

Intelligent building

The Role of Intelligent Systems in Traditional Courtyard Houses in Baghdad, Iraq

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Abstract

Intelligent systems (IS) are seen as a vital component in improving building performance. The research reported in this thesis explored the potential role of such systems in improving the performance of courtyard house types in Baghdad, Iraq. The Iraqi government's intention to refurbish those courtyard houses that possess significant historical architectural value was based on modifying the ambient social and environmental condition to protect the occupants. The benefits of IS are generally to: provide environmental control and system control, reduce running costs, improve operational effectiveness and energy efficiency, maintenance/building upkeep, reliability/dependability, and last but not least monitoring and observation. However, the majority of IS research and development has been on commercial and office buildings, and although there were applications in dwelling houses, their potential benefit for certain house types, for example courtyard houses, has not been well understood.

Against the background of the possible refurbishment of the courtyard house, the aim of this research is to explore the potential role of intelligent systems in improving the performance of the courtyard house type in Baghdad, Iraq. The main objectives of this research were to: (1) investigate the characteristics and features of the traditional courtyard house in Iraq, (2) investigate the meaning, nature and application of intelligent systems in buildings, (3) investigate the lifestyle of current users of traditional courtyard houses and how these buildings support their needs, (4) examine the potential role of IS in improving the performance of courtyard houses, and (5) make recommendations on the possible applications of IS to courtyard houses.

Various research methods and strategies were adopted to achieve the defined aim of this research. These methods include an extensive literature review in both the areas of the courtyard house and intelligent buildings, and a case study was collected the data from two main sources through: (1) semi-structured interviews with twenty five architects and twenty four occupants, and (2) physical survey and observation of the traditional courtyard house type in the Al-Kadhimiyah historic area. The qualitative method was used to analysis the data collection.

Abstract

The findings from the study identified the following new themes which provide the basis for exploring the research question: (1) Architectural value - key feature through the passive system of the traditional courtyard house type in the Al-Kadhimiya, (2) Limitation of space use, some spaces were not used, and the residents felt as if they were paralyzed at these times and (3) Requirement for new systems in this house type.

It is concluded that the key features of the traditional courtyard house type are passive systems which support the lifestyle by achieving thermal comfort. Adding simple IS as applications which are integrated and wireless, with an actuator, 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, decreasing the social struggles, and supporting the response to the environment.

This study contributes to the role of ISs in enhancing the performance of the traditional courtyard house. For the current users, these roles are achieved through three major steps: (1) the nature of IS in traditional courtyard house, (2) The priority of systems; (3) Using the courtyard house as a container for intelligent systems. Future users are likely to have a different lifestyle and so the level of intelligence may change; thus, the potential need for ISs might change too due to the type of IS and its operation. A clean air recirculation module is one application to be used in the traditional courtyard house type in Al-Kadhimiya, which can be selected to enhance house performance.

To those who roam the depths of the seas and probing the depths of the universe...

To those who are looking for the secret of existence...

To my father and unit soul who instilled the roles life in my heart...

To my wonderful mum, sisters, and brother...

To my twin soul who taught me how to appreciate knowledge, and life...

To my lovely daughter...

I dedicate my humble opinion.

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Abbreviation

Arch.	Architect interview.
BP.	Building performance.
CH.	Courtyard house.
HP.	House performance.
IB.	Intelligent building.
IBs.	Intelligent buildings.
IS.	Intelligent system.
ISs.	Intelligent systems.
IT.	Information technology.
Occ.	Occupant interview.
PH.	Physical survey.
PH.CH	Physical survey of the traditional courtyard house in Al-Kadhimiya.
T.C.H.T	Traditional courtyard house type.

Arabic terminology

Bad-Geer	Air-scoop.
Hash	The courtyard.
Iwan	The semi closed space.
Jam-khana	The winter family room on the ground floor.
Kafish-Kan	The mezzanine level between the ground and first floor.
Mamsha	The semi open space in first floor.
Muqarnas	Decorative techniques in T.C.H.T which uses brick and gypsum and other.
Neem sardab	The mezzanine level between the basement and ground level.
Sardab	The basement.
Shanasheel	It is a timber screen in each window on first floor over the street.
Takhta-boosh	The space looking to the basement.
Tarma	The semi opens space in first floor.
Ursi	The family room.

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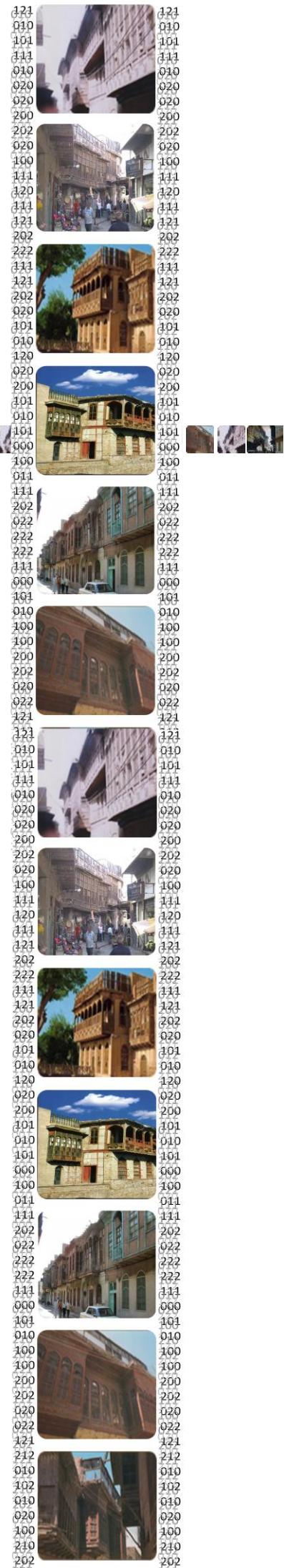
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Chapter One: General introduction



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1. General introduction

1.1 Introduction

This chapter describes the context of the study by presenting the background of the research project and a brief explanation of the topic, it then highlights the definitions and key features used in the statement of the problems and study questions, the research aims and objectives, and scope; lastly, the research organization and chapter layout are described.

1.2 Background to the research

The author's interest in intelligent technology was growing day by day; the more she reads about the subject, the more she recognizes that there is more needed to be known and learnt. The motivation for this research arose from the need to improve the performance of the traditional courtyard house concerning the problems linked with disintegration in this type of house.

1.2.1 *Iraq and refurbishing projects*

Iraq, is at the centre of the Middle East, Baghdad is the capital and lies in the centre. As a country, Iraq has seen considerable changes due to war and international sanctions, as well as environmental conditions. Certain social values and cultural standards have been altered, as have Iraq's architecture and cities in terms of their quality and quantity. As one of the largest Gulf countries, Iraq has many historical areas with historic architecture. The historic regions of Baghdad city contain a type of house known as the courtyard house, which has a high value of land use. The historic regions having this kind of house include cities such as old Rasafa and Karkh, or sub-city centres such as Al-Kadhimiyah and Al-Adhamiyah.

Despite the Iraqi political situation, the government aimed to refurbish the courtyard house (CH.) of historical areas. The current government has made an effort to improve the infrastructure and housing stock of Baghdad. Ten years later, the Iraqi state's cities report 2006-2007 (SICR) referred to the typology of residential areas including courtyard houses which developed organically within Arabian culture. For the defence and improvement of the historical centre of Baghdad, the Baghdad Council, in cooperation with several consultant architectural offices (2007-2010), investigated the urban development of the historical area and architecture heritage around Al Rasheed Street. The study project titled "*Building Al Rasheed for the*

“future” uncovered several issues with historical areas. The study proposed to conserve this area includes using high technology like renewal energy for transportation. In the same year, the Municipality of Baghdad (2009) presented 12 investment opportunities for contemporary projects in Baghdad. Half of these projects are located in historical areas with courtyard houses; these are:

- Developing Haifa Street
- Developing Khlaafaa Street
- Developing Bab Al-Sheikh area
- Developing Al-Sheikh Omer Street
- Developing Khether al-Yas in historical area of Karkh
- Developing Al-Kadhimiyah historical area in the sub centre of Baghdad. This project was to refurbish those traditional courtyard house type (T.C.H.T.) that possess significant historical architectural values, by modifying the ambient social and environment condition to protect the occupants. In this way, it is clear that the greatest strengths of traditional units with an interior courtyard are demonstrated at the level of the general fabric, and at the level of the individual unit, such as engaging conservation and rehabilitation. Perhaps the most important factor that makes the study area suited to this investigation is the presence of a government plan to refurbish courtyard house types. However, we must consider why this T.C.H.T needs improvement.

1.2.2 *The need for improvement in traditional courtyard house*

The courtyard house represents a major type of building and it is often the central focus of the residence in terms of space and socialising, and as an environment. It is a secluded area that facilitates safety and privacy, but also productivity. It responds to and interacts with all these aspects to determine the typical nature of the place. Thus, the courtyard in the world satisfies the essential requirement for shelter, and other needs such as privacy. The courtyard is one of the determining and organizing factors of a dwelling house which involves various aspects.

However, the growing body of literature from many authors such as Ihsan Fethi (1976), Warren and Ihsan Fethi (1982), Al-Azawi (1984), Al-Qaisi (1984), Al-Rahmani (1986), Al- Jawadi (1986) Al- Al-Azawi (1996a, 1996b), UN-Habitat. (2005) and (2006-2007), Al-Akkam (2013) and others have identified several existing problems in T.C.H.T in Iraq. These are: (1) Functional problems such as modification of the residential type into commercial and government offices. (2) Economic problems,

especially the lack of financial resources for maintenance or conservation. (3) Cultural problems: such as loss of identity and cultural continuity, because of the modernization process which has mainly been influenced by technology and new materials and transformed living styles, the rejection of living in the traditional physical environment, mass migration of person of immigration, the decline of the safety and security such as crime, robbery, and terrorism, and the prevalence of addiction, poverty and disorder, and breakdown in social organisation. (4) Structure and services problems: such as deteriorated structures, slums, lack of infrastructure maintenance, and neglect and decay. (5) Re- development problems: clearness schemes for civic centres, including the demolition of buildings and the defragmentation of historical areas.

Thus, the T.C.H.T has not had to adapt to changing needs because of the problems which have had a negative effect on the house performance. As a result, the social aspect causes a number of challenges to lifestyle. This is a way of life related to the role of everyday different activities in terms of the relationship with places¹, spaces², and levels³ during different times, and the possible changes in the need to respond to the appropriate thermal comfort. For these reasons, the T.C.H.T needs to be equipped to face these changing needs according to the awareness of the basic needs of the lifestyle of current and future users. However, intelligent technology could be used as a part of the refurbishment projects for this type of house and enhance their performance.

1.2.3 *Information technology and performance*

Information technology (IT) has increased the speed of information flow, which is considered a key aspect of improving intelligent building (IB), and the performance of different types of building as a result (CABA, 2014, p.5).

Many researchers have attempted to identify of IB such as Wong et al. (2005), Holden (2008), Chan et al. (2009), Alwaer and Croome (2010), Watson (2011), Wang et al. (2012), Zhou, et al, (2014), and others. As a result, the operational definition relies on a designation of IB which is considered to be the ability of the building by using intelligent systems (IS.) to monitor the information from the different environmental situations, and then to assess, and dynamically respond to changing

¹ It refers to functional area such as ursi

² It refers to degree of enclosure such as Iwan

³ It includes different levels such as sardab

needs that improves the performance for a comfortable living environment and improved occupancy. Many researchers have attempted to identify and categorise the benefits and advantages of IB to enhance the building performance. The IB leads to the accomplishment of a type of building which has the optimum benefit in terms of performance socially, environmentally, and economically, such as by reduced running costs (Holden, 2008). Others have shown that the benefits of environmental control (CABA, 2002), control building systems (Alwaer and Clements-Croome ,2010, p.800), enhance productivity, and provide safety and reliability (CIBSE, 2000). A number of researchers (Wong et al. 2005, Wong and Li 2006, Wong et al. 2008) have focused on better operational effectiveness and energy efficiency; enhance user comfort, and better dependability. Research in the area of smart homes has confirmed the benefits of IS through better health and provide less social isolation, and improved household management for better decision-making (Courtney, 2008). Activity/ observation and monitor physiological systems (Helal et al., 2005, Chan et al. 2009), maintaining /Building upkeep (Kroner, 1997, pp. 387-389) and others.

However, all IB contain varying amounts of IS and the amount of these systems which have the function of controlling and responding. Therefore, we can introduce an IS as a recognizable whole that has different applications linked in a systematic way. It can determine boundaries, the environment, and intent and has evolving capability. This system has the ability to communicate with other systems which could connect to the internet. The type of ISs which must exist for a building to be seen as intelligent is difficult to define. Although buildings have some device that deliver a type of automatic reaction to external change, they cannot always be seen as IB. This is due to the problem of pinpointing when a building becomes “intelligent”; that is knowing which technology or systems add to the creation of a building’s intelligence. To achieve the goal of an IB, we must consider how IS can enhance the building performance.

1.2.4 *Enhancement of building performance*

Before discussing how to enhance building performance (BP.) by using IT, we need a clear picture of what is meant by performance which was started in the humanities and social sciences and, following this development, also in the arts and sciences in general. In this case, it is considered to be the act of doing something successfully, or employing knowledge, as distinct from just having it or using it, or the way it functions or operates (AD, 2013, P. 17). Against the background of the wide

context of architecture nowadays, the idea of performance is especially key and will continue to be so. This is due to the rise of the importance of the environment and our general surroundings. This should concern environmental quality for different aspects such as lighting, temperature, air flow, acoustics, humidity, water, and others (Hensel, 2013, p.17-23).

At the beginning of the 1970, Jenks and others pointed out that BP merges various meanings, which appeal to opposite faculties of the mind and the body, so that they interrelate and modify each other's (Jencks 1978, p132). At the beginning of the 21st century, Kolarevic and Malkawi (2005) stated that BP has an influence on a building's design, its processes and practices, by merging the difference between geometry and analysis, and between appearance and performance. Hensel (2013 p. 26) posited that the BP stems mainly from the depth of the connection between form and function, and often coincides with the related art, and science or the relation between building and users. Kamara (2013) defined BP. as "*the extent to which a building supports the immediate and changing needs of its users, and how its impact on society and the environment is optimised.*" The current research agree with the last definition of BP is how far a building fulfils the current and future needs of its users, and its effect on society and the context in which it is used. Thus the BP should improve the environmental status of a building. A key phase of developing the built environment is to create a way to promote building performance over as vast a range of environmental and energy criteria as possible (Agha, 2015). Alexander (1998) and Worthington (1998) pointed out that performance equipment from building control manufacturers may specify a range of values for the aspects of building performance.

The designer is responsible for determining the precise needs of the building and ensuring that the equipment can be tailored to these requirements. These are: (1) Technical capability –Energy, “greenness” of a building and solar gain, fabric and others (2) Technological environment –Flexible location and relocation of computing equipment and telephones, networks, and others (2) Business and its processes – Support for a rapidly changing work environment and open-plan to cellular divisions (4) User comfort –User ability to directly control his/her own micro environment.

The literature has clarified that the building performance could be enhanced by:

- Arkin and Paciuk (1997, pp. 471-479) considered the “*magnitude of systems integration*,” which means enhancing BP equal systems integration to improve the level of intelligence (see Section 4.3.3).

- Wong and Li (2006) “*Intelligent amenities quotient*” refers to enhancing BP and the equal classification of IS into categories as a phase of improving the level of intelligence, which includes primary and secondary systems. Similarly, Frances Duffy, a world renowned architect of IB (cited in Kroner 1997, p.383) suggests other classification of IS as: office automation; advanced telecommunications; building automation; and creativeness to change.
- Many like Preiser and Schramm (2002) have conducted a “*User evaluation*” in an attempt to quantify the environment. In response to this, these authors developed the “*post-occupancy evaluation process model*” (POE) to reveal the BP. They applied the POE process model to assess IB in the Multi-Cultural Context and proposed that the POE model might “*enhance building performance evaluation in intelligent buildings especially on a long-term, continuing basis*” as the assessment system permits the monitoring of the performance of novel high-tech approaches and their outcomes for building occupants, and the efficacy of these systems generally.
- Several studies have considered “*Performance criteria*” as assessment methods of level of intelligence to enhance the BP. In 2008 (p. 286) Wong et al. highlighted how the Multi-Criteria Decision-Making (MCDM) method has been suggested to resolve the difficulties in building system. The multiple aspects of system intelligence (i.e. the intelligent features) of the main IB systems are to be assessed by an analytic hierarchy-network process, namely as integrated approaches.

So and Wong (2002) and Wong et al. (2005, pp. 144-145) proposed a two-stage resolution to form a suitable IB level. The first level is composed of nine “*Quality Environment Modules (QEM)*” (M1-M9), and the second has three main elements: functional needs, functional areas, and technologies. Chow suggested the incorporation of extra modules (M10) in addition to the extant nine modules to cope with the health needs of the buildings. The modified QEM includes: “*M1: environmental friendliness—health and energy conservation; M2: space utilization and flexibility; M3: cost effectiveness—operation and maintenance with a focus on efficacy; M4: human comfort; M5: performance efficiency; M6: safety and security measures—fire, earthquake, disaster and structural damages; M7: culture; M8: high technology images; M9: the construction process and structure; and M10: health and sanitation*”. Each of the ten main modules listed above will be provided with key elements in a suitable order of priority.

The development of a “*building intelligent assessment index (BIAI)*” was intended to analyse a seven building features, and was developed by Smith (2002, p.35-58) as follows, as “*site specification, operational cost, intelligent architecture, identity, intelligent technology, system responsiveness, and access and security.*” Nevertheless, many methods of assessment have been derided for their limited scope in tackling either the tangible or intangible features of buildings, and failure to give a total performance evaluation of IBs.

An extensive survey of the literature has revealed the attributes to be employed in the choice of an IB system. More precisely, AIIB has clarified a number of factors related to the assessment of the intelligence level of an IB, and these elements were placed in nine criteria groups (cited by Wong and Li 2006, p. 1107) “e.g. *greenness, space, comfort, work efficacy, culture, high-tech image, safety and security, construction procedure and structure, and cost effectiveness*”.

However, which of these ways are appropriate to be used in T.C.H.T to enhance their performance, and the reason behind this. Therefore, we need a clear role for using IS in T.C.H.T.

1.3 Problem definition

This section clarifies the gap in knowledge and then extracts the research problem, which arises from:

First, the need for improvements to courtyard houses in Baghdad. However, the literature has focused on many current problems of T.C.H.T in Iraq/ Baghdad. These problems concern function, economy, culture, structure and services, and those linked to re-development, as show, in section 1.2.2. Therefore, the T.C.H.T has not respond to changing requirements due to these issues, and others, such as the changing weather and climate conditions for example dense solar radiation, extreme temperatures, low humidity and dusty winds, which have had a negative effect on the house performance. For this reasons the T.C.H.T needs to be improved because of the problems that exist in the performance, the challenges it faces, and the key drivers for improvement in T.C.H.T. to be equipped to face these changing needs.

Second, there are the demonstrated benefits or potential role of IS to bring about the improvements in the other buildings, and therefore the potential to be useful in bringing about improvements in courtyard houses. The potential of IB is generally to provide greatest values in terms of BP as confirmed by Alwaer and Clements-

Croome (2010, p.799). Promoting the BP in the form of the built environment due to enhancing the life cycle of the new buildings, as confirmed by Kroner (1997, p. 387), or the on the other side, Kua and Lee (2002, pp. 231-239) considered how IBs can be used to promote BP of existing one due to build heritage conservation, and future architectural and building attempts by giving a longer lifespan. However, the potential benefits of IB to bring improvement in terms of performance socially, environmentally, and economically, which could be achieved by reduced running costs, environmental control, control building systems, provide safety and reliability, operational effectiveness and energy efficiency; and better dependability, observation and monitor, maintaining /building upkeep and many others as show in section 1.2.3. Thus, the potential of IB to assist in establishing improvements in courtyard houses.

Third, there is the absence of any insights into how IS might be potentially and/or actually useful in courtyard house. An IB can be seen in different types of buildings and incorporates every kind of living and working context. Currently, most IS support has been extended and developed in commercial and office buildings, libraries, laboratories, factories, commercial, restaurants, and education facilities (Kroner, 1997, p. 382), but there are also applications in dwelling houses such as the INTEGER house at BRE, Garston (CABA, 2014). However, many academic researchers believe that IS can improve building performance, the potential of the new technology has not been fully recognized in the CH. Therefore, IS are not implanted on a broad basis in the T.C.H.T., and is thus quite unexplored which means the researches have not yet defined how IS can directly or indirectly influence the CH. The previous research to date has tended to focus on IS such as Clements-Croome (2013), Chan et al. (2009), Wong et al (2005), other were focused of the courtyard house (CH.) individually. In addition, no research has been found dealing with the role of IS in the courtyard house type. It is reasonable to concentrate on the general concepts and internal relationships between the two areas of IS and T.C.H.T because of the complex nature of the IB, the variety of onsite information, and the features of T.C.H.T have to consider many interrelated roles that can enhance courtyard house performance in order to fulfil users' requirements. These interrelationships are not clearly identified which is necessary to understand the role of IS in the T.C.H.T. in enhance their performance. Thus, the research problem emerged as:

- *There is no clear picture about the possible role of intelligent systems in improving the performance of the courtyard house type.*

Therefore, the thesis includes the identification of the key features of this courtyard house type, which is an important factor that has been continued from the courtyard house too often in the past. Through the occupants' style of living in the courtyard house type which is an important aspect in the decision making about intelligent systems alternatives. Accordingly, the research seeks to address the following questions:

- *What are the key features of courtyard houses and to what extent do these support the lifestyles of current and future users?* Section 9.2.5 answers this question.
- *What are the features and capabilities of intelligent systems and to what extent can these enhance the performance of courtyard houses with respect to the lifestyles of current and future users?* Section 9.3.1 answers this question.

Current researchers have targeted the area from a different perspective through different research approach, to explore the potential of applying ISs in the T.C.H.T. This is done through investigating a series of related themes around the courtyard house type, and intelligent building, as well as intelligent systems.

1.4 Aim and objectives

This study seeks to explore how to enhance the performance of the courtyard house type by IS, and meet occupants' needs. Accordingly, the research aim will be:

- *To explore the potential role of intelligent systems in improving the performance of courtyard house types in Bagdad, Iraq.*

In order to achieve this aim and respond to the challenges, a number of objectives have been formulated to guide the research:

- *To investigate the characteristics and features of the traditional courtyard house in Iraq.* Section 3.2.5 and 9.2.4 answer this objective.
- *To investigate the meaning, nature and application of intelligent systems in buildings.* Section 4.3.6 and 4.4.2 answer this objective.
- *To investigate the lifestyle of current users of traditional courtyard houses and explore how these buildings support their needs.* Section 9.2.1 and 9.2.4 answer this objective.

- *To examine the potential role of IS in improving the performance of courtyard houses* Section 9.3 answers this objective.
- *To make recommendations on the possible applications of IS to courtyard houses.* Section 9.3.3 answers this objective. Figure 1.1 clarifies the main research questions of current thesis and their relations to the main aim and objectives.

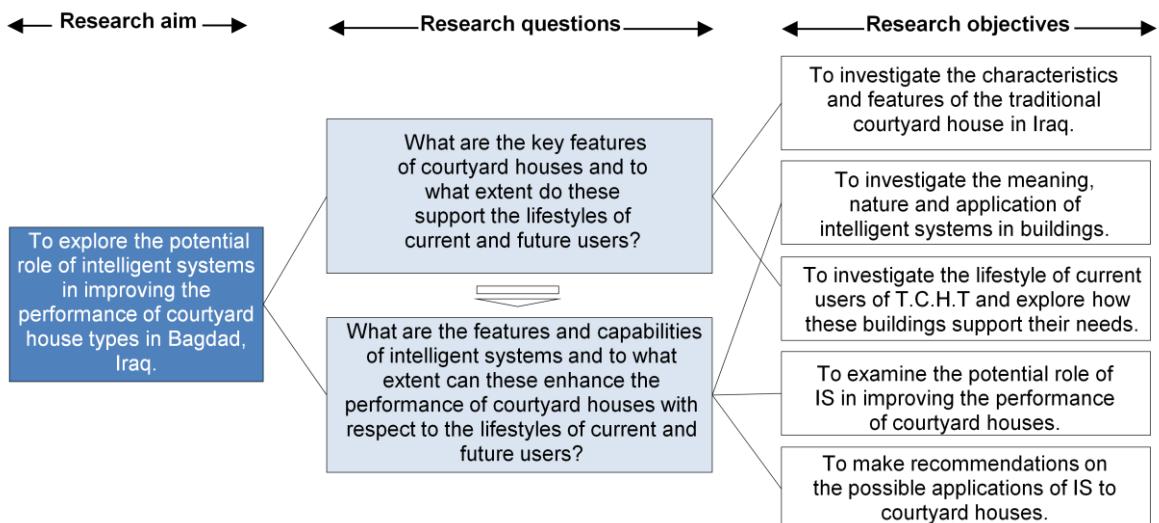


Figure 1.1: clarifies the min research questions and their relations to the main aim and objectives (Author).

1.5 Significance of the study

This section highlights why this study is important. The current study focuses on the role of intelligent systems in the traditional courtyard houses in Iraq because many architectural studies have avoided intelligent technology in the courtyard house, and this identified problem is worthy of study at this level. Therefore, the research lies in exploring how intelligent technology may be one of the main ways of improving the performance of the courtyard house type, which is linked to the likely benefits of IS in this type of house.

This research is concerned with identifying the key features of T.C.H.T and the features and capabilities of intelligent systems in it, where the people spend most of their time living and doing private activities in it.

In particular, this courtyard house type needs to be given an equivalent significance to their performance. The importance of CH to the cultural heritage of Iraq and the potential for IS to enhance and extend their useful life could be one reason why this study is important. It is hoped that this research will be able to clarify

the role of IS in the courtyard house type to enhance their performance for both current and future users.

1.6 Scope and limitation

Many factors have influenced the CH which was based on transformation of this type of dwelling units related to changing needs. Accordingly, we can classify the development of CH in Iraq into:

- Traditional courtyard houses before the First World War 1918
- Modified traditional courtyard houses between 1920-1936
- Closed courtyard houses 1936-1945 (Ihsan Fethi, 1976)
- Also, there are contemporary courtyard houses done by a few architects as separated dwelling units.

The current study focuses on the first type of CH, which is T.C.H.T, because of its differing architectural features and characteristics.

In addition, the T.C.H.T in Baghdad was chosen; it has four historic areas: Rusafa, Karkh, Aadhimiya, and Kadhimiyah, which contain a large number of different traditional buildings, housing types, and the CH is essentially an urban type of dwelling in a traditional city (Macintosh, 1973, P.7). However, these historic areas are high risk for strangers and especially females. The limitation which this created was overcome by selecting the Al-Kadhimiyah historical area, which had little risk for investigation since it is one historical area and excludes other historical areas in Baghdad. It concentrates on the courtyard house type in Al-Kadhimiyah before 1918 with specific feature and characteristics. These houses were chosen as a representative of the T.C.H.T according to objective justifications, and they were then analyzed according to certain criteria. Moreover, this research concentrates mainly on well-structured T.C.H.T rather than quantitatively deteriorated examples. The scope of this research embraces the main themes that enable us to achieve its objectives.

1.7 Thesis structure

The thesis has been divided into three parts: the first part is the general introduction, covered in chapter one. The second part, the literature review, is covered in chapter's two to four for several different areas which are important to the study's subject. Finally, the third part consists of five chapters, from five to ten. Figure 1.2 clarifies breakdown and the main issues discussed in each chapter within the

three main parts of this research. The thesis which is structured around ten chapters following the traditional pattern:

Chapter 1: This chapter gives an overview of the study and starts by presenting the main subject areas, then highlights the definitions and key features for the statement of the problems and study questions. The third section focuses on the research aims and objectives. The fourth section presents the research scope and limitations. The chapter ends with the organization and chapter layout.

