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Effects of Area of Walls, Internal Corridors, and Stairs on the Built-Up Area of Houses

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Abstract

Designing a house requires developing initial perceptions of many elements' spaces, which consume quite a bit of space and are often neglected, including the space of stairs, internal corridors, and walls. Through a survey of previous literature related to the subject, it became clear that there is no concept or study concerned with determining the approximate proportions of the wall area and the staircase area with the internal corridors inside the residential house and the extent of their impact on the remaining spaces The deductive method for analyzing a group of samples to reach an approximate unified result resulting in approximately 17% for the combined area of stairs and internal corridors, and 17% for walls. Accordingly, a preliminary conception of the area of the remaining spaces in the residential house can be developed. Considering such a percentage in the architectural designer will reduce the differences between the architect and the client and give an initial visualization of possible spaces.

Keywords: Built-up area; Internal corridors; Staircase area; Walls

1. Introduction

The general housing plan in Iraq divided the housing unit into many basic functional sections. For example, a room is habitable and comprises reception, living, and sleeping spaces. Service spaces are allocated for the kitchen, bathroom, toilet, and store. The internal movement spaces represent the internal pathways linking the various spaces of the residential unit. In terms of privacy, the spaces are divided into four spaces. The main entrance represents the public area of the residential unit, while the reception area is semi-public. The living, kitchen, dining, and other service spaces (bathroom and toilet) represent the semi-private area. Bedrooms represent the private area for family members [1]. When designing a house within a specific land area, an initial perception of the area of these species often comes as a result of the architect's experience. Still, it remains just an initial perception because the issue of the area of internal corridors, stairs, and walls cannot be calculated only after the design. Therefore, estimating the percentage representing this area can develop a clearer initial perception of the rest of the area in the house. In addition, this estimation will help the engineer create a preliminary estimate of the cost of the building [2].

According to the above, there is no conception or study concerned with determining the approximate percentage of area for walls, internal corridors, and staircases to the rest area of houses in Iraq. The objective of this research is to give an initial visualization of the approximate percentage of the area of walls, internal corridors, and stairs to the built-up area inside a house in Iraq. This Objective can be achieved through the methodology of analyzing a group of house samples with different plans and arriving at a consolidated approximate result of the proportions of the walls, staircase, and internal corridors and their relationships with the construction area of a house.

2. The Design of the House

Experience and sufficient knowledge are essential in engineering design in various specializations [2]. Providing an approximate ratio of the area of the walls, internal corridors, and staircases can provide a preliminary vision that helps engineers form an initial picture of the spaces of the house spaces. Therefore, there is a need to know the lost or not included in the calculation of the dimensions of the area in the design of residential houses. Among these areas are the area of the walls in the home in addition to the area of the internal corridors and the area of the stairs.

2.1. Literature Review

The research found that most of the previous studies on house designs focused on several points, such as the sequence of spaces from the public to the semi-public to the semi-privet to the private, transformations and changes that occurred to the residential house during its development, spatial zones within the house, house materials and finishing, house building methods, house Bubble Diagrams, the principle of sustainability [3]. While studies neglect the percentages of the area of walls, internal corridors, and stairs, this study came to fill this lack. It can be briefly reviewing here some studies that specialized in studying the Iraqi residential house in particular:

2.1.1 Transformations of the Iraqi residential house in the first decade of the twenty-first century

The details of the Iraqi residential house were addressed in the first decade of the current century. For example, the Adhamiya region was used as a model for conducting the field study [4]. The study compared the role of the first phase of the first decade of the atheist century Twenty with the second phase of the last three decades of the twentieth century on several aspects, including areas, sizes, formation, orientation, and function to reach the most prominent transformations that occurred in the dwelling during that era. The study concluded that economic, social, and technological factors, as well as urban regulations and laws, mainly contributed to the transformations in residential homes during the specified period in the study. Fig. 1 shows the relationship between civilization and architecture.

