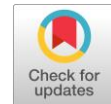


The possible application of intelligent systems in traditional courtyard houses in Iraq



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ABSTRACT

The focus on the Intelligent System (IS) in our existing types of building is a question of suitability, rather than creativity to enhance the building performance. This research explores the possible application of IS in improving the performance of courtyard houses in Baghdad, Iraq by answering the research two questions which are Q1: What does the traditional courtyard house (TCH) contain that should enhanced its performance? Q2: How (IS) could be added to the TCH in Iraq? The investigation which was done through literature review of courtyard houses type as seen beside intelligent building is supported by case studies investigation 12 (TCH) in Al-Kadhimiya through physical survey, observation, and documentation, in addition to 24 semi structure interviews with occupants of the same houses, and then using the qualitative method to analyse the data collection. The key findings highlight the need for adding new systems and architectural values to such TCH which is the basis of adding intelligence systems in such houses to enhance their performance. This could be improving the partial control of the environment related to structure and materials; decreasing the environmental challenges related to the ease of making modifications, the role of government regulations, and modernization requirements. Minimizing social struggles related to the idea of place psychology. Therefore, the current study concludes that the TCH could be as a contender of IS to enhance its performance through retrofit of such houses that contain high architectural value and re-build these houses with low architectural value and slum structure .

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1. Introduction

The focus on the incorporation of IS into current forms of building relates to the appropriateness of the design, and then significant changes can be made from their performance according to changing needs. The enhancement of building performance achieved by IS can be seen in a long list of benefits, such as: environmental control of lighting, cooling and heating, water, energy and others. Decreased running costs are created by a reduction in the following items: energy use, security monitoring and others, but also by avoiding equipment breakdowns or replacement through the early identification of problems. The building is able to receive and adopt new technology according to changing needs. It can be planned to notify of the need to replace materials and components, and this can include the ability to self-repair. Last but not least, the benefit of IS are monitoring for energy use, water, electricity, and others [1], [2], [3], [4], and [5].

However, the previous literature refers to the possibility of adding IS to enhance the performance to buildings such as residential of full occupancy in the case of those who live alone or the elderly in individual houses or multi houses, or for part occupancy such as hotels [6]. Nevertheless, it does not

refer to full occupancy in an individual house as in the case of a family for full occupancy, such as that in the courtyard house.

Therefore, the aim of this research is to explore the possible application of IS in improving the performance of TCH in Baghdad/ Iraq. This done by literary review of both Iraqi government projects, the feature of TCH in Iraq, and Intelligent building (IB) as a container, the logical approach taken to get finding of case study, and arrive the conclusion

2. Method

2.1. Iraq and Development Projects

The contemporary city of Baghdad has four historic areas: Rusafa, Karkh, Aadhiimiya, and Kadhiimiya (see Fig. 1), which contain a large number of different buildings and housing types [7]. The current government has made an effort to improve the housing stock of Baghdad. Ten years ago, the SICR report of (2006-2007) referred to the typology of residential areas in Iraqi cities that include courtyard houses which developed organically within Arabian Islamic culture. To protect and enhance the historic centre of Baghdad that contained TCH, the Municipality of Baghdad in cooperation with several consultant architectural offices (2007-2010), investigated the urban development of the historical area and architectural heritage of Baghdad using high technology. In the same year, the Municipality of Baghdad (2007) and (2009) announced several computations plan to develop the historic area such as Al-Kadhiimiya that include TCH. Besides, the Municipality of Baghdad (2009) presented 12 investment opportunities for modern projects in Baghdad with one of them Al-Kadhiimiya. In 2007-2010, the Municipality of Baghdad suggested that architectural and planning offices form proposals to enhance the Al-Kadhiimiya of historical area in Baghdad and modernize them according to the lifestyle for the historical cities' through international competition to develop a culturally and historically sensitive site in Al Kadhiimiya. The scheme maintained, rehabilitated, and conserved many TCHs. for their unique architectural values via high technology [8], [9], [10] and [11]. In this way, it is clear that the greatest strengths of traditional units with an interior courtyard are engaging rehabilitation. Perhaps the most important factor that makes the study area suited for this investigation is the presence of a government plan to refurbish TCHs.



