The Relationship between the Servant Spaces and the Served Spaces in Single Families Residential Patterns: Baghdad as a Case Study

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Abstract. Servant and Served spaces is a concept used in Architectural theory and planning; Servant space represents those spaces that connect, frame and enable the served spaces to perform its functions. Servant Spaces could be a circulation space (a stair, a corridor), a storage, a bathroom, a mechanical room, or any auxiliary space. In this research, we tried to study the relationship between the servant spaces and the served spaces in different types of Baghdadi house plans based on temporal division through a period of 120 years, started from the beginning of the 20th century till now. Research goals are: to address the role of this relationship in organizing the plan of the house in Baghdad city for the above mentioned period, to find the different types of the relationship between the Servant spaces and the Served spaces, and how it had been changed through time. Depending on a descriptive, analytic, and logical reasoning methodology. The research had examined four patterns of houses which represent the main shifts in Baghdadi house plans. The research found that the placement and utility of the Servant and Served spaces is one of the main factors that give each pattern its characteristics, so the served spaces achieve beauty all their own.

1. Introduction
Servant and served spaces, is an idea used in architectural theory and planning; that the Servant space is the domain of utilitarian spaces that link, shape, and allow the served space to perform its formal task. A servant space may be a staircase, a corridor, a storage, or similar secondary space. [1] Palladio denotes his concept about these spaces in The Four Books of Architecture that there are different size of rooms, small rooms can be considered as servant spaces which would not be appropriate to place in rooms where one sits or sleeps.[2] Palladio’s houses aim to fulfill platonic ideals intended to apply anywhere and for everyone [3]. Louis Kahn echoed this idea at a 1961 meeting of ”main and supporting spaces” and discovered that small spaces are intended to enhance and serve the main spaces. [4] The idea clarified two spaces. First, the servant spaces are either separated or grouped into a service block that contains services and utilities such as mechanical rooms, storage rooms, kitchens, bathrooms, and circulation like stairs or corridors. Secondly, served spaces which can also be considered habitable space when the servant space is the inhabitable space. [5] As for the Frank Lloyd Wright’s Winslow House compactly internalized small service spaces for pantry, kitchen, entrance, etc. without affecting the single living spaces. He used geometric patterns to merge new services into cascading house plans [2].
While Francesco Cacciatore in 2011 introduces a different concept to refer to Kahn’s relationship between servant and served space, Cacciatore assumes the ‘auxiliary and main’ term to distinguish between servant and served spaces. Auxiliary areas are a servant or secondary spaces. While the main areas are served or primary spaces [6].

Considering the single-family housing in the city of Baghdad, different shapes and patterns can be found depending on plan organization, with different numbers of each pattern through time. The Baghdadi idea of a house goes far beyond physical aspects, this idea has gained a new relationship with the modernization of society. In Iraqi architecture, every need is realized in design issues as well as in socio-physical systems. The research assumes that changing the relationship between the servant spaces and the served spaces will change the organization of the plan of the house, which reflects a specific pattern of the house design. The Baghdadi house includes flexible complexity in a multi-grouping space, not only in the number of the spaces but, also in the multiplicity of functions for each space. Therefore, there were many local studies, that studied the housing unit in Baghdad in particular, but it did not deal with the servant and served parts of residential spaces, rather, they discussed changing the house with a focus on the joints of the inward or outward-looking plans, and the “zones,” such as sleeping zones, living zones, etc. as in Faiz Al-Beiruti study [7] that the research relied on. Some of these studies were focused on studying the pattern or style only or the social aspects, others were focused on the cultural or legislative aspects and their impact on the house plan like John Warren and Ihsan Fathi [8], Saher Al-Qaissi [9], Hala Ala al-Din [10], and Roqaia Basem’s study and others [11]. In this research, the relationship of the servant and served spaces of the house patterns in Baghdad was studied for the past 120 years from the beginning of the 20th century till now. The research is based on previous researches and studies and the in-site observation of the researcher, it was found that the significant change in pattern had occurred after a specific crisis, represented by the war, and the new pattern continued and dominated mainly after the enactment of a new housing law related to that crisis. So we were able to reach a division of the stages of change starting with the “Traditional houses” pattern that was prevailed till the British occupation of Iraq in 1917 (Figure 1).
Then the pattern was shifted to a “Detached, Semi-detached, and row houses” which lasted to the year 1980 the outbreak of the Iran-Iraq war to record another shift in residential house changes, so two of the three patterns mentioned above disappeared and the “attached pattern” continued only till the United States occupation of Iraq in 2003, which gave rise to the emergence of a new pattern of the single-family house, that started as an extended-family house and developed later on to the “Multi-family House pattern”, and These are the stages on which the research will depend in studying the nature of the servant and served spaces and its relationship.

