Functional Reuse of Contemporary Residential Houses to Multiple Functions in Baghdad: an investigation of the most widespread functions, using Sulaikh 600 as a case study

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Abstract. Functional reuse of contemporary residential houses for multiple functions has been recognised, as an obvious issue in several residential neighbourhoods in Iraq in general and Baghdad in particular. This issue is currently becoming more prominent for several economic, social, and other reasons. Many previous studies have dealt with the concept of reuse to preserve residential houses with historical value, and this concept has been developed in several contemporary residential houses based on the desire of their owners to preserve them via economic investment. This paper thus highlights the growing importance of issue. The research problem was identified by determining the impact of this issue the urban context to facilitate the design of levels for contemporary residential buildings based on a diagnosis and evaluation methodology. The aim of this paper thus to the most prevalent functions of such reuse and their positive and negative effects on the urban context and local design levels. The research adopted a descriptive and analytical method to examine a selected sample of the residential houses, (with eight examples taken from one Baghdad neighbourhoods (Sulaikh 600) which has a history of functional reuse of residential houses for multiple functions. This research found that the functional reuse of contemporary residential houses as educational locations (schools and kindergartens) is the most prevalent type due to its positive effects including compensation for the shortage of government institutions, outweighing the negative effects of increasing the number of users and placing heavier pressure on the infrastructure services of the residential area, which may be functionally unsuitable for non-residential functions. This supports the development of a periodic assessment and diagnosis of this issue by the concerned authorities to preserve residential neighbourhoods to meet urban and design standards by offering better provision for needs currently met in this way. Based on the large scale of the problem, the research also highlights each sample in an attempt to diagnose the case exclusively.

Keywords: functional reuse; residential houses; multiple functions; educational functions.

1. Introduction
The functional reuse of contemporary residential houses, as a process, refers to a change in the original function for which the property was designed to a new one; this has emerged in the changes that have occurred in residential houses in Baghdad after they construction of wide-scale residential neighbourhoods. A lack of assessment processes or any methodology for diagnosis and evaluation for contemporary residential houses that have been functionally reused to examine the advantages and disadvantages of this process means that previous research has identified a problem with a lack of knowledge about the effects of this issue on multiple functions in the urban context and design level. This paper thus offers a diagnostic and assessment system that allows assessment of the spread of new functions to determine the positive and negative impacts at both building level and in the urban context. It deals with the problem by clarifying the concept of functional reuse both linguistically and
idiomatically and defining its relationship to architecture to determine the current levels of such reuse and the reasons behind it. An applied study was also conducted in a residential area in Baghdad, Sulaikh 600, in an attempt to assess the effects of functional reuse of contemporary residential houses in Baghdad at the building and urban context levels in order to evaluate the most prevalent functions of such reuse in real terms.

2. Definitions of functional reuse
The definition of functional reuse used in this research was taken, linguistically, from both Arabic and English dictionaries, as well as idiomatic references and various fields of knowledge with the intent being to present a definition suitable for use in architecture. Linguistically, reuse in the dictionary of meanings [5] and the Oxford English dictionary [21] refers to the act or process of using again, implying a similarity of use in each cycle; however, from an ecological perspective, this includes the secondary use of things for the same purpose or for another purpose, with added modifications as needed. Engineering of materials refers to the reuse of materials in the construction process where these are incorporated without changing their inherent characteristics, though their shapes can be changed, and they can be used as needed [18].

3. Concepts of functional reuse
Many studies have dealt with the concept of functional reuse in multiple aspects. Some of these have focused on studying the concept and its connection to processes such as use change and transformation [23], referring to it as the modification of building for uses other than the original use, particularly where the process of fundamental change in use is undertaken to restore the state of the original building. Some studies have thus linked this to the preservation processes [25], as this is the process by which the largest number of original buildings are preserved as the process increases the level of performance to suit the requirements of changing usage and modern standards, or offers a sustainable strategy to improve performance [14] and to offer new opportunities for use of abandoned buildings. The concept has also been linked in some studies to rehabilitation and renewal processes [12], being the process of renewing and rehabilitating homes for new uses, with the concept highlighted as a means of preserving important historical buildings and protecting them from demolition. Finally, the concept has also been linked to the processes of addition and expansion [7] without necessarily removing the specific original function, instead expanding the use of a building in a combination of transformation, treatment, an improvement to provide more efficient use of the original building, increasing its economic feasibility.