Chapter 2: The aim of this chapter is to provide a clear picture of Baghdad, Iraq, as the study area, by clarifying the scope of the spatial context. This chapter begins with an overview of Iraq generally and Baghdad especially concerning different aspects such as the climate elements, the existing situation of its infrastructure, and safety and security issues. The second part clarifies the Al-Kadhimiyah district as one of the historic areas of Baghdad and the refurbishing and development projects in it are described.

Chapter 3: The aim of this chapter is to investigate the features and characteristics of the T.C.H.T in a manner that allows the researcher to have clear information which will help lay the foundation for a better understanding of house type and how it respects and responds to the users. The first part is related to the T.C.H.T type in an arid zone generally and in Iraq especially. The second part discusses the contemporary courtyard house as a successful example. It then highlights the advantages and disadvantages of the CH.

Chapter 4: The aim of this chapter is to investigate the meaning, nature and application of intelligent systems in buildings to provide an overview of previous work in the area of intelligent building. Therefore, this chapter focuses on the following aspects: intelligent buildings, intelligent systems, and the applications of intelligent systems.

Chapter 5: In order to enhance the understanding of the research domain, this chapter investigates the appropriate methodology for this research through searching for guidelines that are relevant to the methodology and justifying the adopted methodology used in this research. It explains, first, the general approach and methodology consideration, and secondly it looks at the research design. Also, it highlights the fieldwork.

Chapter 6: This is an introductory analysis for the first category of the field study. This chapter aims to present the findings obtained from interviewing architects by exploring the possible use of IS in T.C.H.T. This process is presented according to: the architect interviews, their professional experience with the CH type, and the knowledge emerging from the architect interviews.

Chapter 7: As a second category of the field study, this chapter presents the findings as obtained from a physical survey of the T.C.H.T in the Al-Kadhimiyah historical area which clarify the current condition of this house type. Thus, the chapter is organized into three main sections. The first section refers to the T.C.H.Ts being selected for the case study. Section two describes the existing condition of this type of house, and the chapter closes with the emerging knowledge from the physical survey.

Chapter 8: As a third category of the field study, this chapter presents the findings obtained from the occupants which describe the everyday life of the current users of the T.C.H.T in the Al-Kadhimiyah historical area. This chapter is classified into three main sections: the occupant interviews selected for the case study, the information collected from the current users in the T.C.H.T in the Al-Kadhimiyah historical area in Baghdad city, and the emerging knowledge from the occupant interviews.

Chapter 9: This chapter crystallizes the emerging knowledge with the intention of using the ideas extracted in the current study to provide research findings. It explores in depth the logical themes and supporting issues extracted from both the interviews and physical surveys and observations, based on the findings of the qualitative methods, and also on an explanation of these findings and possible linkage with IS, as driven by the research question. Thus, this chapter is divided into two main sections: environmental control, challenges, and social struggles, and the IS in relation to the T.C.H.T. in the Al-Kadhimiyah

Chapter 10: The final chapter concludes the research with a discussion of how the research has satisfied the proposed objectives and how the research has contributed to knowledge and practice. This chapter summarises the evidence presented throughout the study, and also reviews the contribution of the research to current knowledge. Several recommendations are formulated; the chapter ends by suggesting further studies to enrich the subject.

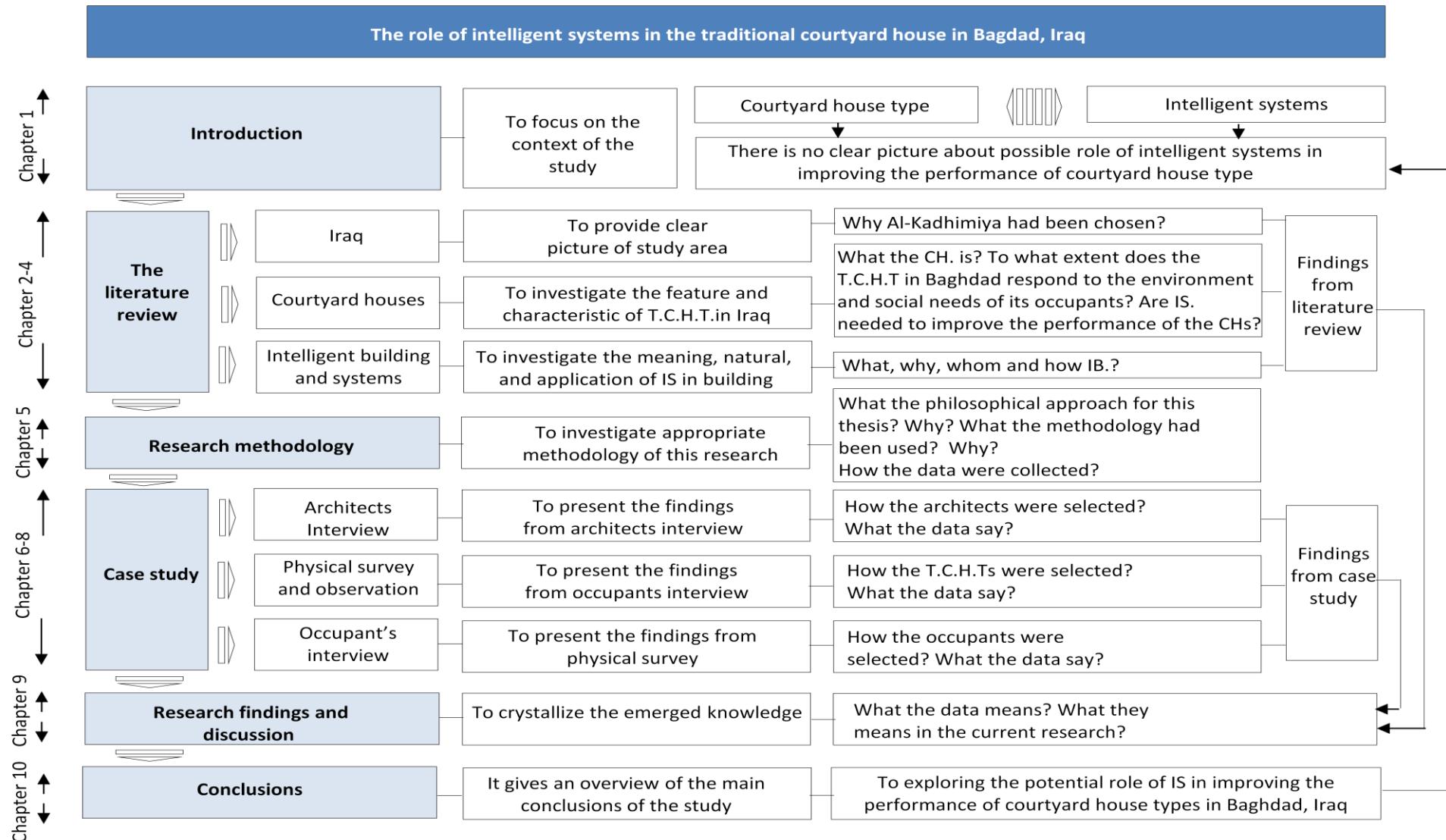


Figure 1.2: Chapter breakdown, aims and the main issues discussed in each chapter within the three main parts of this research (Author).

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2 Iraq

2.1 Introduction

The aim of this chapter is to provide a clear picture of Iraq, Baghdad, as the study area which clarifies the scope of the spatial context. This chapter opens with a general review of Iraq by considering the climate elements, the existing situation of its infrastructure, and safety and security issues. Then, the Al-Kadhimiyah district, one of the historic areas of Baghdad is described.

2.2 General view of Iraq

Iraq is located in southwest Asia, latitudes 29.5 and 37.22 north, and longitudes 38.45 and 48.45 east. It is on the eastern edge of the Arabian nations, and is situated on the Tigris and Euphrates rivers, comprising a total expanse of 435,052 km² (UN-Habitat (2005). Figure 2.1 clarifies that Iraq is bordered on all sides by other countries), including Turkey in the north, Saudi Arabia and Kuwait on the southern edge, Iran in the east, and Jordan and Syria in the west; it has only a very small opening on to the north of the Arabian Gulf.



Figure 2.1: Iraq location and neighbouring region (Google map)

Baghdad is the capital and largest city in the country and lies in the central region that is situated on the Tigris River and 50km from the Euphrates with total area 4,555 km² (Ihsan Fethi, 1977). The estimated population in July 2011 was 30,399,572 and the rate of growth was 2.399%; the population of Baghdad was 5.751 million (FRD, 2006).

There is a great deal of information on Iraq; however, this section focuses on specific issues relevant to the study.

2.2.1 Climate

The various regions in Iraq include: desert plateau, mountains in the north east, highlands, and an alluvial plain; it therefore has different environmental conditions. The country's climate is increasingly variable and this has a clear relation to house design and lifestyle, as it is the main challenge to adapting to, and controlling, the changing weather.

Iraq's mainly continental climate is characterized as mostly desert. However, two major seasons are identified in the year; the cold and rainy season from December to March and the hot and dry season from the end of April to the end of October, but there is also a moderate season. The basic climatic elements are explained below.

- **Solar radiation and sunshine**

Iraq is located in a region of strong solar radiation and sunshine. In summer, most parts of Iraq have a sun duration time of about 14 hours. In spring and autumn the sun duration time is 12 hours. In winter, because of the presence of a varied amount of cloud, the sun duration time is not the same in all regions, although one can enjoy at least four hours daily of sunshine in this season. The maximum sun altitude in Baghdad is at noon in summer and the minimum at noon in winter. The average monthly level of solar radiation for Baghdad during the last ten years is 106.1J/cm²/day (Hussein, et al., 2013, p. 855-858).

The Sun's daily motion has a major effect on the internal situation of the building, whereas protection from direct sunlight is required in summer. Direct sunlight is welcome inside buildings in winter.

- **Temperature**

Now, Iraq is vulnerable to global warming, and both Iraq and Baghdad are challenged by an exceptional set of environmental difficulty. It tends to be very hot in summer and mild in winter because of the variation in solar radiation. The maximum is in June-August of 43-50C. The monthly minimum for January is between -8-14.4C, and there is a different temperature between the seasons 36-51C, and between day and night from 20-28C. The thermal stress of each month for Baghdad indicates six months are hot with temperature between 25-49C night and day, two months are

moderate with temperature between 11.6 – 24.3C night and day, and four months are cold with temperature between 2-15.4C night and day (Darwish et al., 2013, p.154).

There are variations in temperature between day and night, and summer and winter has a direct effect on the level of comfort in the buildings; this requires consideration in terms of how to deal with this element of the climate.

- **Wind speed and direction**

Iraq has two kinds of wind pattern which can cause both sand storms. Between the middle of June and the middle of September, dry Mediterranean air is channelled between the Saudi Arabian high plateau and the mountains in the north and west of Iraq. The resultant north westerly winds intensify as the summer progresses and the ground continues to heat. From April to mid-June, and again from mid-September to November, the wind pattern changes from southerly to south-easterly. These currents produce winds that in general are gustier but not as persistent as the summer and in Baghdad the high wind speed is 4.2m/s and the lowest is 2.6m/s (Thompson, 2002, p. 200).

Wind speed is most welcome in hot dry climates and is preferred for cooling purposes both day and night during spring and autumn, and only at night-time during summer. The use of wind plays a major role in the thermal comfort¹ of the indoor environment and on the degree of comfort in the buildings, when obtaining the maximum benefit from its natural cooling capability.

- **Sky and sun light**

Iraq's sky condition indicates that for most days of the year there is a clear sky and the sun light in Baghdad is 33,107-10,5078 Lux in June, and 6,322-49,789 Lux in December. The illumination in Baghdad is 11,097-16493 Lux in June, and 7,448-12620 Lux in December (SCB, 2011A, p.10-11).

This element of the climate has a significant influence on the level of natural lighting in the buildings.

- **Dust storms**

Dust storms represent a significant weather phenomenon characterised as a type of natural hazard in Iraq. Dust storms have a significant negative effect on human

¹ Initially, thermal comfort is defined as the condition when people desire neither cooling nor heating (Thompson, 2002).

and social development at both the national and regional level. Iraqi dust storms affect transport and the disposal of materials of different sizes, leading to causing change in the Earth's surface (Mohamedi et al., 2012, pp.54-55). In 2013, Marten Cobler (cited in Kazem et al., 2014), stated at a Nairobi conference on the environment that Iraq has experienced 122 sand and dust storms, many of which lasted for a number of days. One was thought to be the most awful storm in Iraq's history, and it is predicted that Iraq will see 300 storms a year over the next half a decade. As a consequence, sand and dust storms will continue to be calamitous. In Iraq, these storms happen largely in spring and summer. Most of the sand storms happen in March to May, and cover 50% of all the sandstorms, which are less frequent from December to January.

Dust storms have a negative effect on humans in terms of both social and health level, and therefore protection from this phenomenon is important in the different type of building.

- **Rainfall**

Iraq typically has either dry or semi-dry weather and rainfall is relatively low, except in the mountainous areas in the north and north east, which receives more than 800mm. Beyond other area of Iraq receives less than 150mm of annual precipitation and high evaporation rates, the maximum rainfall is in January and there is no rainfall at all during July and August. The heaviest rainfall occurs in April and tends to be sporadic heavy showers accompanied by thunder storms. The rainfall in Baghdad is 67.5 mm (Mohammed, 2013). This element might have an impact on the buildings.

- **Humidity**

In the last 30 years in the world generally and Iraq especially, there have been changes to the weather. Most of Iraq has an extremely arid or semi-arid climate, with relative humidity of 22-72 depending on the location. Baghdad humidity in winter is 71.7, in summer 17.1 (SCB, 2011B, p.1).

Humidity as an element of climate has great effect on the building design; however, because of the extremely lengthy hot dry weather in summer, as shown above, we need to increase the humidity to moderate the temperature in the buildings.

2.2.2 Infrastructure

Infrastructure is of growing concern in assessing the service systems that have a direct impact on building performance. During the last two decades, the infrastructure and level of services has deteriorated largely due to the situation in Iraq.² The issues for services are explained below.

• Water and sanitation

- Water is an abundant resource, but it is not always available for human use in the quantities, quality, time and place it is needed. By the turn of the century, water services to urban areas had decreased to 92 per cent, with the daily per water supply falling by over half in many areas. In Baghdad, the ratio of people having access to sustained and improved water resources was 93.2%. On the other hand, 95.2% were linked to the public network, which was among the best percentages in comparison with other governorates. The percentage of the population able to have drinking water from a public network was above 90% in Al-Kadhimiyah (JAU, 2013). However, a study by the UN published in 2013 clarified that one fifth of properties in Iraq relied on unclean sources of water, and 16% said they had difficulties with the supply every day.

With the issues concerning the availability of water occurring all the time around the year, it may be that specific water systems need to be added to the building to control and manage water usage.

-Sanitation, the sewage disposal system is largely for Baghdad, serving around 80 per cent of the people. This contrasts with just 9 per cent of people outside Baghdad who are served by sewage systems. The sanitation system is therefore a significant environmental and health risk, and reports from the UN in (2013) indicate that not one sewage plant is in working order, with raw sewage discharged into rivers and water courses. The ratio of people with updated sanitation facilities 66.4% of people depended on the public system as their main service, whereas 18.9% had a septic tank, and 7.7% depended on an enclosed channel outside their property. The percentage of population with better sanitation in Al-Kadhimiyah was above 98% (JAU, 2013).

² During the 1991 and 2003 Gulf War's the infrastructure was greatly deteriorated, and due to prolonged conflicts the government was failure to response to increased demands due to delayed maintenance, poor technical and managerial abilities, and negligence have led to a worrying effect on Iraq's infrastructure (UN, 2003, p.20).

A sewage system that is not integrated between the public and private systems in a specific place, such as in historical areas, might need additional systems in the building to manage sewage, such as the odour levels.

- **Electricity**

Now, the majority of Iraqis have none or only little access to electricity services, or have to depend on expensive options for electricity supply. The national network is the primary electricity source for 38.7% of properties, whereas 60% depend on a common generator³. On the level of the governorate, 86.9% of properties linked to the national network noted daily problems lasting for over 12 hours, whereas 12.4% noted problems lasting between three and 12 hours each day. Generally, the class of the electricity services is given as 'bad or very bad' by 88.2% of those in the governorate. Numbers of hours-per day of electricity supplied by government in Al-Kadhimiyah was 6-8 per day (IAU 2013). Moreover, the cost of electricity and fuel has over time generally been very low, meaning that development of the system has been largely funded from the budget (UN, 2003, p.9).

However, increasing energy fees depending on different electricity suppliers represent a similar problem. The cost is an important aspect regarding the need for specific systems in the building that might reduce energy consumption. `

- **Telecommunications**

Networks in modern Iraq are key, for access to information is obviously an important part of life. Television is the most common information source for Iraqis, and there are private and government channels which can be seen daily by most people citizens, (around 67 per cent). There is no need for a licence and most channels are free. The second important source is access to the internet for receiving up-to-date information and communicating with others, (used by 55%), but there is a limited allowance due un limited usage, and it is not connected to a landline. However, phones are essential for communicating with others (IAU et al., 2012).

The telecommunications system has a significant effect on internet services and operation systems in different building.

³ The remainder depend on private generators

2.2.3 Security

Since the last decade, the level of conflict with the security situation in Iraq in general and Baghdad especially is a significant issue which has had a widespread effect on the lifestyle. Baghdad is one of the most insecure areas in the country. In 2012, 28% of all security issues in the country (1,341 of 4,771) were in Baghdad, although their incidence has decreased when compared to 2008 and 2011 levels (9,462 and 2,446 security incidents in Baghdad). Nevertheless, in the first half of 2013, total incidents registered in the governorate (1,625) were more than the total in 2012. Terrorist assaults (62%) accounted for the most common type of incident in the governorate in 2012, then armed conflicts (25%), and other crimes (11%). 27% of all security incidents in the governorate were in the Karkh district, and 25% were in Kadhimiyah (JAU, 2013). The security issue therefore requires attention for better living.

2.3 Al-Kadhimiyah

The contemporary city of Baghdad, as shown in Figure 2.2, has four historic areas or interesting architectures around 523.59 hectares: Rusafa, Karkh, Aadhimiyah, and Kadhimiyah, which contain a large number of different buildings and housing types (Ihsan Fethi, 1977, p.320).

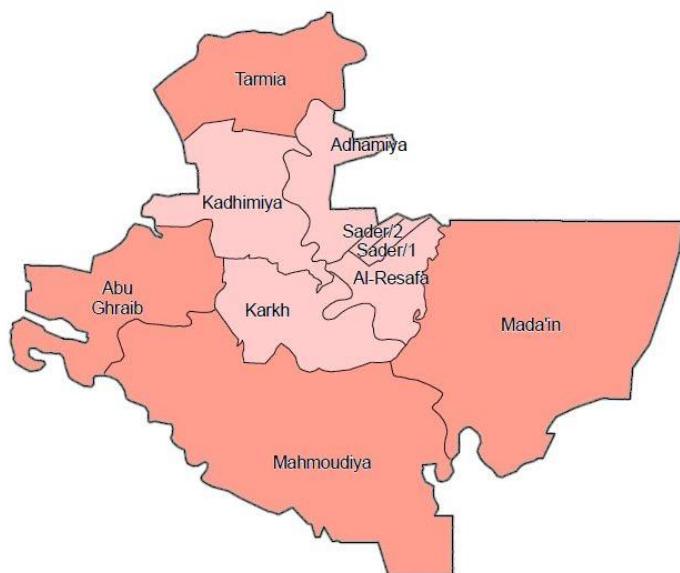


Figure 2.2: Baghdad as capital of Iraq has four historic area, one of them is Al-Kadhimiyah (JAU 2013)

2.3.1 Historical area

Figure 2.3 illustrates Al-Kadhimiyah which is the one of four historical cores of Baghdad, at about 89.61 hectares with a population of around 65,347 approximately,

which is more preserved than the other historic area. The centre is characteristic of shrine cities in Iraq, for example Samara and Najaf, which is approximately circular in shape, around one kilometre round, and having the shrine inside it (Al-Akkam, 2013, p.44-45). The area consists of four sectors named Shiyoukh, the biggest, Tell, Dabagh Khana, and Qatana that had high density.



Figure 2.3: The Al-Kadhimiyah historical area in Baghdad that possess high value of the land use, viewed from the air. Google Earth (2011)

Al-Kadhimiyah is a township which until this century lay isolated and compact among its palm groves on the west bank of the Tigris and north of Baghdad. It is central and dominating, and has functionality and a social life. Al-Kadhimiyah derives its name from the Shrine of Imam Musa Al-Kadhim which is clarified in Figure 2.4, the revered Shia descendant of the Prophet, and a shrine was built there in 800AD (Ihsan Fethi, 1977, p. 343).



Figure 2.4: The holy Shrine of Imam Musa Al-Kadhim, with golden domes (Author)

The urban fabric of the traditional area is categorised by the older fabric being largely organic and compressed, with constricted alleyways and a low sky line, but it also has a distinctive layout, and building materials (Al Akkam, 2012, p.64). The traditional alleyways typically have an upper floor projecting narrow paths which create shade and coolness in the difficult environmental situation. A very compact city area with a dense population is due to the small area, an average of 50-150m². The traditional houses are centred around an open courtyard, which is the key aspect, having been effectively used over millennia. A main consideration with the design of this type of house is privacy, and this developed as a reaction to the heat and the dry climate conditions (Al-Rahmany, 1986, p. 134-140).

Of the four historical areas possible for selection, Al-Kadhimiyah was chosen as a case study and the other were excluded because of the historical areas represent a

strong risk for non-locals and women particularly. Thus, this restriction was managed by choosing the Al-Kadhimiya historical area, which represented much less risk as confirmed in section 2.2.3.

2.3.2 Refreshing and development projects

The historic area in Baghdad/ largely requires restoration especially for its infrastructure, to achieve a comfortable living environment. In fact, one motivation of Iraq government has refurbishing and development projects that reflect the importance of historic area which content T.C.H.T. Therefore, in that light this section focused on Al-Kadhimiya projects rather than other historic area. For the defence and improvement of the historical area, there were continuous state-driven building works in Al-Kadhimiya sub city centre between 1978-1981. Moreover, the Iraq government had project to conserve and rehabilitate Al-Kadhimiya historical area between 2007-2010.

The Municipality of Baghdad (2007) has invited many architectural and planning offices to develop the Al-Kadhimiya historical area in the sub centre of Baghdad. Also, the Municipality of Baghdad (2009) presented 6 investment possibilities for refurbishing and development projects in Baghdad in historic places one of them in the Al-Kadhimiya. In (2010) the Municipality of Baghdad suggested that architectural and planning offices form proposals to enhance the Al-Kadhimiya historical area in the sub centre of Baghdad and modernize them according to the lifestyle for the historical cities' fabric through international competition to develop a culturally and historically sensitive site in Al Kadhimya, Baghdad, and were chosen from ten pre-selected international and domestic design practices. The winning design was considered to have the most appeal in terms of being comprehensive, aesthetically beautiful, and in keeping with the area's history, culture and social character. Acknowledging the importance significance of the historic local market and traditional houses at the Al Kadhimya site, and the necessity to maintain religious tourism in Iraq, the chosen company combined contemporary and traditional architectural structures. The scheme demolished some of the surroundings of the holy shrine, but maintained and rehabilitated many T.C.H.T for their unique architectural value. Moreover, the plan suggested the conservation of the Al-Kadhimiya historical area, via high technology such as renewable energy. Mohamed Al Assam, who was the chairman and director of the project, explained that the main concern of the plan was to seek methods which would enable changes to make to the area in keeping with

modern requirements, without injuring the spiritual history present its extant historic structures. The development must be done so that the place retains its spirit, and this was one of the key concerns in the design process. Another concern during certain religious ceremonies and festivals was that the location of Al Kadhimiyah sees many visitors. It is important that the urban fabric is able to deal with these extra demands at peak times, but there is also a need to keep the area lively and attractive for residents during the year. The core urban area contains key parts of the historic urban fabric, which will be improved, refurbished and adapted plot-by-plot, in accordance with information gathered in the future, to retain the scale and the core features of historic Baghdad.

In this way, it is clear that another justification for choosing the Al-Kadhimiyah historical area relates to the renovation and development work which has been conducted there.

2.4 Discussion

The different issues and the selected contextual factors are deemed to be relevant to the study because of their relationship to house design, lifestyle and the building performance, which includes: (1) the climate uniquely different elements are briefly described and the implications of these are as follows: solar radiation and sine, wind, temperature, sky condition, dust storm, rainfall and humidity. Iraq suffers from versatile of climate and weather conditions between the seasons and day and night patterns has already become apparent, with greater frequency, more intense weather events, and further environmental decay in the country (see Section 2.2.1). (2) The infrastructure is related directly to this study, because of its relationship to the building performance and the lifestyle. However, this factor has been affected during the last 30 years for different reasons. We have demonstrated that in many challenges there are interrelated respects, such as water and sanitation, electricity, and telecommunication (see Section 2.2.2). (3) Security was another key issue that has a significant effect on the lifestyle in building (see Section 2.2.3). However, these environmental changes, level of services and security need to be control and provide a proper and comfortable healthy interior environment for people in the building, and so eliminate the challenge of the harsh environment and general situation in Iraq.

Iraq has a number of historical areas and much traditional architecture. The historical areas in Baghdad city that contain the T.C.H.T are those such as old Rasafa and Karkh or sub- city centres like Al-Kadhimiyah and Al-Adhamiyah. Al-

Kadhimiya was chosen as a case study and other historical areas in Baghdad were excluded because the historical areas were too dangerous for non-locals and women. Thus, this restriction was dealt with by choosing the Al-Kadhimiya historical area as this area posed a lower risk. However, these historical areas possess high value land which has seen many refurbishing and development projects (see Section 2.3.1). Perhaps the most important factor that makes the study area suited to this investigation is the presence of a government plan to refurbish courtyard house types, which has prompted an investigation of the potential relevance of IS in this regard (see Section 2.3.2).

2.5 Summary

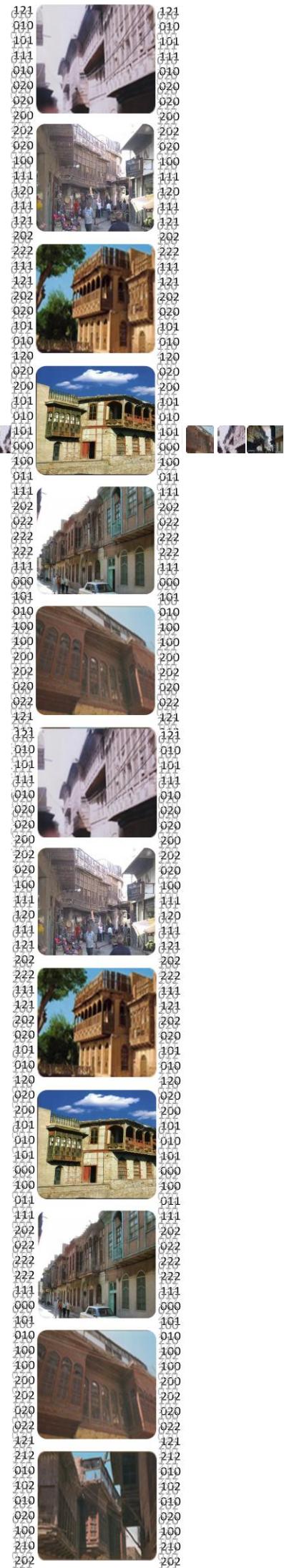
This chapter has presented a number of issues about Baghdad, Iraq, as a study area, and then established the reasons for Al-Kadhimiya being chosen, including the historical area; to properly investigate the relationship between IS in the T.C.H.T.