Fig. 1. Al-Adhamiyah and Al-Khadhiimiya, containing TCHs [12]

2.2. The Feature of Traditional Courtyard Houses in Iraq

TCHs in Iraq share the same concepts with other in the whole world. The feature of TCH play an important part in the instrumentality of the study area for understanding why they were choose. This include the families with a single courtyard or multi-courtyards configuration which they presented through:

Form, the TCHs in Iraq have been free from within the given specifications of the site. The urban fabric of historic area in Baghdad was not cut into precise segments of regular shapes, but grew piecemeal, with the residential areas developing under similar general constraints, but nevertheless they conformed within a certain measure to general overall patterns; consequently, they fitted together coherently, irregular as they were [13]. The courtyard house is usually closed from three sites which characterized by its open courtyard space and also has their habitable spaces that grouped around it [14].

Size, the size of TCH depend upon using the criterion of the number of courtyards incorporated within each TCH in Iraq, they can be grouped into four categories: One-courtyard houses, these that comprise the family quarters only; they represent the great majority of houses in Baghdad. They were classified into three sub-categories, depending on sizes (150m², 100 to 150m² and the 40-100m²). Two -courtyard houses are comprised of their following: family quarters, kitchen house/ complex, or the guest quarters. Three courtyard houses comprise the following: family quarters, kitchen house/ complex, and guest quarters or a stable. Four courtyard houses are comprised similar to the previous type [15].

The components, the components of TCH in Iraq can be classified:

First: courtyard and transitional space including the courtyard “hash”, transitional spaces such as iwan, mamsha, and tarma. Second usable spaces including the entrance, reception and living rooms, bed and multi-purpose rooms, and service rooms, sardab and neem sardab. Finally, architectural elements including air-scoop: “bad-geer”, Shanasheel, muqarnas, wooden columns, and ornamentals [16].

2.3. Intelligent building as a container

Intalligent buildings (IB) uses combined elements and systems to give a satisfactory experience by which the building can achieved its goals, all of which impact on the building's performance. An IB can be seen through different basic elements that provide optimisations through a continuous interaction. According to the latest literature by Agha [17], these elements can be classified into: systems, structures, services, managements, and the interrelations between these aspects. A number of key ideas to IBs has already shown the inclusion of IT into building forms as show in Fig. 2. This will be illustrated through:

Retrofitting, the focus on the smart technologies in the present existing types of buildings is a question of suitability, rather than creativity. It was noted how smart technology can be packaged in a retrofit, and thus change the building through containerized technology into a pro-designed container, which happens after building implementation [18]. This is a simple manufacturing, building connected with cost issue rather than being connected to problems of architecture. The smart technology is concealed beneath the flooring, pipework, ducts and ceiling, and therefore there is no observable indication of altered architecture. Technological invention was not thought to be the primary reason for the choice of the system. Auto Value Central Auto Parts/Alberta, Calgary, is an example of IB as the retrofitting of existing buildings through effective integration of the building's systems.

New design or new build, the other perspective for IBs as a container related with per-design/ design stage is to build structures with integrated systems able to anticipate and respond to phenomena, either internal or external, which influence both performance and occupancy. It was suggested that an IB will develop as a result of new design issues [19].

The literature has focused on the incorporation of IT such as a sysem, services, managmaents, structures and releated between them in building, which refers to the possibility of IB to be as a container of IT in accordance with the appropriateness of the building's features, and then significant

changes can be made to their performance, as well as adaptations to changing needs linked to the nature of the buildings.