4. Levels of functional reuse
Functional reuse can be classified into two levels. The first level includes the elements of external organisation (location, structure and urban fabric) while the second level includes the elements of internal organisation (services, space and the occupants). Figures 1 and 2 illustrate these elements in a building as layers of different ages. That change over time and vary in their life cycle rate. These life cycles are also affected by many external factors, such as technical and economic developments, and these affect multiple building layers and stages in life cycle in different ways:
- The first stage is birth, which is the creation of a building for a new user.
- The second stage is change, in which the building begins to accommodate new requirements from the user, often manifest as functional expansion or performance change.
- The third stage is maturity, which includes maintenance and the addition of new areas.
- The fourth stage is repetition, which includes changes that increase the capacity of the building to meet the needs of the user within the original market needs based on technology development.
- The fifth stage is demolition which may include the re-use of a building, renovation, or providing a new building, as in Figure 3. [14] and [26].
5. **The Factors affecting functional reuse of residential houses**

The existing research highlights several factors that affect the functional reuse of residential houses due to their clear impact on a building’s life stages:

5.1 **Economic factors**

The Economic factor are considered one of the most prominent factors with a direct impact on the functional reuse of residential houses; some examples are offered below:

5.1.1 **Real estate investment:**

The investment in residential real estate through the purchase of residential houses [8].

5.1.2 **Loans:**

Loans granted by private and government banks for investment projects.[6]

5.2 **Social factors:**

Social factors control the movement of community members, changing the size of housing demand with respect to available housing stock as well as having an effect on the capacity of services and their ability to meet societal requirements, especially in residential neighbourhoods. These include:

5.2.1 **Population increase from immigration:**

Baghdad witnessed increased immigration from both rural area and from cities and neighbourhoods in different regions of Iraq after 2003 due to various driving economic factors. The new circumstances and the absence of laws such moves towards Baghdad, as well as the population laws of 1957 and 1977 [27]. led to an increase in the population and increased pressure on services and infrastructure, especially during after the events of the 1990s [9].

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**Figure 1.** Classification of houses layers and percentage of change [11].

**Figure 2.** Classification of houses and adjacent layers [24].

**Figure 3.** The stages of the building life cycle [14].
5.2.2 Security situation:
The poor security situation in Baghdad caused many residential houses to be sold or otherwise disposed of by their owners or other investment entities, leading to an increase in the housing balance in conjunction with a lack of demand, which consequently, led to the sale of houses and movement between cities and residential neighbourhoods in Baghdad. This made some investors convert such unwanted houses to multi-functional uses [22].

5.3 Controls and laws:
The importance of this factor is evident in all residential neighbourhoods in Iraq, especially at the level of the urban context, these determine percentage of construction density, heights of residential houses, standards of services that must be provided for each residential neighbourhood, and land use and similar controls. These factors include:

5.3.1 Change of Land use:
Land use has been changed in many residential areas, especially those major streets which connect with the main sectors of the city. The Municipality of Baghdad has converted many public residential streets into commercial streets, permitting construction of buildings with three floors or more, and this change has penetrated the residential minor streets close to these public streets, which have tended to also become non-residential in order to achieve financial gains for their owners, both with and without the approval of authorities. [10] [15]

5.3.2 Increase in construction density for houses:
The increase in construction density for houses was changed when the Baghdad Municipality allowed for the construction of three floor building implementing Law 94 2008 [3], which led to a general increase in the number of users in residential houses. This affected the adequacy of available infrastructure services for residential areas, breaching the environmental standards of many housing units.