2. Method of the study

The research is based on ‘Analytic Thinking’, which is based on dividing the problem into smaller parts, and, according to the above, the relationship of the servant and served spaces within the single-family house was studied in each pattern. An analytical study was made for several housing plans from the city of Baghdad within its various sectors and for each pattern of the four main patterns that we found through the period of the study (9 samples of each pattern), which represent random samples throughout the period of the emergence of each pattern.

The research studied the calculation of the area of each space (servant and served), its percentage from the whole area of the plan, the location of each space, and the relationship of spaces based on the servant and served concept. These factors were represented in six tables, each related to one of the main patterns, and the other two are part of the same second pattern. The table represents the average value gained from the 9 samples. A model plan of each pattern was chosen to demonstrate the organization of the spaces, and to indicate the servant spaces and the served spaces in different plan levels. The research had adopted the UCL Depthmap method to reach the degree of spaces connectivity which represents the efficiency of the circulation area, as a servant spaces; and its relation to the served spaces, as it is the dominant factor in arranging spaces in the plan. A helpful method applied to simulate these spaces with UCL Depthmap. It is a specialized software pack that participates in the evaluation and identification spaces. It had created at London University by Alasdair T. to perform an analysis based on the indices of connectivity, integration, and depth for these spaces [12]. Visibility graph analysis used in cases where the objects of study indicate complexity in patterns. The essential of this analysis is the connectivity areas from a particular point. Therefore, this graph is based on the rebound of the light and specifies the shifting patterns in people's behavior in the environment [13]. Given that, our aim is to implement an analysis on the architectural level, so this graph analysis is relied on to examine space syntax. The results of the analysis is a colored map, in which each indicator is represented by colors from red (represents maximum value) to blue (represents minimum value).

3. Traditional House

The traditional house is the first pattern studied in this research, its design reflects the social, economic, cultural, and environmental aspects of Baghdadi people. Mainly, spaces were arranged around a single courtyard; (with some exceptions where the house had 2nd or 3rd courtyard). The courtyard represents the center of the activities of the family, with regular geometric boundaries, that links different spaces with each other. It was built in two levels with one or two basements, an upper portico, upper bedrooms with a wooden window called ‘Shen Schol’ to achieve privacy of inner living spaces and the visual connection with the outside [8] (Figure 2).

The servant spaces are different from served spaces in summer and winter due to the nature and intensity of use of these spaces. From (Table 1) we find that the servant spaces used in the summer are: entrance, kitchen, bathroom, lavatory, storage, arcade, and tarma on the first floor, while in winter they are: entrance, kitchen, bathroom, lavatory, arcade, basement, neem, courtyard (which is mostly used as a node and distributor except for the sunny areas in the first part of the day). The roof-top terrace changed from being a served space in the summer to be a servant space in the winter to be used for drying clothes or store things. The calculation indicates that the percentage of servant spaces is 17.1% of the total built-up spaces, it occupies 16.5% of the ground floor area in summer. it also constitutes 41.7% of the total built-up spaces, which occupies 43% of the ground floor area in winter.
Figure 2. Regular geometry sample of the courtyard house in Baghdad and Connectivity graph analyses [14, 15].

Table 1. Set of constraints used in the Traditional House experiments.

| Space       | Existence | Dimensions (M) | Area (M²) | Relationship |
|-------------|-----------|----------------|-----------|--------------|
|             | S^a W^b  | min  | max  | min  | max  |                 |
|             |           |      |      |      |      |                 |
| 0  | Basement/neem  | • | □ | 3.4 | 8.9 | 27.2 | 33.8 |
| 1  | courtyard  | • | □ | 4 | 14.9 | 22.8 | 137.7 |
| 2  | entrance  | □ | □ | 1.4 | 12 | 6.08 | 51.6 |
| 3  | guestroom  | • | □ | 3.6 | 12.4 | 19.6 | 75.6 |
| 4  | Living room  | ○ | - | - | - | - | - |
| 5  | dining  | ○ | - | - | - | - | - |
| 6  | library  | ○ | - | - | - | - | - |
| 7  | bedroom  | • | □ | 3.1 | 8.2 | 14.8 | 43.9 |
| 8  | iwan  | • | □ | 2.4 | 3.2 | 13.2 | 36.6 |
| 9  | kitchen  | □ | □ | 2 | 6.3 | 5.2 | 15.4 |
| 10  | tarma  | • | □ | 3.3 | 9.1 | 18.7 | 25.7 |
| 11  | bath  | □ | □ | 1.2 | 6 | 2.24 | 11.4 |
| 12  | lavatory  | □ | □ | 1.2 | 1.3 | 1.56 | 1.3 |
| 13  | storage  | □ | □ | 1.1 | 6.3 | 2.2 | 12.6 |
| 14  | tlar  | • | □ | 2.9 | 11.4 | 13.9 | 37.9 |
| 15  | Stairs  | □ | □ | 0.9 | 6.2 | 2.8 | 8.1 |
| 16  | Void  | ○ | - | - | - | - | - |
| 1  | bedroom  | • | □ | 3.1 | 8.2 | 14.8 | 43.9 |
| 2  | arcade  | □ | □ | 1.8 | 7.7 | 15.2 | 26.3 |
| 3  | ursi  | • | □ | 3 | 7.2 | 18.6 | 54.6 |
| 4  | kabishkan  | • | □ | 2.6 | 3.4 | 9.1 | 12.6 |
| 7  | balcony  | ○ | - | - | - | - | - |
| 1  | roof  | • | □ | - | - | 150 | 588 |
| 2  | garden  | ○ | - | - | - | - | - |
| 3  | garage  | ○ | - | - | - | - | - |
| 4  | circulation  | • | □ | - | - | 27.7 | 89 |

