Contents lists available at http://qu.edu.iq

Al-Qadisiyah Journal for Engineering Sciences

Journal homepage: https://qjes.qu.edu.iq

Post occupancy evaluation of private open spaces in dwelling units in single family investment housing projects in Erbil city

***Mand Ibrahim Aziz**, Shayan Shero Ahmed*

Department of Architecture Engineering, College of Engineering, Salahaddin University, Erbil, Kurdistan Region, Iraq.

ARTICLE INFO

Article history:
Received 00 January 0000
Received in revised form 00 February 0000
Accepted 00 May 0000

Keywords:
POE
Private open spaces
Dwelling unit
Household satisfaction
Investment projects

ABSTRACT

Due to urbanization, it has been found that public open spaces shared in the city is not maintained in many cases, as new investments are trying to get use of the land to construct more buildings, same tendency has been noticed with residential estates. The treatment for the shortages of public open spaces can be achieved by providing sufficient private open spaces in housing estates. Furthermore, it is important for the designers to consider the dwelling layout to provide the best environment for the residents; this will be through maintaining high level of household satisfaction. One main element of household satisfaction is open spaces. In this research paper, private open space assessments in 4 investment projects with 98 samples were approached in Erbil. To investigate and examine how the exterior environment of the dwellings affects the residents' satisfaction, based on plot size and number of bedrooms that been performed by survey on selected projects through documentation survey and questionnaire. The evaluation had been performed through two stages, first the technical assessment according to Iraqi standards, and second resident's response regarding satisfaction level. The research objectives obtained using SPSS software, through using descriptive statistics, correlation and regression analysis, the results of the research discovered that all the projects except Minara B were in the range of Iraqi standards, slightly above minimum level. Moreover, the level of overall satisfaction with these projects started from neutral to slightly satisfied, but residents have responded that they need some more parts of private open spaces.

1. Introduction

In general, when the designers of a residential project design the houses, they take user's needs into consideration, but that is only implied for the building part of residential units, despite that, while planning open space areas, they practically neglect residents' point of view. In addition, due to urbanization, the space specified for open space in those projects has decreased because they want to have as much closed space as possible. As Oktay says, Open areas around residences are extremely important for developing and/or boosting social interaction among inhabitants as well as enriching daily living in individual units - especially in hot climates, (Derya Oktay, 2010). Furthermore, the success of a building or a project does not only depend on the interior design but according to some studies the space around and between the buildings has more effect on the success of a project. While designing open space the residents' requirement, culture, and lifestyle should be considered; all these factors affect people's satisfaction about a project. However Open space is a significant part in every residential area, because Residential open space as a housing setting is related to the form, shape, plan, structure, and functions of the built

* *Corresponding author.*
E-mail address: *mandibrahimaziz@gmail.com* (*Mand Ibrahim Aziz*)

https://doi.org/10.30772/qjes.2023.141738.1011

environment and has a valuable effect on the quality of the residential environment, (Trancik 1986, Gehl 2011, Pakzad 2007).

Open space can be categorized into four groups: public, semipublic, semipublic-semiprivate, and private spaces, (Azad, Morinaga, and Kobayashi, 2018). In this paper, private open spaces were evaluated, and the main defined parts are: Balcony, Private Garden, Garage or Car Parking, and Outdoor Circulation. These areas are important for the residents, and Principles of private open spaces ensures that the dwelling has an outdoor living area that is an extension of the indoor living area. It must be large enough to be usable, (Environmental and Sustainable Development, 2013). In addition, open space is a very important part of the design of a dwelling because it affects satisfaction positively, and it provides place for the residents to relax, play, and enjoy nature.