The environmental and social aspects play an important part in the instrumentality of the T.C.H.T for understanding how and why to choose housing technology options. The next chapter discusses these issues in CH. However, the chapter ends by stating the objectives that underpin the structure and direction of analysis in both the theoretical approaches and the practical works.

Chapter Three: Courtyard houses



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3. Courtyard house

3.1 Introduction

The aim of this chapter is to investigate the features and characteristics of the traditional courtyard house in a manner that allows the researcher to have clear information, which will in turn help lay the foundation for a better understanding of his house type and how it respects users and responds to them.

This chapter is organised into three main parts: it starts with the traditional courtyard house type in an arid zone generally and in Iraq especially. The second part focuses on the contemporary courtyard house as a successful example. It then highlights the positives and negatives with the courtyard house.

3.2 Traditional courtyard house type

This section highlights what the traditional courtyard house type (T.C.H.T) is. However, the term “*Traditional courtyard house type*” is used here to mean the houses are older than the First World War, which are known in Iraq as the Oriental, or Open

3.2.1 *Traditional courtyard house concept*

The literature has described that the T.C.H.T is an indigenous urban house form that evolved at least 6,000 years ago in various regions of the world with different climates, cultures and building materials across the ancient world. Goh and Sibley (2009) stated that the T.C.H.T was found in the Bronze era in Greece, in the Classical, Hellenistic and Roman periods, and Islamic civilisation to the current day. In terms of its architectural type, it can be seen across Europe, both the Middle East and the Far East, and North and South America, and Africa.

A T.C.H.T. typically has an inner open space, the courtyard, which serves as the focal point for all the other habitable spaces, as stated by Al-Zubaidi (2007). The T.C.H.T, as referred to by Al-Mumin (2001) similarly in 2007 (p.971), Shokouhian et al., generally uses the inward-looking designs for which traditional courtyard houses are renowned. It not only provides an appropriate microclimate to obtain light and natural ventilation, it also delivers the privacy and secluded area, security, and social oneness required in such traditionalist societies. The well-concept of Oktay (2002, p. 1006) says that courtyards which are open to the sky create satisfactory spaces for the residents, with various functionality as a social meeting space in both the

afternoon and evening, and for domestic chores such as the preparation of food and other domestic work. Similarly, Memarian and Brown (2003) stated that the T.C.H.T not only facilitates climate and visual or acoustic protection, it enables the resident to go outside.

If we think deeply, we find that the T.C.H.T has an inward looking plan concept consisting of a courtyard around which all habitable rooms and spaces are grouped. Hence, these rooms and spaces look inwards onto a private and secluded open space, through which they obtain sunlight, daylight, and natural ventilation. They also have visual interaction. The T.C.H.T related of their feature and characteristics that are explained in the next sections.

3.2.2 *Traditional courtyard house categories*

This section illustrates the T.C.H.T according to different categories.

- **Form**

When one looks at an old city plan, one can see that the neighbourhoods which have the T.C.H.T form are a contiguous and amorphous mass of buildings separated at random by winding shapes and narrow gaps representing the meandering alleyways as show in Figure 3.1. The form of the T.C.H.T was grew piecemeal, with the residential areas developing under similar general constraints so that houses were not of a given orientation but nevertheless they conformed within a certain measure to general overall patterns; consequently, they fitted together coherently, irregular as they were. The overall patterns produced a natural coherence which gave regular texture to the city (Warren and Worskett, 1983, p.32). Thus, there were fundamental practical reasons for maintaining a plan form found in the earliest cities of the region.

The T.C.H.T in Iraq shares the same concepts of plan, section, and elevation with other T.C.H.T in the world. It is generally not a precise shape and is linked from three sides, since other courtyard houses are built contiguously along these sides. There is one elevation which is in effect the facade of the house along the alleyway. In plan concept, the T.C.H.T essentially consists of an interior courtyard and all the family rooms are grouped around three or all of its sides. In section, it can have one or two floors, a roof, and some have a basement (Shokouhian, 2007, p.971). This mass is irregularly punched with holes of various sizes.



Figure3.1: The compactness of T.C.H.T in Al-Kadhimiyah as a contiguous and amorphous mass of buildings separated at random by winding shapes and narrow gaps viewed from the air. Google Earth (2011)

- **Size**

The T.C.H.T in arid zone generally and in Iraq specially were not built of an exact size. In the book of “*Traditional Houses in Baghdad*” Warren and Fethi, I (1982) referred to how the T.C.H.T was not cut into precise segments of regular sizes. Al-Jawadi (1986, pp.12-31) classified courtyard houses into three sub-categories, depending on size. Figure (3.2) illustrates different sizes of T.C.H.T.



Figure 3.2: Classification of the courtyard house type in Al-Kadhimiyah according to size (Author)

(1) Small (PH, CH.4, 2012) (2) Medium (PH, CH.3, 2012) and (3) Large (PH, CH.10, 2012)

- The larger houses, these were built of an area greater than $150m^2$ in size, and usually consist of two storeys. This type of house has a veranda running around the courtyard, contributing to the shading of the courtyard, and decorating the house and protecting walls and windows from winter rain. The house usually consists of two reception rooms, one for males and one for females, several bedrooms, a large kitchen, toilets and bathrooms. These houses usually have basements, one or more terraces, galleries and a small garden. Bad-geer¹ is one of the dominant characteristics of these Baghdadi courtyard houses.
- The medium houses, houses are built on land between 100 to $150m^2$ and each house has several rooms, a kitchen, toilets and a small bathroom. Such houses have shanasheel² on the first floor. A basement might exist, and bad-geer also exist in these houses, which can be considered typical Baghdadi houses since they possess most of the climatic, social and security needs required by their occupants.
- Small houses, these were mainly built on plots between (the 40-100m²) and tend to be very simple in style with one to three rooms and a small courtyard. The thermal environment cannot be controlled adequately in such types of houses and the only benefit of the design is the reduction of exposed walls. In truth, however, the small courtyard plan is a product of urban living, and is not in the least unique to Baghdad.

¹ See section 3.2.3 part 3

² See section 3.2.3 part 3

- **The number of interior courtyards**

Usually, the T.C.H.T has one or two courtyards; however, this house type in Iraq is different from other T.C.H.T in the world. These houses include the single courtyard as shown above or multi-courtyards configuration, using the criterion of the number of courtyards incorporated within each house. The T.C.H.T in Iraq consisting of two courtyards or more are usually different in terms of the size of house plot, size of built area, and the number of habitable rooms and spaces at each floor level. According to Al-Azzawi (1984, p. 56), the T.C.H.T in Iraq can be grouped into four categories related to the number of interior courtyard(s):

- One-courtyard houses, these comprise the family quarters only; they represent the great majority of houses in Baghdad. Figure 3.3 highlights an example of one courtyard house.

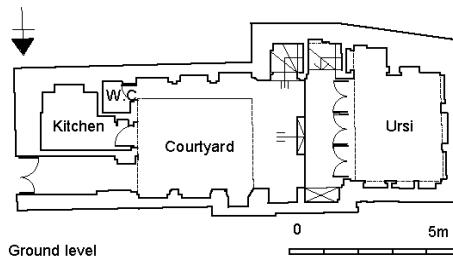


Figure 3.3: Example for one courtyard of T.C.H.T in Al-Kadhimiya (PH, CH.12, 2012), (Author).

- Two-courtyard houses, for these had two courtyards which were comprised of the following: family quarters, kitchen house/ complex, or the guest quarters. Figure 3.4 example for T.C.H.T that contains two courtyards.

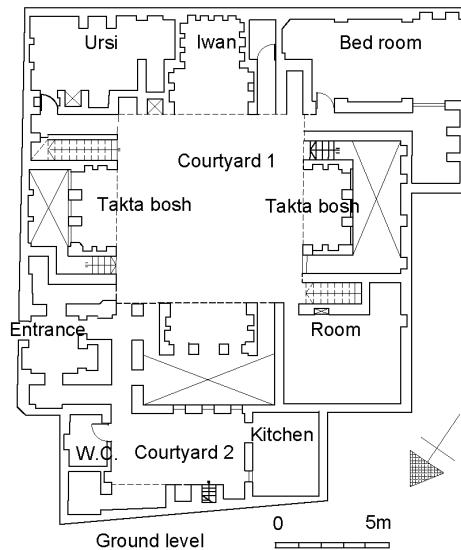


Figure 3.4: Example for two courtyards of T.C.H.T in Al-Kadhimiya (PH, CH.1+4, 2012), (Author).

- Three-courtyard houses, these comprise the following: family quarters, kitchen house/ complex, and guest quarters or a stable.
- Four-courtyard houses, these types of houses are comprised similar to the previous type. When viewed from the inside, the four parts of the house have in plan distinctly differentiated and physically separated domains. Each part of the house has its own courtyard, around which are grouped its own inhabitable accommodations and spaces, and additional areas; therefore, there are four courtyards of different sizes. There are also communicating doorways, corridors or ante-rooms between the spaces on the same level or at both floor levels and at roof terrace level. Figure 3.5 shows an example of T.C.Hs with four courtyards.

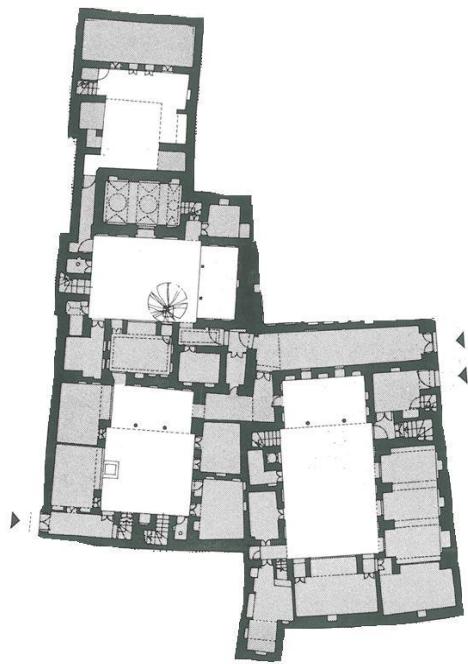


Figure 3.5: Example for four courtyards of T.C.H.T in Al-Kadhimiya (Warren and Ihsan Fathi, 1982)

• Material

Also, the design of T.C.H.T is generally equal in various areas in the world, albeit with small variations from one area to another, this variety is dependent on the materials and technologies available. Yang (2007) pointed out that each T.C.H.T exemplifies an understanding of the local built context through the construction by using fire bricks, stones, and mud which create a basis for potential traditional materials and provide of ecological housing development. However, in Iraq the T.C.H.T used the same materials.

The T.C.H.T categories have been described. Some of these categories relate to size, which increases to 300 m², and number of interior courtyard(s), which increased to four courtyards; both are found in the specific region such as Iraq. These categories of house type had specific components which are explained in the next section.

3.2.3 Traditional courtyard house components

There is a large volume of published studies describing the components of the T.C.H.T. We can classify these components into three groups:

1) Usable spaces

The usable spaces in the T.C.H.T include:

The Entrance

The house is usually entered directly from the alleyway through a double door, and into the entrance hall, which is usually defined by an arched doorway and bent or crooked space (Haw-Change, 1986, p. 45).

The living rooms

This item includes:

- Reception rooms –some houses of well-to-do families incorporate a reception room on the first floor in addition to that on the ground floor, which is used mainly in winter and the cool periods of spring and autumn. In this first floor reception room was noted as incorporating the shanasheel and is normally used by the adult male members of the family and visitors, while the female members of the family and their female visitors use the internal rooms overlooking the courtyard. It is usually approached by means of a special staircase and a special latrine situated in the entrance hall; hence, male visitors enter and leave without intruding on the privacy of the family and without coming into contact with the female inhabitants (UN-Habitat, 2005, p.83)
- The ursi – is one of the main habitable rooms on the first floor, and is a family room for the cooler weather, particularly if it was on the northern side of the courtyard; however, it may also be used during the cool periods of spring and autumn. It is a relatively long and narrow room and is located along one side of the tarma. Its main elevation may overlook the courtyard directly without a tarma or even a "mamsha" in between (Al-Zubaidi, 2007, p.70)

- The takhta-boosh – the timber floor, as well as the space above it at mezzanine level, is known as the takhta-boosh. It is usually approached and entered from the courtyard where its floor finish is either at the same level as the courtyard or approached by many steps (El-Shorbagy, 2010, p.17).
- The jam-khana is the winter family room on the ground floor which is located over a basement. The wooden of the floor of the jam-khana is constructed of poplar joists. Poplar trees are grown in the north-eastern mountainous region of Iraq. The courtyard elevation of this room is similar to that of the ursi (Al-Azaawi 1984, p.134, p.148).

Bedrooms and multipurpose rooms

The bedroom is used here to denote rooms where the inhabitants normally sleep overnight in winter. Some of these rooms may be used as family rooms during the day and in the evening. Some of these rooms are small in size and have a few small windows or no windows at all, with the exception of a fan light on top of the door. In such cases, daylight and natural ventilation are provided mainly through the door. Figure (3.6) clarifies the kafish-kan is a multi-purpose room located in the mezzanine level of the first floor, which may be planned as an external corner to overlook the courtyard, alleyway or both at the same time depending on the corner it occupies in relation to the courtyard and the alleyway. Where a kafish-kan overlooks the courtyard, its elevation consists mostly of windows and special decorative patterns rather than a solid wall (UN-Habitat, 2007, p.106).



Figure 3.6: The kafish-kan as multipurpose rooms of T.C.H.T in Al-Kadhimiyah, (Author).
1. (PH, CH10, 2012) 2. (PH, CH1, 2012)

Basement

Depending on its size, a T.C.H.T may incorporate an underground level. In Iraq, there are two underground levels named:

- The sardab –This is buried under the floor of the courtyard, which is a habitable subterranean cellar located immediately underneath, with its floor finish level being about 5-6m below that of the courtyard.

However, T.C.H.T in Iraq specially had other a habitable room or cellar at the subterranean level. This includes

- The neem sardab –Usually, there is one, or more, neem sardab without a sardab in T.C.H.T. The neem sardab is an inhabitable demi-cellars which is partially underground and positioned either immediately alongside the courtyard and overlooking it directly, or indirectly through it (Al-Azaawi 1984, p.134, p.159).

Service rooms

This item includes:

- Kitchen is either a mere recess or a small room without any window. Originally, the kitchen did not incorporate any facilities such as a water tap, basin, or a drain.³ In the large houses, the kitchen is a complete and independent entity with a built-in hearth and a chimney, built-in stands for pots, one or more store rooms for keeping food and cooking facilities, and one or more habitable rooms for the cook and the servants.
- Bathroom- the houses of well-to-do families incorporate a traditional oriental bathroom⁴. However, T.C.H.T of the great majority of the population in Baghdad does not incorporate a bathroom in small houses⁵ and their inhabitants depend on the use of public baths, particularly in winter.
- Toilet usually located under the main staircase leading from the ground floor to the first floor with access directly from the courtyard. The latrine consists of an open rectangular ditch in its raised floor above that of the courtyard without any flushing device. The sloping floor of this ditch is connected to a seepage pit by a circular drain of earthenware or by a rectangular drain of brickwork (Al-Azzawi, 1984, pp.70-73).

³ During the early 1930s, piped water was introduced in Baghdad, and a water tap was installed in the courtyard house.

⁴ Turkish steam bath type

⁵ Back to section 3.2. 2 the size of courtyard house

2) Transitional space

This group covers:

The iwan

It is another habitable, covered and semi-enclosed space. A T.C.H.T may be composed of one iwan on the ground floor, oriented away from the sun and used as a family room in summer, and one or two iwans on the first floor. While it is used as a family room in winter and is therefore oriented towards the sun. The central space might be an iwan entered from the front or a tarma screened and divided from it by two columns and entered from the sides (Moradi and Akhtarkavan, 2008, p.22)

The tarma

The tarma concept was generally implemented on the upper floor located between closed and enclosed space. This T.C.H.T may incorporate one, two, three or even four tarmas depending on their size (Haw-Change, 1986, pp.123). Figure (3.7) show the tarma.



1



2

Figure 3.7: The tarma as a transitional space of T.C.H.T in Al-Kadhimiyah, (Author).
 (1) (PH, CH.4, 2012), (2) (PH, CH. 10, 2012)

The mamsha

The floor at the first floor level usually projects internally into the courtyard and is defined by the walls of the rooms surrounding the upper part of the courtyard and by a timber balustrade overlooking the courtyard. This projection forms the access gallery that is known as the mamsha and which is located along one, two, three or four sides of the courtyard, where it is narrow (Moradi and Akhtarkavan, 2008, p.25). Figure (3.8) shows the mamsha.



Figure 3.8: The mamsha as a transitional space of T.C.H.T in Al-Kadhimiya (PH, CH.10, 2012), (author).

3) Architectural physical elements

The T.C.H.T includes many architectural elements, such as a third group of components, which are:

- **The courtyard “hash”**

Courtyards have a central role in houses. Other spaces within the house are placed around this roofless space and open their doors and windows towards that direction (Muhaisen, A. 2006, p.1731-1732).

- **Air-scoop “bad-geer”**

In order to introduce outside air into the courtyard house spaces and induce cross-ventilation through them, a number of air-ducts, called bad-geer in Iraq are included in the design of the T.C.H.T and incorporated into the relevant walls Al-Zbaidi (2002).

- **Shanasheel**

It is a timber screen of lattice work incorporated in each window on first floor over the street; to provide the interior with adequate day lighting and air flow. The shanasheel is usually of a rectangular shape in plan and built of light construction which was used in conjunction with a second window located immediately above it, as well as it is effectively double-glazed as it consists of two identical skins separated by an air space (Toulan,1980, p. 82). Figure (3.9) shows different types of shanasheel.



Figure 3.9: The shanasheel as a physical architectural element of a T.C.H.T in Al-Kadhimiyah, (Author). (PH.CH9 2012), 2. (PH.CH7 2012), 3. (PH.CH5 2012).

- **Muqarnas**

Waran and Ihsan Fethi (1982) said “*moqarnas is one of the most characteristic aspects of construction and decorative techniques in T.C.H.T in Baghdad are the use of stalactite composition and construction*”. It uses brick and gypsum mortar, and plaster or timber to achieve these aesthetically exciting and pleasing forms and configurations.

- **Wooden columns**

The columns at ground and first floor are always of timber, usually poplar wood from trees grown in the north eastern mountainous region of Iraq. The capital of the column gives the column capital a richly decorated effect (Qaisi, 1984). Figure (3.10) illustrates these wooden columns.



Figure 3.10: Wooden columns as a physical architectural element in a T.C.H.T in Al-Kadhimiyah (Author).

(1) (PH, CH.10, 2012), (2) (PH, CH.7, 2012).

- **Ornamentals**

Brick, stone, wood and mirror panels were used in some houses on the opposite walls or ceilings, and on the roof and inside the rooms or galleries by creating ornamentals (El-Shorbagy, 2010, p.19). The ceiling of the sardab in the T.C.H.T in Iraq is shaped from shallow domes, and there are also arches and vaults of brickwork that create geometric ornaments (Al-Azzawi, 1984, p.388). Figure 3.11 depicts decoration techniques in the T.C.H.T.



1



2

Figure 3.11 Brick ornaments in walls and ceilings in a T.C.H.T. in Baghdad/ Al-Kadhimiyah, (Author).
 (1) (PH, CH.9, 2012) (2) (PH, CH.2, 2012).

The components of the T.C.H.T have been clarified; we found that these components are related to the size and number of courtyards of the T.C.H.T. The T.C.H.T in Iraq is distinguished from others in the world, as it has can have a neem Sardab in addition to a sardab. However, questions were raised in reference to the potential of these components to respond to the environment, how these components can respect the users, and which elements might support the lifestyle of the current users. The next section focuses on this.

3.2.4 The responsiveness of the traditional courtyard house

The T.C.H.T is generally found within in a traditional city and is fundamentally a home. CHs should flourish from its environment, society. In this respect, the Arabic architect Rasem Badran (1998) declares that CH. is concerned with culture as well as the surrounding environment. This section focuses on how the T.C.H.T responds to the environment and social aspects and these are now highlighted.

1. Respond to the environment

The T.C.H.T is response to the changing of environmental condition such as the air movement and air flow of wind, the sun light, and also the change in temperature

during the day and seasons to promote the house performance through the following items:

- **House components and passive systems**

The general objective of reducing solar radiation in T.C.H.T is to protect the surfaces of structures as much as possible from direct exposure to the sun. Two methods of achieving this have been confirmed by Leylian et al. (2010, pp.279-280) Likewise, Muhasian (2006), and these are: the use of compact T.C.H.T forms and coherence and adjoining urban fabric frees three out of the four sites having minimum exterior surface areas, and the clustering of structures so as to provide maximum shade. Since these internal party walls are relatively thick, protected from direct solar radiation, and always in the shade, they are usually cooler than the other walls; therefore, they maintain coolness in the house in summer through the effect of thermal inertia and shedding. The reduction of the surface area open to direct solar radiation during summertime is important as habitable rooms open directly onto the courtyard and the courtyard is exposed directly to the sky. In the book "*Housing in Arid Land*," Fried and Labs (1980) pointed out that the T.C.H.T in an arid zone is protected from direct sunlight, speed wind, and different temperature, dust storm through the inward looking plan.

The presence of a basement enables T.C.H.T to store heat and cold through thermal inertia⁶. The design of underground levels is either completely or partially buried in the ground, and so is kept cool throughout the day mainly by the effect of the surrounding ground. Therefore, they receive very little or no direct sunlight either by their orientation away from the sun or by another space. Hence, the problem of heat gain from direct solar radiation is avoided. Thermal inertia promotes natural cooling and heating in the T.C.H.T through the use of soil energies to achieve relative thermal comfort conditions in summer or winter (Leylian et al., 2010, p.279). As Labs stated (1980, pp.123-125), underground placement is a total shading approach to the elimination of direct solar heat load on surrounding walls. The great virtue of this technique is that it is self-shading to achieve coolness; no adjacent or adjoining structures are necessary to capture its benefits. Al-Mumin (2001, pp.105-106) argued that the main advantage of using underground levels is the comparative seclusion

⁶ Thermal inertia is the ability of the house space to store heat via natural resources (Agha, 2015)

from the outer environment. For the T.C.H.T, this indicates thermal constancy which leads to thermal comfort.

The floor-to-ceiling height of the ground floor is usually less than the first floor, particularly in the T.C.H.T. which response to thermal gain and loss in different seasons. The ratio for habitable rooms used for summertime inhabitation and located mainly at ground level is very small in order to reduce, and even avoid, the thermal gain to the interior either from the sun directly or from the hot and dry external thermal environment. For habitable rooms used for wintertime inhabitation and located mainly on the first storey, this ratio is relatively big in order to facilitate direct solar heat gain to the interior to make it warmer (Ozdemir et al. 2008, p.971) The reasons for this ratio were confirmed by Sozen and Gedik (2007, p.1814). These are: to allow the sunlight in winter to penetrate deeper into the interior and therefore produce a relatively warmer internal thermal environment; to provide adequate cross-ventilation through in the upper floor, particularly overnight in the spring and autumn.

The T.C.H.T had many elements that response to changing the weather and climate condition, such as the courtyard provided light and ventilation and was the temperature regulator and circulation space, as well as the zone where the several stratifications of the house came together. In summary, the courtyard's influence on moderating temperatures and in enhancing air circulation cannot be ignored to ensure adequate ventilation in kitchens, bathrooms and halls. Ventilation can also be organized to work automatically, either daily or seasonally, while solar energy can be harnessed to provide convective drafts either to extract air or bring in temperate air (Stead, 1980, p.43) and (Dilia et al., 2010, p.921). In the courtyard, a concentration of cooler air is kept, as it weighs more than the adjoining warm air and the planted section gives movement and creates a better microclimate in the courtyard and the house through increasing the humidity (Oktay, 2002, p.1006).

The composition, design and orientation of bad-geer which introduces air from the roof level into the underground level ensure that the external hot and dry air is cooled and humidified. It also helps to induce cross-ventilation in this level, which helps to decrease the surface temperature of its floor, ceiling, and walls. These surfaces help to keep the internal thermal environment conditions desirable most of the day (Al-Zbaidi, 2002). Al-Temeemi (1995, p.43) found that the bad-geer helps to reduce the heat and dry air of the prevailing wind which is cooled by the thermal processes of conduction, convection, and evaporative cooling. Therefore, it continues to descend

into the vertical air-duct because of the physical force of the prevailing wind and also because it has become denser as a result of being relatively cool; by descending in this way, it continues to cool. During the last ten years, El-Shorbagy (2010B, p.17) noted that the internal surfaces of the vertical air-duct have the effect of humidifying and cooling the incoming hot and dry air through the process of evaporative cooling. It does not receive any sunlight, and are therefore always in the shade. They are usually at a lower temperature than that of the incoming external air, particularly where the bad-geer is incorporated within the thickness of a party wall.

Different authors such as Warren and Ihsan Fethi (1982), and Al-Qaisi (1984) have confirmed that the shanasheel served several functions, as follows: To provide adequate cross-ventilation and air-movement. Moreover, they allow the sun to penetrate the interior in winter in order to make it warmer. There is provision for more shade in summertime from sun on the external and internal elevations by the horizontal and vertical projection, as confirmed by Al-Zubidi (1999, p.4), from the first floor shanasheel beyond the outside face of the external walls at ground floor. This protects beyond the face of the external wall overlooking the alleyway from harsh weather.

The T.C.H.T built with thick walls that response to different environmental conditions. Yang (2007, p.191) clarified that thick walls help to delay and reduce heat gain from the heated outside to the colder inside and therefore retain a comparatively cooler interior in the daytime in summer. Thick brick walls with their high heat holding capacities also have overall high thermal resistances and cause a considerable time lag between the maximum external and internal surface temperatures. In 2007 (p.31), Pyla argued that the thick wall gives good thermal insulation in winter and summer.

Furthermore, T.C.H.T had the ability to reduce heat gain and loss by using natural material. Al-Azaawi (1984) pointed out that the use of brick or a mix of clay or chopped dried grasses for the walls and roof provides adequate time-lag to delay and reduce heat gain from the hot outside to the cooler inside during the day in summer. This construction also helps to reduce heat loss from the interior to the exterior in winter. Imamoglu (1980, pp.69-70) illustrated that the brick used on exterior walls usually has a fine texture and a light colour. This reflects most of the solar radiation; hence, the overall heat gain of the structure is reduced to a great extent. Ozay (2005, pp.845-846) and Hinrichs (1987) added that the heat created by the sun patches

formed in the courtyard is either absorbed by the ground or causes evaporation through the bricks which are always wet either from the earth underneath. This helps to increases the comparative humidity of the dry air and lowers its high temperature. By being exposed to the clear sky, the floor of the courtyard loses heat by long-wave, outgoing radiation. This radiative heat loss helps to decrease the temperature of the ground of the courtyard and consequently that of the layer of air it is in contact with; it reduces the temperature of the surrounding habitable rooms and spaces to enhance the thermal comfort.