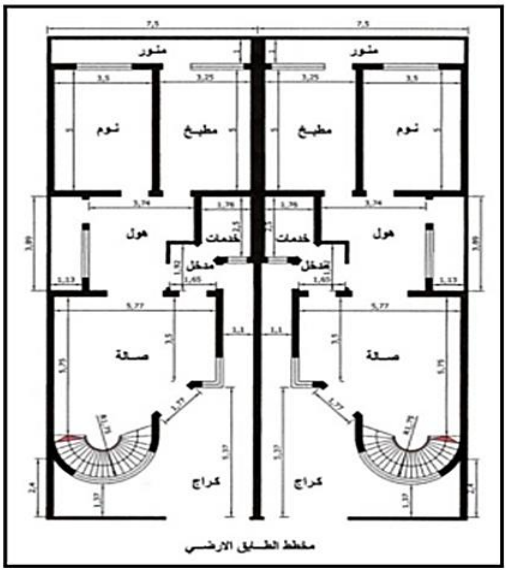


Figure 1. Twin residential homes [4]

2.1.2 The Attributes of Architectural Form of Traditional House Internal Facades of Mosul's Traditional House as a Case-study

This study relies on a brief search for the formal characteristics adopted by Islamic architecture in the ancient city of Mosul and at the level of the traditional dwelling in it. The organized design process was conducted by exploring some of the characteristics used in forming the internal facades of Mosul's Traditional House. It also considered the connections of these characteristics with them to reach the integrated system of the architectural form of those facades and its production mechanisms to be useful models in the designs of modern facades with a spatial character [5].

2.1.3 The architectural development of the house in Baghdad during the twentieth century, with a focus on cultural and social influences

The study [6] aimed to identify the process of the architectural development of the house in the city of Baghdad during the first eight decades of the twentieth century, forming an intellectual perspective, considering the house as a civilized and human product, reflecting its development of human thought and society in all its details, connections, relationships, values, customs, and traditions. The research emphasizes an intellectual understanding that depends on considering the house as an integrated entity or a system linked to neighboring systems in relationships. It has also been focused on emphasizing the qualitative rather than the quantitative side in researching these relationships and their association.

2.1.4 The effect of the positive and negative spaces of the internal living space in the residential unit on the comfort of the occupants

The study [7] aimed to verify the relationship between the method of distributing furniture and the kinetic interior spaces in the interior space. This study showed that. An increase (waste) or decrease in areas of the internal spaces due to the poor distribution of internal furniture. This negatively affects the comfort of the occupants of these housing units. The study focused on the appropriate movement for these spaces in a way that suits its occupants without increase or decrease, as well as the appropriate (acceptable) possibilities for the shape of the interior spaces, their dimensions, and the method of distributing furniture in them. as shown in Fig. 2.

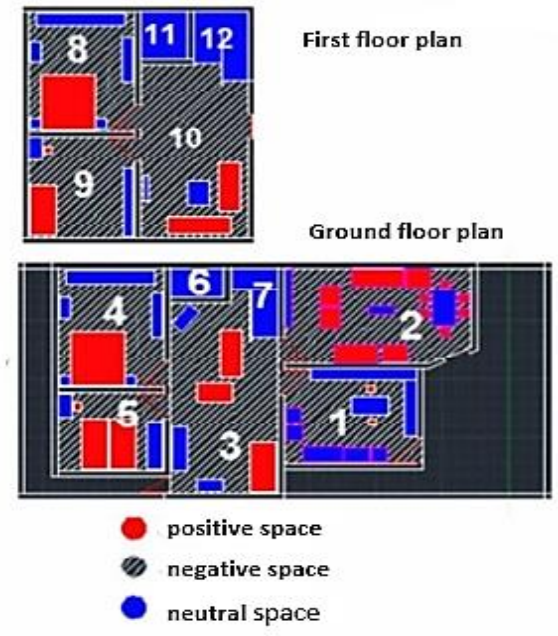


Figure 2. Positive and negative spaces [7]

2.1.5 The effect of the area and proportion of the land of the single-family housing unit in patterns Space organization in the city of Mosul

The study [8] assumes that there are specific patterns of spatial composition for each area and proportion of plots of land. This study aimed to consider the similar functional and economic requirements of people. The author identified and selected a sample of single-family homes for several designers, consisting of 30 houses with an average of 5 units of the six most important areas and proportions of plots of land in Mosul city using the methodology of installation and spatial analysis. The internal spatial composition of the sample was analyzed by focusing on five essential components, namely reception, living, sleeping, kitchen, and staircase, which is the gateway to the upper floor.