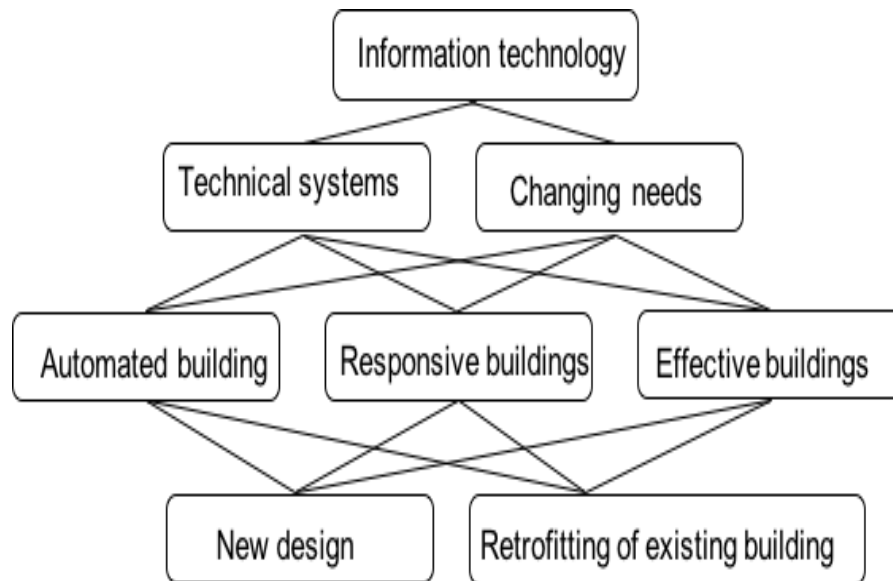


Fig. 2. Types of IB as a container of IT. [Author]

2.4. Research Methodology

The aim of this research is to explore the possible application of IS in improving the performance of TCH in Baghdad by answering the research questions which were shown in Fig. 3. They were: Q1: What does the TCH contain that should enhance its performance? Q2: How could be added IS to the TCH in Iraq?.

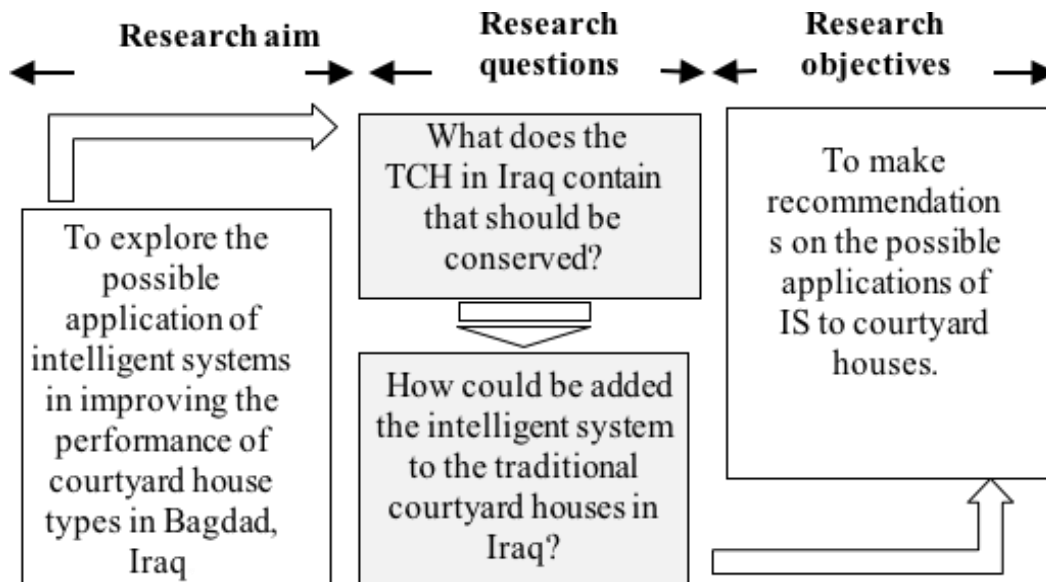


Fig. 3. The main research questions and their relation to the main aim and objective [Author]

However, this research differs from other researches dealing with IS since there is no clear picture that add IS to the TCHs to enhance their performance. Therefore, the current research is used as a qualitative method for analysis the data from both literature review and case study.

The case study holed in Iraq included the physical survey and observation with photos taken for twelve TCHs which were selected in the Al-Kadhimiya historical area located in five neighbourhoods, and two occupants per house were selected for individual or a group interview.

The current research focused on the first and second examples and excluded those TCHs which had three or four courtyards because the occupants of these houses refused to permit the physical survey inside the house. Concerning the size issues, many of these houses that had three or four courtyards were very large and many of them were divided and each house had its own courtyard. Therefore, it was very difficult to know if a certain house was divided from an original house.

However, the data collection from case study analysis was done by using qualitative methods through extracted the themes and issues.

2.5. Finding

To understand the existing situation of the TCHs in the Al-Kadhimiya historical area [Table. 1](#) and [Table. 2](#) shown the information concerning TCHs in Al-kadhimiya.