The served spaces also differ in summer from winter. In the summer it consists of: the basement, neem, courtyard, guest room, bedrooms, tarma, iwan, kabishkan, and ursi on the first floor, the roof-top terrace is a served space in summer. In winter, they are the guest room, bedrooms, tlar, tarma, and iwan on the ground floor because most of these spaces are doubled, one of which is used in summer and the...
other in winter for most studied samples. As for the first floor, the served spaces are the bedrooms, kabishkan, and ursi. The served spaces constitute of 82.9% of the total house space, which is 83.5% of the total ground floor area in summer. It also constitutes 41.7% of the total built-up spaces, which is 57.3% of the ground floor area in winter.

We find from (Figure 2) that the relationship between the served and the servant spaces is (inclusion/contiguity), where the servant spaces completely fold into the served spaces without coinciding with them. In addition to the continuation of these spaces with the served spaces represented by the courtyard, as the servant area falls behind at the (end) of the served area.

4. Detached, Semi-detached, Attached Houses

The arrangement of these three patterns was due to the enactment of Road and Buildings law to determine the division of residential plots between (100m² - over 2000m²) depending on certain standard for controlling urban neighborhood fabric[7], as a result, the single-family house had been changed from inward-looking planning to outward-looking planning, which designated a decline in traditional house pattern in favor of a new modern design house, more suitable to the new class of governmental employees. This had addressed the presence of a new pattern (the villa) [16].

4.1. Detached House

The joints of the relationship between the public and the private parts as well as the servant and served spaces differed due to the location of the house within the plot (Figure 3) (Table 2) [9]. The house orientation was shifted from the courtyard to joining the house mass towards the outer space (the garden), but the place of the courtyard relative to the house spaces were preserved (plan A), especially at the beginnings of this pattern and it was called ‘the hall’, which was used as a living space for the family, even though it was contained the staircase to upper floor [17]. In this pattern, the served spaces are: Guest room, living and/or the ‘hall’ (which remained an alternative space of living until the 1950s then it became as shown in plan B), and bedrooms for the ground floor. We also note the emergence of a dining space (in the samples after the 1940s), which is commonly located near the kitchen and connected to the guest room, and in the continuation of the pattern (in the 1960s) we had noticed the emergence of another served space, the library, which was not found in houses before that time. As for the first floor (if any), it contains bedrooms, a balcony, while the roof-top terrace remains used as a Served space for sleeping during the summer and abandoned in winter. The under-ground basement continued the same use of the (traditional) pattern, but with the continuation of the pattern, it began to disappear in some samples and the room space disappeared permanently.

The served spaces constituted of 56.5% of the total house built-up area; a 54.6% -62.8% of the total ground floor area depending on the number of levels found in the house. The servant spaces consisted of:
the entrance, kitchen, bathroom, lavatory, and storage, but the "hall" overlaps between the served and servant area because it was used as a living room, also; it connects the different spaces of the house horizontally and (in most samples) vertically, by containing the staircase space. As for the first floor (if any) it contains a corridor leading to the rooms and possibly a bathroom. As for the roof-top terrace, it is left at most times (except summer season) and usually contains another storage to store things. The basement (at the ends of the pattern) used for safety purposes due to wars or for storage. The servant spaces percentage was 43.5% of the total built-up area and 37.2% - 45.4% of the ground floor area. The relationship between the served spaces and the servant spaces is (exclusion / overlapping), where the servant spaces are fully excluded from served spaces and vice versa, while there is interference in some servant spaces like living space, corridor, and circulation.