Moreover, many details in T.C.H.T were also, response to the environment, for example the massive ceiling structure and construction of its shallow domes, there are arches and vaults which are built of brickwork in Basement. These therefore provide additional thermal insulation against heat gain in summer, in order to take advantage of the thermal inertia of the adjacent ground, and of the thick walls in providing relatively comfortable internal thermal environment conditions (Al-Azaawi, 1984 pp.76-77). The parapet wall that included opining allows cross-ventilation and air-movement to take place through it. These projects have the advantage of losing their heat to the atmosphere by radiation and convection immediately after sunset (Sozen and Gedik, 2007, p.1812). The mamsha partially protects the habitable rooms and spaces on the ground floor from harsh weather (Moradi and Akhtarkavan, 2008, p.25). Incidentally, Dilia et al. (2010, 2011) highlighted the location of windows at high level also helps to avoid glare from the external ground. For the house itself, the fewer the exposed external walls, the better it is able to resist the penetration of the high suns of summer. Also, it helps to reduce thermal gain to the interior in summer. Akbar (1980, p.32) stated that the ratio of the void to solid over of the walls in courtyard elevation is very small for habitable rooms used in the hot season to reduce to the minimum the amount of thermal gain both from the sun and from the hot and dry external thermal environment. At the same time, this ratio is relatively large for habitable rooms used in the cold season to encourage thermal gain from the sun; this heat gain helps to warm the interior. Table 3.1 summaries how the T.C.H.T responses to the environment by created passive systems.

Table 3.1:
Summary of how the T.C.H.T responds to the environment with passive systems, (Author)

Site	How	Passive system	Indicators	
			House	
The urban fabric due to compactness.	Form of the T.C.H.T. Orientation of the house and space. The presence of architectural elements linked to proportion. Structural linked to the thick walls. Using natural materials. Spaces dimension and relation. Details such as shape and size. Buried habitable	Natural heating Natural cooling Natural ventilation Natural lighting	Slow process to change the temperature Cold air then reduce the temperature Creating air flow and then air movement Allow the house to be lit during the day	

However, the principle and strategies of T.C.H.T could achieve appropriate environmental performance which provides a thermal comfort especially in summer. This can be achieved by the specific components in the T.C.H.T are created the passive systems which are comprised of a number of environmental factors. The current research determined these factors according to thermal comfort related to cooling, heating, and ventilation, as well as there is lighting. These desirable environmental conditions experienced by the inhabitants at various times during different seasons in the various habitable rooms and spaces of T.C.H.T are created micro-climatic.

- **Physical movement pattern and lifestyle**

The arrangements of family living in one day/ season can vary, due to the response of the climate conditions in T.C.H.T such as the movement of sun and wind, change the temperature which differentiate and typify one main season from another, and also one transitional season from another. Stead (1980, p.43) pointed out in the T.C.H.T that there is a noticeable migration from the cool cellar during the day to the cool roof at night. The important point is to realize the reason for this movement and to provide suitable spaces which will give the required results. We can classify this movement in Iraq especially as follows:

- **Seasonal occupants' movements**

In the case of Baghdad, its residents had to change their family living activities biannually. According to Al-Azzawi (1996B), who classified the seasonal occupants' movements into:

1. Movement during the cold season

The ground floor is used intermittently during the day; however, it is not entirely left alone as the core household duties are still conducted there. The first floor is used for other family living activities. Hence, the ground floor is used less frequently than the first floor; this is due mainly to rising dampness at ground floor and the basement. With this change, the occupants forgo the outdoor secluded open spaces and in-between spaces on the ground floor for the enclosed and closed inside spaces on the first floor. Also, the first floor obtains sunlight for a longer time than the ground floor.

2. Movement during the hot season

The residents use the ground floor, underground level and the roof because of the more comfortable micro-climatic conditions. With this change, the occupants forgo the inside closed spaces on the first floor for the outside secluded open spaces. It is worth noting that, all year, the ground floor receives less sunlight than the first floor and thus from a micro-climatic viewpoint the ground floor is more appropriate and attractive for summer inhabitation than the first floor, due to the very hot and dry micro-climatic conditions predominating in it. Figure 3.12: illustrates these different movements in different seasons, to accomplish daily activities.

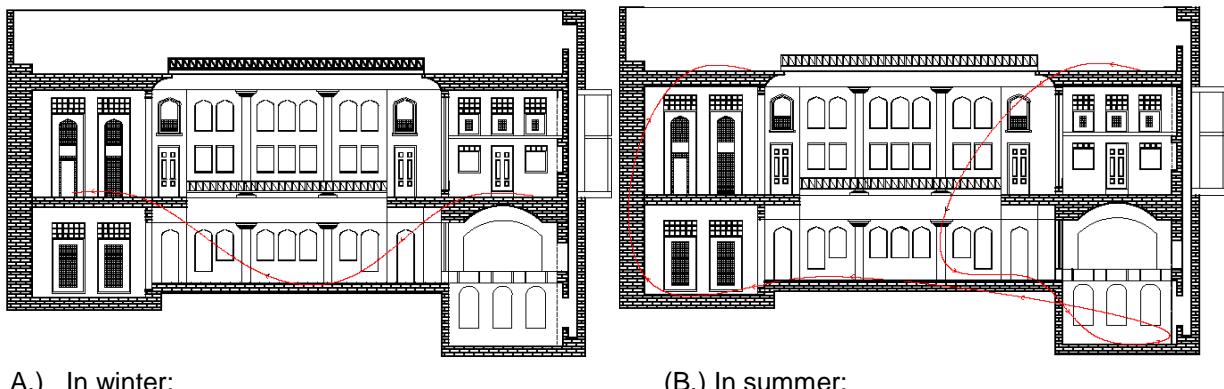


Figure 3.12: The vertical and horizontal movement in the house section during different seasons, to accomplish daily activities of T.C.H.T in Al-Kadhimiyah (Ph.Ch7, 2012), (Author)

- A.) The families focused on the first floor of their activates and the ground floor is used less frequently than the first floor
- B.) The families focused on the ground and sardab floors of their activates and the roof and the first and second floors were not

- Daily occupant movement

The daily living pattern of urban family life during a 24 hour cycle in one season is

different from that of a similar cycle in another season. The reason for this is the prevailing micro-climatic conditions which affect, if not dictate, the daily pattern of urban family life. The same conditions influence the overall concepts and detail designs of individual houses in plans, sections and elevations, as well as in many other aspects in detail; they also affect the concepts. Al-Azzawi (1996A) identified two types of daily shifts or daily movements in the T.C.H.T in Baghdad.

- Vertical movements in summertime

Vertical movements occur in section, and happen between one level and another generally by going through the courtyard. During a typical day in the hot and dry season, the family spend the night asleep on the roof at the second floor level, and descend to the ground floor in the morning; they often eat breakfast in the courtyard or one of the inhabitable spaces around it. About mid-morning, the residents move from side to side or from corner to corner in the courtyard, where they have lunch. Following lunch, the occupants generally go down to the inhabitable rooms on the ground floor or underground levels. At tea-time, they forgo their shelter below ground and begin living above ground once again on the same day. Around sunset, they will return to the terrace. The inhabitants have dinner in the courtyard, or the semi-open space on the ground floor. After that, the residents go up to the roof level where they have their daily evening.

- Horizontal movements in summertime

Horizontal movements are performed in plan and occur either within the courtyard or between one space and another. These movements happen in different time periods. First, either at mid- or late morning the residents go from one side of the courtyard to the other to escape the direct sunlight by following the comparative coolness of the shade. Secondly, around midday, as the sunlight spreads across most of the floor area of the courtyard when the sun is at its zenith, the occupants leave the courtyard and go into a space on the ground floor. Thirdly, in the late afternoon or early evening, the inhabitants move from the semi-open space to the courtyard to benefit from the desirable out-going radiation from its floor to the clear and cold sky, when the zenith is the coolest part of it.

The physical vertical and horizontal movement between the house parts during the day and night or winter and summer reflects the original family lifestyle in T.C.H.T.

Response to the environment through the passive systems and lifestyle which defines in section 3.2.5 is one aspect, other aspects that we should seek the social and cultural connotations of architecture in the everyday experiences of communities, while this is explained in next section.

2. Respond to the social cultural dimension

Also, the T.C.H.T responds to social cultural needs. T.C.H.T within Arab society follows one rule is that the family unit is fundamental. An overriding concern in the design of the house was seclusion and it is significant that this is the local word for a house. How-Chang (1986) provided the broad social and cultural influences upon the form of the courtyard house by spatial organisation and determinants of the physical elements. This response achieved through:

- **Privacy**

Al-Alwani (2014, p. 99) argued that "*The T.C.H.T reflects the family structure and lifestyle which are the major aspects shaping these houses that has endured many vicissitudes, and it stands as a major architectural achievement*". The house was continuously renovated, enlarged, or even transformed into a cluster of inter-related households. In the traditional life, there was a sharp divide between the public world and the private. Every house was a private, introverted enclosure, shut off from its surroundings by high and solid walls. It provided its occupants with a total contrast to the hustle of life in the street. Likewise, a study by Leylian et al. (2010, pp.279-280) pointed out that the form and arrangement of being inward-looking ensures complete privacy and avoids their being overlooked by passers-by and neighbours.

For example the concept of an internal courtyard resulted in the provision of a private and secluded open space exposed to the sky. for example the entrance is located at one end of the front elevation rather than near the middle by avoiding a direct and axial form of entry, which is known as bent or crooked, also, the present of shanasheel provides a visual link with the outside along the alleyway, projecting out to within a short distance of others it was a platform for communication across the street itself, and gives a sense of privacy by identifies callers at the front door, particularly in winter when the family living activities are transferred to the first floor and many other details (Haw-Change, 1986, p. 45 and Al-Azzawi, 1996, p. 280).

Guyt (1978, pp.93-208) pointed out that the nature of the living in T.C.H.T was dominated by two basic and interrelated forces:

- First, and perhaps most important as far as the design of houses is concerned, is the role that women played in society and their place in the household structure
- Second in influence on house design is the nature of the socialization process in a society dominated by men. These two forces were instrumental in shaping daily interactions, and their influence is easily identifiable in the design of upper class housing. The traditional house, therefore, is introverted, and must possess the necessary conveniences and must be isolated. In these cases, houses are made up of separate parts

Due to the Arab need for the segregation of the gender and for privacy, courtyard houses used to have various spaces, as confirmed by Touman and Al-Ajmi (2005, p.1078). These can be classified as follows:

- The first was semi-public in nature and was intended to provide the male head of the household with facilities for social gatherings, entertainment, and accommodation
- The second is a private section used by women and members of the family, and was more private with limited access to the outside.

This separation meant that sections of houses became independent residential units from which women can look out, but no one can look in. Likewise, female members of the family avoid the possibility of being overlooked by the neighbours opposite and passers-by. This segregation meant the complete and absolute privacy of the family domain and has also been one of a significant characteristic that influenced the employment of the notion of T.C.H.T. Therefore the privacy is fundamental aspect of the user's lifestyle in this type of house.

- **Extended family**

As a part of living in T.C.H.T is the families are extended which is response to social cultural need as confirmed by Yang (2007). During the last ten years (El Shorbagy, 2010A, p.15) said that "*T.C.H.T was extensive and broadened outside the household by extended family relationships. The interrelationships of families were the sinews that reflect society need*". Therefore, extended families became other significant part of lifestyle in T.C.H.T.

From this we understand the privacy and extend family were fundamental role of the living in T.C.H.T which reflect the lifestyle that created social cultural aspects in it.

3.2.5 The traditional courtyard houses in Iraq

This section focuses how the T.C.H.T in Iraq distinguished from other T.C.H.T in the world? and to what extent does the T.C.H.T in Baghdad respond to the environment and respect to the needs of its occupants?

The CH. is generally found within in a traditional city and is fundamentally a dwelling. The T.C.H.T has an inward looking plan concept represents constant aspects of domestic architecture in most of the world. It responds to and interacts with different aspects to determine the typical nature. T.C.H.T has courtyard secluded space which has other living spaces adjoining it so that they can receive light and natural ventilation, and permit visual and physical communication (see section 3.2.1).

The current research focused on the feature of T.C.H.T through categories as a form, a size, number of courtyard (s) and materials. However, what they distinguished this type of house in Iraq related to the size which include different size small, medium, and large that increased to 300 m², or with the number of courtyards, grouped into: one two, three and four courtyards see Section 3.2.2. Can we find these categories in Iraq on the ground without any change? Are these categories had the same house performance? Is the different size are usually the same number rooms and spaces at each floor level? What is the number and functionality of the room, and the position of various undertakings? To more understanding the T.C.H.T, we need to know the components as other feature, which are classified into three groups: (1) usable spaces; (2) the transitional space; (3) architectural elements (see Section 3.2.3). However, other distinguished of T.C.H.T. feature in Iraq which had two types of basement sardab and neem sardab. One can ask what the orientation of house/ spaces; this could be to achieve a comfortable environment for different activities. Also, is the function of each space and place fixed or changed according the need? What is this need that created this change? What is the relation between the function and their activities? Is this space and place achieving a comfortable environment for different activities? What is the location of different activities? Do the service rooms achieve comfort for the occupant, or have they been changed to be appropriate to the modern lifestyle? Also, what are the types of existing systems the occupants had and additional systems the occupants need such as electricity, lighting devices, cooling and heating devices, water services, drainage and sewage systems, and potential electronic communication?

The current research has illustrated that the most significant characteristics of the T.C.H.T were its first response to the environment through the passive system and lifestyle. The house components were linked to the plan section elevation, elements and details, and the structure and construction created passive systems due to thermal comfort linked to cooling, heating, ventilation, and lighting. The term passive systems was highlighted by Raman et al. (2001, p. 319) as being those techniques used to deliver heat, cool air and ventilation according to the time of year. Agrawal (1989, p. 557) describes the methods of utilizing the solar heat and air movement available in buildings, as they relate to the architectural concept, to provide thermal comfort. Agha (2015, p.30) defined passive systems as the assembly of natural and architectural components which convert elements of the climate and deliver heating, cooling, ventilation, and lighting without mechanical power. This research will depend on the latter meaning by Agha in the current research, which clears the process of these systems. The climate and weather condition in Iraq has suffered from difficult phenomena concerned with the temperature difference between day and night and different seasons, the presence of dust storms, and other issues as confirmed in Chapter 2.2.1. However, we must consider the difficulties in adapting to changing needs as concerned with different T.C.H.T categories, especially large and medium T.C.H.T, and those with three or four interior courtyards. It is important to determine if passive systems are sufficient for the occupants in the T.C.H.T to adapt to changing needs.

Also, the physical movement pattern of seasonal and daily movement between the house parts is the second aspect in achieving thermal comfort around the year. The vertical movements in section indicate that there may also be a vertical temperature difference between the floor levels and basement around 20°C in summer. With horizontal movements in plan there is differentials between sides to side around 3-5°C do of course directly relate to comfort conditions, as confirmed by Warren and Ihsan Fethi (1982, pp.103-104). The important factor is the range of conditions, which becomes a substantial advantage to the inhabitants who can choose their place of work or rest to suit the circumstances. This movement became part of lifestyle of T.C.H.T in Iraq. This study has explored many journals on topics related to lifestyle such as energy policy which is defined lifestyle as how we live and work in buildings (Diamond, 2003, p. 1211). Lutzenhiser and Gossard (2000, p.207) illustrated that lifestyle is "*distinctive modes of existence that are accomplished by persons and groups through socially sanctioned and culturally intelligible patterns of action*".

Sanquist et al. stated that lifestyle can be generally seen as patterns of consumption affected by choices at different points during the lifetime, for example which profession to have, where to reside, when (or if) to wed and start a family, and other choices about purchases and operating devices which consume energy. These definitions have addressed the social relation of behavioural aspects, or the human relation to place. However, the lifestyle in this research means a way of life related to the role of everyday different activities in terms of the relationship with places,⁷ spaces,⁸ and levels⁹ during different times,¹⁰ and the possible changes in the need to appropriate thermal comfort. However, do the occupants in the T.C.H.T still have the same lifestyle; in other words, what is the lifestyle for the current users and what possible changes may there be for future users?

The second significant response to society and culture has been explained in the T.C.H.T in terms of both the privacy for different genders and for extended families, due to the family structure, which is part of the lifestyle in this type of house (see Section 3.2.4).

However, many questions were raised regarding the T.C.H.T what will happen to the lifestyle of the current user? Does the T.C.H.T still have occupant movement? Is this movement compatible with different activities, all of which are stimulated to response the different environmental conditions? Is this is there any change of the original lifestyle? Have the T.C.H.T experienced any change or not? A difficulty and inefficiency of information on what are the key features of T.C.H.T and to what extent do these support the lifestyle for the current and future user are not clearly identified and not comprehensively presented, details of the T.C.H.T that includes these factors and interrelationships is necessary to provide role on refurbishing and implementing IS for this type of house. Therefore, we need further investigation by conducted case study. These considerations should be understood and considered carefully in terms of the current key features of the T.C.H. Therefore, this study believes that detailed studies are needed on the potential of IS in the T.C.H.T in terms of environment and social perspectives to enhance the performance and adapt to the changing needs of

⁷ The places include the living room, bedrooms, kitchen, and others.

⁸ The spaces refer to open, semi-open, semi-closed and closed spaces.

⁹ Levels are either vertical or horizontal.

¹⁰ Different times means the time of day and night, summer and winter.

its T.C.H.T over time. To deal with this type of technology, we need to understand why IS in T.C.H.T.

As we know, the T.C.H.T is an indigenous residential form in a traditional city which has, however, transformed and been developed in different ways, and has been influenced by different factors (Schulz, 1982). The successful example of the CH needs to be clarified, such as the contemporary form, which is illustrated in the next section.

3.3 The contemporary courtyard house type

The previous section presented the T.C.H.T, and this part looks into the transformation of various CH typologies according to change needs which is a response to different aspects.

However, type has a meaning similar to that of “*model*,” and describes the characteristics of structural, material technique, distributive, geometric, spatial, plastic, and stylistic iconographic (Güney, 2007, p.9). Also, type refers to the categorisation of structures by use for example hospital, school, or prison- or by morphology such as buildings with courtyards, pavilions, long halls (Sailer, 2014). Lastly, type is a definite spatial, socio-cultural and political product which stems from the city as an abstract idea, whereas typology translates generic into precise driven and structural solutions (Jacoby, 2015). Now we stated that the types are linked to the many factors which have influenced the planning and design of dwelling units, and these are: cultural and religious influences, society and the structure of families, economic and technological factors, and the local climate, all which provides historic continuity. The transformation of CH. has resulted in the development of different configurations which is vital in defining the contemporary CH. typology developed for a single working class family, and how it began to be designed for housing the masses and this are now highlighted in this section which help as to understand Why do we need an IS in the T.C.H.T?

1. Contemporary courtyard house concept

The concept of contemporary CH. occurred in the latter part of the 1920s in Frankfurt, Germany. In particular, the Bauhaus movement was the hub of theory development which sought to integrate the built form with nature (Panerai, et. al, 2004: 153). Schoenauer (2000, p. 422) suggests that it was an adaptation and reinterpretation of Roman atrium house principles. Segal (1953, p.31) demonstrated

that the design was transformed from the “saw-tooth” or castellated terrace principles seen in Sweden, resulting in the design development of the L-shaped courtyard or patio house with a zero lot line plan layout.

However, the term of contemporary CH was created afresh which does not refer merely to the age of the urban fabric, but also denote houses of fundamentally different design and characteristics. Nonetheless, most of these contemporary CHs built in old industrial towns were demolished for different reasons, often to make way for new developments (Firley and Stahl, 2009, p.108). However, these type of houses classified into different categories which explain next.

2. Contemporary courtyard house categories

This section presents the categories of the contemporary CH. through:

- Form

Three main concepts were used to propose a design for the contemporary CH: detached with a private garden was first planned by Hugo Haring in 1928, also semi-detached, and row housing as show in Figure 3.13 which suited the cultural and socio-economic needs. The urban design has given this scheme its own character and created a cohesive small scale community development in this regeneration area (FAT 2009).

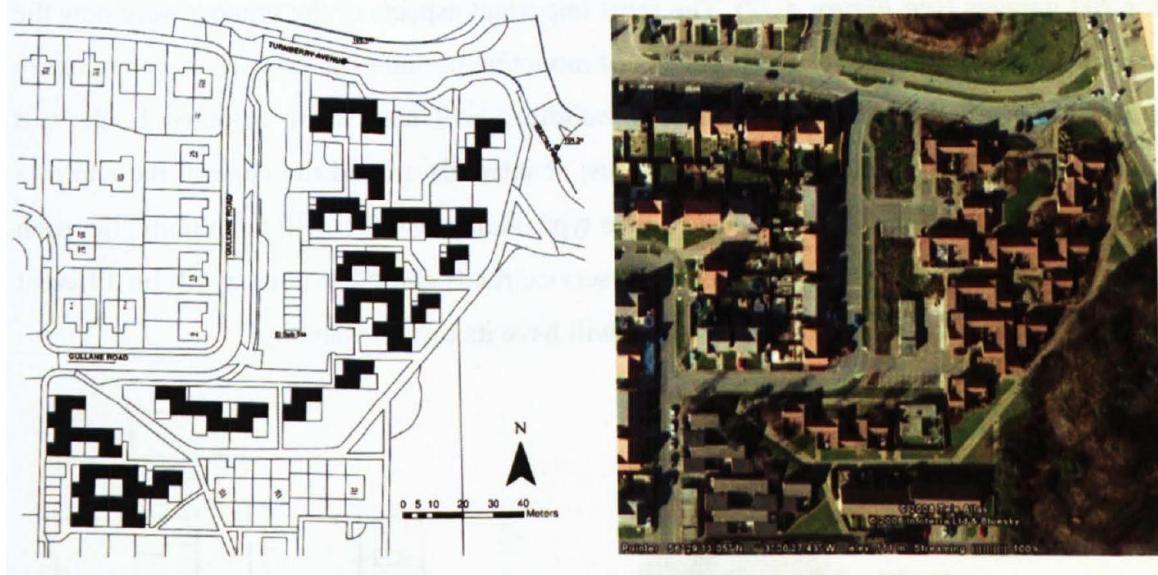
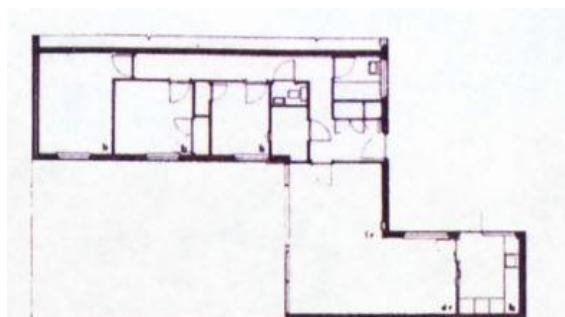


Figure 3.13:
Example of urban fabric of the contemporary CH -West Ham, London (Goh, 2010, p.109)

As a consequence, various contemporary CH conformations were designed and developed with either single or multi-storeys like a stacked L-shaped with sleeping

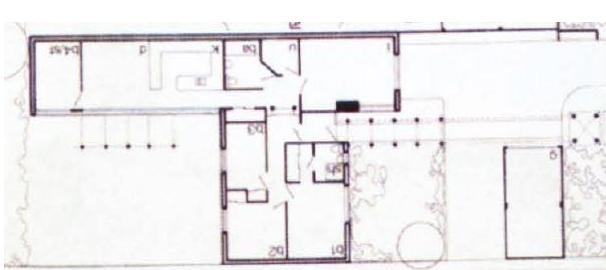
and living rooms was planned by Hannes Meyer and Ludwig Hilberseimer at the Bauhaus in 1931. This shape the widespread use of contemporary CH in the world is likely to be the consequence of Walter Segal's *"Home and Environment,"* published in 1948 (Colquhoun, 2008). MacIntosh (1973, p.41-42) highlights that the Z-shaped contemporary CH was developed by Hilberseimer (Type D) in 1932, by indenting the external corner of the L-shaped CH to form a small entrance courtyard to provide greater seclusion at the front door and any spaces facing outward which improve the outlook by having the carport located adjacent to the kitchen space. The U shaped courtyard house developed in 1935 at Churt in Surrey was the earliest contemporary CH found in the world. In addition, it is important to note that the growth of the courtyard house configuration was also in accordance with the *"adaptable or expandable"* house notion such as I-shaped which long-narrow with an internal court, T-shaped, and a hybrid terrace court (Burnett, 1986: 309) See Figure 3.14. These different shapes build in different size.



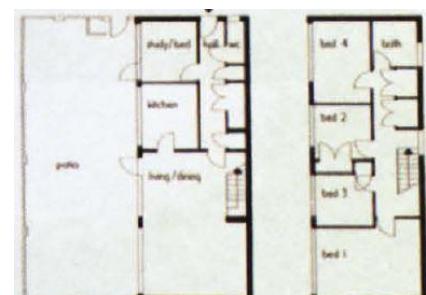
(1) Z shape-Kenton Bar, Newcastle upon Tyne



(2) L shape S t Michael's Hill, Bristol



(3) T shape -Shenley Lodge, Milton Keynes



(4) I shape -Calverton End, Stony Stratford

Figure 3.14: Example of a contemporary CH with a clear shape (Goh, 2010, pp.102-136).

- The size

The design of contemporary CH. is a small size low rise; there are four types of house size with the contemporary CH. The households and the remainder are family houses of various sizes are: around $45m^2$ for one and two persons or elderly people likely to live in small dwellings; 64, 68 and $78m^2$ for a mixed development of 3-8-

person family houses; these sizes exclude the area for the courtyard, such as those built in Ardler in Dundee which were built between 1963-1965 see Figure 3.15. Furthermore, single-storey courtyard houses are more suitable for small families than for large ones because the ground coverage and internal circulation becomes excessive if designed for large families. The double-storey courtyard house is costly, however, and so is usually more suitable for large families because of economies of scale (AJ, 1978: 257). The small size of the contemporary CH. allows the occupants to have control of the house performance.



Figure 3.15: Example of the size of a contemporary CH- Ardler in Dundee (Goh, 2010, p.107)

- The number of interior courtyards

One courtyard and garden or two courtyards in each contemporary CH. and its size is related consistently to house size to provide greater variety of outline than the single courtyard, where its division of function is between service and recreation (French, 2008: 45). Therefore, having few courtyards means it is easier to control them, especially if the size of the courtyard and house is consistent.

3. Contemporary courtyard house components

The contemporary CH. had few spaces which include:

Usable space

The usable space in contemporary CH. consists of:

- The living space, studios which will be put to a multitude of uses: home offices, teenage hideaways or granny flats, dining room with a separation of cooker and sink, and bed rooms (ARU, 1970: 100).
- services space such as kitchen with sink and cooker place, provision of an external store within the house shell that is accessible from the garden or living court, bathroom and toilets according to house family numbers, as well as a centrally placed warm air unit such as at Ardler in Dudee/ UK(19963-1965) (ARU, 1970: 100). Garage and parking space in front, such as the Ryde in Hatfield, the UK (built 1962/3-1965/6) (FAT 2009).

Architectural elements

The design of contemporary CH. had courtyard as the main architecture element. The courtyards are provided with a fitted store, and being fully enclosed, either by vertical palisade fencing or by walls (French, 2008: 45).

4. The responsiveness of the contemporary courtyard house

Its initial aim was to accommodate the flexible requirements of families and households with changing need. The contemporary CH was adopted to accommodate residents' requirements for the modern lifestyle through the following items:

- Design

The plan provides flexibility with the layout and size of spaces which was the main feature of the contemporary CH. house, provided flexible space for the dwellers, and seasonal adaptation (Delda, 1974; MOYA, 1983). Moreover, all the areas were linked by the living wall space that permitted circulation and a flexible organization with plentiful storage facilities and services, whilst also allowing easy future upgrade of services (Design Built Network, 2008). Some rooms have clerestory lighting over the perimeter walls to make the planning more flexible and to remove the externally bleak appearance of completely inward-looking buildings (French, 2008: 45). Flexibility in room layout to suit the changing needs of users was features which were emphasised in the design of these house plans (Beigel, 1988, p. 58).