Table 1. Introduction of the twelve TCH in Al-Kadhimiya as a case study [Author]

House code	Interviewcode	Neigh.***	Ownership	House size	Courtyard(s)no.	Level of house
PH, CH1*	Occ. 1 + 2**	Akked Al-Kanjalle	Government/conserved	Medium	2 (one of eachpart)	6 level for the biggest courtyard
PH, CH2	Occ. 3 + 4		Government/conserved	Medium	1	4
PH, CH3	Occ. 5 +6		Government/conserved	Medium	1	4
PH, CH4*	Occ. 7 &8**		Government/conserved	Medium	2 (one of eachpart)	5 level for the smaller courtyard
PH, CH5	Occ. 9 +10	Akked Al-Sada	Government/conserved	Small	1	4
PH, CH6	Occ. 11+ 12		Government/conserved	Small	1	4
PH, CH7	Occ. 13+ 14		Government/conserved	Big	1	5
PH, CH8	Occ. 15 & 16	Al-Bahea	Private /conserved	Small	1	4
PH, CH9	Occ. 17 + 18	Um Al-Noomy	Private /conserved	Big	2	4 levels
PH, CH10	Occ. 19 + 20		Government/conserved	Big	2	6 levels
PH, CH11	Occ. 21 + 22		Government/conserved	Medium	1	4
PH, CH12	Occ. 23 & 24	Al-Anbareen	Private /conserved	Small	1	4

^a. *PH, CH1 + PH, CH1= the original TCH content two courtyards big and small had been divided into twohouses after 1980 by the government each one has one courtyard.

^b. **Occ. 1+2= Group interview

^c. **Occ. 7&8= Individual interview

^d. ***Neigh. =Neighbourhood

The finding of this investigation:

- 10/12 houses were owned by the government except those in Al-Bahea, and Al-Anbareen neighbourhoods.
- All 12 houses were conserved for different reasons.
- In all neighborhoods, these TCH in Al-Kadhimiya had more than two levels and roof on around 4-6 included: ground floor as street level; upper floors such as first, second or mezzanine (*Kafish-kan*), and the roof; and lower floors such as mezzanine (*neem sardab*) and *sardab- basement*. For an example of a TCH with 6 levels see PH, CH 9.

Table 2. Introduction of the twelve TCH in Al-Kadhimiya as a case study [Author]

Structure						
House code	Rehabilitation	System	Condition	External Wall thick.	Materials	Memorial
PH, CH1	1980, 2000 & 2010	Load Bearing wall	Good	90-150 cm	Brick & wood	The Iraqi government maintained this house by Indian company as anexample of TCH in Iraq
PH, CH2	1980 & 2008		Good	75-90 cm	Brick, wood & Iran	It has been a great deal of research onthis house
PH, CH3	1980 & 2000		Good	75-90 cm	Brick, wood & Iran	This house turns from TCH to school, the hotel, and then back to houseagain.
PH, CH4	1980 & 2000		Good	75-120 cm	Brick & wood	The Iraqi government maintained this house by Indian company as anexample of TCH in Iraq
PH, CH5	1980 borderedby their original ownerfor more than 30 years		Bad	60-75 cm	Brick & wood	It has been a great deal of research onthis house
PH, CH6	2003& 2012		Good	45-60 cm	Brick & Iran	It had been visited by several workforces over the years
PH, CH7	1980, 2003 & 2010		Good	75-90 cm	Brick, wood & Iran	Many proficient persons visited this house and suggested different ideas todevelop it.
PH, CH8	1980, 2003& 2012		Good	60 cm	Brick, wood & Iran	It drowns by many artists
PH, CH9	1980, 2003 & 2009		Part of house is Slum*	75-90 cm	Brick, wood & Iran	It used for record many documentedfilms
PH, CH10	1980, 1990, 2000 & 2010		Good	90-150 cm	Brick, wood & Iran	Iraqi cultural centre, the Iraqi government wanted to turn it and its neighbouring houses into museums or “historical classical houses”.
PH, CH11	Bordered bytheir original owner		Bad	45-60cm	Brick & wood	The house that the former Prime Minister of Iraq, Nori Al-Saeid, used for shelter in 1958. In the 1970s,
PH, CH12	1960, borderedby their original ownerfor more than 50 years		Bad	45 cm	Brick & wood	This house had been visited by different famous persons such as thepresident of the government.