| Table 2. Set of constraints used in the Detached House experiments. |
|---------------------------------------------------------------|
| **level** | **Space** | **Existence** | **Type** | **Dimensions (M)** | **Area (M²)** | **Aspect ratio** | **FAR** | **BCR** | **Served area** | **Servant area** | **Relationship type** |
|----------|----------|---------------|---------|-------------------|--------------|-----------------|--------|--------|----------------|----------------|---------------------|
| 0        | Basement | ●             | ■ □    | 3.6               | 7.4          | 12.6            | 45.3   |         |                |                |                     |
| 1        | courtyard | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 2        | entrance  | ●             | □      | 1.8               | 4.6          | 4.6             | 16.5   |         |                |                |                     |
| 3        | guestroom | ●             | ■       | 3.6               | 9.6          | 20.1            | 72     |         |                |                |                     |
| 4        | Living room | ● | ■ □ | 3.8 | 8.3 | 18.2 | 46.5 |         |                |                |                     |
| 5        | Hall      | ●             | ■ □    | 5.6               | 7.6          | 42.5            | 42.5   |         |                |                |                     |
| 6        | dining    | ●             | ■       | 2.9               | 6.4          | 11.3            | 26.8   |         |                |                |                     |
| 7        | library   | ●             | ■       | 2.8               | 7.2          | 9.5             | 38.8   |         |                |                |                     |
| 8        | bedroom  | ●             | ■ □    | 3.6               | 6.5          | 14.8            | 28.6   |         |                |                |                     |
| 9        | iwan      | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 10       | kitchen  | ●             | □      | 2.1               | 8.5          | 8.6             | 35.7   |         |                |                |                     |
| 11       | tarma    | ●             | ■       | 1.8               | 11           | 8               | 51.8   |         |                |                |                     |
| 12       | bath      | ●             | □      | 1.2               | 4.6          | 2.2             | 9.9    |         |                |                |                     |
| 13       | lavatory | ●             | □      | 1.4               | 4.6          | 1.5             | 5.5    |         |                |                |                     |
| 14       | storage  | ●             | □      | 1.1               | 7.9          | 2.3             | 26.8   |         |                |                |                     |
| 15       | tlar      | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 16       | Stairs    | ●             | □      | 0.9               | 6.5          | 3.2             | 16.1   |         |                |                |                     |
| 17       | Void      | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 1        | bedroom  | ●             | ■ □    | 3.6               | 6.5          | 14.8            | 28.6   |         |                |                |                     |
| 3        | ursi     | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 4        | kabishkan | ○             | - - - - |                   |              |                  |        |        |                |                |                     |
| 5        | bathroom | ●             | □      | 1.2               | 4.6          | 2.2             | 9.9    |         |                |                |                     |
| 6        | lavatory | ●             | □      | 1.4               | 4.6          | 1.5             | 5.5    |         |                |                |                     |
| 7        | balcony  | ●             | □      | 2.4               | 4.4          | 8.8             | 14.4   |         |                |                |                     |
| 8        | garage   | ●             | □      | 3.1               | 12.6         | 15              | 66.9   |         |                |                |                     |
| 3        | circulation | ○ | - | 329 | 851 |                |        |        |                |                |                     |
| 4        |            | ○             | - - - - |                   |              |                  |        |        |                |                |                     |

4.2. Semi-detached House
This pattern can be represented by the projects designed and constructed by western consultancy Foundations such as Doxiades, which had plans for Yarmouk, Zayouna, Sadr city, and western Baghdad housing project (Figure 4) [17].
The Yarmouk housing project represented a semi-governmental sector designed to accommodate governmental employees depending on modern Architectural style (Table 3) [9]. Each house was attaching its neighbours’ house from one side and detached from the other 3 sides. The hall disappeared and replaced by a space designed as a living room [7]. From (Table 3), we can find that some of the spaces were merged together such as the guest room, living, and dining with the possibility of separation by a sliding door. Library space was no longer be found in this pattern and the pattern reflects an increase in the servant spaces. The garden was present in front of the house and in the other two sides. The percentage of served spaces was 55.8% of the total built-up area of the house, while the servant spaces percentage was 44.2%. This pattern indicates different organization of spaces by using a service outdoor open space that the servant spaces were arranged around it, such as the kitchen, the storage, and the bathroom resulting in a kind of separation between the servant spaces and the served spaces, to create separated zones of the servant and served spaces.

