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Roles of the Mechanisms of Merging and Deleting Internal Spaces in Realizing Economic Design for Affordable Houses in the City of Mosul

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Abstract

Merging spaces and deleting unnecessary activities are essential mechanisms to minimize the cost of affordable housing. However, their act must meet the multiple aspects of sustainability both in its economic and social aspects (by reducing the house area within acceptable limits of the resident adaptation to the implemented design). However, there is still a lack of local studies that clarify the role, ranges, and procedures for applying these concepts and the relationship between them in influencing the design and controlling its spaces areas. Accordingly, this research aims to "determine the role and the influence of each of the two mechanisms in spaces rationalization for sustainable urban housing" and the association of their effect with the variables of the area and dimensions of the residential plot. The research assumes that determining the building area can create a lot of modalities that govern the merging and cancellation in providing housing activities. To achieve this goal, a field study was conducted for a group of residential houses of the limited plot area within different proportions from the private urban residential sector of the city of Mosul, assuming that these designs can be considered as a realistic reference to how these procedures influence house design.

Disciplinary: Architecture Science and Engineering.

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1 Introduction

The economic factor stands out to be at the forefront of sustainability in housing projects, (Khurfa, 2010) and in different manners, like reducing a residential plot area (Witchayangkoon et al., 2021), controlling the house, or the housing project design taking into account the appropriate living conditions (Aranya, 2001). This may change the housing costs are too expensive and rarely match the budgets of the poorest intended recipients (Wainer et al., 2016).

2 Literature Review

2.1 Mechanisms for Controlling the Building Area

Various studies have presented three important principles to determine the area of the dwelling. They were: (Al-ukaedi, 2018).

- Preventing recurrence of activities.
- Deleting unnecessary activities.
- Merging activities.

While it is possible to deal easily with the first factor, which keeps the existence of activities, dealing with the latter is more complicated. The decision to merge or delete specific activities needs the assurance of the resident adaptation to canceling the activity or accomplishing it within integrated spaces and in different functional relationships.

2.1.1 Merging of Activities

Merging of activities is the principle of exploiting a single space with more than one activity with range depends on the size of the dwelling and the degree of its privacy. It can take place based on time separation (Rafat, 1996), or (as in our study) by the spatial separation of activities within the same space by furniture, movable partitions, and the sliding doors or by different levels (Tannous et al., 2013).

Merging activities relate to the concept of the open plan, which denotes the principle of spatial integration of functions and has constantly connected to the principles of flexibility and fluidity of space. It is generally used in all modern living spaces contributing to quality and space comfort. Employing the space for more than one activity increases its operational efficiency and eliminates the need to add spaces rarely used. The open plan method works directly on designing a house with less space needed (Alfirevic et al.,2016).

Merging the activities classified in several studies. Dielmann classified some of the activities able to merge, including (bathroom + toilet + washing/ reception + living + dining), (Dielmann, 1979). This procedure distinguishes between important activities, such as living, and other activities that are of less use, such as the activities of reception and dining for guests (Al-Rashoud, 2004).

Locally, the recommendations for studying the housing scheme in Iraq for Paul Service formed the most important local indications that turned to the value of merging activities in

achieving the affordable housing design, which can change depending on family lifestyle and privacy required for its members (Haidaran, 2002). The study proposed four basic schemes in which different levels of merging activities are achieved with gradients that have emerged most clearly in the design of residential areas of limited size (150m^2), where it suggested merging living activities(dining + living + reception) and (cooking + storage) beside (bathroom + washing) each in one isolated space. On the actual real side, a study based on a sample of (<200->350 m^2) houses in the city of Mosul reviewed limited merging operations that focused on merging (cooking + dining/shower + washing) activities and only (2.3%) of merging of living activities by a reception. This showed a weak acceptance of the housing reality at the time for the open plan and all its economical advantages (Al-Sanjary, 1990).