1.1. Definition terms

1.1.1 Post Occupancy Evaluation (POE)

Is the most widely used method of building assessment and planning among building inspectors and planners, The term 'post occupancy' refers to a building that has previously been occupied and is available for inspection. (Preiser et al., 1988; Preiser, 1995, 2003; Preiser at al., 2005), As a result, assessment is utilized to collect feedback from building users and specialists in order to enhance the building's condition. According to Fronczek-Munter (2017), traditional POEs typically focus on technical building performance. Jensen (2012), on the other hand, proposes that combining technical and user-oriented building evaluation performance could result in significant improvements in building performance

1.1.2. Open Space

Open space is any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public. Open space provides recreational areas for residents and helps to enhance the beauty and environmental quality of neighborhoods, (Wang et, al. 2019). However, since it is believed that, plazas, playing fields and urban squares are contributing to improving public health and environmental quality of the neighborhood, they are often included in the definition as well, (Olsson2012). It can even be thought of as extending to include all significant outdoor spaces, which fall within the influence of the urban area (Stiles, 2011).

1.1.3. Dwelling Unit

A dwelling unit is a building or a portion of construction that is used by one person to maintain a household or by two or more individuals to maintain a joint household as their place of residence, sleeping spaces, or other living arrangements. (Stat. 2007).

1.1.4. Household Satisfaction

The household satisfaction index is not only an important measurement index of household living quality, but also a reflection of the housing industry's economic performance and production effectiveness. (Fengyu, and Lijun, 2011). Housing satisfaction refers to how a customer reacts to the overall components of housing items in response to their expectations. It is also the extent to which residents believe their housing is assisting them in achieving their goals, (Jiboye, 2012).

1.2 Literature Review

Oktay's 2010 research paper is about the usage and meaning of housing's open spaces. The author says that the success of housing does not depend on the interior design only, but it depends more on the spacing between the buildings. Moreover, the designers should consider the users' culture and lifestyle, while designing the open spaces. He discovered that the response from people who were living in flats were more negative in comparison to the house residents. For flats, the private open space comes inform of balconies, so in general their level of satisfaction is found to be lower. Furthermore, the author has shown that garden plays an important role in people's lives and their satisfaction, so it should be considered carefully for the success of the projects. Most people are not satisfied with their open spaces due to poorly designed open space both in flat and house resident.

Azad, Morinaga, and Kobayashi's 2020 research paper talks about the 'effects of housing layout and open space on residential environment'. They identified that urban development has led to decrease in open space, but it is important for designers to consider the layout and take open space into consideration because it is directly related to the residents' satisfaction. As it is mentioned in the article, "Residential open space as a setting of dwelling is related to form, shape, plan, structure, and functions of the built environment and has a positive impact on residential environment quality. (Trancik 1986, Gehl 2011, Pakzad 2007)." (Sepideh Payami Azad, Ryohei Morinaga & Hideki Kobayashi 2018) The open space provides some privacy for the residents to relax, play, enjoy nature, and communicate. Moreover, there are several environmental functions of open space, and those functions are defined as the borders between houses, separating neighborhoods, and allowing entering of fresh air and sunlight. Sarkissian, Bateman and Hurly's 2013 paper is about open space in medium density housing. Private open spaces directly associated with individual house and with individuals' satisfaction. The authors identified that, "Because of the importance of indoor-outdoor connections in a sub-tropical climate, the design, orientation and furnish ability of these spaces are critical to resident satisfaction." (Sarkissian, et, al. 2013). Moreover, they mentioned that beside the public open spaces, there should be private open spaces in the dwellings as shown in **(**Fig.1**)**. In addition, the effects and effect on importance of private open spaces should not be underestimated because it has direct residents' mental and physical health

Figure 1. Private open space: general site overview source (Sarkissian et, al. 2013**)**

According to the authors, there are several aspects for private open spaces, and those aspects are as the following. The direction of the gardens should

not be facing south, and it should not have high walls, so that the plants can grow. In addition, "Avoiding significant overshadowing from adjacent buildings, fencing or trees in designing the development as far as possible" (Sarkissian, et, al. 2013).

Irwin and Bockstael's 2020 paper talks about 'measure and effects of open space on residential property value'. They have found that the effects of open space on land value depends on the size of the neighborhood that is being considered; they say that "within a tenth of a kilometer radius, the proportion of open space has a positive and significant effect on land values, but within a larger than one kilometer buffer has a negative and significant effect." (ELENA G. IRWIN AND NANCY E. BOCKSTAEL, 2020).