**Table 3:** Set of constraints used in the Semi-detached House experiments.

| level   | Space      | existence | type | Dimensions (M) | Area ($m^2$) | Aspect ratio | FAR$^a$ | BCR$^b$ | Served area | Servant area | Relationship type |
|---------|------------|-----------|------|----------------|--------------|--------------|---------|---------|-------------|--------------|-------------------|
| Ground floor | entrance | ● | □ | 1.4 | 5.1 | 2.7 | 14.8 |
|          | guestroom | ● | ■ | 3.4 | 11 | 25.1 | 53 |
|          | Living room | ● | □ | 3.7 | 8 | 18.1 | 60 |
|          | dinning   | ● | ■ | 2.6 | 5.6 | 8.5 | 25.2 |
|          | library   | ○ | - | - | - | - | - |
|          | bedroom   | ● | □ | 3.1 | 5.7 | 14 | 30.2 |
|          | kitchen   | ● | □ | 3.2 | 6.1 | 11.2 | 23.5 |
|          | tarma     | ● | ■ | 1.6 | 13.8 | 6 | 34.5 |
|          | bath      | ● | □ | 1.4 | 4.5 | 3.2 | 9.4 |
|          | lavatory  | ○ | ■ | 0.8 | 2.4 | 1.3 | 3 |
|          | storage   | ● | □ | 1.6 | 6.6 | 5.0 | 39.6 |
| First floor | Stairs   | ● | □ | 0.8 | 6.9 | 4.7 | 11.7 |
|           | Void      | ● | □ | 3.9 | 4.8 | 18.7 | 18.7 |
|           | bedroom   | ● | □ | 3.6 | 6.5 | 14.8 | 28.6 |
|           | bathroom  | ● | ■ | 1.4 | 4.5 | 3.2 | 9.4 |
|           | lavatory  | ● | □ | 0.8 | 2.4 | 1.3 | 3 |
|           | balcony   | ● | ■ | 6.4 | 14.3 | 23.8 | 96 |
|           | roof      | ● | □ | - | - | 114 | 250 |
|           | garage    | ● | □ | 2.9 | 18.9 | 25.6 | 79.3 |
|           | circulation | ● | □ | - | - | 6.5 | 48 |
| Overall plan |          | ● | □ | 390 | 1069 | - | - |

$a$ Floor area ratio  $b$ Building coverage ratio  ● exist  ○ not exist  ■ Served space  □ Servant space
The relationship between the served and the servant spaces is (exclusion / contiguity), where the servant spaces are fully excluded from served spaces, while there is also a possibility of opening and continuing between the spaces as in dining space and guestroom to became one big space if needed.

4.3. Attached or Row House
The foundation of the Iraqi state, with its development needs and the enactment of construction process laws, had a major impact on the outcome of the next phase [18]. Lands acquired and new suburbs constructed for low income families. Doxiades proposed plans in the 1950s, in a quick time, large (row houses) suburbs appeared [19]. These houses did fulfil only the basic needs of these families. Because the spaces have been greatly reduced from the previous two patterns [20], which makes each house has only a living room/guestroom, one room for men and another for women, kitchen, pantry, lavatory, and the necessary verandas. All the above estimated between 80- 100 m² [21] (Figure 5). the served spaces in this pattern are: the guestroom and/or living room, dining room which is not found in the samples with an area less than 100 m² but replaced by a part of the kitchen space as a corner for family's meals to start the overlap between these two spaces, one bedroom on the ground floor or more, some Samples with an area less than 100 m² does not contain a bedroom on the ground floor (Table 4).

While the tarma used for sitting and presenting the entrance. The first floor usually contains bedrooms and perhaps a balcony overlooking the garden. The roof-top terrace has kept its function as mentioned previously. Served spaces occupies 55% of the built-up area and between 58% -69.1% of the ground floor area. As for the servant spaces, the entrance precedes the spaces of the residential unit, which may be work as a distributor and connect all the house spaces. The kitchen area has increased as a result of allocating part of it as a corner for dining and family (especially in samples that do not contain a separate living room), a bathroom, toilet, and perhaps a storage also are servant spaces. The space under the stairs is usually used as a storage or for WC. This pattern usually contains outdoor open space ‘void’ which has become very common as an external servant space. The balcony (in some samples) contains an external ladder that leads to the roof which remains preserving its function as in the previous patterns.

We also notice that the garage, in small area samples, replaced by the tarma (as a result of the fact that this pattern is intended for people with limited income who normally do not own a car). This part occupies 45% of the built-up area and between 30.9% -42% of the ground floor area. The relationship between the served spaces and the servant spaces is (contiguity / overlapping), as the servant spaces were surrounded by the served spaces without matching them. Rather, there is communication and overlapped between them, as in the entrance, kitchen, and dining.
Table 4. Set of constraints used in the Row House experiments.