2.1.2 Cancellation of Unnecessary Activities

A successful functional design must be free from the area of unexploited spaces. It must also be determined the actual need for each activity and the extent of the continuing need for it to determine the justification for the commitment to provide it (Zarour, 2013).

Many local studies provided several indicators about the cancellation of activities in urban housing. Al-Sanjary classified two types of spaces in the dwelling, the basic and possible spaces, depending on the area of the house plot and the resident's properties. This indicates that the house area reduction deletes some house activities (Al-Sanjary, 1990).

Al-Din (2011) also discussed the proportions of the existed, merged, or canceled spaces in the house while reducing the area of the residential plot of contemporary housing in Baghdad.

2.1.3 Distinguishing Between Merging and Cancellation Activities

A distinction can be made between the merging and the cancellation of unnecessary activities. The former works to cancel the independent existence of specific activity with the possibility to achieve it within a space for other activities which may get changes in its area or its relationships with the organization. Cancellation includes the same process of deleting the activity but without any spatial or organizational change to other spaces to accommodate their achievement.

Although cancellation and merging are two possible mechanisms to reduce the built-up house area, they work differently in achieving the principle of sustainability. The first archives it by clarifying the higher degree of economic rationalization while merging achieve a less degree of rationalization to present the higher compatibility with the needs of the inhabitant by creating an opportunity to provide the activity, albeit in a compact manner.

2.1.4 The Role of Plot Determinants on the Procedures for Merging and Cancellation in the Housing Activities

The correlation of the emergence of merging and cancellation in the dwelling activities with the reduction of a house built area justifies the interest in the effects of the determinants of the dwelling plot on the appearance of these mechanisms, through its role in determining the possible

built-up area. The Al-Ukaedi Study linked the house total built-up area with the residential plot area and with the plot width within the fixed plot area. This may justify more signs of cancellation and merging of spaces with the decrease of the area and width of the residential plot. The limited area of the residential plot in contemporary housing pushed some activities to the upper floor, such as the reception space (the study of Al-Ukaedi) or sleeping spaces in general (the study of Shams al-Din) or to cancel some external spaces such as the garage and the front garden. These limitations justify the study concentration on the cancellation and merging procedures within the ground floor without the upper level, which is usually occupied by sleeping spaces excluded from these procedures.

3 Method

The local reality indicates the lack of studies clarify the ranges and possible detailed procedures to apply both methods in sustainable urban economic housing in the city of Mosul. These are the ranges that express the privacy of the resident's decisions and priorities in rationalizing the housing area. Since the wrong exploitation of deleting and merging mechanisms can give negative effects on the adaptation of the resident with his house design characters, the difficulty in distinguishing their role in influencing housing design and controlling the areas of its spaces and the relationship between them is considered a clear problem facing the sustainable design process in housing projects.

This research determines the roles and location of each of the two mechanisms' effect in the spatial rationalization of the spaces of sustainable urban housing and the nature of its association with the basic residential plot variables of the area and dimensions.

The research proposition is that "determining the house built-up area in the urban environment of the city of Mosul can create several modalities expressing the resident viewpoint of using merging and cancellation in provided housing activities and the nature of their role in this field." Discovering such patterns can support the designer with the economic procedures on the standard housing designs without compromising the maximum limits of the resident adaptation in the future. This matter becomes more important by the increased interest in establishing housing projects, the absolute necessity to restore normal life to the city today.

To achieve this goal, the research relied on an analytical approach applied to the data of the real contemporary housing in the city considering that analyzing its actual outcome (and regardless of the efficiency of the designer) can present the methods of dealing between the two mechanisms and the functional plan according to resident opinion in the actual housing.

3.1 Field Survey Sample

The actual outcome of the real housing can present by the field survey of an elected house sample from modern residential neighborhoods in the city of Mosul. To achieve the research goals, the houses samples should be:

1- For newly constructed houses. (not more than 15 years old)

2 - Varying of the limited plot area (not more than 165 SQM) and facade width (7.5 M or less).