2.1.6 Housing development - its dimensions and components

The study [9] focused on the various dimensions and components of housing development, which were defined as preventing the destruction of the residential environment and the ability to sustain its social and economic components. The concept of affordable housing is that housing that fulfills the family's requirements without increase or decrease and within the limits of its material capabilities, achieving the main goal of the dwelling.

2.1.7 The transformation in the relationship between the private and public space in the local housing unit and its impact on the urban environment

The research [3] relied on the phenomenological approach, in addition to the analytical and descriptive methods, by reviewing, discussing, analyzing, and comparing the characteristics of the housing unit models. These models represent the local traditional models of modern and contemporary housing units (dealt with in some studies). The study also focused on the relationship with which private and public spaces are linked in both cases.

The results showed that there has been a shift in the relationship between private and public spaces in the dwelling (inside and outside) in response to external and internal needs and influences (economic - religious - political - social - cultural - technical). In addition, his shift has - greatly affected the urban environment of local architecture through its impact on some of the basic characteristics of the dwelling (the level of the part) and the urban environment (the level of the whole).

Diodes play a supportive and complementary role in producing the final product, and the link between them is through the architectural joint. The joints arise from the superposition of two or more parts at several levels and bear the architectural reference; the residential unit's functional pattern regulates this relationship.

Diodes and the formation of these joints have been affected by the environment surrounding the housing unit and the time of its construction. This led to the emergence of multiple housing units in our local architecture. Fig. 3 shows the Stages of development of the local house.

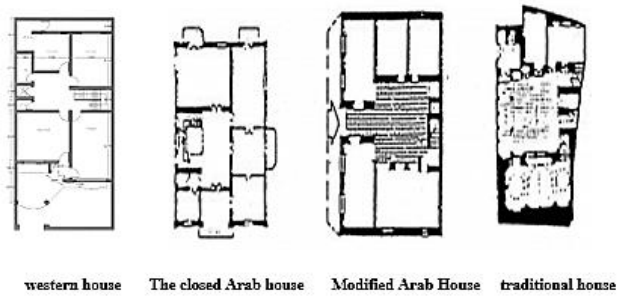


Figure 3. Stages of development of the local house [3]

The quick and simplified review of these local studies aims to emphasize the lack of knowledge in the studies that determine the areas of walls, interior corridors, and stairs compared to the rest of the house's area. This study came to fill this knowledge gap and determine an approximate percentage of these spaces. This can develop a preliminary vision of the remaining space for other residential spaces and assist the architectural designer in his design discussion with the client**.**

2.2. Wall

A wall is a continuous, vertical structure [10]. It is a fixed building separating two independent areas. The height of the wall varies according to the design and the degree of independence between the two areas that separate them. The height of the wall may or may not reach the ceiling.

Certain general factors affect the choice of materials for a particular scheme. The materials for building walls differ according to the materials prevailing in that region, the economy, and other factors. The research will depend on brickwork as the dominant building material for two-store houses in Iraq [12]. In this search, the area of the wall built from the bricks will be calculated, including whether it is built with a full brick or a half brick, because, in both cases, this wall occupies an important space from the area of the house. Fig. 4 shows brick walls.

Figure 4. Building walls using bricks [12]

2.3. Inner Area

The principal schemes of functional zoning of a house are private zones (bedrooms, study, etc.), collective zones (living room, dining room, kitchen), servicing zones (storage, cellar, laundry), sanitary zones (bath, WC, etc.), and communicated and access zones (corridors, entrance hall, stairs, etc.) [13]. The research subject is dedicated to the area of the walking path (horizontal and vertical).