6. Levels of functional reuse in residential houses
The effect of functional reuse in residential houses can be seen at both at the residential level and in the urban context on several levels, the most important of which are examined in this research as follows:

6.1 The effect of functional reuse on level of services:
Infrastructure is affected by the reuse of residential houses due to increases in the number of users on the same land area, which negatively affects the stability of designs for infrastructure networks within the basic design of the city of Baghdad, which was created based on certain numbers of users and an expected increase in the coming years. Where unforeseen population densities occur, this thus leads to overconsumption of infrastructures resources and an inability to provide services at the required level. (4)

6.2 The effect of functional reuse on levels of vehicle traffic:
The residential neighbourhoods in the city of Baghdad were designed according to a basic design which was prepared such that the volume of traffic assumed was that suitable for the population densities of the residential neighbourhoods, Thus, an increase in the number of users in residential neighbourhoods, due to residential houses undergoing reuse in other functions in addition to the development of existing residential houses constitutes additional pressure being placed on the streets due to the increase in the number vehicles [16].
The effect of functional reuse on levels of noise pollution:
According to other work in this research field, high noise levels have been observed in residential buildings subjected to functional reuse, especially where such uses are of an educational nature. Noise pollution has several negative effects, such as disturbing the residents of adjacent houses negative social reactions from residents; these negatively affect the psychological state of neighbourhoods’ residents [20]. Noise hinders the proper performance of work, especially work that requires concentration such as studying and reading. [13]

7. Case study

7.1 Reasons for choosing the study area(Sulaikh 600 Rusafa/Baghdad).
This area was chosen as a case study because the principle of functional reuse has been applied in many modern residential houses. Samples were taken from the main street, which has been converted from residential to commercial, and the changes that have occurred on the planning and design levels of the urban context were examined.

7.2 Study area
Al-Sulaikh District 600 is located on the Rusafa side, of the north of Baghdad, between Muhammad Al-Qasim Highway and the Army Canal Highway, two of the main roads that connect north Baghdad with the south, as shown in Figure 4. This area also known as (Al- 600). The houses here cover 600 to 800 square meters and the area administratively affiliated to the municipality of Adhamiya. This area characterised by a wide green area and wide streets, and Street Al-600 in the Al-Sulaikh District is one of the main streets for the study of residential houses. [1]

Figure 4. Location and borders of the Sulaikh 600 neighbourhood in the city of Baghdad, [19]

7.3 Samples
The segment chosen as a model for this study was 600 Sulaikh Street, as shown in Figure 5, as this contain multiple previously residential houses that have taken on multiple functions, as shown in Table " . The selected samples and their details are further explained in Tables 2, 3, 4, 5, 6, 7, 8 and 9.
Table 1. Formerly residential houses

|    | school | institution | clinic | school |
|----|--------|-------------|--------|--------|
| 1  |        |             |        |        |
| 2  |        |             |        |        |
| 3  |        |             |        |        |
| 4  |        |             |        |        |
| 5  | labora|             |        |        |
| 6  |        |             |        |        |
| 7  |        |             |        |        |
| 8  |        |             |        |        |

Commercial function | Entertaining function | Healthy function | Educational function

Figure 5. Reused residential houses- (Ref. Google earth)

Table 2. Sample No.1

| Al-Rawan Mixed Elementary School |
|----------------------------------|
| Previous function | House | Current function | School |
|-------------------|-------|------------------|--------|
| Space             | 600   |                  |        |
| Number of floors  |       | Before 1.5       | After 2 |
| Impact level      | Low   | Moderate         | Severe |

| street           | severe |
| inhabants        | severe |
| noise            | severe |
| Function         | Appropriate | Inappropriate |
| Number of spaces | inappropriate |
| Space capacity   | inappropriate |
| Mobility         | inappropriate |
| Site spaces      | inappropriate |
| External spaces  | appropriate |
| Services         | appropriate |
Table 3. Sample No.2

| Previous function | House | Current function | Institute |
|-------------------|-------|------------------|-----------|
| Space             | 300   |                  |           |
| Number of floors  | Before | 1.5              | After 1.5 |
| Impact level      | Low    | Moderate         | Severe    |
| street            | moderate |              |           |
| inhabitants       | moderate |              |           |
| noise             | moderate |              |           |
| Function          | Appropriate | Inappropriate |           |
| Number of spaces  | inappropriate |              |           |
| Space capacity    | inappropriate |              |           |
| Mobility          | inappropriate |              |           |
| Site spaces       | appropriate |              |           |
| External spaces   | inappropriate |              |           |
| Services          | appropriate |              |           |