3- Comprehensive for different residential neighborhoods of the city.

4- The sample should not be of the full architectural effort in the design (to monitor the procedures applied directly by the dweller).

Table 1: Field survey sample

Sample plot characteristics		plot area			Total
		≤ 115	140-115	> 140	
Plot width	≤ 5.5	10	10	10	30
	5.5 - 6.5	10	10	10	30
	> 6.5	10	10	10	30
Total		30	30	30	90

3.2 Field Study

Thus, the field study was conducted on an elected sample of 90 house units classified according to the plot area and width (Table 1). As the sample size is limited, the analysis results cannot accurately represent the actual frequency ratio in reality, which may require additional studies and larger samples to be carried out

4 Result and Discussion

The results review the most important procedures observed in the sample within the following paragraphs:

4.1 First: Sleeping Spaces

Bedrooms appeared in a number between (1-2) rooms in most of the sample size. (Table 2) shows the ratio of samples of one, two, or free of bedrooms houses and also shows that the effect of plot area on the number of bedrooms located on the ground floor.

Table 2: Bedrooms distribution in the survey sample

Plot area		<115	140-115	>140	% of the total sample	Average of plot area m^2
% Of number of bedrooms in ground floor	0	2.2	0	0	2.2	105
	1	30	12.2	21.1	83.3	125.5
	2	1.1	1.1	12.2	14.5	149.1

The whole sleeping spaces area of the sample ranged between (13-41.2m^2) at a rate of (19.8m^2) which was proportional to the average area of the residential plot, see Table 3. The bedroom area in the sample of one room ranged between (13-23 m^2) at a rate of (17.8 m^2). In a two-bedroom sample, the area of the first room ranged between (15-25 m^2) and at the rate of (17.7 m^2). The area of the second room ranged between (10-16.2 m^2) at an average of (13.8 m^2). Except for one case, and compared to the criteria of the general housing scheme (MCHI, 2010,), all bedrooms areas were above the minimum standard area (12 m^2), and each of the two-bedroom samples contained a bedroom with an area of more than (15 m^2) the minimum standard area of the main bedroom. This case also included (95%) of houses of one-bedroom in the sample.

Table 3: Avarage of sleeping spaces areas in the sample

Plot area	<115	140-115	>140
Average area of sleeping spaces	15.9	19.4	24.6

4.2 Second: The Reception Suite

The semi- Public part of the dwelling which of the following spaces:

4.2.1 Reception Space

This space appeared in several distinct forms (Figure 1).

First: Independent space, (86.7% of the sample), appeared in several design patterns include:

A: The independent space on the ground floor, (82.2% of the sample), appeared in several shapes, include:

1- Completely independent from the living space (52.2% of the total sample) (Figure 1-A1).

2- Separate space abilitable to be opened to the living space, (20% of the total sample) (Figure 1- A2).

3- Reception space containing family living space: This can offer the unavailable family daily living space (4.4% of the total sample) (Figure1-A3).

4- Reception space abilitable to be isolated: which can be opened or isolated without affecting the family privacy (5.6% of the sample) (Figure1-A4).

B: The independent space on the upper floor (4.4% of the sample) (Figure1-B).