2.3.1. Stair Area

The staircase is the entire structure relating to a stair, comprising steps, treads, risers, strings, balustrading, landings, etc. [14]. The stairs are those parts of the buildings that a person uses to move between the different levels (floors), and the designs must be prepared. The designs of other parts are ready from the buildings that make up the buildings [15]. The area of the stairs in the house varies according to its design on the one hand and the height of the floor on the other.

.2.3.2 Corridor

A corridor is a passageway (as in a hotel or office building) into which compartments or rooms open [16]**.** It is an area that significantly affects the rest of the area of the house. Usually, three main factors lead to a significant difference in the design of interior corridors. These factors are the area of the house, client requirements (homeowner), and the architect's experience and design style. The area of the stairs and the internal corridors remain variable. The architect often tries to study their design well to obtain the largest possible area for other internal areas.

3. The Building Area of the House

It is the total area of the floor (Gross Floor Area) (GFA), which is the total area in a certain unit of measurement (such as being in square feet or square meters) for the floor in the building down to the outer face of the outer walls [17]. Thus, it can be found that the built-up area differs from the area of a plot of land, as it occupies a specific area. The building area varies according to the area of the plot of land and the designer's opinion, as shown in Table 1.

Table 1. Building percentages according to the regulations of the Municipality of Baghdad. [17]

Sequence	Plot area in square meters	construction percentage %	Return from the public road	Reversal of the secondary road
1	240-120	%80	1.5	0.0
2	400 -241	%65	2.5	1.25
3	600 -401	%60	2.5	1.25
4	800 -601	%55	4.0	2.0

4. Simple Linear Regression

It is a statistical method that allows us to summarize and study the relationships between two variables. For example, the total built-up area and the staircase area with the house's internal corridors. According to the equation (1) [18]:

According to the equation: $Y = a + bx$ …….(1)

Where:

X is the independent variable

Y is the dependent variable

a is constant, and

b is the slope of the regression line

5. Architect and client

Several tools, including budget, time, building materials, computers, and architectural knowledge, can help the architect reach satisfactory solutions with the client.

Building design information is affected by collaboration between stakeholders. When information can be fully coordinated and organized, it enables better communication between the client and the architect [19]. One of this knowledge is knowing the proportion of walls, interior corridors, and stairs, which convinces the client of the design outcome.

6. Case Study

The practical aspect will be divided into two parts, the first for the area of the walls and the second for the area of the internal corridors and stairs. This division process is because the walls are a structural area, while the area of the corridors and stairs is a space. Therefore, the structural area (walls) gives an initial perception of the number of bricks, mortar, and finishing materials needed in the house. The area of the (interior corridors and stairs) gives a preliminary perception of the amount of cooling and heating required for the home, in addition to the area of the usual areas such as bedrooms and others.

6.1. Sample Selection Criteria

The criterion for selecting the sample was based on four points:

1- The difference of the area of the ground floor of the house so that it can be matched with the standards of the Capital Municipality, Baghdad.

2- The designs should be for more than one architect to obtain credibility for the large proportions that will be reached as if they were for one architect, as the design approach will differ from one architect to another, resulting in subsequent differences in the design of corridors and stairs.

3- The plans are from the last 20 years because the old designs were based on old construction methods, such as wall thickness, while the study aims to give an approximate percentage that depends on the architect in describing a house that has not been designed yet.

4- The focus was on land areas less than 240m^2 due to the large number of these areas in Iraq compared to larger areas.

The study's limits are in Iraq, as all plans are from Iraq. In addition, it relies on the specifications of the Municipality of the Capital regarding building areas and lands.