Al-Noori's 1987 paper is about 'environmental design evaluation of housing in Baghdad'. She discovered that the satisfaction of residents is directly affected by open space. Moreover, privacy is very important aspect in open space that should be considered by the designers. She mentioned that during the site visits, the number of private gardens surprised her even though it was not been included in the designs. That shows the need for open space by people. The study has showed that more people who were living in flat\s were satisfied with their type of open space with its balcony. Nevertheless, it has been found out that people were using their balconies for other purposes. Meaning it was not the same purpose that the designers have intended. According to the author, "the studies suggested that private open space, whether it is a garden, patio, or balcony, is a highly significant component of the housing environment, which is appreciated and used by the majority of residents for outdoor living and as an extension of the indoor living area, as well as for leisure and hobbies." (Walaa Abdulla Al-Noori, 1987).

Limsombunchai's 2014 paper is about prediction of price of the houses. Open space affects the price of the houses, so it is better for the designers to consider it. According to the research, houses without garden are cheaper than houses with garden. Moreover, garage, which is another type of open space, has also affected the price of the houses. It is not as significant as garden, but it affects people because people are satisfied about their garages. The importance of garage comes when the evaluated house is without a garden. As the author says, "For house without garden, age of house and the number of garages are factors that have strong impact on the house price. Land size for house without garden is less important compared to house with garden. On the other hand, age of the house, the number of bedrooms, the number of garages and amenities around the house areas do impact the house price for the house without garden when compared to the house with garden.

This research paper is concerned with 'planning indicators of open spaces in residential areas. While designing a residential area there are several important factors that should be considered beside interior design and structures, open space should also be considered. As it is mentioned that, "All family dwellings must be provided with space close to the dwelling for the activities of the family. This may be done in one of two ways - either by providing enough Private Open Space around the house to accommodate all the activities as shown in **(**Fig.2**)**, or by providing a Communal Open Space shared between several dwellings to accommodate some of the activities and a small Private Open Space near the dwelling for activities which cannot be accommodated in the Communal Open Space." (Open Space in Residential Areas) open space should be provided for the dwellings to accommodate activities for the residents, and its area should not be less than 50-meter square. It should receive sufficient sunlight and daylight; not be overlooked from other houses, and housing committees should allow it for change, extension and development.

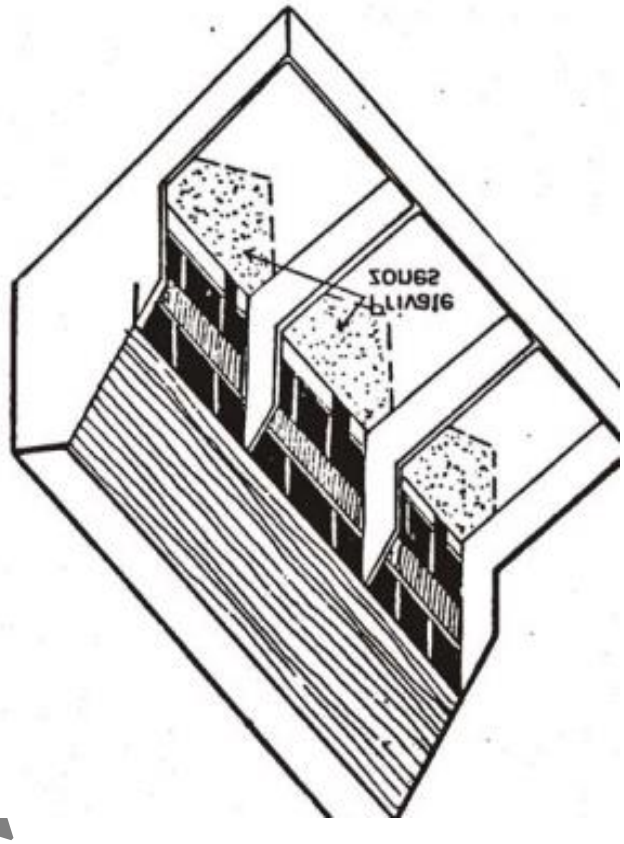

Figure 2. Private open space source (Limsombunchai 2014)

1.3 Research problem

Due to urbanization, investment in residential area has increased, some estates failed to follow standards that guide the designers in a way not to underestimate private open space. In addition, there is not enough control about areas provided for open spaces in both private and public projects, with low commitment to standards by the designers to provide sufficient services for householders. Mainly their satisfaction is ignored when it specifically comes to private open space. There are limited researches about public open spaces, with even less numbers about private open spaces.