*Due to the rocket fell near the house 2003

The structure system of all these were load bearing wall and used brick as the main material. In spite of all 12 TCHs having been built before 1920, surprisingly, I noticed that the structure of nine of the houses of different neighbourhoods was in good condition due to maintenance by the government or owner. In one house with two courtyards in the Um Al-Noomy neighbourhood, the structure of the large part was poor, and the structure of the small part was good. 2/12 of these houses had a poor

structure in the absence of any maintenance, such as those in the Akked Al-Kanjalle and Anbareen neighbourhoods. In all these houses in the five neighbourhoods, the structural system was a load bearing wall, and the material used was fire brick. The external walls in two out of the 12 houses had been conserved and increased to 1.20-1.50m such as those houses in the Akked Al-Kanjalle and Al-Anbareen neighbourhoods, according to certain aspects. However, in the other houses in all neighbourhoods it was between 0.60-0.90m. These walls consist of outer and inner layers with a soil-filled centre, and are also covered with liner

Many residents had lived in this TCH since birth. For some of them, their parents had been born in them around 1890. They planned to stay in these houses as long as they could and never leave. One family member lived with his wife in the Al-Kanjalle neighbourhood, said:

“All children are married and live independently. This house is for Grandmother only, none of my children choose to stay in this house after marriage, but near enough, so they never stop visiting me, however, we will never ever leave this house until we die”. (Occ., 3+4, 2012).

3. Results and Discussion

The themes which emerged are outlined below

3.1. Partial control of the environment

Means what the occupants have at their disposal to maintain control of the environment. The evidences from the case study parallel with the literature review explored this theme by the building fabric through:

- Structure and materials
- This means the elements that are used to move the load from the ceiling and wall to the foundation by the style or method of material used in the house. The structure and materials of the TCH control of the changes in arid environmental conditions.
- The use of a heavy weight structure of thick brick walls for the TCH in the Al-Kadhimiya in order to achieve adequate time lag manages heat according to the season by delaying and reducing heat gain from the hot or cold exterior to the interior, thus preserving the degree of warmth or coolness in the spaces by allowing only a slight temperature change.
- The structure establishes a balance in losing and gaining heat, and is a slow process compared to the external environment that works to change the temperature. This idea was echoed by physical survey of the 12 TCH in Al-Kadhimiya:

“The Baghdadi house is distinguished by thick walls more than 75cm provide thermal isolation, while the temperature can be controlled through the thickness of the outside walls by stopping any loss of internal temperature” (Occ., 8, 2012).

Furthermore, the TCHs in the Al-Kadhimiya were built with local building materials, in addition to natural resources, such as bricks, stones, woods, mud, gypsum, clay, soil, and palm. These are highly efficient due to their capacity to store thermal energy and reduce thermal loads to the minimum. Thus, the natural house material establishes a balance in losing and gaining heat which is able to resist heat flow based on thermal conductance.

A possible explanation of this is that the building's fabric response due to the structural system based on the load bearing walls of the TCH in the Al-Kadhimiya depends on the utilization of these natural materials. These are employed for both their shape and size, to provide a natural environment through thermal insulation and thermal capacity by adequate time lag for thermal load. This affects the space being naturally heated or cooled by the non-mechanically powered systems, and again thermal comfort.

It is interesting to note that the building fabric response linked to the structure and material created passive systems in TCHs. which encourage thermal comfort in this type of house. Thermal comfort is the state of being subjectively satisfied with the temperature of the environment [20]. Therefore, these passive systems contribute to the achievement of partial control of the environment. However, the

presence of such passive systems in the TCH may not be enough for the current users to achieve appropriate environmental performance in it.

3.2. Environmental Challenges

3.2.1. The ease of making modifications

This phrase refers to how easy or difficult it was for the residents to modify the TCH. It finds the environmental challenges living in this type of house due to flexibility.

The evidence from the occupants and the physical survey accords with the literature review in showing that the TCHs in the Al-Kadhimiya historical area were built by as heavy structures linked to load bearing walls (as confirmed in Table. 1). This means that the residents were limited in the changes they could make, such as reshaping space or defragmentation of the house as a result of rigidity and government regulations. One interviewee and his wife, who lived in Aked Al-Kunjalee, said:

"We tried to add an air vacuum to the kitchen and we drilled the wall more than 100cm in depth, unfortunately we could not reach the other side of the wall" (Occ., 1+2, 2012).