Table 2. Building area of the samples with the area of the walls and its percentage

sequence	Land area (m2)	building area of the ground floor (m^2)	Wall area on the ground floor (m^2)	Percentage %	The general average of the percentage %
1		60	11.5	19.2	
2		75	14.5	19.3	
3		76	14.8	19.5	
4		76	14.6	19.2	
5		77	14.75	19.2	
6		77	14.75	19.2	
7		78	14.4	18.5	
8		80	14.18	17.7	
9		80	14.27	17.8	
10		93	15.7	16.9	
11	240-120	120	21.27	17.7	
12		123	23	18.7	
13		127	22.8	18.0	
14		130	25.8	19.8	
15		136	24.5	18.0	
16		138	23.5	17.0	
17		138	26	18.8	
18		140	24	17.1	17.1
19		150	24.7	16.5	
20		160	24.3	15.2	
21		163	28	17.2	
22		187	33.1	17.7	
23		188	28.18	15.0	
24		189	28.8	15.2	
25		191	31	16.2	
26		196	28	14.3	
27	241-400	204	30.7	15.0	
28		216	34	15.7	
29		226	36.5	16.2	
30		230	35.5	15.4	
31		236	40.5	17.2	
32		256	40.7	15.9	
33	401-600	292	40.8	14.0	
34		313	42	13.4	

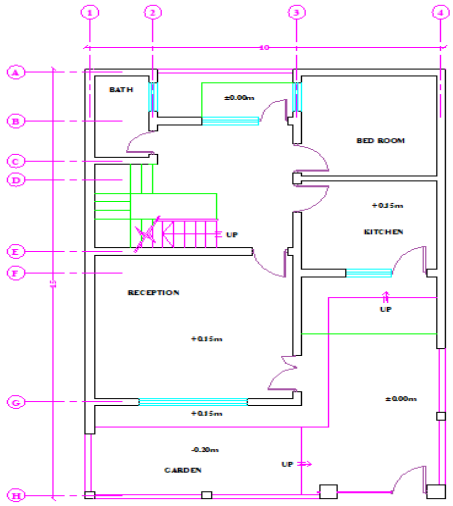
6.2. Wall Area

This practical side included calculations for (34) sample house designs of different sizes and designed by other architects. Fig.5 shows a sample of a residential house, showing the ground floor's building area and the walls' area. Based on Table 2, it is possible to clarify the relationship between the area of the walls and its percentage within the building area. The relationship appears inverse; the greater the area of the walls, the lower the Percentage, and vice versa, as in Fig. 6.

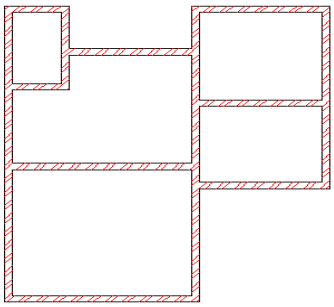
According to Table 1 and relying on the simple linear regression equation, it is possible to arrive at the percentage and amount of wall area as well as the remaining building area and its percentage, as shown in Table 3. Fig. 7 shows the simple linear regression between the construction area for the Ground Floor (Symbolizes (x)) and the wall area for the Ground Floor (Symbolizes (Y)), which was derived using Microsoft Office/ Excel 2010. The final equation is as follows:

$$Y = 0.1313x + 5.1712$$

The Multiple R (regression) = 0.97, which means that there is a robust relationship between the two variables. The R(regression) Square = 0.95, which means that changing the building area significantly impacts changing the area of the walls. The adjusted R(regression) Square = 0.95 means that 95% of the wall area is related to the area of the house. The simple linear regression equation shows the relationship between the wall and the rest area of the house; the more significant the area, the greater the area of the walls.



Ground Floor Plan



Wall Area on the Ground

Figure 5. A house plan and the building area, the location of the staircase area, and the internal corridors.