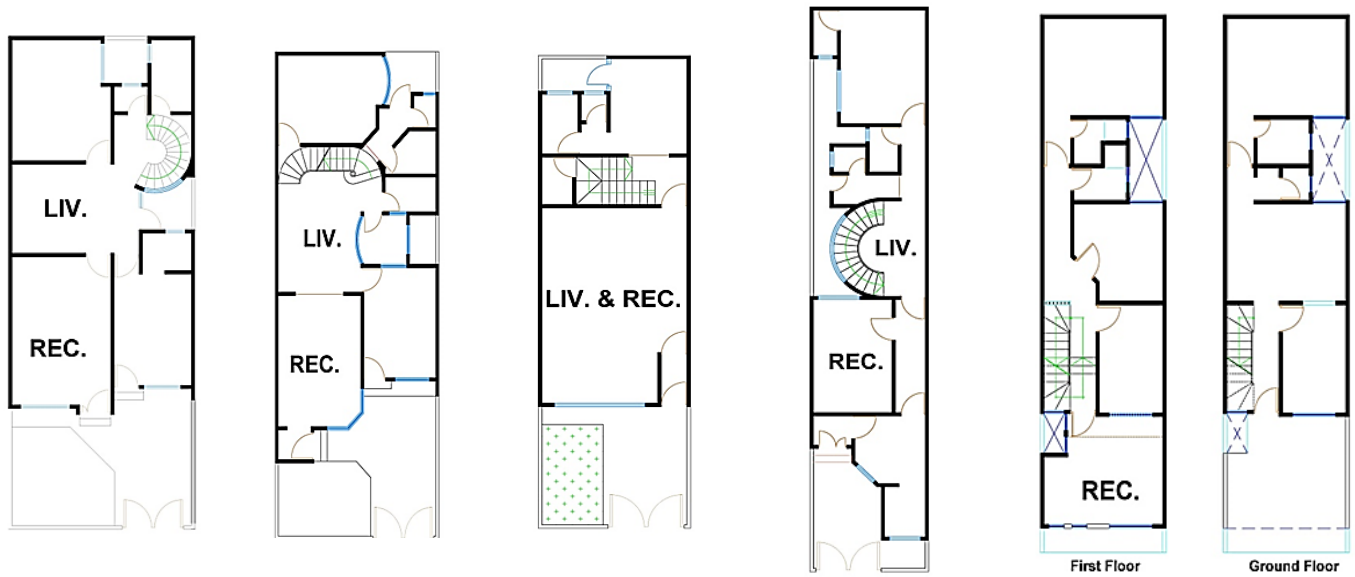

Figure 1: The main distinctive forms of reception space in the survey sample

Independent reception spaces ranged between (9-28.7 m^2) and at the rate of (17.5 m^2). Except for one case, this area is larger than the determinants of the Iraqi general housing standards(MCHI, 2010) which ranged between (12-15m^2). The available space was affected by the width of the plot and its area, as shown in (Tables 4 & 5).

Table 4: Relationship between reception average area and width of residential plot

Plot width	< 5.5	6.5-5.5	> 6.5
Average area of reception space	16.83	17.28	18.5

Table 5: Relationship between reception average area and area of residential plot

Plot area	<115	140-115	>140
The average area of reception space	17	17.36	18.21

Second: The lack of a separate reception space (13.3% of the total sample) where the reception space was even canceled or merged with the living space.

The average area of living space in this sample was (23.18m^2) ranged between (15.5-45.5 m^2) which indicated the difference in the family's interest in the reception space. Comparing with the criteria of the general housing standards (Urban-Housing-Standards,2010), which defined the minimum living and reception space with (18-21m^2), and (12-15m^2) straightly, it is possible to separate the two cases according to the area of the living space. (41.7%) of this sample, where the living spaces are less than 18m^2, can be considered as a house with a deleted reception space. While it can be considered as of merged reception (with 20-27 m^2 living space in 41.7% and more than 30m^2 in 16.6% of the sample). The free floor of the separate reception sample is associated with the narrower and the lesser area of the housing plot (as shown in Table 6), of the whole sample. Several shapes of the first type of reception appeared at different rates of resident plot area ranging from the largest in case of independent reception to the lowest with the independent space on the upper floor (see Table 7). By adding the upper floor reception sample to the sample free from a separate reception on the ground floor, the house average plot area changed between the two types (with or free from reception) to (131.5, 114.14 m^2) straightly.