1.4 Research objectives

The main aim of this research paper is to investigate private open spaces within dwelling units in Erbil's housing estates, defining its parts, total area, and indication of resident's satisfaction. To focus on value of open spaces that makes designers better consider this subject.

Hence, this study is subjected to achieve finding answers to the stated issues:

- To understand the term and parts of private open space in single-family houses.
- To compare those parts of private open spaces in different dwelling units' types.

Comparing dwellings overall private open spaces with Iraqi standards.

To discover the relation between demographic factors and satisfaction factors of residents in each dwelling units' type.

Discovering the overall household satisfaction about private open spaces in each selected dwelling unit, and factors contributing to this satisfaction

2. Methodology

To attain research, aim and objectives, current study methodology consists of two main parts which are documentation and survey adopting questionnaire:

2.1 Documentation

This stage consists of general information about housing estates to select dwelling units that represent whole housing in Erbil city based on number of bed rooms and plot size of dwellings.

2.1.1 Selecting samples of case studies and data collection

After visiting several projects in Erbil city, four housing projects were chosen as case study based on the ratio of dwellings according to number of bedrooms, and plot size namely, projects “Minara city, Lana city, Italy city, and Hiwa city." As shown in (Table 1**)**. Research classification based on number of bedrooms to connect the private open space parts to the dwelling unit interiors, with the plot area to make comparison with Iraqi standards. Then the sample of questionnaire for each dwelling unit is conducted based on the total number of the houses in each project. As the total sample reached 98 samples for all dwelling units, it satisfies two conditions, first number of cases per each type is to be more than 5 samples, secondly the number of samples per group must be 24 and above for main groups except 3 bedrooms that reached 75% of cases as shown in table 1.
Then the questionnaire conducted to 98 households in all dwelling units through direct interview

Table 1. Classification of dwelling units according to bedrooms and plot size, with Questionnaire sample

Dwelling units	Number of bedrooms	Plot area m^2	Total number of dwelling units	Optimum sample size	Optimum group size
Minara A	2	200	1050	22	22
Lana	3	200	464	10	16
Italy 2	3	200	321	6	
Minara B	4	200	386	8	36
Italy 2	4	240	670	14	
Lana	4	300	55	2	
Italy 2	4	320	569	12	
Hiwa	5	200	444	8	24
Hiwa	5	400	803	16	
Total			4762	98	98

2.1.2 Descriptions of the selected housing investment projects

- Minara city (200 m2): this project is located in Kurdistan Region in Eastern of Erbil city on. It is an investment project which consists of 1436 units with two and four bedrooms; for this research, both units with two and bedrooms has been selected for evaluation and household satisfaction about private open spaces.
- Italy 2 city (200 m2): this project is located in Kurdistan region in Erbil city, on 120m road and Shaqlawa road. It is an investment project, which consists of 1560 houses with different size of the house and number of beds. In this research, paper all different types have been selected which they are 200m2, 240m2 and 320m2 with three and four bedrooms, for evaluation and household satisfaction.
- Hiwa city (200 m2): this project is located in Kurdistan Region in Erbil city on Koya’s road. It is an investment project which consists of 1247 houses, and they are divided into two types 200m2 and 400m2. For this research both types with five bedrooms have been selected for evaluation and household satisfaction.
- Lana city (300 m2): This project is located in Kurdistan Region in Erbil city on Koya’s Road. It is an investment project, which consists of 519 units with two different areas 200m2 and 300m2. In this research, both types have been selected with three and four bedrooms for evaluating household’s satisfaction about private open spaces.