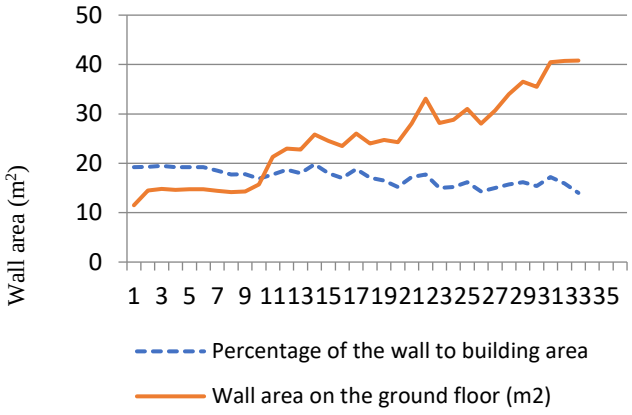


Figure 6. The relationship between the area of the walls and the building area

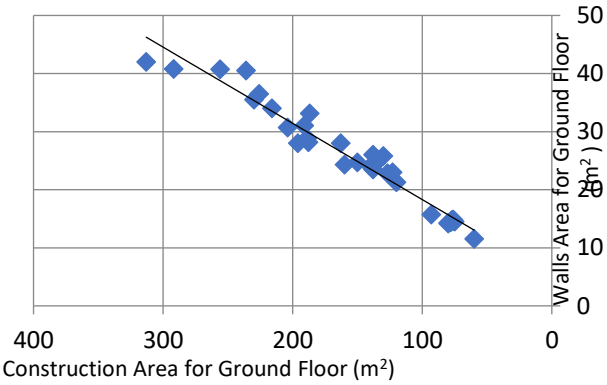


Figure 7. Simple linear regression

Table 3. Area based on Baghdad Municipality controls and simple linear regression equation

area of plot (m^2)	Building percentage %	Built-up area (m^2)	Area of walls according to simple linear regression equation (m^2)	Built-up area without walls (m^2)	Percentage of the walls %
240-120	80	192-96	1830 -	176 - 77	15.8 - 18.5
400 -241	65	260-156	39 – 25	245 - 140	15.1 - 16.4
600 -401	60	360-240	54 – 37	345 - 225	14.6 - 15.3
800 -601	55	440-330	63 – 49	426 - 315	14.3 - 14.7

6.3. Interior corridor area and staircase area

As mentioned earlier, calculating the percentage of stairs and internal corridors. and what was previously calculated from the percentage of the walls will give a clear picture of the percentage of the net internal spaces of the house. The combination of the staircase space and the internal corridors was required because these spaces are often designated for horizontal and vertical movement, as well as open within the house and not closed within a space with a door. This practical side included calculations for (34) sample house designs of different sizes designed by different architects; see Fig. 8 and Table 4.

Table 4. The samples' building area, including the staircase area and the internal corridors, and their Percentage.

Sequence	Land area (m2)	Building area of the ground floor (m^2)	Staircase area with the internal corridors on the ground floor (m^2)	Percentage %	e general average of the percentage %
1		60	9	14.2	
2		62	8	12.9	
3		68	9	12.6	
4		69	10	14.5	
5		73	11	15.1	
6		74	10	13.5	
7		77	11	14.3	
8		76	11	14.5	
9		80	13	16.3	
10		81	14	17.3	
11		84	14	16.7	
12		87	17	19.5	
13	120-240	89	14	15.7	
14		91	15	16.5	
15		100	17	17.0	
16		107	17	15.9	
17		116	21	18.1	
18		122	21	17.2	17.1
19		123	21	17.1	
20		124	24	19.4	
21		126	22	17.5	
22		131	24	18.3	
23		138	23	16.7	
24		145	24	16.6	
25		154	30	19.5	
26		160	30	18.8	
27		188	35	18.6	
28		191	31	16.2	
29		194	33	17.0	
30	241-400	204	33	16.2	
31		207	40	19.3	
32		226	43	19.0	
33		246	42	17.1	
34	401-600	313	51	16.3	