Table 6: Distribution of reception types among the survey sample

Plot area		Up to115			140-115			Greater than 140			Total sample (%)
Plot width		<5.5	-5.5 6.5	>6.5	<5.5	-5.5 6.5	>6.5	<5.5	-5.5 6.5	>6.5	
% Of reception type	independent	5.6	7.8	10	10	11.1	11.1	10	10	11.1	86.7
	Merge	2.2	2.2	1.1	1.1	0	0	1.1	0	0	7.8
	deleting	3.3	1.1	0	0	0	0	0	1.1	0	5.5

Table 7: The relationship between reception type and the area of residential plot

reception type		% of sample	average plot area	
Independent space	on ground floor	50	130.8	130.6
	Open to living	20	135.1	
	Living container	5.6	127.1	
	Isolated	6.6	130.1	
	on upper floor	4.4	113.6	
No independent space	merging with living	5.6	114.6	114.3
	deleting	7.8	114.1	

4.2.2 The Main Entrance

This space appeared in (57.8%) of the sample. Its lowest appearance was with the independent reception separated from the living of the house (isolated or open to living), as the Isolated reception space minimizes the need for family privacy. This justifies the increase in its appearance in other cases of the independent reception space (capable of isolation or living containers) and especially with the reception on the upper floor which can be added to the sample free from the independent reception space as shown in (Table 8) that indicates the higher ratio of entrance existence in this partial sample.

Table 8: Distribution of entrance space among types of reception space in the sample

Reception type		% of sample	% availability of entrance space	% availability of entrance space	Type of reception space
An independent space	on the ground floor	50	33.3	39.2	independent reception on a ground floor
	Open to living	20	11.1		
	Living container	5.6	60		
	Isolated	6.6	83.3		
no independent space	on the top floor	4.4	100	81.3	no independent reception on a ground floor
	merging with living	5.6	80		
	deleting	7.8	71.4		

4.2.3 Guests Toilet

The space was available only in (8.9%) of the sample associating with the availability of the guest entrance. (except for one case) it related to independence regardless of the area of the residential plot.

4.2.4 Guest Dining

This space appeared in (12.2%) of the sample, linking to independent reception space in houses of the largest plots (average of 140.5 m^2). The space appeared in two shapes, as an independent space (samples of average 154.4 m^2), or as a space combined with the reception (samples of average 132.5 m^2).

This sample did not provide a clear correlation with guest toilet or entrance which is an expected conclusion from the concentration of this space with separate reception, unlike the entrance space.

4.3 Third: Cooking and Family Dining

The hot kitchen space appeared in (33.3%) of the sample to meet the activities of cooking and storing food materials. So, the storage space appeared only in three samples, two of which did not contain the hot kitchen. The average plot area of the floor of the hot kitchen was 138 m^2 distributed as in Table 9, which indicates that its area Increased in direct proportion with the house plot area and width. The area of the kitchen space (hot + cold) ranged between 5.5-23.4 m^2 at a rate of 13.46 m^2. This is higher than the minimum space standard for the general housing standards and varying clearly with the increase of the plot area as shown (Table 10).

Table 9: Distribution of hot kitchen space in the sample

		Plot width /M			
		<5.5	6.5- 5.5	>6.5	total
Plot area /SQM	<115	%6.7	%6.7	%10	%23.4
	140-115	%3.3	0	%23.3	%26.6
	> 140	%3.3	%20	%26.7	%50
	total	%13.3	%26.7	%60	%100

Table 10: Relationship between kitchen space area and plot area

	average area of the plot/SQM		
	<115	140-115	>140
Average area for kitchen space/SQM	111.8	12.2	15.4

The family dining space is distributed in 3 main locations according to (Table 11) which presented that the hot kitchen helped the kitchen to contain the family dining space. Most samples of the hot kitchen were associated with the dining in the kitchen (or in a separate space), while 96.7% of the sample of dining cases in the living were free of the hot kitchen.