The most obvious point to emerge from this is that the rigidity of this type of house presents limitations in terms of the type of change possible, such as reshaping and defragmentation of space. Therefore, inflexibility is a manifestation of the environmental challenges. However, this inflexibility might have affected house performance.

-The role of government regulations

Government regulations concerning conservation were found to be important in shaping the environmental challenges of living in the TCH. The evidence from the occupants showed that the TCHs in the Al-Kadhimiya historical area studied in the fieldwork had been conserved by the government as historic or heritage houses which presented in Table. 1. This conservation created a difficult role for the occupants, who had to keep the appearance of these houses unchanged. It is not surprising that this was referred to in the account of one interviewee and his wife who lived in the Aked Al-Kunjalee neighbourhood:

"We disliked changing the style of the house because we were tenants and the government had strict rules about any change" (Occ., 1+2, 2012).

This issue illustrated that conservation restricted the occupants and this could have influenced house performance. It can therefore be assumed that the conservation caused environmental challenges in living in this house type.

3.2.2. Modernization requirements of the courtyard house

Modernization in this case means adapting to modern ideas or methods according to modern needs and this has gradually led to environmental challenges concerning living standards. Living standards refers in this study to the quality of house related to the necessities available such as environmental systems. The evidence from occupants was in accordance with the physical survey and showed that the government or the owner had rehabilitated a TCH in the Al-Kadhimiya between 20-50 years ago according to the modern style (See Table. 1). However, at the time of the study the inner courtyard did not meet the requirements of comfortable living for most families, who required upgrading of their living standards. One of the ideas repeatedly mentioned by one interviewee in the Al-Bahea neighbourhood was that:

"An Indian company repaired houses in the Al-Kadhimiya and covered the inside walls, also support the old structure in Sardab with iron greed, I like to do the same with my house" (Occ., 15, 2012).

Interestingly, the living standard of a traditional unit and the need to develop to meet changeable needs has been caused by not upgrading and could impact house performance. Thus, living standards have led to environmental challenges.

3.3. Social Struggles

Related to emotions which reflect to the lifestyle of occupants'. This is illustrated through:

3.3.1. The idea of place psychology

This represents the interrelationship between place and human effect [21], through mental comfort and feelings associated with governing a situation or activity for the resident in this type of house. Place psychology is mainly interpreted as social struggles linked with belonging and nostalgia or privacy.

Belonging refers to the personal effects or specific events in relation to the inhabitant for these types of houses [22]. Nostalgia is a longing or wistful affection for a period in the past [21]. The evidence from the occupants revealed that the occupants wanted to leave this type of house for modern houses for different reasons, but they were still there because many residents had collective memory related with house type refers to memories shared or recollected by a specific event, or site specification passed from one generation to the next. For example, they had lived in this TCHs in the Al-Kadhimiya since birth or marriage. For some of them, their parents had been born in them around 1890.

One house was the house of the Astrebad family, where the former Prime Minister of Iraq Nori AL-Saeid was hidden after July 1958 revolution in his last two days of life. Another house had been visited by different famous persons such as the president of the government. At the same time the evidences from the physical survey accordance with occupants confirmed they miss special people who were dead or leaved this house. For example, an interviewer and her husband alluded to such practices in their account:

"I have not seen my sons and daughters for a long time. We miss and lack our old social contacts" (Occ., 3+4, 2012).

These data refer to the fact that belonging and nostalgia had been created by the collective memories of living in to the TCH (Fig. 4). Therefore, the belonging and nostalgia represented the social struggles of living in the TCH.

Privacy refers to freedom from disturbance. The evidence from the occupants revealed that the occupants in the TCH in the Al-Kadhimiya had lost their freedom, which affected relationships between the family members in terms of privacy, because there is limited simultaneous use of different machines at one time. It is not surprising that this indicator is referred to in the account of one interviewee and his wife who lived in the Akeed Al-Kunjalle neighbourhood:

"We cannot use all our devices and we tried to gather together as much as possible during uncomfortable weather because of cooling and heating. We have an unmarried daughter and son sleeping in the room with us because of the limited use of energy, and therefore, this affects our privacy" (Occ., 1+2, 2012).