- Structure

The contemporary CHs. were achieved using the concept of two bay plans: this two bay plan concept was first adopted in West Ham, London between 1961-1964. The advantages of two bay plans were that it permitted owners to decide how they

were used in the houses, as all the living space was on one level and could be extended, opened up or divided either permanently or temporarily using the sliding screen. Prefabrication system also was used with contemporary CH. such as those in Islington Square at Ancoats in Manchester (2005-2006). The advantage of current prefabrication system is that it enables future extensions to the house for economic and practical reasons (Davies, 2008). The houses are designed according to Lifetime Home Standards in which the ground floor could become self-contained if residents were to become physically disabled. The ground floor water closet could be modified for wheelchair use and the structure of the house was designed to cater for a lift to be installed. The houses also achieved an ecohomes “excellent” rating and have superb insulation (Colquhoun, 2008, p. 219).

- Services systems

Contemporary CH. was built with advance services systems to control the house performance at the same time these systems were flexible in use according to residents need. For example Accordia at Brooklands Avenue in Cambridge (2003-2010) which had electric under floor heat was built in throughout, supported by storage heaters where necessary (Goh, 2010). Drainage works like permeable surfaces, sedum roofs and reed beds keep rainwater which helps to maintain these practices. The contemporary CH. was aimed at delivering high-performance fabric with a very good eco-rating, which would maximise passive solar gains but also enable choices for future upgrades and potential use of PV and solar panels (Design Built Network, 2008). Hence, the contemporary CH was planned to provide high levels of thermal insulation. In addition, the houses were fitted with an advanced glazing system and super-insulation system in wall and roof (Yannas, 1994b, p. 65). The contemporary CH has been respond to changes in service technologies as main issues connected to traditional townhouses.

The contemporary CH was adapted to accommodate the need for flexibility in residents' requirements, and this was the main characteristic of this type of house to allow families to live in ways that suited their particular needs.

5. Traditional and contemporary courtyard house

The contemporary CH. has been developed and transformed to have flexibility linked to design, structure, and service systems, in term of changing needs. Flexibility in contemporary CH means to gain more space within the small house; to control of house performance or response to specific needs, good communal facilities for

elderly people, an adequate infrastructure of amenities in the housing; upgraded with new technology, high standards of management and maintenance, and last but not least the possibility of “*fitting*” the courtyard house plans into the different conditions, specifically through the structure and services that can be adapted to the changing needs of its dwellers over time (see Section 3.3.4). The contemporary CH is regarded as one of the great housing schemes of the twentieth-century which successfully provides flexible family house according to changing needs, and has encouraged these families to remain in the housing for longer (Building Design, 2009).

Table 3.2 Summary of the features and characteristics of the CH, both traditional and contemporary, (Author).

Features and characteristics		T.C.H.T	Contemporary CH
Categories	Form	Compact/ linked from three sides. No specific shape	Detached, semi dictated or row The shape was L,Z,U,T,I,
	Size	Small up to 40-100 m ² Medium 100-150 m ² Large more than 150 m ²	Small up to 45 m ² Medium 64 and 68 m ² Large 78 m ²
	Number of courtyards	1,2,3 or 4	1 or 2
Components	Usable space	Entrance, living rooms include: reception room, ursi, takta-boosh, and jam-kana. Bedrooms and multipurpose rooms such as kafish-kan. Basement includes: sardab and neem sardab. Service rooms such as kitchen, bathroom and toilet	Living space, dining room, Bedrooms and multipurpose room such as studio. Service rooms such as kitchen, bathroom and toilet, store, and garage
	Transition space	Iwan, tarma, and mamsha	
	Architectural elements	Courtyard, shanaseel, bad-geer, muqarnsa, wooden columns, dome and vault, and ornamentals	Courtyard
Response dimensions		Environmental aspects through passive systems and cultural and social aspects through the lifestyle	Changing need through the flexibility of systems

However, Table 3.2 is quite revealing in several ways:

What they distinguished the form of T.C.H.T through the compactness is efficiency of site coverage, economy in infrastructure, and density increases comparative with contemporary CH. UN-Habitat (2007, p.107) highlighted that compact planning has various aspects: it reduces the demand for housing land use. The house covers the

whole site and thereby exploits the land to its full potential. There is less expenditure as public services are more economical to install per house run, and in addition the journey from home to work or the shops is easy, and more direct, usually on foot. Furthermore, the form of the T.C.H.T was closed on three sides to provide more protection from the harsh weather, and this could have an important impact on the T.C.H.T's characteristics compared with the contemporary CH. The reason for this is that the houses shelter one another from the sun in summer and precipitation in winter.

The surface area of these houses that is exposed to direct solar radiation is greatly reduced and therefore the undesirable thermal gain in summer is minimized (N-Habitat, 2007, p.107). This disagree with Sir Leslie Martin and Lionel March investigated contemporary CH. built forms make the most effective use of ground area which has comparatively optimum urban performance (Martin and March, 1972,p.38). Moreover, these different forms in the contemporary CH are detached, semi-detached or row, to improve the outlook. However, each house has a loss of privacy and reduction in safety and security issues, compared with the T.C.H.T, with an inward looking plane. Also, what makes the T.C.H.T distinguished is its significant components, such as having two types of basement called the "*sardab and neem sardab*", in addition to many architectural elements which respond to different aspects.

Therefore, the T.C.H.T had dominant features that reflect the greatest strengths of traditional units with an interior courtyard; these are demonstrated at the level of the general fabric, and the individual units, compared with the contemporary CH.

Turning back to table 3.1, we found that the small size and clear shape of contemporary CH. had the ability to control on different environmental aspects according to change needs. The contemporary CH. had a clear shape which was easy to deal with according to their performance, in contrast to the T.C.H.T which had no specific or exact shape. Also, the different categories of T.C.H.T due to different sizes were likely to face difficulty in response to or control of their performance, especially with bigger and medium houses, although the smallest one may be bigger than the contemporary CH. classed as big. This may have also been difficult to control in terms of the varied environmental factors, according to changing requirements. The contemporary CH is easier to warm and cheaper; the ease of maintenance was preferred by most residents to the small city's edge tower block flat

with expensive heating bills (Leeds Civic Trust, 2007). In Iraq, these different categories of T.C.H.T are linked to the number of courtyards, which may reach four in one house. This illustrates the difficulty of controlling the environment and influences the house performance. The control may be easier with one or two courtyards, especially when the size of the courtyard and house were consistent, such as in the contemporary CH. The contemporary CH. had little space and so was easier to control than the T.C.H.T, which had many usable spaces and also transition spaces which were potentially hard to control.

Therefore, the T.C.H.T had significant features which made good house performance potentially difficult, according to changing needs as confirmed in chapter 3.2.5. This will result in a rising need for the enhancement of their performance due to development and rehabilitation (see Chapter 2.4) Therefore, there is need for new systems and advanced technology in different aspects. However, what is the T.C.H.T positive and negative which deserves to develop? This issue will explain next.

3.4 Advantage and disadvantage of the traditional courtyard house

In previous sections, we discussed the features and characteristics of the CH., and this part now focuses on what does the T.C.H.T contain that should be conserved and not re-built by discussing the advantages and disadvantages of this type of house.

Accordingly, Warren and Fethi, I (1982) noted that the identified earliest T.C.H.T go back no further than 140 years in Iraq, though many of the substructures are undoubtedly older. The latest houses built entirely in the traditional style date back only about 70 years. In a survey of the historic areas in Baghdad city less than 9% of the houses listed as being of historical worth were built prior to 1869. So, is the T.C.H.T deserve to be conserved or need to re build?

Many interesting explanations stand behind the advantages of the traditional residential neighbourhoods that include T.C.H.T; these are listed below:

- High density low rise

In terms of rising the population in CH type, Yang (2007) argued that the main advantages in the CH are the “*high density low rise*” that provide the high density of people in the historic area, which includes traditional units related to different reasons compared with other dwelling houses.

- Distinguished features and characteristics of the T.C.H.T

As seen in section 3.2.5, the T.C.H.T incorporates special features related to the categories and components, and specific characteristics in response to the environment to mitigate the severe micro-climatic and internal thermal environment conditions prevailing in different seasons, which are dependent on systems that work without mechanical power. Ratti et al. (2003) highlighted the question "*What building forms are the best regarding built potential for lighting?*" The study pointed out that courtyards work best when their design considers the link with the climate. It has; however, had an ongoing effect on urban design, as confirmed in Figure 3.1. Also, the principles and design of the T.C.H.T respond to social and cultural factors as a fundamental aspect of the lifestyle and the need for privacy and extended family.

- Affordable housing

The aim of the CH under the concept of "*high density low rise*" housing development is to achieve space standards which are value for money. This urban design addressed affordable housing, which was a strategically important issue in such a new residential (PRP, 2007p.18).

- Social interaction

Moreover, there is traditional social interaction of customs, behaviours and tradition of the inheritance of the historic neighbourhood. Ultimately, the grouping of T.C.H.T has facilitated and encouraged social contact and interaction between neighbours, and particularly between mothers, through narrow alleyways and cul-de-sacs, and low-rise, high-density houses not more than two storeys high. Al-Qaisi (1984, p.122) said: "*The traditional Baghdadi house reflects the Iraqi culture and social that encourages interaction and contact between neighbourhood and made society cohesive*". This was achieved by compactness and coherence of this type of house.

- Energy conservation

The compactness urban planning is an energy conserving concept which is essential part of the CH. This was achieved by efficient in both the utilization of land and sun at the same time, excellent insulation, solar gain and loss, and the usage of traditional local natural materials and others (Passive Solar House, 1982; MOYA, 1983). During the past 15 years, much more information has become available in journals (such as Al-Mumin, 2001) which have considered the appropriateness of the

sunken courtyard¹¹ in the arid climates. It is able to create a pleasant microclimate and protection against climate by reducing energy consumption. A study by Muhaisen and Gadi (2005) highlighted how influence of courtyard ratios on solar heat gain and energy needs in the milder climate are obtained by solar radiation in winter and avoided in summer in order to reduce the energy consumption. This is because of the lower amount of radiation achieved in deep forms in summertime, resulting in low energy needs for cooling, while in winter deep forms maintain minimum heat loss and therefore reduce the need for heating. Goh and Sibley (2009) highlighted that the thermal performance was improved through the house design of the T.C.H.T. by improving energy conservation. Later, Goh (2010) investigated the potential to reinterpret the contemporary CH. by creating urban housing which could adapt to the changing needs of its dwellers over time in the UK by low energy consumption through appropriate design.

However, there are disadvantages in CH which have had a negative effect on house performance such as:

- Lack of maintenance

It should be pointed out here that T.C.H.T. were compulsorily purchased in Iraq 1958 and have been used in this way since that time without any indication as to when re-development might take place. Throughout these years such houses have deteriorated so badly that their compulsory destruction has become inevitable (Warren and Ihsan Fethi, 1982). This leads to premature dilapidation, and finally to the destruction of these houses for comfortable reasons. Haw-Change (1986) agree in many cases they lack the structural and constructional safety required for human habitation, yet people still live in them through sheer necessity. Therefore many of this T.C.H.T were in poor physical condition particularly in the absence of any maintenance.

- Overcrowded

In terms of raising the living standard of the population with the T.C.H.T, based on the situation of the historic area and deriving the examples from Baghdad, there is the rapid growth of cities in area and population since the beginning of this century, and the rising living standards of the population (Al-Rahmani 1986, pp.31-39). When

¹¹ The sunken courtyard building is a subterranean structure that has an introverted design to the famous conventional above ground courtyard structure above it.

"high density low rise" is achieved, and families are extended, this results in overcrowded conditions in the T.C.H.T., as confirmed by Yang (2007). The disadvantage of the historical urban fabric with overcrowded conditions has an effect on the level of infrastructure and then leads to stress on service systems, as well as a rise in environmental pollution, and other issues. Also, in spite of these type of houses had special community and as a result of overcrowded in historic area presented fear and anxiety about crime, robbery, and terrorists, looting and vandalism and last but not least prevalence of addiction (Azadi, 2008, p.124-179).

- The house size

As seen in section 3.3 part 5, the T.C.H.T had big size with one to four courtyard which difficult to control comparative with other CH such as the contemporary one that have clear shape.

From this, we understand that high density low rise, affordable housing, social interaction, energy conservation, and distinguished features and characteristics of the T.C.H.T are the significant aspects that provide the advantages, of the CH. generally and the T.C.H.T specifically, which deserve to be conserved. Yang (2007, pp.17-18) argued that the T.C.H.T represents a way of life, and is a key architectural accomplishment which deserves development and conservation. From a different perspective, CH. should not be demolished but should be rebuilt extensively and professionally. This T.C.H.T was not widely built because they were relatively expensive (MHLG, 1968 and Burnett, 1986, p.309). Also, they cannot perform repairs because they have no proficient persons with specific qualifications to build this type of house (Al-Azzawi, 1984). Therefore, these aspects provide the need for conservation.

Also, the disadvantages of the T.C.H.T such as the lack of maintenance, overcrowding, and big size have had a negative effect on courtyard performance through the difficulty of controlling performance across the house generally and in the service systems particularly, in the absence of update according to changing needs. These in turn are required for development continuity, and should be rehabilitated such as by adding new systems.

Obviously, all these studies seen in Table 3.3 confirmed that attention has been placed on environmental issues, as they dominate other issues related to CH performance. This is in agreement with the current research on the T.C.H.T. and how

it needs to enhance its performance. However, it may not be up to date with changing needs, such as those of the modern lifestyle and new technology, and changes in weather and climate conditions which required rehabilitation and IS to be a significant part of this development. From a different perspective, it seems that no overt advanced technology system has been researched in this study area, and none of the previous study have identified the possible influence of using intelligent technology in the existing courtyard house type as a part of enhancing the CH performance. Therefore, IS could be significant part of enhancing the T.C.H.T performance.

Table 3.3: Different issues in the courtyard house type discussed in the literature, (Author).

Literature	Environmental issues	Social issues	Economic issues	Design issues
Al-Azzawi (1984)	•	•	•	
How-Chang (1986)	•	•		
Al-Temeemi (1995)	•		•	
Al-Azzawi (1996)	•	•		
Al-Mumin, (2001)	•			
Ratti et al (2003)	•			•
Muhaisen and Gadi (2005)	•			•
Raydan, D and et. al (2006)	•			•
Muhaisen (2006)	•			•
Al-Abidin (2006)	•			
Yang (2007)	•			
Goh (2010)	•			•
Agha (2015)	•			

3.5 Summary

The purpose of considering the literature review is to clarify what the CH. is? to what extend do the T.C.H.T. in Baghdad responds to the environment and social need of its occupants? and why we need an IS in T.C.H.T? This was accomplished by conducting a literature study in this area.

This chapter has investigated the features of the T.C.H.T via different categories and components, and the characteristics of the response to the society and environmental aspects through the passive systems and lifestyle in Iraq, which are particularly important in a family dwelling which is difficult to control, according to changing needs.

Also, it clarified other successful CH such as contemporary one which is flexible according to changing needs comparative with T.C.H.T which needs to develop or why do we need an IS in the T.C.H.T.

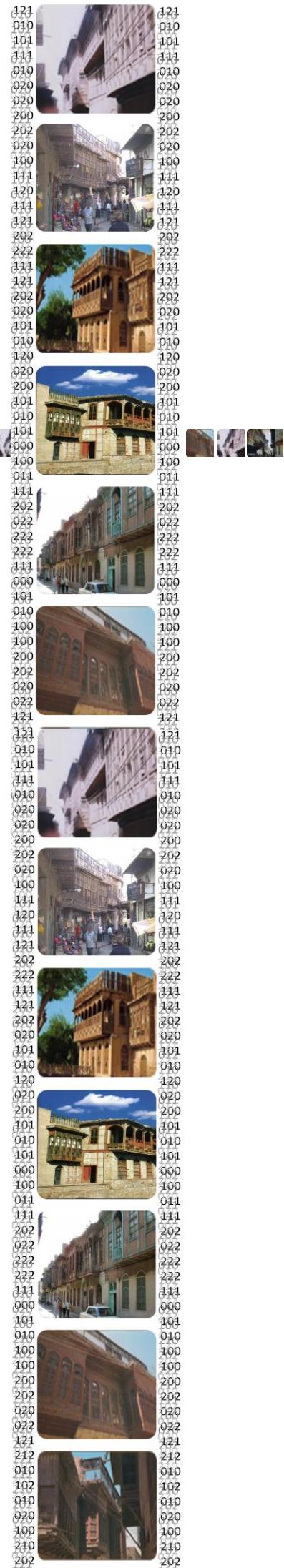
The advantages of the T.C.H.T were the significant aspects in this type which deserves to be conserved and not demolished but should rehabilitated extensively and professionally. Also, there were disadvantages of T.C.H.T which represent the best possibility for the refurbishment and development of this CH type, to improve its environmental performance. In order to explore the key features of the T.C.H.T and to what extent these support the lifestyles of current and future users, details of the T.C.H.T are necessary. Therefore, this study believes that detailed studies are needed on the potential of IS in the T.C.H.T in terms of enhancing the performance and adapting to changing needs over time. To deal with this type of technology, we need a level of awareness of IS. The next chapter will introduce intelligent buildings, systems, and their possible application in the home as a part of the refurbishment projects for this type of house and enhancing their performance.

Chapter Four:

Intelligent building and systems



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4. Intelligent building and systems

4.1 Introduction

The aim of this chapter is to investigate the meaning, nature and application of intelligent systems in buildings to provide an overview of previous work in the area of intelligent building. This chapter is divided into three parts: the first focuses on the intelligent building, the second highlights intelligent systems, the last part illustrates the applications of intelligent systems.

4.2 Intelligent building

This section focuses on what an intelligent building (IB) is? Through the following items:

4.2.1 *Intelligent building definition*

Many attempts to formulate a specification for an IB have been made. Focusing on the word intelligence may give an different interpretation in connection to IB. In order to fully understand the term IB, we need to consider what is meant by intelligence in building, as the spectrum of meaning to be found in IB closely reflects the compound nature of the interrelated terms. Figure 4.1 illustrates how many terminologies come under the remit of IB definitions and those that relate to this study will be explained and presented.



Figure 4.1: Some terminology related to IB, (Author)

The definitions of IB are classified according to technical systems and user needs. At this point, certain definitions of IBs will be assessed to allow a more appropriate or comprehensive?

- About the technological systems

Cook and Dos, 2005 highlighted that IB as smart environment “*is richly and invisibly interwoven with sensors, actuators, displays, and computational elements*”. Kroner (1989, p.327) defines IB as intelligent architecture, which is the ability of a building to be fully responsive to the environmental situation of the place both externally and internally, as well as the individual user situation, through the architecture itself and its system components.

Two terms related to IB are automated building and integrated building. An automated building is one which uses central computer systems to achieve control for different purposes (Wang et al, 2010, p.26). An integrated building integrates technology and processes through the interoperability of various system functions, which unite the data and services of several applications or systems to provide a new function (IBD, 2007, P133).

Also, smart and digital building terms such as IB are increasing in number; Jia et al. (2014, p.18) defined that smart building “*...is a key role in efficient building operation and has a close relationship with emissions reduction*”. Members of IEEE such as Zou, et al. (2011) added that It is generally incorporates a high degree of comfort, excellent power efficacy, and is environmentally friendly. Broadly speaking, however, Naji et al. (2011, p. 9) defined that an IB makes use of computer technology to control and adjust the building climate to accomplish the best use for the comfort of the users, optimum energy usage, safety and work productivity. Watson (2011,p. 573) highlighted that the digital building is an infrastructure for end-users in power distribution network and improves the responsiveness, reliability, interactivity, and transparency in distribution system.

Furthermore, there is a great deal of academic and technical research which discusses the definition of IBs. The UK-based European Intelligent Building Group describes an IB as “*one that creates an environment which maximizes the effectiveness of the building's occupants, while at the same time enabling efficient management of resources with minimum life-time costs of hardware and facilities*”

(Wong, et al., 2008A). Conversely, the IB Institute of the United States explains it as “one which provides a productive and cost-effective environment through optimization of its four basic elements, including structures, systems, services and management and the interrelationships between them”. The IB Institution in Washington (1988, cited in Kroner, 1997, p. 383) defined an IB as follows: “an IB is one which integrates various systems to effectively manage resources in a coordinated mode to maximize.” Yang and Peng (2001, p. 68) extended the definition of IB reflects to “performance adjustment from its occupancy and the environment” and “one which has fully automated building service control systems” within the definition.

These definitions focus on the technical systems to enhance the environmental performance rather than the user needs. However, researchers do not agree with this definition as it does not take into consideration the combination between the technical systems and user needs.

- Concentration on user needs

In response to this, sentient building and green building are alternative terms for an IB. In 2006, Mahdavi highlighted that a sentient building responds to the requirement needs of their occupants, and continuously uses a sensor network to predict and activate change when needed. The Building Intelligent Group (IBD, 2007, pp. 114, 254) referred to a green building as one with energy efficiency, minimum influence on the environment, and a healthy environment in which to work and live. In 2010 (p.5), Wang introduced IB through the term of intelligent design as a building design which adapts to nature and responds to the social, cultural, political and economic aspects.

An alternative term for living as IB is a dwelling unit, such as “*Smart home*”, or an “*intelligent home*” which is precise differentiation between like systems or terms employed in connection “*assistive technology*” or “*telemedicine or e-health*”. Authors such as Chan et al. (2009, p.91) stated that a smart home is a residency equipped to make the best use of assistive technological systems, and allows the observation of its occupants and/or facilitates the independence of the systems and their maintenance, and provides proactive services. He added a smart home is generally prepared with many networked sensors that work together to perform processes and make deductions based on the data acquired on their home, in addition to the

goings-on and behaviours of its occupants. Recently, Belley et al. (2013, p. 2) introduced the idea that a smart home has sensors that track the occupants, and can tell when the situation becomes abnormal by observation; it can then intervene and help the person either visually or editorially if necessary. In the future, sensors can be used to monitor household activity and the vital signs of the occupants, control energy usage, and deliver entertainment, learning, and communication (Intille, 2006, p. 349). When technology is implemented in the house of the future, the concept of the internet of things covers a greater form of control, and as a result the traditional smart home is then outdated. Darianian and Michael (2008, p. 116) noted that the key aspect of an intelligent residential area by the idea of the internet of things (IOT)¹. As an example, the smart home incorporates family safety, medical assistance, data processing, entertainment and business.

Consequently, So and Wong (2002, p.212) proposed that the revised IB definition has two aspects, which facilitate the use of technology, and the requirements of the occupants: "*intelligent building is not only able to react and change accordingly to individual, organizational and environmental requirement, but is also capable of learning and adjusting performance from its occupancy and the environment*". According to Kroner (1989), who stated that "*intelligent buildings are not intelligent by themselves, but they can furnish the occupants with more intelligence and enable them to work more efficiently*". Clements- Croom (2013, p.1) defines IB. which "*respond to the needs of their occupants and of society, they are functional and sustainable and promote the well-being of the people living and working within them*".

Within these definitions, an IB can be seen as having different components, such as the systems in consideration of the users' needs. However, the researcher agrees with those definitions which take into consideration the combination between the technical systems and user needs to enhance the building performance, rather than just focusing on one aspect such as technical systems.

How these intervening of several aspects of intelligence act as a representation of the general agreement of these concerns in IB to be considered. As a result, from these definitions building intelligence may be mainly seen in terms of several capabilities, for example "*reasoning, problem-solving, acquiring knowledge, memory*,

¹ The Internet of Things (IOT) technology links all things and the Internet by sensor devices and employs intelligent identification and operational control (Li and Yu, 2011, p. 2087).

speed of operation, creativity, general knowledge and motivation" (Clements-Croome, 2013, p.9). If we think deeply about intelligence in building, we find that they all have something in common: assessing of different stimuli conditions and response to make a decision. However, we need more explanation of IB. concepts which helps to understand the IB. definition.

4.2.2 Intelligent building concept

In spite of the widespread development of the concept of intelligent buildings (IBs), there is only a short history of the concept of this type of building. It has focused on the control of environmental performance and the changing needs of user requirements. Historically, the notion of IBs was initially employed in the United States in the beginning of the 1980s, and it has developed various emphases, largely spurred on by the evolution of linked technologies and the shifting requirements of the built environment. It has evolved since that time, motivated by the expansion of information technology (IT). According to Wigginton and Harris (2002) and Ghiaus et al, (2006), three stages are linked to the notion of IB which will now be explored in chronological order.

- Until the middle of the 1980s, the key focus was on "*automated buildings*" and the IB was a set of novel technological systems. According to Clements-Croome (1997, p. 395), there has been rising cognizance of service systems and the process of managing the work of a building, as linked to human health and comfort, for example. During this period of time, IB focused on IT-related technical systems, for example, the Human Resources Development in Canada, Toronto, had automated systems which integrated HVAC and lighting systems to enhance thermal comfort.
- Between 1985-1991, the central idea arose that "*responsive buildings*" and the IB notion are typified as a set of technologies capable of reacting to organizational variation over time. So et al. (1999, p. 19) highlighted that the design and construct of an IB is founded on the choice of good quality environmental modules which suit the user's needs in terms of the right building facilities, and in so doing accomplish longer term building values. In the same way, Sterk (2005) added that the IB is a base from which to respond, emphasizing ways to build it and control it in the process. For example, to create a responsive building, the British Columbia Institute of Technology in the UK used an installation of integrated IS and a

structured cabling system that enabled full central control of equipment in the facility, responsive to the required level of lighting and thermal comfort.

- After 1992, the “*effective building*” idea arose, not only to promote business aims and integrate suitable space, business and building management, but also to view technologies as the means to promote and achieve these aims. This was stated by Smith (2002, p. 36), who noted two views of the “*intelligence*” of today’s buildings. One is linked to the way the building reacts to alteration, whereas the other is linked to flexibility. For example, Crestwood Corporate Centre, Building 2/Richmond UK 1998 used IS such as HVAC, and lighting systems which enhance building performance through integration with natural systems to enhance quality of air, and lighting level, and then reduce energy consumption.

However, the concept of IB is focused on the building and its technologies, such as automated building through IT linked to IS to promote the building performance. Responsive buildings and effective buildings, for example, concern how the IT is linked to structure and construction and also the possible use of IS according to changing needs through the enhancement of the building performance. From this, we understand that the concept of IB developed largely as a container of IT. The possibility of an IB. being a container of IT through specific components will be clarified next.

4.2.3 *Intelligent building as a container*

IBs use combined elements and systems to give a satisfactory experience by which the building can achieve their 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 Alwaer and Clements-Croome (2010, p. 799), we can classify these elements into:

- Systems such as energy use, security, life safety, communication
- Structure, such as responsive construction, intelligent components, flexibility, materials, fabric, and equipment
- Services, such as voice, video, data, office automation, shared tenant services, after work operation, directories
- Management such as automation, control, maintenance and performance assessment, and facilities management, and
- The interrelations between these aspects.

We understand that number of ideas key to IBs has already shown the inclusion of IT into building forms as show in Figure 4.2. This will be illustrated through:

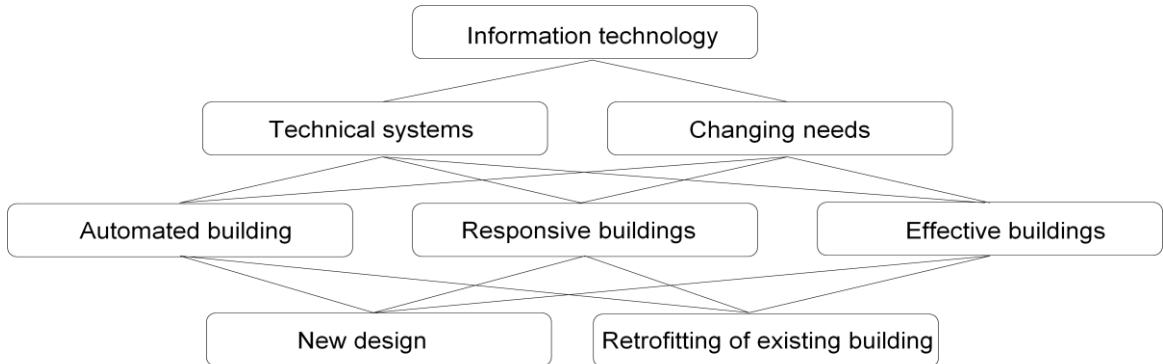


Figure 4.2: Types of IB as a container of IT, (Author).