| level  | Space                  | exist | type          | Dimensions (M) | Area (M²) | Aspect ratio | FAR a | BEC b | Served space | Servant space | Relationship type |
|--------|------------------------|-------|---------------|----------------|-----------|--------------|-------|-------|--------------|---------------|-------------------|
|        |                        |       |               | min | max | min | max |       |       |              |               |                   |
| 1      | entrance               | •     |              |     |     | 1.4 | 4   | 6.7  | 7.2 | 2.25 | 26.6 |                  |                  |                   |
| 2      | guestroom              | •     |              |     |     | 3.4 | 10.5| 15.3 | 15.0| 30.0 | 76.5 |                  |                  |                   |
| 3      | living room            | •     |              |     |     | 3.5 | 6.5 | 15.0 | 15.0| 30.0 | 76.5 |                  |                  |                   |
| 4      | dining                 | •     |              |     |     | 2.6 | 6   | 6.1  | 6.1 | 27.3 | 45%  |                  |                  |                   |
| 5      | bedroom                | •     |              |     |     | 3   | 6.3 | 14   | 14  | 27.0 | 55%  |                  |                  |                   |
| 6      | kitchen                | •     |              |     |     | 2.6 | 7.7 | 9.6  | 9.6 | 35.4 | 0.71 |                  |                  |                   |
| 7      | tarma                  | •     |              |     |     | 1.7 | 7.4 | 6.2  | 6.2 | 32   | 0.71 |                  |                  |                   |
| 8      | bath                   | □     |              |     |     | 1.5 | 3.9 | 2.8  | 2.8 | 11.0 | 0.71 |                  |                  |                   |
| 9      | lavatory               | □     |              |     |     | 0.9 | 3   | 3    | 3   | 11.2 | 0.71 |                  |                  |                   |
| 10     | storage                | □     |              |     |     | 1.5 | 4.6 | 3    | 3   | 11.2 | 0.71 |                  |                  |                   |
| 11     | Stairs                 | □     |              |     |     | 0.9 | 5.8 | 3    | 3   | 16.25| 0.71 |                  |                  |                   |
| 12     | Void                   | □     |              |     |     | 1.4 | 9.2 | 3.7  | 3.7 | 20.6 | 0.71 |                  |                  |                   |
|        |                        | □     |              |     |     | 3   | 6.3 | 14   | 14  | 27.0 | 55%  |                  |                  |                   |
| 1      | bedroom                | •     |              |     |     | 1.5 | 3.9 | 2.8  | 2.8 | 11.0 | 0.71 |                  |                  |                   |
| 2      | bathroom               | □     |              |     |     | 1.5 | 3.9 | 2.8  | 2.8 | 11.0 | 0.71 |                  |                  |                   |
| 3      | lavatory               | □     |              |     |     | 0.9 | 3   | 3    | 3   | 11.2 | 0.71 |                  |                  |                   |
| 4      | balcony                | □     |              |     |     | 1.2 | 9   | 10.8 | 10.8| 36   | 0.71 |                  |                  |                   |
| 5      | roof                   | □     |              |     |     | -   | -   | -    | -   | -    | -    |                  |                  |                   |
| 6      | garden                 | □     |              |     |     | -   | -   | 47   | 47  | 363  | 0.71 |                  |                  |                   |
| 7      | garage                 | □     |              |     |     | 2.6 | 18.4| 14.2 | 14.2| 82.8 | 0.71 |                  |                  |                   |
| 8      | circulation            | □     |              |     |     | -   | -   | 9.4  | 9.4 | 50.3 | 0.71 |                  |                  |                   |
| Overall |                      | □     |              |     |     | 83  | 685 | 83   | 685 |                  |                  |                   |

a Floor area ratio
b Building coverage ratio
• exist □ not exist □ Served space □ Servant space

5. Attached House

In the mid-1980s, an agreement was reached to do a comprehensive development plan for Baghdad but the work stopped after the Gulf War broke out in 1990 [19]. The government specified the area of reclassified residential plots within 200m², which permitted to build more than one house on one plot [22]. During this period, the concept of merging two spaces into one space appeared (Figure 5) [11].

The proportion and numbers of servant spaces and served spaces changed significantly from the previous patterns due to the functional changes of these spaces (Table 5). The dining space begins to disappear as a standalone space permanently so, part of the guest room devoted for it. The living space is usually combined with the staircase (in most samples) and part of the kitchen joined to the served spaces due to allocating a corner for dining which called locally (cold kitchen). The tarma has become
too close to the street and not suitable for sitting. The garden begins to disappear, and its area has significantly decreased. The served spaces constitute 59.67% of the total built-up area of the house, which constitutes approximately 65.1% of the ground floor area.

As for the servant spaces, the entrance has become connected to an additional WC space dedicated to guests, and there is duality in function of the living space, as it became a distributor and living. The tarma retracted its use from an external sitting space to a corridor to enter the house. The bathroom and WC spaces overlapped from two spaces to one only. The outdoor open space 'void' space became more important to ventilate spaces, and the number of these spaces in one house has increased, while its area decreased.