From this, we understand that loss of privacy was created by the simultaneous use of different devices, and therefore privacy led to social struggles when living in the TCH.



1



2

Fig. 4. The belonging and nostalgia had presented social struggles of living in to the TCH in the Al-Kadhimiya [Author]. (1) (PH.CH.1, 2012), (2) (PH.CH.10, 2012)

The key issue extracted from the case study is that TCHs in Al-Kadhimiya had limited of changed, according to the specific situation, the attention paid of these TCH by the government since 1980, they need for continual improvement, most of these houses had different historical value. However, Fig. 5 below clarifies the new issues raised in the previous section concerning the multi-faceted relationship of these different issues and themes, as related to what the TCH has and needs.

Architectural value. The passive system is the key feature of the TCH in Al-Kadhimiya, and it definitely supports the lifestyle of the current users, and is likely to do so for future users. This significant finding formulated new and different issues, and clarifies the strong architectural value of the TCH. Memorial

Needing for add new systems. This strength issue was present in this study, as there is limited space use because not the entire house had an equal environment all year round. For this reason, newsystems are needed to refine and equalize the internal environmental performance of the whole house around the year. Thus, the IS could represent the type of new system required in the TCH.

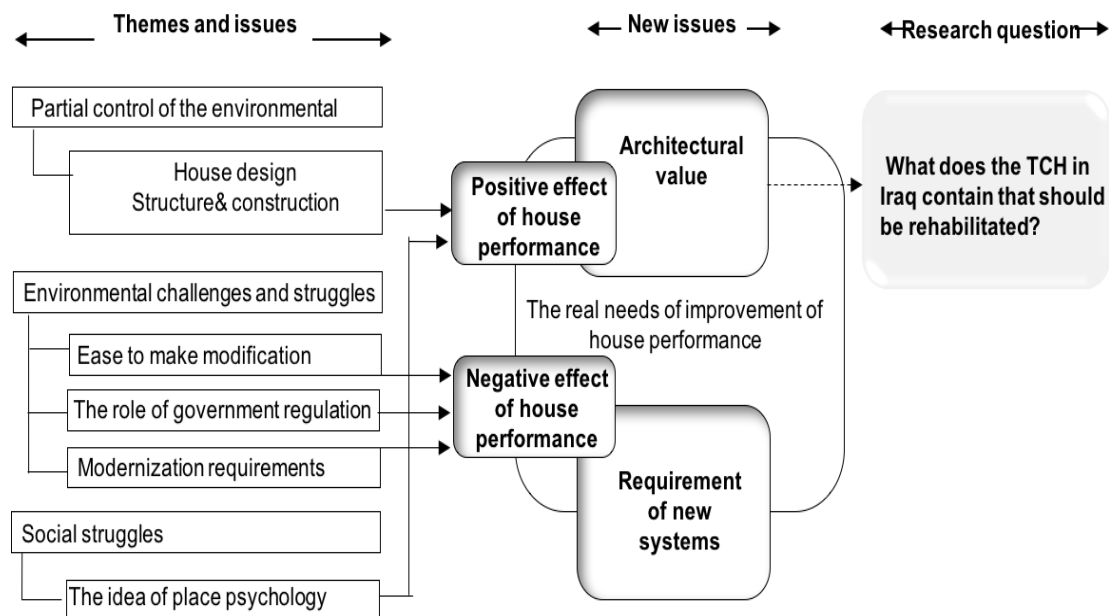


Fig. 5. The different issues and themes of the TCH in Al-Kadhimiya, as related to the first researchquestion (Author)

Therefore, the capabilities of additional ISs in the TCH will certainly help the residents fulfil the varied TCH performance potential, by:

- Enhancing the level of control over the environment via full control of it, by supporting the response to the environment by enhancing the building fabric response linked to the structure and material then promoting the thermal comfort.
- Reducing environmental challenges by making modifications easier by decreasing the limitations of rigidity. Also, reducing effect of the role government regulation, by promoting conservation and then saving the house appearance. Lastly, providing modernization by developing the house living standards for further upgrading and rehabilitating this house type.
- Decreasing social struggles by enhancing occupant interaction as strong place psychology can be provided by developing a richer sense of belonging and nostalgia for these types of houses, besides achieving privacy by refining individual freedoms

In this way, adding IS will enhance the house performance by maximizing place, space and level use, and thus will improve the architectural value of this house type. As a result, these changes will

assist the lifestyle of the current users, and in turn enhance family life, which is very important for them to achieve user comfort (see Fig. 6).