• **Retrofitting**

The focus on the integration of smart technologies in our existing types of building is a question of suitability, rather than creativity. Kroner (1989, p. 322) noted how smart technology can be packaged in a retrofit, and thus make the building containerized technology in a pro-designed container, which means after building implementation. This is a simple manufacturing, building, and cost issue rather than being connected to problems of architecture. The smart technology is concealed beneath the flooring, pipework, ducts and ceiling, and therefore no observable indication of modify building. 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**

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. Kroner (1997, pp. 386-392) suggested that an IB will develop as a result of new design issues. These are:

- First, the possibilities arising from the creation of an intelligent design by using the technical systems and structural systems which are responsive to changing needs.

For example, the Miller SQA building in the USA is an example of an IB as a new

design which had integrated systems with natural resources for maximum day light usage.

- Second, intelligent use and maintenance through technology integration, such as interoperability between different systems. DNP, C and I building is an example of an IB with a new design which uses integrated systems to control the daylight, air conditioning, and energy supply.

The literature has focused on the incorporation of IT such as a system into current forms of 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.

In order to fully understand the term of IB, the definitions and concepts explained, presented, and compared above can be linked to related concepts such as data and knowledge. As a result, the operational definition relies on a designation of IB which is considered to be the ability of the building by using IS to monitor the information from the different environmental situations, and then to assess, and dynamically respond to changing needs that improves the performance for a comfortable living environment and improved occupancy. Now the meaning of IB was explored, however, one can ask why IB?

4.2.4 *The benefits of intelligent building*

In previous sections, we presented the what of IBs to understand why we need them. We need to explore its benefits.

A considerable amount of literature has described the goals of IB, as follows. Kua and Lee (2002, pp. 231-239) published a paper in which intelligent goals focused on the notion of linking IB projects to be sustainability in the built context by promoting the performance in the form of the built environment. The promotion of IB is carried out with the objective of enhancing the performance of these buildings due to enhancing the life cycle of the new buildings, as confirmed by Kroner (1997, p. 387). Similarly, Alwaer and Croome (2010, p.799) stated that IB leads to the achievement of a level of building that has the greatest values in terms of building performance. For example, Condominiums at 77 Governors' Road/Dundas 1999 were able to achieve high performance by the use of different systems, among other features. On the other side, Kua and Lee (2002, pp. 231-239) considered how IBs can be used to

promote built heritage conservation, and future architectural and building attempts by giving a longer lifespan through the employment of IT. For example, the Fairmont Hotel /Vanvouver, Ecole de Technologie Superieure (ETS)/ Montreal, and the Royal Inland Hospital/ Kamloops were built over 100 years ago, and have been transformed into IB by using IS which adopting different aspects in terms of performance.

There is large a volume of published studies on IB which have highlighted and dealt with the benefits. These are summarised as:

- Environmental control, as these can benefit environmental control of lighting, cooling and heating, water, energy and others with suitable pre-programmed reactions, and being aware of the presence of humans and/or occupancy features in all areas of a building. Being aware not only of the angle of light and solar radiation, but of its intensity, temperature and humidity; the building's condition is modified in accordance with the preferred performance for the interior; Detecting odours and contaminants and increasing ventilation rates as a result (CABA, 2002). For example, the Queen Elizabeth School, which was retrofitted by installing water systems integrated with the heating system.
- Control building systems, after-hours building control arrangements via computer or telephone interaction; after-hours system use is traced for cost purposes, (Alwaer and Clements-Croome ,2010, p.800). Such as those in the Canada Place project that retrofit by installation of IB automation systems.
- Cost effectiveness through an environmentally approved situation is achieved by installation of several systems via the lifespan, the green built environment, well-being, and marketability (Clements-Croome, 2013)
- Reduces running costs –Holden (2008) added that IBs provide important cost savings, and therefore offer additional improvements. These savings are brought about via: (1) A reduction in the following items: energy use by more exact observation and control of the internal environmental quality. The quantity of waste produced by better flexibility and more precise monitoring and control of building procedures. Operating expenses are reduced by performing system maintenance as needed. System replacement and upgrade costs are completed through the use of a common communications protocol. Travel expenses, and the linked cost of time, are achieved through video conferencing. Theft and improved well-being are achieved through 24/7 security monitoring. (2) Avoiding the following items:

the costs incurred by equipment breakdowns or replacement through the early identification of problems. There is the need, through better location awareness of assets and equipment, to purchase or rent equipment. Consumption costs are managed through zone control on a time of day schedule, for example the Four Point Hotel/ Toronto made \$52,000 of total energy savings and \$16,000 of natural gas savings in seven months, with \$36,000 in electricity cost savings through the installation of efficiency lighting, boiler, HVAC, management, and communication systems.

The National Research Council NRC, (cited in CABA Technology Roadmap for Intelligent Building, 2002, pp.1-2) determined the benefits of IBs:

- Standard building system wiring which facilitated easy upgrade adaptations of control systems; a greater value of the building can be achieved; system use can be monitored for charging purposes; one “*human resources*” interface can modify telephone, security, and wireless devices and the building directory, among others. An example is Auto Value Central Auto Pars/ Calgary, which employed as the model the national energy code for buildings. The Northern Gateway Regional Division No. 10/ Edmonton allows for upgrades to different systems that give longer term energy effectiveness by connected the whole building with communication network.
- Flexibility— the building able to supply and adopt new technology according to changing needs, for example the Queen Elizabeth School/ Sioux Lookout had a flexible system design, and used various equipment suppliers to improve occupants’ comfort level.
- Maintaining /Building upkeep – IT can be planned to notify of the need to replace materials and components, and this can include the ability to self-repair, and indicate preventative and remedial maintenance. Kroner (1997, pp. 387-389) confirmed that intelligently using and maintaining buildings is needed if the design is to be considered intelligent; it must also consider the life-cycle and longer term adaptability of a structure and its systems and parts. For example, Central Plaza/ Hong Kong was able to perform routine upkeep with little tenant disturbance through different systems such as management and maintenance systems.

A review of literature by Wong et al. (2008B), Al-Ali et al. (2011) added how the operational benefits of implementing IB features include:

- Better operational and energy efficiency, such as in the Central Plaza/ Hong Kong, which has a quieter air conditioning system, which was able to have individual zone cooling/heating requirements. The Fairmont Hotel/ Vancouver had a very efficient lighting and water systems that optimised energy use.
- Reliability/ dependability and better productivity –to improve the dependability of building services through better transfer of the operation of the buildings, productivity rather than the building's issues are concentrated on. For example, the Miller SQ building improved employee productivity and work quality. Canada Place/ Vancouver was able to have flexible systems and lighting regulators which reduce the dependability.
- The last but not least, monitoring and observation – the benefit of IB was monitoring for energy use, water and electric source, in different environmental situations (CABA, 2002B, p.A6). From a different perspective which ensures both monitoring and care, and fosters an appropriate environment for its inhabitants independently specifically in connection with smart homes, for example “*assistive technology*” or “*telemedicine or e-health*”. Authors such as Helal et al. (2005, p.55) and Chan et al. (2009, p.91) have discussed activity/ observation, memo/prompting technologies, systems to detect falls, smart devices and appliances², sharing meals with family who are not physically present, and biometric technology to monitor physiological systems³. Courtney (2008, pp. 76-78) added that this is an encouraging, unobtrusive form of home care, providing more independence, better health and the less social isolation. Such systems can improve household management for better decision-making. They provide assurance that the individual is secure and can perform daily actions, and therefore no caregiver needs to be alerted. Authors such as Ding et al. (2011, p.131) and Intille (2002) pointed out a smart home has the capacity to observe the goings-on of daily life and the security of occupants, and to detect changes in their habits, through the convenience of cheap low-energy sensors for people, especially those who live alone. Until recently, the idea of the smart home was thought to be ahead of their time and farfetched with the main focus on being convenient, and it may be used interchangeably. Today, they have become more real, for example, the INTEGER Millennium house Watford which ensures both

² Such as smart phone, smart mail box, and others

³ Such as weight, temperature

monitoring and care, and fosters an appropriate environment for its inhabitants independently through the several systems.

The ability to completely take advantage of the advantages of IB technologies is influenced by several challenges, discussed by CABA (2002) and Chan et al. (2005 p. 70-72) as follows:

- Need for integrated systems –the evolution of the processes required to build a combined communications system differs from those that have traditionally been used, and the continuing service arrangements needed for such a system
- There is a negative effect on human interaction when making use of this type of technology, as it possibly substitutes communication with people, and thus has an effect on the emotional and psychological well-being of the family group.
- Increasing initial cost –the financial effect is always important, including capital costs. The unwillingness of developers/owners to use IB technologies because of their concerns about higher start-up costs and untested technologies;
- The challenge with reaching an agreement –there is limited established interoperability and universally agreed criteria, and there is a requirement for the stakeholders to co-operate and agree on their interests
- Few selected appropriate competencies –the challenge is for the architect to choose professionals who are able to complete the consolidated activities required to design and build an IB.

The previous literature has identified the importance of using IS in IB numerous studies have pointed out what IB gives the users, and how it creates the preferred indoor environment for them. Such benefits can affect a building which has the optimum performance by a mix of environmental, social and economic aspects, according to the significance of IS in each building to achieve their benefits, as well as other elements. In spite of the previous literature presenting the benefits of IB, there were several challenges related with IB facing the operators or developers more than the users (Table 4.1, which illustrates concepts, benefits, and feature of different projects as IB according to different types).

Table 4.1: What, why, when, and how IB for different projects according to different types, CABA (2002A+B), Holden (2008). Continued...

Projects	Rang of function							Benefits				Components	Level of intelligence
	Renovating	New building	Residential	Commercial	Office	Educational	Health care	Hotels	Entertainment	Government	Controlling systems	Controlling environment	
1 Australian Parliament House/ Australia	•								•	•			•
2 Autovalue Central Auto Parts/Alberta	•								•	•			•
3 British Columbia Institute of Technology/UK	•			•		•	•	•	•	•			•
4 Canada Place		•		•		•	•	•	•	•			•
5 Central Plaza/ Hong Kong 1992	•	•							•	•			•
6 Condominiums at 77	•		•			•	•	•	•	•			•
7 Crestwood Corporate Centre, Building	•	•				•	•	•	•	•			•
8 DNP C & I building Japan	•		•			•	•	•	•	•			•
9 Ecole de Technologie Supérieure	•	•						•	•	•			•
10 Famous Players Theatre/ Ste. Foy Canada	•		•			•	•	•	•	•			•
11 Four Points Hotel Airport/Toronto 1998-2002	•			•	•	•	•	•	•	•			•

	Projects	Rang of function							Benefits							Components	Level of intelligence												
		New building	Residential	Commercial	Office	Educational	Health care	Hotels	Entertainment	public	Government	Controlling systems	Controlling environment	A higher value building	Safety / security and health	Cost effectiveness	Reduces running costs	Standard building system/	Flexibility	Maintaining buildings	Better operational and energy	Reliability and better productivity	Monitoring and observation	Dependability	Structural	Systems	Management	Services	
12	Hospital Rivera Prairies 1999	•					•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
13	Human Resources Development Canada- 4900		•		•						•	•	•				•		•	•	•	•	•	•	•	•	•	•	
14	Le Château Frontenac 1995/ Quebec city	•						•				•					•	•	•	•	•	•	•	•	•	•	•	•	
15	Miller SQA Building/ U.S.A		•	•	•						•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
16	Mother Teresa Elementary School/ Oakville	•				•					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
17	Northern Gateway Regional Division No.	•			•						•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
18	Queen Elizabeth School/ Sioux Lookout	•				•					•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
19	Royal Inland Hospital/ Kamloops	•					•				•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
20	The Fairmont Hotel Vanvouver	•						•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
21	The INTEGER house at BRE, Garston UK 1998		•	•							•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
22	Wolf Creek School Division No. 72 /Alberta	•				•					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	

4.2.5 The potential of intelligent building in traditional courtyard house

IB is an essential and tangible concept in which the performance requirements of the buildings' stakeholders are achieved. IB has been defined by different researchers as technical systems, such as Zou et al. (2011), Watson (2011), and Jia et al. (2014). Such definitions concentrate on the technical aspects and not the users' needs, to improve the environmental ability. Other researchers such as Chan et al. (2009), Belley et al. (2013), and Clements-Croome (2013) have defined IB as concentrating on users' needs (see section 4.2.1). However, in this study we agree with the latter group of definitions as these unite the technical systems and users' needs in terms of enhancing the building performance rather than the simply concentrating on one feature.

IB as a concept is becoming more important every day. The development of IB as related to technologies should involve uniting the way of life and the potential future needs. The idea of IB was provoked by the evolution of IT and the growing need for an appropriate living environment and more occupant control when needs change (Wong et al. 2005, p. 149). Thus, the concept of IB has taken various perspectives which can be summarised as: an "*automated building*," by Clements-Croome (1997), a "*responsible building*" by Sterk (2005), and an "*effective building*" by Smith (2002) (see Sections 4.2.2). However, the concept of IB started with the building and its technologies, such as an automated building which might help meet the users' needs. Furthermore, the way that the IB and its technologies were created may also be in accordance with changing needs through being both responsive and effective buildings. The concept of an IB as a responsive and effective building can be achieved through different components, and it could have IS, and an automated building should have IS. Therefore, IB can be seen as a container of IT.

In section 4.2.3, we saw that the current research refers to the potential of IB as a container of IT, if sufficient alternations are made to their performance, as well as adaptations to changing needs linked to the nature of the buildings. According to Kroner (1989 and 1997), for an IB to be a container, there must be: (1) retrofitting of an existing building linked to pro-design through integrated systems; (2) new design of a pre-designed building structure and/or a construction with incorporated systems. If we think deeply, we find that the IB as a container might be achieved in T.C.H.T. by developing and retrofitting this type of house rather than creating a new design.

However, we must also consider what other types of IB can be found in accordance with the appropriateness of the building's features and characteristics.

Now, an IB is classified, explained, presented, and compared above. As a result, the operational definition relies on a designation of IB which is considered to be the ability of the building in terms of its technological systems to monitor information from the different environmental situations, and then to assess, and dynamically respond to, changing needs in such a way that the performance is enhanced for a comfortable living environment for both current and future users.

In Table 4.1, we saw that one of the most significant points is that an IB has been widely used for different kinds of function. Kroner (1997, p. 382) stressed that a building classed as intelligent covers the living and working contexts and others. These IB have tended to be offices and commercial, public, and education buildings, as well as health care facilities and others. It has been applied in dwelling houses, such as the INTEGER Millennium house in Watford, but not in the T.C.H.T. Therefore, there is a lack of information concerning the T.C.H.T. However, one can ask why we need IB in a T.C.H.T.

Holden (2008, p.19) points out that "*IB represent a key benefit that can enable a higher potential return on performance*". IBs provide several main benefits for stockholders, such as: reduced running costs control building systems, enhanced operational efficacy and energy efficiency, better user comfort and productivity, and increased dependability, monitoring and observation, and others as confirmed in section 4.3.5. The goal of IB is enhancing the building performance (BP) for new designs or retrofitting existing buildings; this achieves the optimum performance by balancing environmental, social and economic aspects. However, it is unclear if the benefits of IB will enhance the T.C.H.T performance. From a different perspective, the previous literature has presented the benefits of IB of different types in different functions linked to the lifestyle and partial occupation, such as offices, or full occupation, such as in dwelling houses, especially those where someone lives alone. However, in Table 4.1 the benefits of IBs are unclear for the lifestyle of the current or future users in the case of the T.C.H.T, which could assist occupants to adapt to the changing needs of user requirements, and improve performance for the existing T.C.H.T. In the case of achieving this goal in the T.C.H.T, how could the benefits of

the IB enhance the T.C.H.T's performance? Therefore, the benefit of the T.C.H.T as an IB is as yet unclear.

However, all IB contain varying amounts of IS and the amount of these systems that need to be present for a building to be described as intelligent is not known or easy to determine. All buildings will contain some device that provides some form of automatic response to external changes, but they may not necessarily be described as IB. It is because of this difficulty to precisely say when a building becomes "*intelligent*" that the focus is on IS, i.e. the technologies or systems that contribute to making buildings intelligent. Those systems which are important components of the IB, and due to their importance are also important to this study, are explained in the next sections.

4.3 Intelligent system

In previous sections, we presented the what, and why of IBs, to deal with when these buildings are intelligent in ways that differ from non-IB. Thus, we need to explore the nature of IS in buildings in the following sections.

4.3.1 *The concept of system intelligence*

This section starts with the first stage of exploring the nature of IS in buildings. Bien (2002, p. 6) evolved the idea of "*system intelligence*" by condensing the wide literature on the use of progressive technologies in system and machine intelligence. Wong et al. (2008A, p. 294-296) and DU-Kum et al. (2013) added that an IS ought to be planned in such a way as to permit minimal human involvement while a task is being executed. Self-calibration, self-diagnostics, fault-tolerance and self-tuning are thought of as the main autonomous characteristics of ISs. In addition, an IS should have the ability to interact in user-friendly ways with the operator and staff, allowing human users to feel more relaxed. A system is considered to be intelligent when it has interactive operative functionality, and can satisfactorily control a very complex or simple dynamic system (Himanen, 2004, P. 27).

Four ideas of system intelligence being complex were suggested in the three previous studies:

- Autonomy, the first notion of the IS is linked to self-operating functionality, or autonomy.

- Man-machine interface as a second idea is the ability for humans and machines to interact in a human-friendly way, or “*man-machine interaction*,” and is thus thought to be another significant quality of ISs. This includes “*human-like comprehension or communication, artificial emotion, and ergonomic design*”. They believed that human-machine interaction are common elements of IS or machines.
- The controllability of complex aspects and the features of controllability for complex dynamic systems cover unconventional model-based ones, adaptation, non-linearity, and motion planning in indeterminate conditions.
- Bio-inspired behaviour –The last idea of system intelligence is linked to the ability to perform “*bio-inspired behavioural based technology*”. This is the capacity to interface with the built environment and provided services. In contrast, the constructs of bio-inspired activity and control of complex or simple dynamics are thought to be components linked to ISs founded on the operational features of the groups. Previous studies have indicated that biologically motivated behaviour, cognitive-based intelligence, and neuro-science are thought to be the characteristic bio-inspired behaviour of IS.

The idea of system intelligence as being a complex can be classified into four types in different types of IB. However, the literature does not take into consideration the skill or age difference of the current user and relevant future changes of occupants that may influence the degree of complexity of IS in buildings. One question that needs to be considered is how different users and their lifestyles understand their interaction with the ISs, and how well the interface with the system provides satisfaction to them.

4.3.2 Types of intelligent systems

The type of IS is the second stage in understanding the nature of IS in buildings. Several studies of IS type have been published, such as that by Wong and Li (2006, pp. 1108-1117), which classified intelligent building systems into: Building Automation system (BAS); Information and Communication network Systems (ICNS); Fire protection systems (FPS); HVAC Systems; Safety and Security Monitoring Systems (SSMS); Electrical Installation Systems; Lighting Systems; Hydraulic and Drainage systems; Vertical Transportation Systems; Building Facade Systems; and Internal Layout Systems.

They determined five building systems, including BAS, ICNS, FPS, a HVAC system, and the SSMS. These were thought to be only slightly more significant than the other building systems by the participants. Likewise, in 2008, Wong and Li. confined their investigation of the next eight main building control systems in a typical IB:

- Integrated building management system (BMS) for general observation and building management functionality.
- Heating, ventilation and air-conditioning (HVAC) control of indoor air quality (IAQ) and comfort.
- Addressable fire detection and alarm (AFA) system for fire prevention and alarm.
- Telecom and data system (ITS) as the communication network hub.
- Security and access (SEC) system for monitoring and access.
- Smart/energy efficient lift system (LS) for multiple levels and transportation.
- Digital addressable lighting control (DALI) system for light and control.
- Computerized maintenance management system (CMMS) for inventory control and service works (Wang, Li et al. 2008, pp. 288).

Recently, it has conversely been noted that several types of building system can be combined to effect an IB. Precisely what mix of systems is needed is set by the prospective use of the building. However, the potential applications, and associated technologies, of an IB may be categorised by BRE global (cited in Holden, 2008) as follows:

- Energy use, for overall monitoring of energy and building management, the occupant must be able to understand the energy usage of an individual room or zone within a building, which in turn means they are able to identify areas where energy is being wasted. By utilising intelligent systems, significant financial and emissions savings may be achieved through the monitoring and control of energy usage and mapping this to requirements based on actual building occupancy and use. This applies not only to energy used in heating and ventilation but also to lighting and hot water requirements.
- Environmental control, this includes systems that employ cost-free resources such as daylight, natural heating, cooling and ventilation, and renewable energy where possible. It is designed for thermal comfort, humidity, and satisfactory ventilation in the building, and is also assumed to give adequate lighting for all types of occupation and make lighting use more efficient. Furthermore, it may be

economical, at certain times of the day, to switch between suppliers that are able to provide energy more cheaply in specific quantities or during certain periods. Moreover, building occupancy information e.g. that obtained from an access control system may be used to ensure that systems heat only the amount of water needed to meet demand.

- Communications, a shared communications network is fundamental to the working of an IB. It not only provides the medium through which the measurement and control data are transmitted, but also maintains several important business systems including voice, video and data communications, IT applications, CCTV, and the control of access and lighting by both effective and efficient information transfer in and out of the building. The communications network should be planned, supplied, installed, supported and maintained to provide a flexible and future-proofed infrastructure. Wherever possible, this should operate using a single open protocol, since this facilitates replacement and upgrade of building systems and enhances the choice of systems suppliers, although other protocols may be accommodated to allow continued use of legacy systems.
- Security and access control systems, these systems are particularly suited to an intelligent building utilising a common communications network, which is considered slightly more significant than the other building systems by the participants. They have evolved to survey and control access to determine any unauthorized entry and improve security in the building. It can include a passive infrared (PIR) sensor, which activates lighting only when human movement is detected, and an access control system connected to a shared network could be linked with a CCTV system on the same network and monitored remotely around the year, e.g. at a centralised corporate security facility. The access control system may also be linked with the life-safety systems, so that in the event of an emergency building entry and exit points may be appropriately controlled. Such an arrangement would enable significant cost savings compared with a conventional approach.
- Life-safety systems, these include fire-detection and alarm systems, which are often installed on separate dedicated communications networks, although this is not essential as long as appropriate protection and redundancy is provided. The main utility of this system is fire detection, control and fighting within the building. Where a separate network is used, the life safety system may be interfaced with a common. Communications network so that its operation may be integrated with

other building functions. For example, in the event of an emergency, a pre-planned sequence of actions may be implemented so that, in addition to activating an alarm, the system includes managing the operation of any air-conditioning system to keep escape routes clear of smoke, providing extra illumination in escape routes and implementing an evacuation policy.

- Systems monitoring and maintenance, an IB observes and maintains itself by continuous monitoring of the performance of its many systems, often from a central point, so that the need for preventative maintenance can be identified before catastrophic failure occurs. Preventative maintenance could include monitoring systems' efficiency to identify any shortfall or deviation from expected performance that might indicate the need for maintenance or repair, or it might involve providing an alert when a system is nearing its recommended maintenance service so that this can be included in a previously scheduled visit from an engineer, rather than incurring the labour and transport costs of a separate visit.
- Lifts and escalators, for a multi-floor transportation service, although only applicable to certain buildings, the operation of lifts and escalators may be combined with the building's operational system, enabling monitoring of performance the identification of any malfunctions or maintenance needs. In addition, the operation of lifts might be combined with an access control system that restricts lift access to certain areas. In the event of an emergency, it may be required that the direction of travel of escalators be altered or that they be halted, and that lifts be returned straight away to the ground floor and switched off. This might be done automatically through the building control system.

All building systems are considered important in the literature. The first and second previous sources classified ISs according to the full system type for an office or commercial building, and these systems seem to be appropriate with new buildings rather than with the retrofitting of existing buildings. Holden's classification of an IS according to their application takes into consideration the different types of building to be new or retrofit. However, each of these ISs works in integration. Therefore, it is very important to understand why we need integrated systems in the buildings.

4.3.3 The relation between intelligent systems

As a third stage of exploring the nature of ISs in buildings, we should consider the type of relationships to be integrated or not between different ISs in buildings

distinguished differently as an IB or non-IB. Integration between systems is the ability of systems to gather data and service multiple applications and systems to enable new functionality and better productivity for occupants (IBD, 2007, p. 133).

According to Arkin and Paciuk (1997, pp. 471-479), there is a threefold level of system integration, which includes that:

- The topmost level manages the multiple aspects of ordinary and “*emergency building operation and communication management*”. For example, the Ecole de Technologie Supérieure (ETS)/ Montreal, and DNP C and I building that had management integrated emergency systems with an emergency generator which had a two-week lifetime for use during natural disasters, like a flood or earthquake.
- The mid-level is performed by “*the building automation system (BAS), the energy management system (EMS), the communication management system (CMS) and the office automation (OA) system; these control, supervise and coordinate the intelligent building subsystems*”. The BAS performs energy management, and combines all suitable subsystems on occasion. For example, Auto Value Central Auto Parts/Alberta Calgary1999 and the British Columbia Institute of Technology/UK had effective integrated building systems for environmental control, and energy use.
- The bottommost level covers “*the subsystems of heating, ventilation and air conditioning, and the lighting, fire protection, vertical transportation, security and communication systems*”. For example, the Famous Players Theatre/ Ste. Foy Canada, had HVAC systems.

The previous literature and Table 4.1 has presented the level of integration between IS which reflected the level of intelligence regarding different types of buildings, such as commercial, office, and others. Unsatisfactory awareness of the level of intelligence may generate poor choice of IS types to be used in IB through systems need whether full or application systems. Despite the fact that many buildings are thought to be intelligent, there is significant variation in their actual building intelligence in terms of the intelligence level which has been installed whether integrated or un-integrated. Now, we need to understand the components of IS, and these will be illustrated next.

4.3.4 The relation between intelligent system components

To deals with ISs, we need to know the related between the selected components that comprise a control system and do not communicate with each other (hardwired and software) which are the four aspects under investigation in terms of the nature of IS in buildings. Hardwired can provide satisfactory and economical control of small buildings. It is the modern programmable controller contains a microprocessor and performs local control of a plant or subsystem and exchanges information with the rest of the building management system. Software take place at three levels: the management level for supervisors, automation level for controllers, and field level for sensors and actuators (Doukas et al., 2007; Suberamian 2009).

This section illustrates ISs, including the hardware components, which are more important for this research than the software ones.

- Valves

The aim is to provide a final controlled output which is nearly linear with valve position, to assist in providing satisfactory control. Control valves for hydraulic circuits should be chosen to give adequate authority and a characterisation appropriate for the output device.

- Dampers

Dampers are used to control air flow in ducts in a manner analogous to the use of valves in hydraulic circuits. The damper chosen for a particular situation must satisfy both the physical requirements of the application and also provide suitable control characteristics.

- Motors

Motors are major users of electricity, and can provide energy efficiency. The motor aims to reduce the voltage supplied from an autotransformer.

- Pumps and fans

The specification of pumps and fans is outside the responsibility of the controls engineer. A single pump may not be able to satisfy the full design flow and yet provide economical operation at part loads.

- Control panels and motor control centres

This component gives protection for the equipment and operating staff and allows convenient connection of hardwired interlocks by control equipment, so that it can be mounted in an enclosed cabinet. Thus, the cabinet will contain such equipment as relays, contactors, isolators, fuses, starters and motor speed controllers.