The need for a bathroom attached to the bedroom increased because of the new young families living with their parents. The balcony area shrank dramatically than before and restricts its use as a servant space and for aesthetic purposes only. The roof-top terrace has also become a servant space and is no longer used for sleeping. The servant spaces percentage was 40.33% of the total built-up area of the house, which constitutes approximately 34.9% of the total ground floor area. The servant space was surrounded by the served space, so the relationship indicates inclusion and the intersections between the living room, corridor, and the stairs, as well as the dining/kitchen and dining/guest room, makes the relationship between these spaces (Inclusion / intersection).

Table 5: Set of constraints used in the Attached House experiments

| level | Space   | existence | type      | Dimensions (M) | Area (M²) | Aspect ratio | FAR | BCR³ | Served area | Servant area | Relationship type |
|-------|---------|-----------|-----------|---------------|-----------|--------------|-----|------|-------------|--------------|-------------------|
|       |         |           |           | min | max | min | max |      |       |             |              |                   |
|       |         |           |           |     |     |     |     | 1.61 | 81%  | 59.97% | 40.33%       |                   |
| 1     | entrance | ●         | □         | 1.3 | 1.8 | 1.8 | 3.25 |     |       |             |              |                   |
| 2     | guestroom | ●         | □         | 3.2 | 8.7 | 10.5 | 39.1 |     |       |             |              |                   |
| 3     | Living room | ●         | □         | 2.5 | 7.1 | 11   | 39.0 |     |       |             |              |                   |
| 4     | dining    | ○         | -         | -   | -   | -   | -   |     |       |             |              |                   |
| 6     | bedroom   | ●         | □         | 3   | 5.75 | 8.7 | 22.8 |     |       |             |              |                   |
| 7     | kitchen   | ●         | □         | 1.6 | 12.5 | 6.18 | 43.7 |     |       |             |              |                   |
| 8     | tarma     | ●         | □         | 1.5 | 6.25 | 4.35 | 10.2 |     |       |             |              |                   |
| 9     | bath      | ●         | □         | 1.3 | 3.5  | 2.7  | 6.3  |     |       |             |              |                   |
| 10    | lavatory  | ●         | □         | 1.1 | 2.3  | 1.65 | 3.8  |     |       |             |              |                   |
| 11    | storage   | ●         | □         | 1.2 | 2    | 2.4  | 2.4  |     |       |             |              |                   |
| 12    | Stairs    | ●         | □         | 0.9 | 6.8  | 3   | 9.2  |     |       |             |              |                   |
| 13    | Void      | ●         | □         | 1   | 5    | 2    | 6.25 |     |       |             |              |                   |
| 1     | bedroom   | ●         | □         | 3   | 5.75 | 8.7 | 22.8 |     |       |             |              |                   |
| 2     | bathroom  | ●         | □         | 1.3 | 3.5  | 2.7 | 6.3  |     |       |             |              |                   |
| 3     | lavatory  | ●         | □         | -   | -    | -   | -    |     |       |             |              |                   |
| 4     | balcony   | ○         | -         | -   | -    | -   | -    |     |       |             |              |                   |
| 1     | roof      | ●         | □         | 0.9 | 2.3  | 2    | 3.3  |     |       |             |              |                   |
| 2     | garden    | ●         | □         | 0.9 | 2.3  | 2    | 3.3  |     |       |             |              |                   |
| 3     | garage    | ●         | □         | 2.7 | 12   | 10.5 | 32.4 |     |       |             |              |                   |
| 4     | circulation | ●         | □         | -   | 14   | 51.2 | 60   | 302 | 102 |             |              |                   |

6. Multi-family House

In the first decade of the 21st century, Iraq witnessed a significant change that had a reflection on architecture and housing, that was the enactment of the land ownership law, as well as the changes to building regulation by permitting to add a third floor for residential houses in 2004 [10]. As a result the internal migration that took place due to the unstable political condition, which had a great impact on Iraqi society, people had converted the upper floor to add a new apartment for sheltering young families (children or relatives) or used for rental purposes to increase the family's income [23]. This encouraged more and more divisions in these houses (Figure 6). Houses after 2003 witnessed a severe violation of the coverage rate, among its effects is the decrease and absence of gardens for most residential neighborhoods. They resorted to bypassing the front and side Setback and opens on small outdoor open space ‘void’ and some of them even opens windows on the street directly [24].
The most important characteristic of this pattern is that more than one unit is built on one residential plot and each floor has independent units with a shared external staircase. From (Table 6), the served spaces have shrunk dramatically in this pattern due to the small area of the residential unit and it occupying one or half floor only. That means these spaces are reduced to the minimum spaces only, which is a living and one or two bedrooms for most samples. These spaces constitute 54.5% of the area of the residential unit. The servant spaces are divided into two parts: one inside the unit and the other outside it. The kitchen, returned to being a kitchen only (usually opens to the living room). Due to the narrow-width of the housing unit and its longitudinal shape, made it contain a corridor that connects the backspaces. These spaces constitute 37.5% of the Residential unit area. As for the servant spaces outside the residential unit, they are; the stair and the open circulation that has become outside and shared for all units.