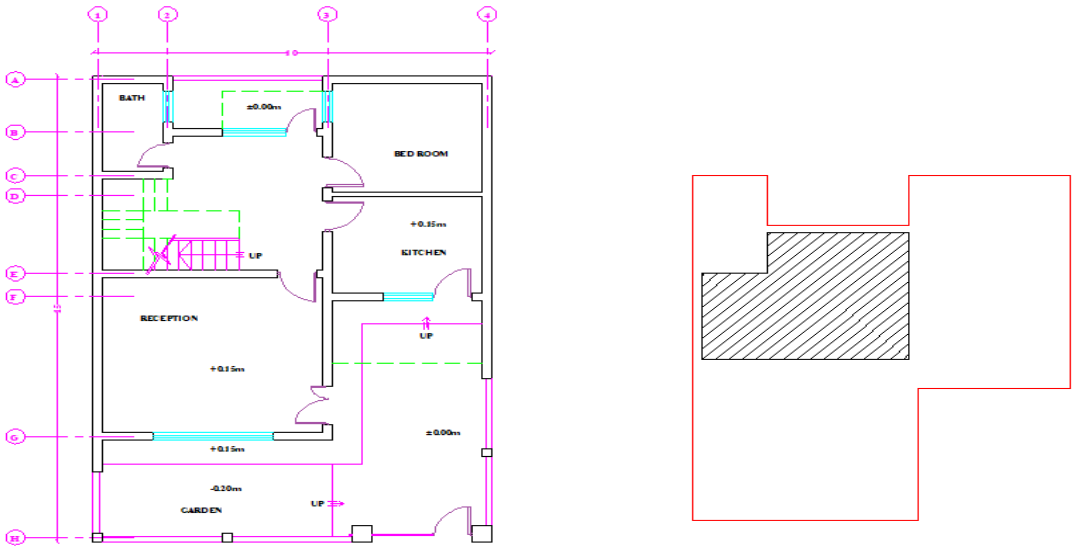


Figure 8. A house plan and the building area, the area of the stairs, and the internal corridors

Based on Table 4, it is possible to clarify the relationship between the built-up area and the area of the staircase area and the internal corridors and staircase. As shown in Fig. 9, it is found that there is an inverse relationship between the two regions. The larger the built-up area, the lower its percentage, and vice versa

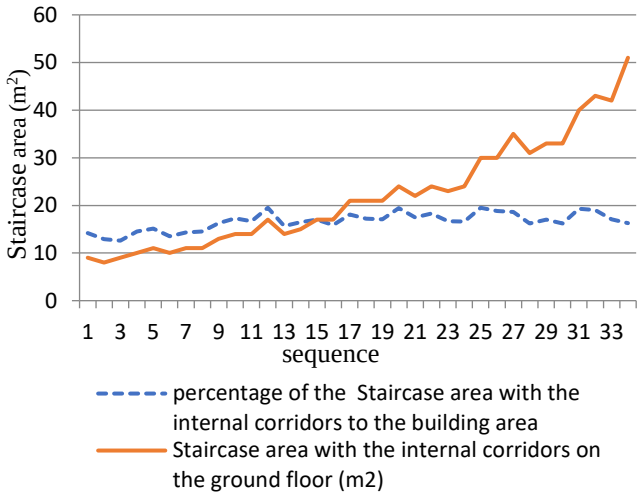


Figure 9. Relationship between the area of the staircase area and internal corridors and their Percentage.

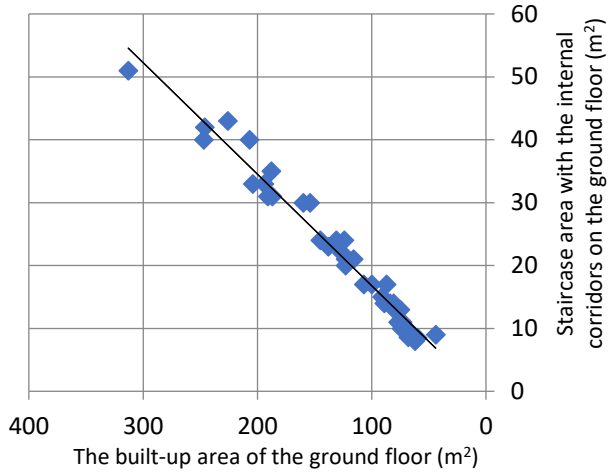


Figure 10. Simple linear regression

According to Table 5 and the simple linear regression equation, as well as the remaining built-up area, the area of the staircase with internal corridors can be estimated.