- The intelligent outstations

The intelligent controller is the workhorse of most control systems. It provides local control of subsystems while communicating over a network with the building management system (BMS). Known variously as a field processing unit, distributed processing unit, freely programmable controller or simply as a controller, it combines a standalone control capability with the ability to communicate over a network with the head end supervisor (CIBSE, 2002).

The most important aspect is the relation between the components in IBs in general. According to the IB (CIBSE, 2000, p. 4-17), communication of these components could be wired or wireless.

A network implies that a number of devices are connected with each other via a communications system. A communications network is characterised by two essential parts:

- A physical medium, which is used to transport the signals, e.g. wire and
- A protocol, which is the set of common language rules for the communication signals. This provides local control of subsystems while communicating over a network with the building management system. The intelligent outstation, or universal controller, is at the heart of the contemporary building management system (BMS). Known variously as a field processing unit, distributed processing unit, freely programmable controller or simply as a controller, it integrates standalone controllability with the capacity to interact over a network. Modern building management systems are controlled by means of software operations. The complexity of a large system places demands on the user interface design. The supervision should be arranged so that access is possible at several controlled levels, from simple supervision to fault location and reconfiguration.

One of the important aspects in current research is the user, and there are two levels of operation which will be explored next.

4.3.5 The operation of intelligent systems

There were two types of operation of IS which is the last aspects under investigation in terms of the nature of IS in buildings. These are:

1) Sensors

A sensor measures a physical amount and transforms it into a signal that is read by an observer or instrument. The sensor has to be placed so that it can provide information representing the amount measured, giving access for maintenance and calibration. Sensors might be inside or outside, but they are required for effective operation (CIBSE, 2002, p.3). Different forms of sensor technology have confirmed the capacity to deal with the difficulties of human activities in IB. which can be classified into the following groups:

- Direct environmental sensing

This form of sensing gives an important insight into real behaviour and situations, although it has practical and complex costs and can also generate privacy issues (Caine, 2005). This sensor includes: (1) simple binary sensors to detect those activities which indicate the occupant's presence and positions in the building; (2) Video cameras and audio equipment which identify and follow the user, and generate detailed information on human monitoring and computer interpretation; (3) Radio frequency identification, which is used to identify the occupants. Authors such as Suzuki and Doi (2001, p.246) mention other sensors in the smart home environment, to help to reveal activities and the need for automatic services. For example, there are sensors which are linked with activities, such as working in a place, eating, and others. However, privacy is the most common issue linked to the use of sensor technology especially for specific buildings. Direct environment systems may give more detail regarding the actual situation and the occupants may not prioritise their privacy if it supports a genuine need.

- Mobile environmental sensing

These sensors include: (1) Wearable devices or implantable devices and Microsystems⁴ linked to a service centre by both wired and wireless networks, with the objective of obtaining concurrent biomedical signals (Chana et al., 2009, p.92); and (2) robots, which interface with the outside via speech, visual displays, facial expressions and physical motions, to track people, make predictions about their

⁴ Can be swallowed, such as microcapsule devices, which are now available (Cook and Song, 2009).

behaviour, and respond in an appropriate way. Robots are designed to help people and range from the simplest to the most technologically sophisticated by facilitating household maintenance and observing those in need of ongoing care or for mail collection and delivery, and window cleaning in building (Ochoa and Capeluto, 2006, p. 1130). The goal of this type of sensor is to help with, and enhance, the life quality for daily activities which might be used with people who live alone, especially the elderly.

- Infrastructure mediated systems

Infrastructure mediated systems need the implementation of single or multiple sensors besides the extant infrastructure of the building. For example, the degree of pressure alteration across all the sensors can be used to identify unique variations in airflow in the physical space due to human movements, such as when a person walks through a door, or when a door opens or closes (Patel et al. 2008, p. 15). A power line noise detector can be connected to a normal wall socket to detect a number of electrical events in the building, to detect the electrical noise on building power lines caused by the sudden turning on of electrical devices and the noise caused by particular devices being operated. Hydro Sense, a custom-made pressure sensor, may be connected to any accessible point in a building's extant water infrastructure, to recognise individual fixtures at which water is in use, and to provide an estimate both of how much water is being used and water usage, with error rates which can be compared to water supplied by meters (Ding et al., 2011, p.132). It seems that this type of sensor helps the occupants to control building performance, such as water, ventilation and others functions.

2) Actuator

An actuator is a motor which moves or controls a system that reacts to the output signal from a controller and affords the mechanical action to control the device, such as a valve or damper (Li and Yu 2011, p.2090). Actuators may be classified into:

- Simple but distributed

In 2009, Cook and Song explained a simple actuator which has inspired them in smart environments, for example light switches, or complex systems, which can sometimes be hidden, for example remote controls for TV and Hi-Fi systems.

- Complex but focused

Kuhnla et al. (2011, p. 693) highlighted another actuator which is difficult but focused, which is the cell phone. Users now use their phones for more than messaging, and are accustomed to the many interaction options provided by touch screens and motion sensors. Although so many features are covered by the phone, enhancing the mobility of life, at home there are still many separate applications with individual interfaces.

To interact with smart environments and an IS, the user might need actuators, and these two types of actuator could be applied in IB according to the lifestyle.

4.3.6 *The potential of intelligent system in traditional courtyard house*

As shown in section 4.2.6, the IS is one significant component of an IB. To select the appropriate ISs in buildings, we need to understand the nature of IS in buildings. In response to this, the nature of IS in the building is clarified through:

- The concept of systems intelligence and whether they are complex or simple systems, as shown in Section 4.3.1. This was the first stage of exploring the nature of IS in buildings. However, the literature does not take into consideration the lifestyle of the current user and relevant future changes of occupants that may influence the degree of complexity of IS in a building, and which of these types is more appropriate for it.

One question that needs to be considered is how well the current user in a T.C.H.T understands their relationship and interaction with the ISs, and how well the interface with the system provides satisfaction to the family's special needs and desires. In spite of such attempts, ideas of system intelligence can be too basic, as little in-depth research has been undertaken on the intelligent properties of the IS in dwelling houses such as the smart home and the complexity of IS, and research is still unclear regarding the T.C.H.T. Therefore, the interface may be influenced by the specific lifestyle for the current users of IS in the T.C.H.T.

- The IS type is full of systems or applications as referred to in section 4.3.2, and this was the second stage of exploring the IS in buildings. The first type of IS confirmed by Wong and Li (2006 and 2008) classified ISs according to the full system type such as HVAC systems and digital lighting systems. The second classification of IS is according to their application by Holden (2008).

However, there are various kinds of building system needed according to the full systems or possible application that might be applied in T.C.H.T. Each of these IS types work in integration as suited to the retrofit of the existing building or new design. One can ask if it is possible for the first classification of ISs that were used in an office or commercial building to be used in an existing T.C.H.T. Specific characteristics and features, as shown in Chapter 3.2.3 with Holden's classification of an IS according to their application, seem to be closer and more appropriate to the existing T.C.H.T. comparative to full systems to the T.C.H.T through the retrofit. Therefore, the current study nominates the last classification of IS by Holden, which is the basis for determining the type of IS needed and the possible application that might be applied in T.C.H.T. What needs to be determined is whether all these systems are important for the T.C.H.T dependent on lifestyle. Therefore, the lifestyle of the current users of the T.C.H.T needs to be explored.

- The relation between IS as integrated or not has contributed to the debate about the level of intelligence as a third stage of exploring the nature of IS in buildings. According to Arkin and Paciuk (1997, pp. 471-479), IS have a threefold level of system integration, which includes: the topmost level, the mid-level, and the bottommost level, dependent on the level of integration between different systems (see Section 4.3.3) at the same time it clarified in Table 4.1.

Both the literature review and Table 4.1 have revealed the level of integration between IS, indicating the intelligence regarding various kinds of buildings through different functions in commercial buildings, offices, and others such as smart homes. However, it does not show these levels of intelligence in the T.C.H.T, which may help the researcher to permit the interface and combination of the IS. Inadequate recognition of the level of intelligence might generate a poor selection of IS types to be integrated or un-integrated in a building, and this affects whether the building is an IB or not. One can ask why do we need to enhance the level of intelligence in buildings generally and the T.C.H.T especially? However, to develop the level of intelligence we need to know the lifestyle of the T.C.H.T to help the researcher clarify which level of integration between ISs is more important for the lifestyle of current and future users.

- Fourth, the relation between IS components is other aspect of the nature of IS in building. The IS has different components and the related between them could be

wired or wireless (see Section 4.3.4). Which of those types appropriated to the T.C.H.T is still unclear.

- Fifth, IS operational comprise a control system which is the last aspect to explore concerning the nature of IS in buildings. The IS operations are important to the user through sensors and actuators (see Section 4.3.5).

To interact with smart environments and an IS in building, the sensor types include: (1) direct environmental sensing. Confidentiality is the main point connected to the usage of sensor technology, particularly for residential homes. Family members raise concerns about their privacy, so these types of sensor may be required in the T.C.H.T. This type of house requires privacy in the design, as shown in Chapter 3.4. (2) Mobile environmental sensing: this type of sensor could be useful to older people or who live alone in a T.C.H.T, but at the same time it depends on the lifestyle and the cost of this type of sensor. (3) Infrastructure mediated systems: these could apply in the T.C.H.T, but we need to determine if this sensor is appropriate for the current users.

The second important operation of IS is the actuators, which are: (1) Simple but distributed, and (2) Complex but focused. To interact with an IS, the user might need actuators, and both types of actuator could be applied in the T.C.H.T according to the lifestyle. However, the user might need actuators or sensors as the method of system operation, which could be applied in the T.C.H.T according to the lifestyle. Therefore, the sensors and actuators are the significant components to illustrate the different applications of IS which could be used in a T.C.H.T.

The investigation of the nature of IS in a building was explored through different options as a result of cross, interaction and combination between the complexity of IS, the type of IS, the relation between IS, and the components, as shown in Figure 4.3. This includes several options of the nature of IS; half of these include integrated systems which led the building to be an IB, and others that include un-integrated systems that led the building to be a non-IB or just a building containing an IS to enhance the building performance. Therefore, it is very important to understand why we need integrated or un-integrated ISs in the T.C.H.T to enhance the performance. However, we must determine which of these options is appropriate to the T.C.H.T and why they should be considered. Therefore, the second research question was

raised in terms of what are the features and capabilities of intelligent systems and to what extent can these enhance or not the performance of courtyard houses with respect to the lifestyles of current users, and possible changes for future users?

This helps explore the potential role of ISs in improving the performance of the T.C.H.T in Baghdad, Iraq. As we concluded the selection of each option of the nature of ISs in a building depends on the lifestyle of the occupant for the current user in building. To explore this, the lifestyle of the current users in the T.C.H.T should be understood. Nevertheless, contemporary analytical studies to develop the T.C.H.T in Iraq are rarely found. While many authors are fascinated by traditional architecture in Iraq because of its boldness and uniqueness, unfortunately all these studies are old, especially those about the lifestyle, as shown in 3.2.4- 3.2.5. To know this, different information is needed and can be obtained from fieldwork and therefore this research conducted a case study.

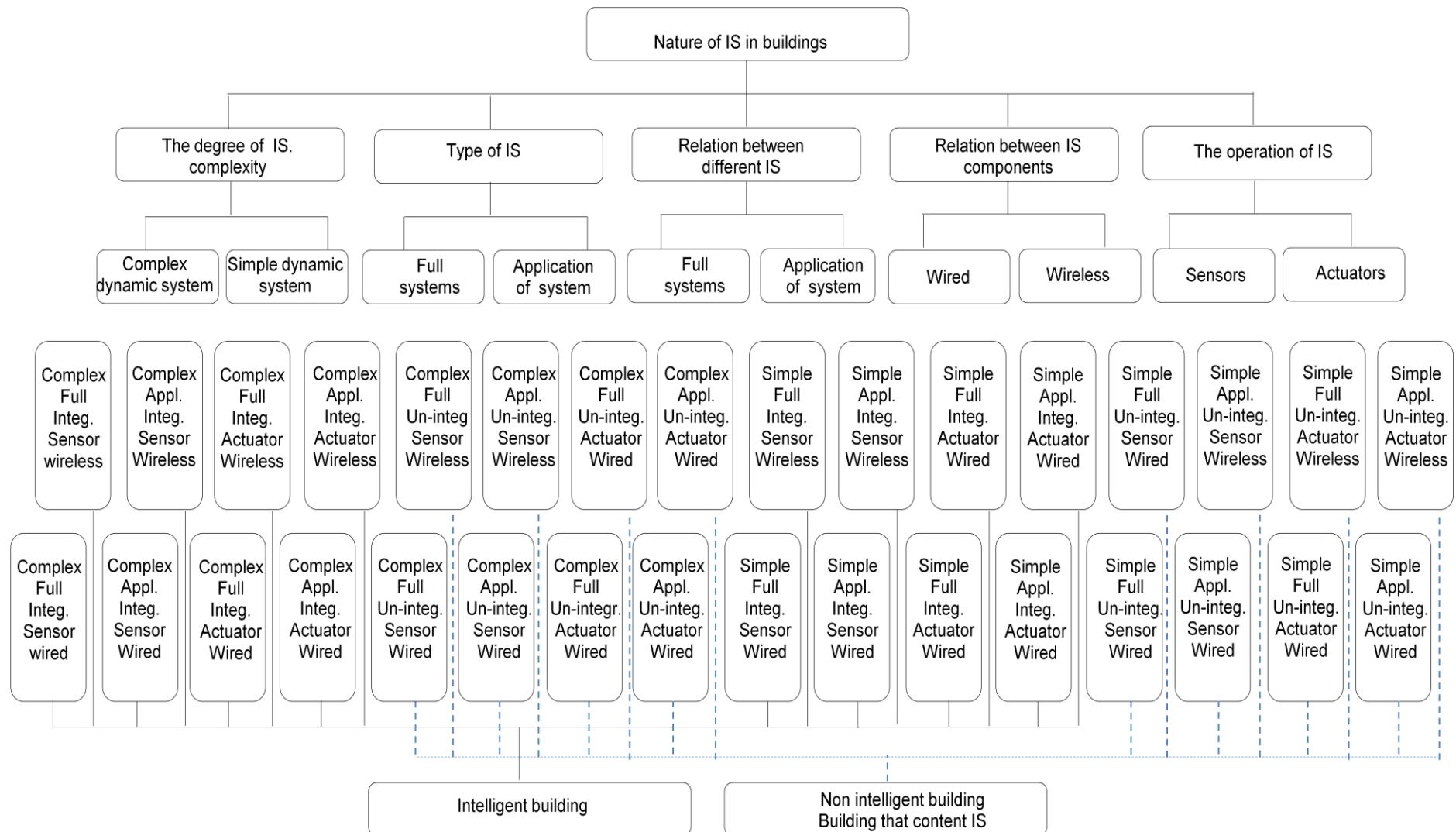


Figure 4.3: Potential for the nature of IS in buildings that distinguish IB from non IB, (Author).

4.4 Applications of intelligent systems

The distinguished between IB from non IB was explored in section 4.3 through different options. To deal with how IS work, we must consider and understand the meaning of this type of system in buildings, by focusing on the possible applications of the IS.

4.4.1 The possible applications of intelligent systems in building

Many companies such as Bosch and Siemens, LG, and others such as Griffiths, 2014; have presented applications. At the same time they are working on the development of those appliances that can be monitored and controlled from mobile devices in the future. Their system intelligence will make communication with appliances even easier and faster and will enable it to be adjusted to customer-specific requirements.

Turn on to the section 4.3.3 Holden (2008) classification of IS related to their applications into: energy use; environmental control; communications; security and access control; life-safety systems; systems monitoring and maintenance, and lifts and escalators. This section has highlighted some applications of IS which could be used in according to the nature of IS in the building.

- **Energy use**

The possible application of this system could be: Washing machines has automatically operation and control which it measures and dispenses exactly the right energy and controlling usage. It communicates easily with a smart phone app, although this is not required which it requires an internet connection, to show rational enhancements to low-key appliances by a reduction in a few frequently-used presets, to reduce the energy consumption. A second button permits the load to be scheduled not by start time but by end time. Dishwasher – application of energy management system where less water is used, less water needs to be heated. When it comes to power consumption, it uses fully ten percent below the limits for the top-grade energy efficiency class. Drying machines tumble dryers with heat pump technology are a big step forward when it comes to domestic energy efficiency which can save 70% of the energy. These appliances use the hot air that is generated in one drying process for the next drying process. Boiled automation and chillers control achieves energy management in efficiency way, due management between water and power. Clean air recirculation module –it is an innovative add-on recirculation module for extractor

hoods, and beats classic exhaust-air systems in terms of energy efficiency, design and ease of installation. This saves energy both for heating and air conditioning. This figure is equivalent to that of an exhaust system and is around 25 per cent higher than for conventional recalculating systems. Plumen lamp, in response to what it perceived at the lack of an attractive to low-energy light bulbs which allowed good quality component and material to achieve faster and strong lighting. This lamp reduces $\frac{3}{4}$ of energy consumption compared with a traditional lamp. A smart chimney hood has energy savings of 80 per cent in comparison with a traditional five-year-old machine. A smart phone, principally, smart phones which are "*low-power*", particularly in the applications processors: for example, when a washing machine automatically takes local water hardness into account on the basis of GPS data or is started automatically in remote mode while the owner is out and about. For instance, dishwashers and laundry care appliances can conceivably spring into action when enough self-produced energy is available. A Smart TV used energy efficiency through conserves the energy about 80 per cent from the other type of TV. Solar energy sheets optimise renewable energy in the building, lowering the electricity bill and facilitating better use of resources. Solar energy is now available to more homeowners. Sending electrical power to PCs as required or due to a pre-arranged priority schedule and automatically initiating backup batteries or systems. Automatic transfer switch provides automatic management that switches a load between two sources when they sense the sources have lost power.

These applications could be part of energy use systems to achieve the management of energy usage, efficiency energy, reduce the energy consumption, and provide renewable energy.

- **Environmental control**

The possible application of this system could be: Washing machines has automatically water manages when the consumer has filled the tanks; it measures and dispenses exactly the right water and conserving resources. It can save a household up to 7,000 litres of water per annum and reduce per unit of liquid. This is also environment-friendly as it prevents more detergent than necessary from entering the sewers. Dishwasher - an intelligent water management system in this application makes sure that the clean water from the last rinse cycle can be used in the first wash cycle of the next load. Depending on its features, an appliance with an intelligent water management system presently consumes 6 or 7 litres of water per

wash cycle. Compared with dishwashers 30 years ago, this can mean a reduction of over 80 per cent. Drying machines - Innovative air condensation drying technology has emerged which enables laundry to be dried without consuming water, as the tepid air that rises in the dryer is cooled by air rather than water. This enables maximum water efficiency, and saves around 40 litres for each drying process. However, although drying must be performed efficiently, it also has to be quiet, making this process one of the most advanced available. Boiled automation and chillers control makes hot and cold water available 24/7, it can also have as water storage in the home. Pumps with a smart float switch is a device used to detect the level of water within a tank which is linked with an alarm to sense power supply and different levels of water within the tank. The switch detects the rising level of water in the tank and energizes an electrical pump which then pumps water in until the level of the water is full.

These applications could be part of water systems which achieve control of the environment and conserve the water in the building in terms of the availability and management of cold and hot water.

Multi split unit –It has multiple sensors for temperature for optimal capacity and performance, filtration systems to enhance indoor air by removing odours, and a sensor which tests the higher and lower parts of a room to find hot or cold areas and regulate temperature and airflow in real-time to preserve a steady and comfortable atmosphere in the space. Solar DC Mini-Split Unit –Many appliances and domestic electronic devices employ direct current electricity (DC), requiring the alternating current electricity to be transformed to DC, resulting in energy losses. This solar-DC mini-split cooling and heating system employs a heat pump to heat and cool air with DC energy from solar photovoltaic modules. Clean air recirculation module – Recirculation brings a breath of fresh air: it had exhaust systems discharge cleaned air outside, clean air is fed back into the room after cleaning. This means that no heat is lost at cold times of the year through the exhaust duct and the open window that it entails. When outside temperatures are high, the system prevents air that has been conditioned from escaping outside. With its increased filter surface, the clean air recirculation module can neutralize up to 95 per cent of odours and turn them into pure air. Smart chimney hood, the new downdraft design for chimney extractor hoods allows the entire hood to be lowered behind the cooker top at the press of a button. As a result, new ideas can be implemented when planning kitchens and the vapour

extraction function can be integrated perfectly in the installation environment and control to the steam, odours, grease and smoke. Smart cooker the appliance had flexible indication which recognizes the cookware in question and turns on the required inductors. It delivers flexibility when it comes to boiling, frying and steaming food, also removes smoke and odour which super-efficient, highly effective ventilation products, rapidly eliminate steam, odours, grease and smoke without extra noise.

These applications could be part of cooling, heating and ventilation systems to achieve control of thermal comfort, purify the air and reduce the odour level through conservation and integration with the natural resources in the building.

Automatic emergency lighting has automatic change-over contactors for emergency lighting, appears automatically if the building has a power outage. The popular method for lighting is battery backup ballasts that are installed in or near existing light fixtures. If a power loss is sensed, the ballasts turn to emergency mode, switching the extant lighting to emergency lighting to meet light safety code requirements without wiring separate circuits or external wall mounts. Its works even without renewable energy, as energy can be stored during off-peak hours and drawn from the battery when rates are high. Automatic transfer switch It is usually installed at the location of a backup generator, to provide temporary power if the utility cannot. This application gives priority for a device to work, and stops the work of devices if the power supply is unstable.

This application could be part of lighting and electricity systems to achieve control of the level of lighting comfort in combination with the existing need for lighting.

- **Communications**

The system could be applied in the following ways: A smart phone, coupled with a growing range of apps, is making life easier in entirely new ways – also in the field of home appliances. It works on innovative ideas for people who trust in smart technology and want maximum energy efficiency, convenience and user friendliness. Wireless router has a wireless access point and network switch give wireless internet access to wireless enabled devices like laptops, computers, tablets, and gaming consoles. Wireless routers connect to broadband, to connect a computer to a Digital Line. Wireless routers are appropriate for home users and small businesses who may select a combination with wireless extenders for more flexibility. It allows you to

transfer data between devices in building faster. A smart TV has an in-built web browser for internet surfing, allowing users to access many features, such as movies, web browsers, downloads, social networking, and news. Smart TV manufacturers offer extra services to differentiate their products and suggestions of what to watch that opining of all online entertainment. At the same time it, offers depth of picture, realism and entertainment in a 3D cinema in the home through a large screen with a very slim design. Digital satellite applications for connection with different TV channels or radio stations. A DVD player brings the latest movies with high resolution. Smart accessories such as glass and adaptors include augmented-reality headsets for playing video games, which are commanding a great deal of consumer interest. Portable Bluetooth speakers let the sound of music flow from headphones into every corner in a building or home through multi room sound and hi quality audio.

These applications could be part of communication systems connected with other systems to achieve control of the use of different applications in buildings, interact between the occupants and with other, and update the information.

- **Security and access control**

The possible application of this system could be: A smart TV helps to illustrate connections with other applications, such as outside cameras. A smart camera is used to cover specific areas and then achieve control, such as of the main entrance, to allow you to know who is coming.

These applications could be part of security and access control systems in a building to reduce the crime.

- **Life-safety systems:**

This system may be applied as follows: A smart fire alarm can be installed for fire and other emergencies for first responders, and can coordinate fire extinguishing and the control of smoke. Automatic transfer switch has the ability to observe electrical outlets for poorly or non-functioning devices, or turning off power to a receptacle, for example if a child puts an object into a socket. The smart refrigerator can store fruit and vegetables in a HydroFresh compartment, which maintains food freshness for double the usual time. The moisture in the compartment can be set manually with a regulator for the type of food being stored at any one time. Humidity is maintained for

certain vegetables, but not for fruit. This assists a healthy diet and modern shopping and storage habits, as commonly eaten fruit and vegetables require many days' storage. The smart fridge, this keeps food much longer in an integrated vacuum drawer, whose function is begun by pushing a button, to begin the process of drawing air out and creating a stable vacuum. This type of preservation requires a change in the localised environment, as less oxygen influences the food. Meat, fish, and cooked meals, for example, are much less vulnerable to microbes or chemicals. A smart oven has a door with a Slide and Hide operation, in which the door is lowered with a slow braking motion and then stored under the oven. Without the door acting as a barrier, food in the oven can be handled more conveniently and safely.

These applications could be part of life-safety systems in a building that helps to promote good health and a safe life.

- **Systems monitoring and maintenance**

The possible application of this system could be: Boiled automation and chillers control makes hot and cold water available 24/7 and decreases boiler maintenance from 24 hours a day to just one. This application is a device used to detect the level of water within a tank which is linked with an alarm to sense power supply and different levels of water within the tank. The switch realises when the water level in the tank is reducing and activates a boiler to work. A smart phone no matter where consumers are, they will be able to monitor and control their household appliances from mobile devices. Other features include automatic push messages when an appliance has finished or if a fault has been detected. Users will also be able to transmit the perfect cooking temperature and time straight to the oven, making sure nothing gets burned any more. Multi split unit had thermostat for the indoor and outdoor units and provides perfect monitoring for temperature choice, and mode selection, as well as various timer and programme possibilities. A digital camera is able to monitor digital systems and communicate by video with another camera which stores images. A Fire alarm is a device for detecting fire, and alerting occupants' .Bagless vacuum cleaners have a built-in sensor to constantly monitor performance and keep it running at the optimum level over many years. If the threshold value falls below the defined optimum, this system automatically triggers cleaning of the depth filter. The advantages of this new appliance in the household turn housework into an experience: low operating noise level, high cleaning performance, no need to buy costly filter bags and hardly any maintenance. Smart

Fridges maintain long term freshness in fridges and freezers. Smart electronic modules are continuously connected to five sensors and cross-check the outer and inner temperatures. They even out those temperature changes which can happen as and when the appliance is opened, or as a result of temperature change on the outside, and therefore they maintain more balanced food refrigeration. For this reason, they can be used to store fruit, vegetables, fish, and meat much longer, and these foods keep their texture and visual appearance for a longer. Also do not accumulate ice as they have low frost technology which decreases ice in the freezer section. As the inside of the appliance has no grids or evaporators, there is much less need for defrosting, and less energy is also used. With the no frost function, there is no need to defrost or de-ice. The smart cooker gives quick access to each cooking zone and permits users to choose the power level via one controller. The quick start function allows a pot or pan to be put on the hob -shown automatically on the control panel- and then users can choose the necessary power level. The temperature switches safeguard any food from being burned. A wide array of cookware, ranging from very small pots to large pans, can be used in conjunction with flexible surface induction. Whether round pots or oval or rectangular roasters, the flexible cooking zones spread broadly over the hob will provide ideal heat distribution for cooking. It can be used as two separate cooking zones in the classic manner, or be combined into one large cooking zone by actuating a control element. Flexible surface induction offers the adaptability to cope with various cooking circumstances. Automatic transform switch these offer interesting perspectives for the efficient use of energy by home appliances in the future. They enable users to transparently monitor their household energy management. For instance, dishwashers and laundry care appliances can conceivably spring into action when enough self-produced energy is available.

These applications could be part of monitoring and maintenance systems in buildings generally and houses especially, through monitoring their household energy management,_planned to notify of the need to replacement which can include the ability to self-repair, and indicate preventative and remedial maintenance.

- **Lifts and escalators**

The potential use of this system could be: Smart lift, which has the ability to respond to the occupants during emergencies such as by suddenly stopping. A smart escalator would stop or slow when not in use through advanced control systems.

These applications could be part of a lift and escalators in a building to provide the easy movement between different levels.