Table 4. Sample No.3

| Previous function | House | Current function | Dental clinic |
|-------------------|-------|------------------|---------------|
| Space             | 150   |                  |               |
| Number of floors  | Before | 2                | After 2       |
| Impact level      | Low    | Moderate         | Severe        |
| street            | low    |                  |               |
| inhabitants       | low    |                  |               |
| noise             | low    |                  |               |
| Function          | Appropriate | Inappropriate |               |
| Number of spaces  | appropriate |              |               |
| Space capacity    | appropriate |              |               |
| Mobility          | inappropriate |              |               |
| Site spaces       | appropriate |              |               |
| External spaces   | inappropriate |              |               |
| Services          | appropriate |              |               |
### Table 5. Sample No.4

| Secondary school for boys | Previous function | House | Current function | School |
|---------------------------|-------------------|-------|------------------|--------|
| Space                     | 600               |       |                  |        |
| Number of floors          | Before 1.5        | After 2 |
| Impact level              | Low               | Moderate | Severe |
| street                    | Low               | Moderate | Severe |
| inhabitants               | Low               | Moderate | Severe |
| noise                     | Low               | Moderate | Severe |
| Function                  | Appropriate       | Inappropriate |
| Number of spaces          | inappropriate     | |
| Space capacity            | inappropriate     | |
| Mobility                  | Inappropriate     | |
| Site spaces               | Inappropriate     | |
| External spaces           | appropriate       | |
| Services                  | appropriate       | |

### Table 6. Sample No.5

| Al-Furqan Dental Lab | Previous function | House | Current function | Dental Lab |
|----------------------|-------------------|-------|------------------|------------|
| Space                | 150               |       |                  |            |
| Number of floors     | Before 1          | After 1 |
| Impact level         | Low               | Moderate | Severe |
| street               | Low               | Moderate | Severe |
| inhabitants          | Low               | Moderate | Severe |
| noise                | Low               | Moderate | Severe |
| Function             | Appropriate       | Inappropriate |
| Number of spaces     | appropriate       | |
| Space capacity       | appropriate       | |
| Mobility             | appropriate       | |
| Site spaces          | appropriate       | |
| External spaces      | Inappropriate     | |
| Services             | appropriate       | |
Table 7. Sample No.6

| Previous function | House | Current function | Clothes storage |
|-------------------|-------|------------------|-----------------|
| Space             | 200   |                  |                 |
| Number of floors  | Before| 2                | After | 3          |
| Impact level      | Low   | Moderate         | Severe          |
| street            | moderate |                |                 |
| inhabitants       | moderate |                |                 |
| noise             | moderate |                |                 |
| Function          | Appropriate | Inappropriate |                 |
| Number of spaces  |        | inappropriate     |                 |
| Space capacity    |        | inappropriate     |                 |
| Mobility          |        | inappropriate     |                 |
| Site spaces       |        | inappropriate     |                 |
| External spaces   |        | appropriate       |                 |
| Services          |        | appropriate       |                 |

Table 8. Sample No.7

Al-Liq a Mixed Primary School

| Previous function | House | Current function | School |
|-------------------|-------|------------------|--------|
| Space             | 600   |                  |        |
| Number of floors  | Before| 2                | After | 3          |
| Impact level      | Low   | Moderate         | Severe |
| street            | severe |                |        |
| inhabitants       | severe |                |        |
| noise             | severe |                |        |
| Function          | Appropriate | Inappropriate |        |
| Number of spaces  |        | inappropriate     |        |
| Space capacity    |        | inappropriate     |        |
| Mobility          |        | inappropriate     |        |
| Site spaces       |        | inappropriate     |        |
| External spaces   |        | appropriate       |        |
| Services          |        | appropriate       |        |
7.4 Field study

Samples of modern residential houses were selected (from the Sulaikh 600 area in Baghdad that had been reused for multiple functions (educational, recreational, health, and commercial). The eight samples were all located on the main (commercial) street of the selected region, and evaluation was conducted based on researcher observation and field visits to extract the most prevalent function by extrapolating from samples, activities after reuse. A subsequent determination of whether these are appropriate for the building design level and measure of the level of influence on planning in the urban context according to the indicators in Table 10 was then conducted using the questionnaire distributed among users of the selected sample buildings to determine both positive and negative effects for these most widespread functions at the schematic and design level.