2.2 Questionnaire list

In this part the list of questions about parts of private open space in the dwelling units been prepared. However, the questionnaire was designed using a Likert scale. The questions were written on the questionnaire paper as statements. The statements were represented by five points on the Likert scale, where (5) represents highly satisfied, (4) represents satisfied, (3) represents neutral, (2 represents dissatisfied and (1) represents highly dissatisfied. The research aim, and objectives achieved through five main indicators which they are:

2.2.1 General indicators

Data here refers to the family and private open space parts, and the variables stated in each dwelling including relations between indicators of those variables
.

2.2.2 Specific indicators

Which refer to size, number, and location of each part of private open space in addition to total private open space size.

2.2.3 Derived indicators

Which consists of variables covering Open Space Ratio (OSR) added to percentage of each component.

2.2.4 Household satisfaction indicators

Concerning the private open spaces parts, variables of household satisfaction stated as following:

- Household Satisfaction about size, number, shape, location, level of privacy, ventilation, number of entries, outdoor activities, and accessibility for each type of private open spaces.
- Needs of the households about size of private open spaces parts with
- The overall household satisfaction about each private open space parts. And relating that to the total satisfaction about open spaces.

2.2.5 Needs (demands) indicators

The questionnaire list determined the needs of the residents. To assess this portion, the same Likert scale degrees were employed, including (much smaller, smaller, same, larger, much larger) for each area: garden, garage, balcony, and outdoor circulation.
Then the Result analysis and findings: the general dwelling unit characteristics compared to the Iraqi standards as well as the results of the questionnaire analyzed through SPSS and Excel programs to approach findings.

3. Results and discussions

3.1 General indicators and housing indictors results

First general indictor results: it was discovered that there is differentiation in area of private open spaces in the units, as shown in table 2. In addition to that the total private open space area was found to compare with the Iraqi standards, which is called Plot open space Coverage as shown in table 3.
Due to the number of bedrooms, in some dwelling units such as Italy2 200m2 and Lana there are different sizes in each part of the private open spaces. Even the two units were designed with three bedrooms, but the private open space parts were different. For example, the front garden in Lana 200m2 is 41.15m2, which is bigger than the front garden in Italy2 200m2, which is 19.84m2, as well as the other parts of private open spaces in the same units and other dwelling units with different number of bedrooms. As clarified in **(**Table 2).

Furthermore, due to the plot size area of the dwelling units, the overall private open space was compared to the Iraqi standards. Then it was discovered that all the projects were considered as within standards, except Minara B with 200m2, where the overall private open space parts is 28.9% while corresponding minimum plot open space coverage in Iraqi standard for this plot area is 30%. Furthermore, in some dwelling units ratios exceeds minimum standard area, such as in Hiwa dwelling units type 400m2 and both types of Lana city as shown in (Table 3).

In the second part of the results of general indictors: the relation between general and housing indictors was delt with, classification based on number of bedrooms, indicators included built up area, plot area, family size, size of each private open space item, and total private open space area.
It has been discovered that most of the indictors had significant correlations to other indicators by using SPSS software. The following findings are stated from strong to weak correlations with the support of (Table 4):

- The strongest correlation between indicators is the relation between total private open space area and size of garden, which is 99% followed by size of plot with 95%. Meaning the total private open space area became bigger mainly due to the size of garden and the plot in dwelling units. Outdoor circulation also follows above ones with 90%.
- Medium level of correlations with private open spaces with values of 60% and 57% followed by 42% obtained by number of bedrooms and total built up areas then garage size means some degree of synchronization.
- The family size increase didn't contribute to the open space ratio increase in housing projects in Erbil.

