept (DV).

In this study, a model that include five independent variables (responsiveness to social need, quality of life –comfort and wellbeing, spatial organization, social interaction, and flexibility) is designed to cover the dimension of the social sustainability and one dependent factor (usability) to indicate the usability of residential spaces. The proposed theoretical model Table 1 includes five independent variables and one dependent variable structured to develop the questionnaire. The measurements of factors were based on the adaptation of available literature. The details of factors measurements are discussed in the following as illustrated in Figure 5.

Table 1: Sub factors summery of IV and DV Variables.

N	Factors	Sub Factors
1	Responsiveness of social needs	Geometry of space
		Accessibility
		Privacy
		Outdoor activities relation with indoor
2	Spatial organization	Layout of building
		Relation between spaces
		Geometry of external façade
3	Quality of life, comfort & wellbeing	Health
		Sense of safety
		Quality of infrastructure
		Indoor air quality
		Aesthetic
4	Social interaction	Gathering space
		Separation between male and female
5	Flexibility	Modification of furniture
		Size of spaces
		Size of spaces
6	Usability	Satisfaction
		Efficiency
		Effectiveness

2.1 DATA COLLECTION

To certify the use of a questionnaire and to study any confusing questions a pilot study of survey was carried out on 25 June 2018 to pre-test the questionnaire before the data collection. Based on the pilot survey, the advanced format of this questionnaire was designed to reduce measurement error and improve the response rate. Thus, the simplicity of use, clarity of statements, and expanding motivation were the essential features of the final format of the study questionnaire [19-20].

The questionnaires were distributed randomly to architects who working in different places, such as private sector, governmental sector including (Investment border, Erbil municipality, Ministry of works & construction), and teaching staff of college of engineering at University of Salahaddin /who they have a different academic qualification. Out of 90 questioners 75 were returned back after three weeks and 15 were not responded. From 75 responded questioners only 50 questioners considered, 25 questioners discarded because of the missing answers.

The Statistical Package for the Social Sciences (SPSS) software was used to provide the statistical analysis of data and give details for in-depth data access and preparation. The data were analyzed in three ways to fulfill the research objectives and answer the research questions, which are :(1) descriptive statistics, (2) correlation, and (3) regression analyzes.

3. RESULTS

The statistical results will be distributed into three sections as follow-

3.1 DESCRIPTIVE ANALYSIS OF THE DEPENDENT AND INDEPENDENT VARIABLES

The aim of the descriptive analysis among the factors is to examine the relation between

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respondents' characteristics and their opinions toward the social sustainability factors.

Accordingly, following statistical tests were conducted in which the maximum mean among the parameters was for responsiveness to social need parameters with 4.18 and 0.85 for standard deviation (SD). While the minimum range of mean was for social interaction with 3.45 and 1.11 for standard deviation. Therefore, the means of spatial organization and flexibility were near to minimum with 3.47, 3.80 and 1.12 ,0.92 for standard deviation respectively. Means of quality of life, comfort and well-being, and usability of space were 4.12, 4.09 with 0.83, 0.78 for standard deviation respectively as shown in Table 2.

Table 2: Result (Mean, Standard deviation and %Agree) of factors.

Factors	Mean	Standard Deviation	Agree%
Responsiveness to social need	4.18	0.85	83.65
Spatial Organization	3.47	1.12	69.30
Quality of life, Comfort and Well being	4.12	0.83	82.35
Social Interaction	3.45	1.11	68.90
Flexibility	3.80	0.92	75.95
Usability of Space	4.09	0.78	81.75

3.2 CORRELATION STATISTIC

The aim of correlating analysis is to assess the relationships of social sustainability factors (Responsiveness to social need, Spatial organization, Quality of life, comfort & wellbeing, Social Interaction, and Flexibility) and the usability of house space. Thus, to define the significant correlation between dependent variables and independent variables, and to test the hypothesis.

In view of that; correlation analysis (Pearson Product Moment Correlation Coefficient Test) was used to explore the relationships among the variables as well as to describe the strength and direction of the liner relationship between variables. Every independent variable is correlated to a dependent variable. Correlation coefficients can range from -1.00 to +1.00. The value of -1.00 represents a perfect negative correlation whereas a value of +1.00 represents a perfect positive correlation. A value of 0.00 represents a lack of correlation[20].

The correlation procedure was subjected to two-tailed test of statistical significant from 0.05to 0.01. The data in Table 3 is clarifying the result of correlation analysis of this study. The purpose of this analysis is to determine the significant correlation between the independent variables (social sustainability) and the dependent variable (usability of house space), following the hypothesis were formulated.

Table 3: Summary of Correlation Analyses between Dependent and Independent Variables.