These spaces constitute 8% of the unit area on each floor. The servant spaces all-together (inside and outside the unit) constitute 45.5% of each unit area. The servant spaces like kitchen and bathroom were included within the served space, so the relationship indicates (Inclusion).
7. Discussion of the results
Looking from the point of view of the relationship between the servant spaces and the served spaces, the results of the case studied in this research indicates that the nature of the residential house in Baghdad had been changed a lot over time, which reflects different types of the relationship;

The nature of spaces, its function (servant or served), its location, and the number of spaces are interchanged with time relative to different seasons, responding to climatic change. In the traditional house pattern, the number of servant spaces had increased by 50% in winter, while in the detached house pattern, results showed more diversity in servant spaces due to the separation of the hall space from the living space, also the served spaces had decreased In number in spite of the emergence of new functions like the library space and the external garden. In the semi-attached pattern, the number of servant spaces had decreased due to the absence of hall space, also, the number of served spaces had decreased to (9 only), as the library and the hall was disappeared again because of the lack of area resulted from a smaller plot area. In raw house pattern, the number of the servant spaces continued falling down, that was because of some spaces like living, dining, and garden decreased in space area due to lower plot areas, while the number of the served area had been increased after transforming part of the kitchen space to served space. In the attached pattern the number and diversity of servant spaces reached its highest level among the studied patterns after transforming some of the served spaces to servant space such as the balcony, living, and the roof-top terrace space that was at the expense of the served spaces. The number of servant and served spaces decreased greatly, as a result of the great reduction in the plot area. Finally, the number of the servant and served spaces had reached its lowest value in the last pattern (the multi-family house unit) due to interference between different housing units that resulted from adopting a minimum space area, which was the result of the limited plot area. Circulation spaces were at their lowest proportions in the traditional pattern because the spaces were connected by the courtyard, which is a multifunction (served; servant) space. In the detached house pattern, the hall space replaced the courtyard, sometime it was restricted as a circulation space only. The corridor occupies an important part to connect the spaces in the Semi-attached house pattern. There were servant spaces such as the storage, the stairs, the toilet, and the entrance, these spaces were reduced to the minimum space in the raw house pattern due to the smaller plot area, and the entrance was used to connect the rest of the spaces at the ground level. In the attached house pattern corridors were merged with living room space that resulted to merge the staircase space with living space. Finally, corridors re-dominated the plan in the Multi-family House pattern that was due to the changes in plot dimensions and proportions to reach an unprecedented longitudinal shape with a ratio of more than 1:3 between the facade and the depth of the plot.

8. Conclusions
1. Servant and Served spaces relationship is one of the main factors that give the house a specific characteristic, which reflects a certain pattern of a single-family house.
2. It is a kind of a relative relationship, that may change from place to another and through time, sometimes it changes with seasons, like the case of traditional house pattern, as the number and function of spaces interchanges from Servant to Served or vice versa, otherwise, it changes due to the plot area and dimensions.
3. The Servant and Served spaces relationship is different in each of the four patterns that the research had focused on. The case study analysis indicates that it reflects a relationship of (inclusion/contiguity) in traditional courtyard house pattern, an (exclusion/overlapping) in detached house pattern, an (exclusion/contiguity) in Semi-detached house pattern, a (contiguity/overlapping) in Attached house patterns, and (Inclusion) in the last emerged multi-family house pattern.
4. Patterns are changing due to many factors: the socio-economic situation of the inhabitants which is, in the case of Baghdad city, had been affected by several economic and political events, that
led to a different kind of crises such as the English occupation in 1917, the outbreak of Iraq-Iran war in 1980, the United States occupation in 2003. Such crises had a major influence on the socio-economic level of the people, then on the urban environment, which was suffering from ignorance and outdated: As a result, the government had to change the laws, and standards for plots division with the lower area and minimum plot facades after 1980, that led to the prominence of the attached house pattern. And then after, in 2004, another change in housing standard had been enacted, by allowing to add a third floor to residential houses in Baghdad, which resulted in a shift from the single-family house unit to the multi-family house unit (the pattern number 4) in this study. The Servant and Served spaces relationship is changed relatively (the two spaces are overlapping and interacting with each other) and the plan organization of the house is suffering from lack of areas, lack of privacy with some shared spaces between more than one household.

5. The research is suggesting to control the process of design of the single-family houses with special care to the organization of Servant and Served spaces, which will lead to better plans and enhance the quality of life for Baghdadi people.

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