Fig.10 shows the application of the simple linear regression equation to the building area, the area of the staircase area, and internal corridors (according to the computer program, where the resulting equation is:

$$Y = 0.1773x - 0.9427$$

Where (Multiple R (regression) = 0.98) means a very strong relationship between the two variables. The (R(regression) Square = 0.97) implies that changing the building area significantly impacts changing the area of internal corridors and staircases. The adjusted R(regression) Square = 0.96 means that 96% of the wall area is related to the house's location.

6.4. Total area of walls, interior corridors, and staircase area

Accordingly, it can reach the final percentage of the approximate area occupied by interior corridors and staircase area (17%), where it will be (34%), which is the approximate percentage of the area occupied by walls, interior corridors, and staircase.

Therefore - and in the presence of this percentage - the architect can refer to it as a measuring point for his design because within the natural state of designing a house - without special requests - the percentage of the area of the walls, internal corridors, and the location of the stairs for his design should fall within one of the three cases: by the walls, internal corridors and staircase are Percentage of wall area (17%) + Percentage.

The first case / (the Percentage is greater than 34%) means there is a defect in the design, as there are lost areas due to the design of the walls, internal corridors, and the area of the stairs.

The second case / (the Percentage is less than 34%) means that the design is good and efficient, as there are no lost areas due to the walls, internal corridors, and staircase area design.

The third case / (the Percentage is equal to or close to 34%) means that the division of area is within the limits of the design of walls, internal corridors, and staircase area.

Table 5. Area based on Baghdad Municipality controls and simple linear regression equation

Area of plot (m^2)	Building percentage %	Built-up area (m2)	Area of stairs and corridors according to the equation of simple linear regression (m_2)	Built-up area without stairs and corridors (m^2)	Percentage of area for stairs and corridors %
240-120	80	192-96	33-16	159-80	17.2-16.7
400 -241	65	260-156	45-27	215-129	17.4-17.1
600 -401	60	360-240	63-42	297-198	17.5-17.3
800 -601	55	440-330	77-58	363-272	17.5-17.4

Human beings live their daily lives largely in indoor spaces regardless of their description and vital functions [20]. Therefore, Taking care of the interior space is very important, and knowing the percentages of walls, stairs, and corridors helps to achieve an efficient interior design.

Therefore, due to the presence of such influential spaces in the design of the house, it becomes necessary to consider the interior design to exploit these areas. Therefore, the comparison process referred to above is very necessary for the architect to reduce the cost on the one hand and to save better spaces for the rest of the home area on the other hand, to obtain a healthy indoor environment, appropriate lighting, and ventilation must be obtained [21]. Increasing the area of walls will reduce ventilation and healthy lighting. Therefore, knowing the approximate percentage of wall space is important in reducing the negative effects within the home spaces.

7. Conclusions and Recommendations

The approximate Percentage of the area of the walls, stairs, and internal corridors of a house compared to the built area of the ground floor is 17% for the area of stairs and internal corridors and 17% for the area of walls, and the total Percentage is (34%). The presence of such a percentage can be a criterion for measuring the efficiency of the design. There is an inverse relationship between the area of the walls and the area of stairs and internal corridors and their Percentage on the one hand and the built-up area on the other. The larger the built-up area, the lower the Percentage and vice versa. Such a percentage can provide an initial image for the architect through which he can give the client a preliminary visualization of the space area, thus reducing problems between the architect and the client. The research recommends explaining the percentages of walls, interior corridors, and stairs within the university study of architecture and how to benefit from this knowledge. It is recommended also to make calculations for the spaces of the walls, the stairs, and the internal corridors for several buildings with different spaces, such as schools, residential buildings, and others. Studying the effect of wall areas, stairs, and internal corridors on fires in the house.

Author Contribution Statement

Hassan Faisal Jaafar suggested the research problem and defined its limits and importance.

Abdulbaqi Ghazi Hussein suggested preparing a practical study to reach conclusions about the research problem.

Ali I. Sabur prepared the accounts and models for the practical study.

Hassan F. Jaafar, Abdulbaqi G. Hussein, and Ali I. Sabur reviewed the results and formulated conclusions and recommendations.

Conflict of interest

The Authors confirm that the publication of this article causes no conflict of interest.

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