S	Hypothesis	r	p	Result
H1	There is a positive relation between responsiveness to social need parameter and the Usability of house space.	0.39	p < 0.01	Significant
H2	There is a positive relation between spatial organization parameter and the Usability of house space.	0.174	P >0.22	Insignificant
H3	There is a positive relation between quality of life, comfort and wellbeing parameter and the usability of house space.	0.255	p >0.07	Insignificant
H4	There is a positive relation between social interaction parameter and the usability of house space.	0.398	p < 0.01	Significant
H5	There is a positive relation between flexibility parameter and the usability of house space.	0.382	p < 0.01	Significant

Based on correlation analyses in Table 3, More than half of social sustainability parameters (responsiveness to social needs, social interaction, and flexibility) are positively correlates to the usability of house space, while spatial organization and quality of life, comfort and well-being parameters are correlates in a very weak relation to the study's main dependent variable.

3.3 MULTIPLE REGRESSION ANALYSIS

The general purpose of multiple regressions in this study is to test the relationship between independent variables (social sustainability factors) and a dependent variable (usability of space). Accordingly, an equation will represent the best prediction of the usability of house space from independent variables of social sustainability.

The suggested model was presented by determining the combined effect of the independent variables namely, (1) responsiveness of social need, (2) spatial organization, (3) quality of life, comfort and wellbeing, (4) social interaction, and (5) flexibility regarding the overall perceived of the usability of house spaces. The model is formulated as follow:

$$\text{Usability} = \beta + \beta 1 + \beta 2 + \beta 3 + \beta 4 + \beta 5 \quad (1)$$

Where, Usability = The usability of house space
β = constant of beta value
β1= Beta value of Responsiveness to Social need
β2= Beta value of Spatial Organization
β3= Beta value of Quality of life, Comfort & Wellbeing
β4= Beta value of Social Interaction
β5= Beta value of Flexibility

The multi regression of the model is summarized in (Table 4), while the R2 for this model is 0.324, representing that the house social sustainability factors clarified 32.4% of the variation toward the usability of house space.

In general, the responsiveness of social need parameter (β =0.319, p = 0.026), the social interaction parameters (β =0.259, p=0.023), and the flexibility parameter (β =0.483, p =0.003) have significant positive relations with the usability of house spaces. The result shows that flexibility parameter is most significant on the usability of house space because every unit of the change in this parameter is correlated with a 0.483 change in the usability of house space. While each of the spatial organization (β =0.163, p=0.871) and the quality of life, comfort and well-being (β =0.049, p=0.814) have non-significant relation with usability of space.

Table 4: Summary of Multiple Regressions Analysis of independent variables.

	β	t	p
Constant	-0.116	0.124	0.902
Responsiveness to social need	0.319	2.306	0.026*
Spatial Organization	-0.017	0.163	0.871
Quality of life, Comfort and Well being	0.049	0.237	0.814
Social Interaction	0.259	2.358	0.023*
Flexibility	0.483	3.196	0.003**
R^2=0.324 F = 5.690 Significance F=0.000**			

* Significant at the level 0.01 (Sig ≤0.05), n=50
** High significant at the level 0.01 (Sig ≤0.01), n=50

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The beta values represent the unique contribution of each variable formulate in the equation (1) to obtain a final equation of the model which is as follow:

Usability = -0.116 + 0.319 Responsiveness to social need + -0.017 Spatial Organization + 0.049 Quality of life, Comfort and Well-being + 0.259 Social Interaction + 0.483 Flexibility (2)

4. CONCLUSION

Social and cultural sustainability is about combining the design of the physical environment (spatial layout and form) with the social needs of users. In other words, social sustainability means satisfaction of basic human needs, continuation of culture, well-being, improvement and maintenance of current and future well-being and improvement of quality of life. While, Usability presents the interactions between user and object. This study discovers the positive association between social sustainability factors and usability of residential spaces in investment projects in Erbil city. A theoretical framework including five parameters (Responsiveness to social needs, Quality of life, Spatial organization, Social interaction, and Flexibility) has been derived from previous suggested models. Through statistical analyses, the Pearson product-moment coefficient correlation results showed that there is a significant positive relation between responsiveness to social needs usability of house space, while the correlation coefficient is $r = 0.39$ at $p < 0.01$, similarly with social interaction, and flexibility that value correlation coefficient are $r=0.174$ at $p=0.22$ and $r =0.382$ at $p<0.01$ in sequence but spatial organization and the quality of life factors correlate in a very weak relation to the study's main dependent variable (usability).

Alternatively, the multiple regressions results indicate that the house social sustainability factors clarified 32.4% of the variation toward the usability of house space, and shows that the responsiveness of social need parameter ($\beta =0.319$, $p = 0.026$), the social interaction parameters ($\beta =0.259$, $p=0.023$), and the flexibility parameter ($\beta =0.483$, $p =0.003$) have significant positive relations with the usability of house space. While each of the spatial organization ($\beta =0.163$, $p=0.871$) and the quality of life, comfort, and well-being ($\beta =0.049$, $p=0.814$) have non-significant relation with the usability of house space.

The findings irrefutably confirmed that the usability of residential space is most significantly impacted by the flexibility factor. Subsequent factors, in a slightly less impactful margin, are responsiveness to social need followed by social interaction. These results are based on the statistical equation of multi regression analyses. The result of the multiple regression analysis representing

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