3.2 Household satisfaction results

The results of residents' satisfaction have been achieved based on firstly analysis of Variance ANOVA then regressions of both satisfaction about individual items separately with determinants and overall satisfaction withdeterminants or variables results are supported by (Tables5**)** and **(**Table 6**)**, which are:

- The results of household satisfaction about size, location, number, shape, and other variables of all private open space parts in the dwelling units was discovered. The level of satisfaction is between neutral and satisfied. For example, the households were satisfied about number and location of garden in their dwelling units, while they felt neutral about size and shape of garden, same for other parts of private open space.
- None of open spaces components were evaluated as non-satisfied with or highly satisfied with as averages. Highest value was balcony size and privacy scored both 4.00 while lower satisfaction corresponded to outdoor circulation shape and movement may be due to design partial ignorance
- Garden: the regression model of the garden variables and household satisfaction regarding gardens is significant with strength of 0.48 as stated in table 6, the satisfaction of household regarding garden depends here mainly on size of garden and number of activities carried in.
- Garage: the garage model is acceptable and there is significant relation between household satisfaction and the garage variables. The most effective variable of garage that has direct impact on household satisfaction is number and size of the garage.
- Outdoor circulation: the achieved regression model of satisfaction about outdoor circulation is significant, with strength of 0.67, items contribute in the model are the movement in outdoor spaces the accessibility to outdoor circulation a very slight negative effect of sizes of outdoor circulation exists in model that can be neglected.
- Overall sat. of gardens in D.U. = 0.52 + 0.89 sat. about number + 0.183 sat. about size.
- Overall satisfaction of garage in D.U. = 0.59 + 0.39 sat. about number + 0.28 sat. about size.
- Overall satisfaction about outdoor circulation in D.U. = 0.20 + 0.67 sat. of movement + 0.16 sat. of accessibility - 0.02 sat. of size.
- The second part of the regression is the overall household satisfaction for all private open space areas with overall household satisfaction of each private open space parts, it has been concluded that there is a significant model between them with strength of 0.47, the outdoor circulation discovered as the most important part contributed in the model of the overall house hold satisfaction as shown in (Table 7).

Overall satisfaction about all areas =1.49 + 0.34 the overall sat. about outdoor circulation. In addition to satisfaction of households about each part of private open space; the households' needs or demands for size each of part has been checked to discover future needs by residents. It has been found that the households in selected dwelling units felt neutral about garden and garage size and they wanted them to be larger. While for balcony size, they were satisfied and they recommended larger ones, except for the outdoor circulation's size, they were satisfied, and they wanted them to be with same size as clarified in (Table 8).

Table 2. Area of the Private Open Spaces (P.O.S.) parts in nine selected units based on number of bedrooms

Bedrooms in D.U. / P.O.S. parts	2	3 bedrooms		4 bedrooms				5 bedrooms	
	Minara A	Italy2 200m²	Lana 200m²	Minara B	Italy2 240m²	Lana 300m²	Italy2 320 m²	Hiwa 200m²	Hiwa 400m²
Front Garden size m²	19.80	19.84	41.15	18.00	30.40	82.70	25.23	18.85	50.50
Back and side garden or court size m²	7.15	13.7	9.90	1.50	10.92	6.12	14.00	No	89.44
Total garden area	26.95	33.54	51.05	19.50	41.32	88.82	39.23	18.85	139.94
Garage size m²	25.20	26.52	30.76	19.20	32.00	39.68	32.3	23.1	30
Outdoor circulation size m²	14.4	4.96	4.00	15.3	6.5	No	41.27	23	62.10
Balcony size m²	No	No	No	3.96	No	No	No	No	9.2
Total P.O.S. area m²	66.55	65.02	85.81	57.96	79.82	128.5	112.8	64.95	241.24
P.O.S. ratio P.O.S.R.=OS/LA	33.3%	32.5%	42.9%	28.9%	33.3%	42.8%	35.3%	32.5%	60.0%

Table 3. Overall private open space area in units with Iraqi standards based on plot size area

Dwelling units	Plot size area m²	Private open space ratio %	Min plot open space coverage	Max built coverage %
Minara A	200	33.27	30	70
Italy 2	200	32.51	30	70
Lana 200m²	200	42.90	30	70
Minara B	200	28.90	30	70
Hiwa	200	32.48	30	70
Italy2	240	33.25	30	70
Lana	300	42.38	35	65
Italy2	320	35.25	35	65
Hiwa	400	60.03	35	65