| Samples     | Appropriate function (1) | Inappropriate function (0) | Impact level | Noise |
|-------------|--------------------------|-----------------------------|--------------|-------|
|             | Number of spaces | Space capacity | Mobility | Site spaces | External spaces | Services | Low (0) | Moderate(1) | Severe(2) | Low (0) | Moderate(1) | Severe(2) | Low (0) | Moderate(1) | Severe(2) |
| Sample 1    | 0                      | 0                            | 0           | 0          | 1            | 1         | 2       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
| Sample 2    | 0                      | 0                            | 0           | 0          | 1            | 0         | 2       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
| Sample 3    | 1                      | 1                            | 0           | 1          | 1            | 0         | 1       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
| Sample 4    | 0                      | 0                            | 0           | 0          | 1            | 1         | 2       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
| Sample 5    | 1                      | 1                            | 1           | 1          | 0            | 0         | 0       | 0          | 0         | 0       | 0           | 0         | 0       | 0           | 0         |
| Sample 6    | 0                      | 0                            | 0           | 0          | 0            | 1         | 1       | 1          | 1         | 1       | 1           | 1         | 1       | 1           | 1         |
| Sample 7    | 0                      | 0                            | 0           | 0          | 1            | 1         | 2       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
| Sample 8    | 0                      | 0                            | 0           | 0          | 0            | 1         | 2       | 2          | 2         | 2       | 2           | 2         | 2       | 2           | 2         |
7.5 Field study result

7.5.1 The most prevalent function the percentage of samples houses in the residential area that had taken on educational functions was 50% making this, the most widespread multi-use function in the region. The rates of other function were 25% health, 12% for entertainment, and 13% commercial, as shown in Figure 6.

7.5.2 The appropriate and inappropriate features of the educational function at the functional level, determined as in Figure 7.
- The percentage of building in such use with the appropriate number of spaces for the function was 25%; the inappropriate percentage was thus 75%.
- The percentage of building in such use with capacity in terms of the appropriate space for the function was 25%; the inappropriate percentage was thus 75%.
- The percentage of building in such use with the appropriate mobility for the function was 12.5%; the inappropriate percentage was thus 87.5%.
- The percentage of building in such use with the appropriate spaces in the site was 37.5%, the inappropriate percentage was thus 62.5%.
- The percentage of building in such use with the appropriate external spaces for the function was 37.5%; the inappropriate percentage was thus 62.5 %.
- The proportion of building in such use with the appropriate services for the function was 100%.

![Figure 6. percentage of educational function and other functions](image1)

![Figure 7. Appropriate and inappropriate facilities among samples for the educational function.](image2)
7.5.3 The effects of reuse for educational functions at street level
The percentage impacts of aspects of educational reuse on the street were 50% severe, 25% moderate, and 25% low, as shown in Figure 8.

7.5.4 Percentage impact of educational functions on inhabitants
The percentages of impact of aspects of educational reuse on the local inhabitants were 50% severe, 25% moderate, and 25% low, as shown in Figure 9.

7.5.5 The impact of educational functions on noise level:
The percentages of the impacts of aspects of educational reuse on noise were 50% severe, 25% moderate, and 25% low, as shown in Figure 10.

8. Conclusions
It is clear from the field survey that the functional reuse of residential houses for educational functions has both positive and negative impact:

- **Positive impacts**: The increase in the number of educational helps mitigate the decrease in government educational functions, assisting the development of further educational levels and curricula and opening doors for students who cannot get places in government institutions.

- **Negative impacts**:

  - At house level (design): The increase the number of users, leads to pressure on basic services and change in houses styles and shape through additions and deletions.
At the urban context level (schematically): Increasing the number of private schools randomly throughout the city of Baghdad, means that success rates can be low due to a lack of consistency. Government schools may be neglected. Distortion of the urban landscape due to a large number of billboards may occur. Noise likely to negatively affect residents near these reused building due to the sounds of more cars, children’s in schools and generators. Pressure on building infrastructure services within the locality is also increased as a result of the increase in the number of users, leading to reduced standard and negative effects on multiple services, causing failure in performance.

9. Recommendations

- This research recommends conducting diagnostic and evaluation processes for functional reuse in the residential neighborhoods of Baghdad to realistically deal with the effects of this phenomenon.
- Investment in using these research results to establish an accredited work method and evaluation diagnostic system for functional reuse operations of houses is required to meet the needs of the designers engaged in the process of reusing specific houses for preservation.
- Function reuse operations should consistently be referred to experienced and specialized architects.

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