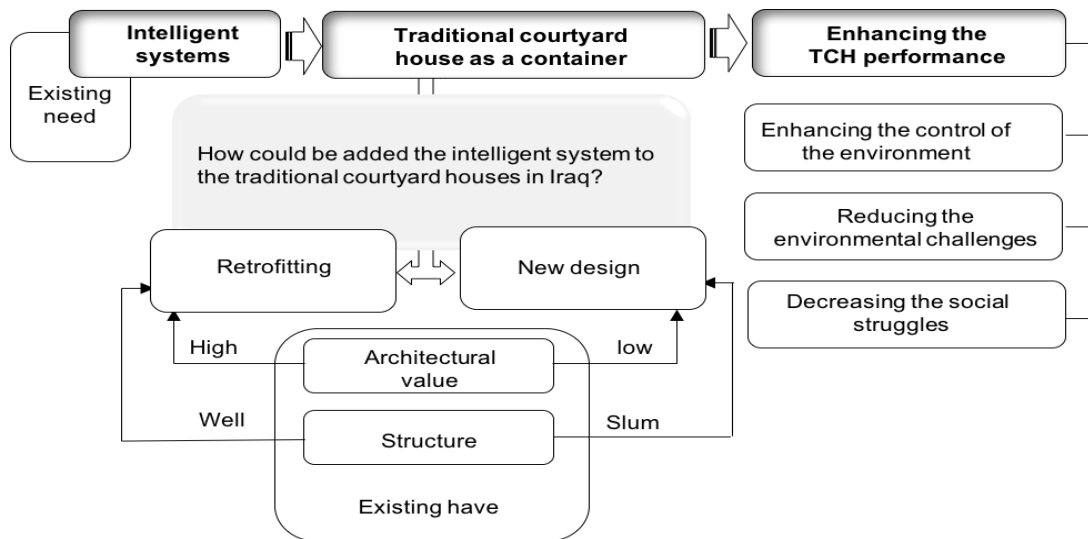


Fig. 6. The interaction between the TCH in Al-Kadhimiya and IS. The basic role of such systems in this type of house is to enhance performance, as related to the second research question [Authors]

As we turn back to the IB as a container of IS section, the author can consider the possible addition of ISs to the TCH in improving performance using the latter as “retrofitting containers”, or as a new design/ new build related to the architectural value in Al-Kadhimiya. The possible application of IS in TCHs by retrofitting will have strong value by improving house performance and then achieving maximum space usage such as in TCHs 1,2,3,4,6,7,8,10 and 11. The other houses with high architectural value and slum structure such as TCHs 5, 12 and part of TCH-9 are in need for re-build. In this case, IS are needed to apply as an application for such as a smart washing machine, a smart TV, a multi split unit, wireless routers and others protects from Bosch and Siemens company, LG and others according to the occupants need. However, using a new design in any TCH is appropriate for those houses with no architectural value, and/or a poor, deteriorating, slum structure. In this case, the need to apply IS as a system type such as Building Automation system; Information and Communication Network Systems; Fire protection systems; HAVC Systems; Safety and Security Monitoring Systems; Electrical Installation Systems; Lighting Systems; Hydraulic and Drainage systems; Vertical Transportation Systems; Building Facade Systems; and Internal Layout Systems must be according to the occupants need.

Thus, the TCH could be transformed into an IB with containerized technology and a level of intelligence through integrated IS. In this way, the TCH becomes a container for ISs, so the potential for retrofitting could be a significant part of a development and refurbishing project, as shown in literature review

4. Conclusion

This research concludes that adding IS will certainly help the residents enhance the house performance in Al-Kadhimiya. This will be done by developing the level of control over the environment, reducing the environmental challenges and decreasing the social struggles. This study contributes to the understanding of ISs in enhancing the performance of the TCH by using the latter as a container through retrofitting these houses that have the significant architectural value and well structure, or re-build the TCH with low architectural value and slum structure.

Declarations

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