Table 4. Correlation between general indictors and specific indictors

	Corr.	Built U. m²	Plot A. m²	Family size	Garden m²	Garage m²	Out. m²	T.P.O.S.
No. B.R	Pear.	.86	.65	.51	.59	.21	.62	.60
	Sig	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Built U.	Pear.		.72	.50	.52	.47	.60	.57
	Sig		0.00	0.00	0.00	0.00	0.00	0.00
Plot A.	Pear.			.34	.91	.51	.93	.95
	Sig			0.001	0.00	0.00	0.00	0.00
Family	Pear.				.26	.01	.32	.24
	Sig				0.01	0.33	0.001	0.008
Garden	Pear.					.41	.85	.99
	Sig					0.00	0.00	0.00
Garage	Pear.						.25	.42
	Sig						0.014	0.00
Out D.C.	Pear.							.90
	Sig							0.00

Table 5. The level of satisfaction about each type of private open space variables

Private O.S. parts	Variables	N	Mean	satisfaction level
Garden	size	98	3.26	Neutral
	number	98	3.50	Satisfied
	shape	98	3.34	Neutral
	location	98	3.50	Satisfied
	privacy	98	3.60	Satisfied
	as the rest area	98	3.20	Neutral
	number of the	98	3.60	Satisfied
	outdoor activity	98	3.00	Neutral
	Overall satisfaction	98	3.02	Neutral
Garage	size	98	3.18	Neutral
	number	98	3.59	Satisfied
	shape	98	3.50	Satisfied
	location	98	3.10	Neutral
	Accessibility	98	3.60	Satisfied
	Overall satisfaction	98	3.30	Neutral
balcony	size	24	4.00	Satisfied
	functional use	24	3.00	Neutral
	shape	24	3.30	Neutral
	location	24	3.70	Satisfied
	Privacy	24	4.00	Satisfied
	Accessibility	24	3.10	Neutral
	Overall satisfaction	24	3.20	Neutral
outdoor circulation	size	82	3.70	Satisfied
	functional use	82	3.20	Neutral
	shape	82	2.80	Neutral
	location	82	3.10	Neutral
	Accessibility	82	2.90	Neutral
	Movement	82	2.80	Neutral
	Overall satisfaction	82	3.02	Neutral

Table 6. The results of regression between household satisfaction and parts of private open space variables

Overall satisfaction of P.O.S parts	Regression variables	Unstandardized Coefficient B	Sig
Garden	Number	0.89	0.010
	Size	0.183	0.016
	Outdoor activity	0.163	0.420
	R^2=0.48		
Garage	Number	0.39	0.000
	Size	0.28	0.001
	R^2=0.29		
Outdoor circulation	Movement	0.67	0.000
	Accessibility	0.16	0.018
	Location	0.95	0.060
	Size	-0.02	0.033
	R^2=0.67		

Table 7. Result of regression between overall satisfaction about open space areas and overall satisfaction of each part area

Overall satisfaction of all open areas	Unstandardized Coefficient B	Sig
Overall satisfaction about outdoor Circulation	0.34	0.00
	R^2=0.47	

Table 8. The household need about the size of each part of the private open space

.O.S. parts	Size satisfaction		Overall satisfaction for each part		Household needs	
	Mean	Level	Mean	Level	Mean	Need
Garden	3.26	Neutral	3.00	Neutral	3.60	Larger
Garage	3.18	Neutral	3.30	Neutral	3.60	Larger
Balcony	4.00	Satisfied	3.20	Neutral	3.50	Larger
Outdoor Cir.	3.70	Satisfied	3.00	Neutral	3.10	Neutral

4. Conclusions

It is proven through this study that open spaces, which consist of garden, garage, balcony, and outdoor circulation, is important in daily life of people, and people's satisfaction about their houses depends on the quality of provided open space. Each part of private open space in those dwelling was compared to Iraqi standards, and it was found that most of those projects were within the minimum range of Iraqi standard except Minara B, which result was below Iraqi Standards and Hiwa city much above standards.Significant relations between general indictors were found. For example, the relation between total private open space area and size of garden size of plot and circulation, are 99%, 95%, and 91%.