Table 11: Relationship between family dining and hot kitchen distribution

Type of family dining space	% Appearing in a sample of the hot kitchen	% Appearing in the total sample
Separate for family & guest	6.7	4.4
In the kitchen	90	80
In the living regardless of space availability	3.3	15.6

4.4 Fourth: Bathrooms

Only two cases were free of the bathroom space, one was without a bedroom on the ground floor and the second was of a bedroom with a private bath. The rest is divided between having separate bathrooms and sanitation (68.2%) and a bathroom with shared facilities (31.8%). The shared type is concentrated in smaller plots at a rate of 119 m^2 while separate bathrooms are concentrated in the larger plots at the rate of 132 m^2. Washing and bedroom private bath appeared only in(8.9%) and (6.7%) of the sample.

4.5 Fifth: Family Living Space

This space presented several variations reflecting the differences in the inhabitants' interests. In many cases, the living was limited to what is available from the movement areas, kitchen, or by using reception outside the guest's present times. the area of this space ranged (except those without a defined living space) between (8.4-23.3 m^2) at a rate of (16.5 m^2) and in proportion to the plot area (Table 12). The average area of space, either for the entire sample or all its details, was below (18 sqm), the minimum required by the Iraqi general housing standards (MCHI, 2010), a condition that only met in (40.2%) of the sample.

Table 12: Relationship between family living space area and the residential plot

	Average of the plot area		
	≤115	140-115	>140
The average area of living space	14.4	16.8	17.74

The sample did not provide a correlation of area change between living space and kitchen, as the change in the kitchen spaces area and by containing dining space was not matched the same change in the living as shown in Table 13.

Table 13: Relationship between kitchen and living space areas.

Kitchen area	< 9	12-9	15-12	18-15	>18
Average kitchen area	7.57	10.73	13.04	16.64	19.47
Average living area	13	16.11	15.66	18.08	18.07
kitchen area / living area	0.58	0.67	0.83	0.92	1.08

5 Conclusion

From the results of this study, the focus of activities on the limited area of the ground floor justified the interest of this floor in examining the effect of space reduction on deleting and merging of activities which competed according to its classification into private (sleeping), semi-private (living), semi-public (guest) spaces and services.

The importance of no less than one bedroom regardless of the available area on the ground floor, while increasing floor area justified the provision of additional bedrooms. The focus on providing the reception space despite all the area limitations emerged several solutions to maintain an acceptable form of this space on the ground floor like offering the isolated reception that can be opened to the family space, the reception space with the possibility to use as a family living space, laying off the bedroom on the upper floor to provide the independent reception room on the ground floor, and providing isolated reception space on the upper floor.

Providing private sleeping and isolated reception spaces within or higher than the minimum recommendations area of the Iraqi housing standards despite all the restrictions of the built-up or residential plot area limitations. The main entrance offered a presence, which was not in line with the effect of the economic factor. Space presented more appearance in the units free of separate reception space to achieve more resident privacy that is not required by houses containing it.

Unlike their interest in the reception space, the family did not present enough interest in adding supportive guest spaces (like guest dining and w.c.). The study showed a wide possibility of deleting these spaces. The interest in private and semi-public spaces affected the share of semi-private and service spaces on the ground floor. A noticed effect shown on the area of the family living and kitchen is that the available living space decrease below the accepted Iraqi standards in two-thirds of the survey sample.

In comparison with the related studies, the sample presented new solutions to offer the isolated reception space instead of dealing with the merging mechanisms of the living activities. As an indicator of the resident changing needs, the sample presented a higher presence of some service spaces (comparing with the results of older local studies of samples with larger plot areas) such as the hot kitchen or the bath attached with the bedroom, while it witnessed the deletion of other activities such as washing and storage spaces.

The outcome of the residential design reality presented two conflicting assessments. The first, the lack of a suitable proportion and sufficient space for the different activities on the ground floor, while the second, clarified some of the design capabilities to provide space organizations that could be a basis for future affordable housing design.

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