By doing ANOVA analysis for all parts of private open space. The results of households' satisfaction about their private open space units are between natural and satisfied. By doing the regression, the factors that have the most impact on households' satisfaction about private open space parts have been recognized. The overall satisfaction of all open spaces parts has been identified, with households' satisfaction regarding each part garages' overall satisfaction mainly contributed to it. Regarding demands on parts of private open space sizes all ask for slight increase except outdoor circulation.

5. Recommendations

Since a house is the place that we spend most of our time in it, and it is the best place to relax, their designs should be considered carefully by the designers. Householders claim more open space in their dwellings, setting out detailed standard for all open space parts. The standards should be updated permanently. Designers to consider household satisfaction results feedback.

Authors' contribution

All authors contributed equally to the preparation of this article

Declaration of competing interest

The authors declare no conflicts of interest.

Funding source

This study didn't receive any specific funds.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request

REFERENCE

[1] Azad, S.P., Morinaga, R. and Kobayashi, H., 2018. Effect of housing layout and open space morphology on residential environments–applying new density indices for evaluation of residential areas case study: Tehran, Iran. Journal of Asian Architecture and Building Engineering, 17(1), pp.79-86.

[2] Derya Oktay, 2010, The meaning and use of open spaces in housing areas: residents' responses in northern cyprus

[3] Elena g. Irwin and nancy e. Bockstael, 2020, The problem of identifying land use spillovers: Measuring the effects of open space on residential property values

[4] Fronczek-Munter, Aneta. (2017). Evaluation methods for hospital facilities. International Journal Facilities Management EuroFM. 215-226.

[5] GUO Fengyu, MA Lijun, Study on Household Satisfaction in the Housing Industry

[6] Gehl, J., 2011. Life between buildings: using public space. Island press.

[7] Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M.C., Shyamsundar, P., Steffen, W., Glaser, G., Kanie, N. and Noble, I., 2013. Sustainable development goals for people and planet. Nature, 495(7441), pp.305-307.

[8] Jiboye, A. D. (2012). Post-occupancy evaluation of residential satisfaction in Lagos, Nigeria: Feedback for residential improvement. Frontiers of Architectural Research, 1. pp- 236–243.

[9] Jensen, K. L., Arens, E. & Zagreus, L. (2012). Acoustical quality in office workstations, as assessed by occupant surveys. Proceeding of Indoor Air.

[10] Merriman, P., Jones, M., Olsson, G., Sheppard, E., Thrift, N. and Tuan, Y.F., 2012. Space and spatiality in theory. Dialogues in Human Geography, 2(1), pp.3-22.

[11] Open Space in Residential Areas, Private open space and communal open space Or. Rev. Stat, 2007

[12] Preiser, Wolfgang. (2003). The evolution of post-occupancy evaluation: Toward building performance and universal design evaluation. Learning from Our Buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation.

[13] Rakhshandehroo Mehhdi, Mohd Yusof Mohd Johari and Sahrakar Afshin, 2017, Terminology of Urban Open and Green Spaces

[14] Sepideh Payami Azad, Ryohei Morinaga & Hideki Kobayashi, 2020, Effect of Housing Layout and Open Space Morphology on Residential Environments–Applying New Density Indices for Evaluation of Residential Areas Case Study: Tehran, Iran

[15] Trancik, R., 1986. Finding lost space: theories of urban design. John Wiley & Sons.

[16] Tötzer, H.T. and Köstl, M., Urban heat islands effects and adapting open spaces–a Vienna case study Wolfgang Loibl*), Richard Stiles, Stefan Pauleit, Katrin Hagen, Beatrix Gasienica, Tanja

[17] Visit Limsombunchai, 2014, Hedonic Price Model vs. Artificial Neural Network

[18] Walaa Abdulla Al-Noori, 1987, Environmental Design Evaluation of Multi-family Housing in Baghdad: Users' satisfaction with the External Areas

[19] Wang, H., Dai, X., Wu, J. et al. 2019 Influence of urban green open space on residents' physical activity in China.

[20] Wendy Sarkissian, Rebecca Bateman and Brendan Hurley, 2013, Open space in medium-density housing guidelines for planning and design.