4.4.2 The potential application of intelligent systems in traditional courtyard house

The previous section considers the possible applications which could be used in intelligent systems in a building. For example, washing machines, dishwashers, drying machines, boiler automation and chiller control, clean air recirculation module, plumen lamp, smart chimney hood, a smart phone, a Smart TV, solar energy sheets, and automatic transfer switch could all be part of energy use systems to achieve the management of energy usage, efficiency energy, reduce the energy consumption, and renewable the energy. Furthermore, applications such as washing machines, dishwasher, drying, boiled automation and chillers control, pumps with a smart float switch, multi split units, solar DC Mini-Split Units, clean air recirculation modules, smart chimney hoods, smart cookers, automatic emergency lighting, and automatic transfer switches could be part of the control of the environment systems in a building linked to water, cooling, heating and ventilation, lighting and electricity systems. This can be achieved through the availability and management of cold and hot water, control of the thermal comfort, purification of the air and reduction of the odour level, and control of the level of lighting comfort. Also, it integrates and conserves natural resources. With wireless routers and a smart phone, a smart TV, digital satellite, DVD player, smart accessories, and portable Bluetooth speakers these applications can comprise communication systems and connect with other systems, achieving control of different applications, communicated with others and update the information. The possible application of security and access control systems in a building includes a smart camera and smart TV connected between two applications or more. Smart fire alarms, automatic transfer switches, smart refrigerators, smart ovens, and others could be part of life-safety systems in a building that facilitate good health and a safe life. The application of monitoring and maintenance systems, such as boiler automation and chiller control, a smart phone, multi split unit, digital camera fire alarm, bagless vacuum cleaners, smart Fridge, smart cooker and automatic transform switch offer interesting perspectives for the monitoring of the building and household energy management. A smart lift and smart escalator could be applied in buildings rather than individual houses.

However, a system is “...recognizable whole which consists of a number of parts that are connected up in an organized way. This recognizable who includes a boundary, an environment, a purpose and emergent properties” (Gosling, et al, 2013, p. 45). From this, we understand that an IS has the function of controlling and responding. Therefore, we can introduce an IS as a recognizable whole that has different applications linked in a systematic way. It can determine boundaries, the environment, and intent and has evolving capability. This system has the ability to communicate with other systems which could connect to the internet. Now, I think the meaning of IS is clear.

However, what needs to be clarified are which applications may be suitable for houses according to the nature of IS in the T.C.H.T. To clarify which of these applications is needed according to changing requirements, we need to explore which systems are needed for the lifestyle of the current and future users in the T.C.H.T. Could these applications satisfy the family lifestyle with special needs and desires, and improve the T.C.H.T performance? However, these applications will be determined according to the appropriate need of natural of IS in T.C.H.T. and which systems are needed according to their lifestyle, as confirmed in section 4.3.5. Therefore, we need more clarification by conducting further fieldwork.

4.5 Summary

A review of the previous research aimed to provide a knowledge foundation from which to learn, and to ensure the research conducted for this thesis added to rather than duplicated existing or other ongoing works.

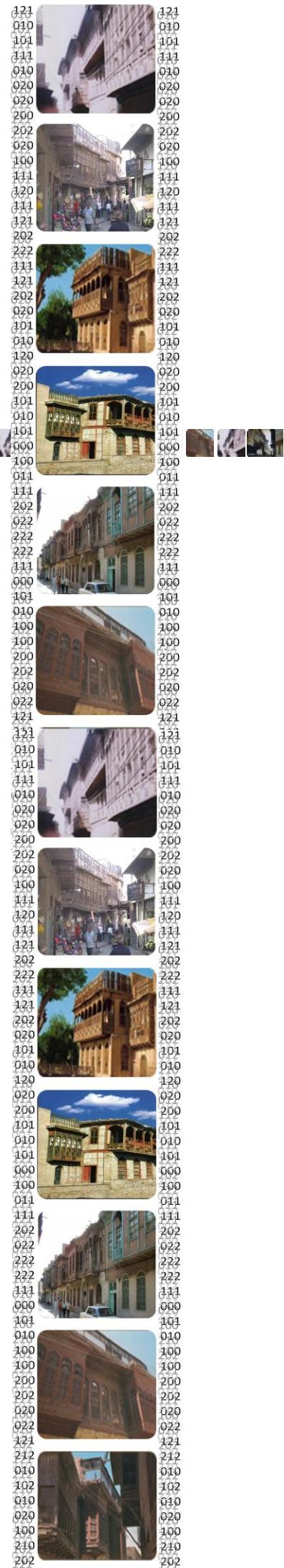
From the previous information, we investigated the meaning, the nature and application of ISs in buildings. Investigating the subject needs an understanding of the essence of IBs as a way of living, not just of the high-priority issues of current users, but this should also involve meeting the opportunities of future needs. These considerations should be understood and considered carefully in terms of IB which are becoming more important every day, and this has led to the development of many aspects in terms of performance. Therefore, further investigation will be conducted through the fieldwork.

Chapter Five:

Methodology and research undertaken



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5 Methodology and research undertaken

5.1 Introduction

The aim of this chapter is to investigate appropriate methodology for this research by search for the logical approach taken and paradigm by this research in terms of the selection of a suitable methodology and research methods. It then discusses the general research design concerning how it meets the aim and objectives of the thesis and describes the reasoning behind the chosen methodology. Also, highlights on the fieldwork.

5.2 The need for an appropriate methodological approach

As started in the introduction chapter, the aim of this study is to explore the potential role of intelligent systems in improving the performance of courtyard house types in Baghdad, Iraq. The specific objectives of the research are:

- To investigate the characteristics and features of the traditional courtyard house in Iraq
- To investigate the meaning, nature and application of intelligent systems in buildings
- To investigate the lifestyle of current users of traditional courtyard houses and how these buildings support their needs
- To examine the potential role of IS in improving the performance of courtyard houses
- To make recommendations on the possible applications of IS to courtyard houses.

Accordingly, the research seeks to address the following questions:

- What are the key features of courtyard houses and to what extent do these support the lifestyles of current and future users?
- What are the features and capabilities of intelligent systems and to what extent can these enhance or not the performance of courtyard houses with respect to the lifestyles of current and future users?

The underlying philosophy and approach used to achieve the objectives is introduced, and is described and discussed below.

5.2.1 General approach

This section clarifies what the philosophical approach for this thesis? Why? This provides the starting point for the rules of logical thinking that is employed in a scientific approach (Hart, 2013, p.28).

1. Philosophy of science

What are the philosophical considerations made by a researcher when he/she undertakes research? Before discussing this, it is necessary to define the term philosophy which is the use of abstract ideas and beliefs to inform the research (Denzin and Lincoln, 2011, p. 12).

Losee (1993) noted that the origin of the philosophy of science can be traced back to ancient Greece. Aristotle established the foundation of speculating about “*the nature of things*” and particularly provided “*inductive-deductive*” reasoning. Trochim (2006) clarified that inductive reasoning works from the specific to broader generalisations and theories, while deductive reasoning works the other way around. With the development of the philosophy of science, Aristotle's view was critically scrutinised. From a historical perspective, Smith (2000) reviewed the significant viewpoints of several key philosophers of science and discussed questions such as how the traditional sciences work, and whether social scientists then apply these methods, modify them, or reject them. The key philosophers of science and their views are provided as follows:

- **Inductive**

The traditional inductivity view of Mill (1806-1873) argued that there are four primary inductive methods:

- Agreement
- Difference
- Concomitant variations and residues, which could be used
- The process of inference and induction leading people to deduce causal relations.

Mill's work described the inductivity view of the scientific method, which stated that science proceeds by collecting factual data through observation and experimentation, which aims to increase the database of observation. Generalisations and causal laws can be completely verified if all the deductions made from them are correct. There are two conclusions about the inductivity view: hypothesis follows observation and we can achieve completely verifiable theories.

However, few modern philosophers of science accept these conclusions. For example, in IT, So and Wang (2002), Wong et al. (2008) and Clements-Croom (2013) alongside many others in IT research have used the detective approach.

- **Deductive**

The hypothetical-deductive view of Popper (1902-1994), a philosopher of science, attacked the inductive view and created the hypothetical-deductive method. Popper stated that science and understanding are furthered by proposing hypotheses, drawing conclusions, making observations, and experimenting continuously to examine these conclusions until they are proven false, and then reworking the hypothesis in response. This statement clearly declares that hypotheses come first and observations follow; observations are interpretations made in the light of theories. The final crucial point about Popper's view is that theories cannot be proved. However, they can be falsified and which is the criterion separating science from non-science, which addresses the question of what characteristics distinguish science from non-science.

However, with this research there is no clear picture about using IS in T.C.H.T and we have no supporting theoretical background for such a relationship. Thus, detective approach may not be helpful to provide the aim and objective related to the current research by exploring something. However, many researches in IT which has provided the conclusion by using the deductive approach, as mentioned above.

2. Research paradigms

A paradigm is the assumption of a theoretical framework which includes a system for people to view events and the approach to questioning and discovery. Information technology research which includes IB and IS research is based on different paradigms which are embedded within interpretive framework/ paradigms as hidden from view when a study is conducted. (Khazanchai and Munkvold, 2003) found three dimensions¹ are used in different research which could be applied in IT research, these paradigms are:

- **Ontological**

Ontological issues relate to the characteristics of reality, meaning the theoretical nature of being. When doing research, researchers consider the notion that there

¹ The three paradigms for Chen (2008, pp.154-155) include: positivist research, interpretive research, and critical research.

may be more than one reality. When studying an individual, proof of this may entail the employment of many types of evidence, employing the words of various persons to represent multiple viewpoints.

- **Epistemological**

Epistemology concerns the theoretical side of knowledge, and is linked to the characteristics of knowledge and its range. It generates principles for assessing knowledge assertions and confirms if such assertions are valid. Epistemological means that the researchers attempt to become close to the participants lives and employment to access their individual understandings and words. The researcher studies in the field to know what they know from the information participants provide.

- **Methodological**

Methodology refers to a procedure by which knowledge is generated, or is characterised and is affected by the researcher's background in generating and analysing the findings.

Each of the paradigms constitutes set of suppositions or beliefs, Chen (2008) and Orlikowski and Baroudi (1991) discussed the sets of beliefs for each previous paradigms follows:

- **The phenomenon**

Ontological suppositions are concerned with the nature of phenomena under exploration, according to whether the empirical world is thought to be objective and therefore not dependent on people, or subjective and thus in being solely because of the human role in making and remaking it. There are two views of human rationality; one is concerned with the intent assigned by researchers to the people they observe, and the other looks at views of social connections and how people interrelate within organisations.

- **The knowledge**

Epistemological suppositions are focused on the way in which knowledge of phenomena can be built and assessed. Methodological suppositions are concerned with suitable methods of garnering valid empirical evidence. The choice of a suitable method relies on the way in which the truth of a theory is constructed.

- The connection between knowledge and the empirical state

The link between theory and practice is reflected in the beliefs and objectives of researchers, and their beliefs must be appropriate to their research and the results they plan to obtain in their work.

However researches based on different assumptions at each dimension can be categorised into different types. Chen (2008, pp.154-155) by classified the research paradigms into three types positivism, interpretive and Critical theory. Lincoln et al (2011) and Craswell (2013, p.19) argued which classification and helped to place philosophy and theory into perspective in the research process, and discussed their assumptions related to each dimension.

- **Positivism²**

Ontological beliefs about the positivism that there is a reality beyond us that the researcher might be unable to comprehend or reach due to a lack of absolutes. Epistemological beliefs about the positive that reality may only be estimated, even though it may be built upon research and statistical data.

The researcher's interaction with the subject should be minimal, as validity stems from peers rather than the participants themselves. Methodological beliefs of the positive position employ scientific means, through which new knowledge is created and developed. The method is essential, and through deductive methods we can test theories, set variables, and compare between sets.

- **Interpretive³**

Ontological beliefs of that many realities are built as a result of experiences and relationships with others. Epistemological beliefs of the positive reality are developed between the researcher and the participants, and are moulded by individual experiences. Methodological beliefs of the positive position employ a more literary way of writing. The inductive method of nascent ideas (formed by agreement) is established by interviewing, monitoring, and the assessment of texts.

² Creswell (2013) used the term “post-positivism” rather than “positivism” to denote this approach because post-positivists do not believe in strict cause and effect but rather recognize that all cause and effect is a probability that may or not occur.

³ Social constructivism is often described as interpretive in another worldview (Creswell, 2013; Denzin and Lincoln, 2011).

- **Critical theory**

An ontological belief of that reality is founded on the challenge of control and identity, while privilege or domination is founded on class and gender. Epistemological beliefs of the positive position are that reality is understood by the observation of social organisation and power, and that reality can be influenced by research. Methodological beliefs of the positive position begin with suppositions of power and identity, records them, and then indicates the need for action and change.

The paradigm of IT research typically concentrates on the dichotomies between each assumption and belief related to that presented above. It constitutes a hierarchy of different levels which define the possible scope of the assumptions related to the characteristic of each research and paradigm, by representing the extremes of a set of continuums. The next section will discuss the appropriate approach and paradigm for the current research.

3. Appropriate approach and paradigm for the thesis

We can begin by thinking about why it is important to understand the philosophical assumptions that underlie IB research and to be able to articulate it in the research study or when presenting the study to an audience.

Huff (2009) is helpful in articulating the importance of philosophy in research:

- It affects how we express the issue and research question, and how we gather information to generate findings
- These suppositions are strongly embedded in training and underpin how to study these issues, and how to add to knowledge through the study
- Knowing how reviewers make philosophical suppositions and where they stand on issues is helpful to the researcher.

Given the subject under investigation, it is reasonable to begin from inductive specific ones to implicit to explicit.

This thesis is unlike other IS research, such as that of Clements-Croome (1991,1997), Yang and Peng (2001), So and Wong (2002), Wong and Li (2006), Wong et al. (2005) and (2008) and Alwaer and Clements-Croome (2010). This thesis holds to a realist, inductive perspective that results in the selection of a range of research methods to be used during the research process. It is reasonable to begin from a specific relationship which is no clear picture of the possible role of intelligent systems in improving the performance of the courtyard house type and move onto

the proceeded by collecting factual data through exploring the knowledge on small of existing T.C.H.T in specific historical area of Baghada/ Al-Kadhimiya and specific architects in Baghdad, leading to formulate the theories through whether or not the IS enhance the performance of T.C.H.T for the lifestyle and people lived there. This approach is less capable of being represented via research in information technology. Therefore, the current study has moved beyond research traditions in IB literature.

The aims of other research into IB were to “*explain*” how to use IS to enhance performance. However, the aim of this thesis is to “*explore*” whether or not IS can be enhance performance. However, the position of this thesis is at the extreme place of the difference in the research paradigms. It takes the form of exploration by attempting to uncover patterns in the data, and then to explain and understand them.

This study argues that the adoption of an explanatory research in the information system field implies focusing only on certain aspects of the phenomena and limiting what and how researchers have studied ISs in organisations. This research realises exploratory that reality is interpretive between both the researcher and the researched. It is affected by their personal experience, is open to various interpretations by participants, and is intended to understand the role of IS in T.C.H.T. from various perspectives. In short, all knowledge is local, provisional and context-dependent.

Other IS research has used a deductive approach through testing theories and comparing between sets by starting from generalisations and theories. However, this thesis uses an inductive approach of nascent ideas (formed by agreement and disagreement) is established.

This research started from a specific relationship, in terms of not understanding the T.C.H.T. relationship with IS; it then proceeded by collecting factual data through exploring knowledge of the small number of existing T.C.H.T in the specific historical area of Baghdad/ Al-Kadhimiya, and by interviewing specific architects in Baghdad. This led to the formulation of the concept of whether or not IS might enhance the performance of T.C.H.T for the lifestyle and the people living there. This approach is not being used via research in IT. Instead, it is considered more appropriate to take a philosophical approach to the thesis (see Figure 5:1).

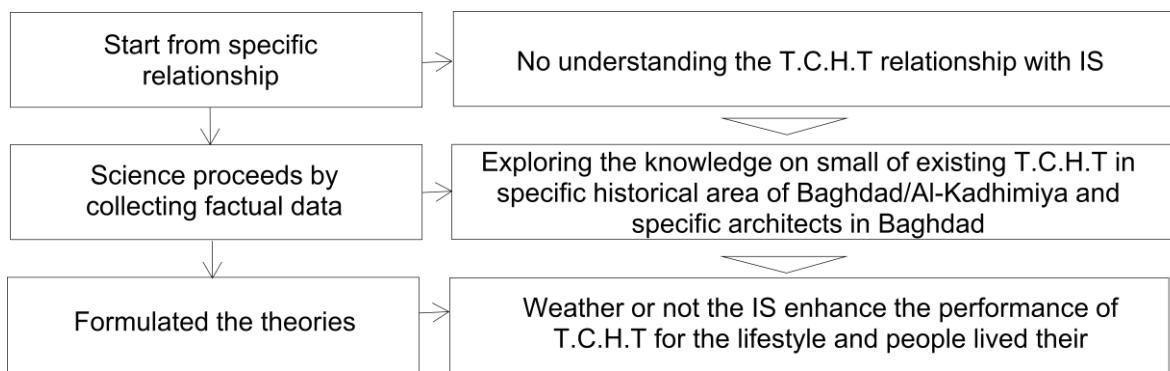


Figure 5.1: Appropriate approach for the thesis, (Author).

These other studies in IT reflect a positivist dimension, in which IB and IS are understood to be objective evidence in the light of previous theory which holds to a realist, ontological perspective relating to the characteristics of reality, meaning the theoretical nature of being. Its belief is that with any positive state that there is a reality beyond it which we may be unable to comprehend or reach due to a lack of absolutes, even though it may be built upon research and statistical data. An alternative trend in previous IS research has been to incorporate a number of disciplines, such as computer science, management and organisational studies, and philosophy (Orlikowski and Baroudi, 1991).

This thesis reflects an interpretive dimension to explore the specific relation between the T.C.H.T. and IS and illuminate the role of IS in the T.C.H.T. The reason for this is that we lack understanding about the T.C.H.T. as it relates to IS generally and there is no clear picture of the possible role of IS in improving the performance of the T.C.H.T. especially. This is the main motive for understanding this research and investigating this knowledge. The current thesis believes that ISs related to T.C.H.T. are first subjectively understood in the mind of the researcher, and this understanding develops during the research period. Also, the thesis is based on the belief that knowledge may be reached and developed between the researcher and the participants. Therefore, interpretations which are solely based on the researcher's own terms cannot be neutral. Indeed, the practical setting of the Baghdad/ Al Kadhimiyah historical area is important. For this reason, the researcher spent time in the field and had to form impressions beyond the actions of the lifestyle and passive systems in the T.C.H.T. The research outcomes thus arise from the interface between the researcher and the research context, and the beliefs and principles of

the investigator are the central mediators. The research perspective is centred on a native insider viewpoint, which is considered the optimum judge of the adequacy of the study.

This research supposes that there are relationships within the knowledge referring to the implementation of ISs in the T.C.H.T. It also assumes that un-valid knowledge in terms of the relationships between them can be obtained by appropriate research methodologies. Therefore, the research adopts an inductive approach according to the aim of the research by exploring the potential role of IS in improving the performance of courtyard house types in Baghdad, Iraq, and the methodology will be discussed in the following sections.

5.2.2 *Methodological considerations*

Methodology is concerned with the process through which knowledge is gathered. It is procedures and principles which enable the collection and assessment of data (Hart, 2013, p.28). Therefore, this section has highlighted the methodology used in IT, and which is the appropriate one for this thesis and why.

The first step towards introducing the selection of research methods is to establish a methodology for the study. In seeking this, the set of questions was:

- What is the appropriate research methodology to gain a better understanding of the potential role of IS in CH. generally and T.C.H.T specially?
- What are the sources of evidence?
- To what extent can access to this data be gained?
- What kind of data, information and evidence need to be collected?
- What is the most appropriate way of investigating and analysing the data?

It was believed that the best approach for investigating the role of IS in T.C.H.T. was to design the study around the research question which arise from no clear picture of possible role of IS in performance of the T.C.H.T. This section focuses on the rationale behind the research approach in IT, the presentation of multiple methodologies, and the introduction of other research methods.

1. Research methodology for information technology

Bjork (1999) referred to the methodological problems existing in IT. One problem is the application of standard scientific methods to this research area, since it is usually focused on the creation of a set of implements which affect reality, but not with observing reality without affecting it. This problem leads to the difficulty of

choosing standard scientific research methods and of designing an appropriate research methodology that are suitable for the phenomena under investigation.

Turk (1999) described the general application of scientific methods in IT research, as follows:

- A hypothesis is normally used. However, the hypothesis is not well defined, measurable and verifiable. Because natural sciences are not changed or influenced by observation, the hypothesis of IT research is vague and cannot be proved by methods used in natural sciences. This is an appropriate approach; however, it cannot be used in this research because there is no clear picture of IS as it relates to the T.C.H.T and determining the hypothesis; indeed, it is usually related to a quantitative approach rather than qualitative approach.
- The "*technology push*" viewpoint evaluates what some information technologies can offer and finds a problem it can solve, or selects the technologies which seem appropriate for a problem in the CH through both qualitative and quantitative methodologies.
- The products and processes are modelled for the selected technology. This is appropriate for one type of system related to quantitative methodology, and this research deals with the role of IS related with different systems.
- The software is written to prove the hypothesis with a prototype. The prototypes prove little until implemented by CAD companies. There is a tendency of growing complexity in model invention rather than applying practices of IS. in buildings.
- The interpretation of the models and prototypes is done by intelligent and flexible humans. The approach of cross-examination and refutation is rarely used.

The application of different scientific methods in IT has been clarified; however, we need to understand the appropriate methodology approach as it refers to the utilisation of one methodology possibly arising from different paradigms within a single intervention, and there are a number of ways in which such combinations can occur (Mingers and Brockesby, 1997). The following summarises the three major types of combined methodology.

- The methodology can be selected from whole methodologies as appropriate to a particular situation, which indicates generally only one methodology will be used in a particular intervention. This is based on the idea that methodologies from different paradigms make particular assumptions about the contexts within which

they will be used, so that a methodology is most appropriate for a context matching its assumptions.

- Different whole methodologies may be used within the same intervention to deal with different issues or to provide different viewpoints.
- The most complex form of multi-methodologies is where methodologies are split or partitioned into components and these are combined together to construct a multi-methodology suitable for a particular problematic situation. The parts may come from methodologies in different paradigms.

It is clear that a variety of methodologies is not always suitable for all kinds of research in IT. Therefore, the methodology selection approach appears to be more suitable in relation to IS with the rather than any other, leading to the specification of the philosophical approach through the inductive approach, as shown in section 5.3.3. Moreover, the "*technology push*," a scientific method related with IT, seems to be appropriate for a problem in the CH. Now the methodology selection approach and the research methods will be clarified.

2. Research methods

Research methodology has been broadly categorised by Hart (2013) as quantitative and qualitative; it was argued that research methods are not mutually exclusive and the different research methods focus on collecting data rather than the examination of theory and literature. Holliday (2012, p.6) discussed the characteristics of each kind:

- **Quantitative methods**

It counts occurrences across a large population, which use scientific techniques to obtain quantified data and then analyses the data to generate quantified results that can be used to assess the hypotheses raised by the theory and findings from the field.

- **Qualitative methods**

It looks deep into the quality of society and life, which requires a detailed knowledge of human behaviour and what governs it. Qualitative research depends on the motivation behind the behaviour. Therefore, it is possible to have smaller, concentrated samples, rather than bigger random samples. Moreover, qualitative research classifies data into trends as the primary foundation for organizing and reporting findings, leading to future knowledge of themes and issues. Authors such

as Thomas (2003, pp.99-110) have pointed out that qualitative research involves its subject matter due to the gathering of different types of information –a case study, personal experience, and introspection.

As illustrated, research methods can be generally divided into quantitative and or qualitative. Fellows and Liu (1997) argued that research methods are not mutually exclusive and the different research methods focus on collection of data rather than examination of theory and literature. The major research methods or styles are discussed in the following sections.

To review the literature, one must select from available documents on the topic, to gather information, ideas, data and evidence. This may be written from a particular viewpoint to achieve certain objectives on the topic and how it is be explored. Moreover, an assessment of this literature must take place in connection with the research being proposed (Hart, 2013, pp.27-29). Hart noted that literature concerns findings in relation to the research which as yet have no status as theory, and may present findings from studies into specific applications of theory. Literature ought to be considered against the background of the theory, methodologies, data, analytical techniques, sampling, and results, in order that a neutral assessment can take place.

The case study is one of many ways of conducting scientific enquiry. It attempts to develop a detailed understanding of a specific case to explore an issue or problem. The conducting of a case study is also important as it can be composed to illustrate a unique case by the analysis of multiple units within the case. Also, in some studies the researcher selects multiple cases to analyse and compare while in other studies a single case is selected. Flyvbjerg (2006, p.220) pointed that the key to understanding is that good case study research involves a description of the case, so that the researcher can identify themes and issues or a specific situation to study which might be organised into a chronology by the researcher, and the analysis is presented as a theoretical model. Finally, case studies often end with a conclusion about the overall meaning derived from the case(s). Yin (2002) highlighted that a case study can be explained as a research strategy that explores a real phenomenon. The definition of a case study has been viewed in two parts:

- First, Yin (2003) explained that the scope of a case study is as follows: it investigates a contemporary phenomenon in its actual , particularly when the lines between the phenomenon and context are unclear, because these are not always discernible in actual situations

- The second part of the definition includes technical features, such as data collection and data analysis strategies.

In architectural research, Groat and Wong (2002, p.347) classified four primary characteristics for the case study method as:

- A focus on single or multiple case studies in actual setting
- The ability to rationalise causality
- A dependence on several sources of evidence, with triangulating data
- The ability to make generalizations to theory.

There is no quick or easy formula for making the choice between single and multiple case studies of their number. Two principles are paramount:

- The type of study questions
- The role of replication in confirming the study's outcomes (Taylor et al, 2011).

The number of case studies depends on the power of generalizability that comes from the concept of replication (Groat and Wong, 2002, p.356). The choice of case studies, in this research, needed to be suited to the study's aims and to produce data which could be analysed according to criteria discussed in this research.

Bjork (1999) pointed that it would be quite straightforward to use standardised scientific methods in the research areas of expert systems and IT-strategy research. For IB-strategy research, standard surveying and interviewing can be applied straightforwardly in this field. However, he argued that the full-scale testing of product model research is costly and difficult because of the highly complex nature that involves data exchanges between several different types of IS.

- Survey research is the means of collecting data through prepared questions in a set sequence in a questionnaire, given to individuals who represent a specific population (Hutton, 1990).
- Modelling is the process of creating a model that represents a real or virtual object, procedure or system, and a reality. All models contain parameters (variables) together with their interrelationships (Fellows and Liu, 1997).
- Interviewing is a means of garnering data by posing questions and having participants give verbal responses. In the last ten years, Dahlberg et al. (2008, p.56) described that in an interview there must be a desire to listen, observe and comprehend, and emphasised that it requires respect and a humility towards the phenomena, in addition to being sensitive and flexible.

Clements-Croome (2013, p.17-19) pointed out that there are three kinds of procedure, which are building rating, facilities management, and computer simulation, which are mainly used in IS.

- The rating method depends on a sequence of factors/indicators linked to design and performance concerns, and their predetermined scales which assess an IB.
- The facilities management method uses professional knowledge to obtain goals in real world IB design, construction and implementation (Clements-Croome, 2013, p.18).
- The simulation is one type of formalisation model although with incomplete manipulation of the model by the discipline's methods, to produce an analytic solution or a numerical value (Fellows and Liu, 1997). The simulation method employs inauthentic settings founded on real-world data from the working of IBs (Clements-Croome, 2013, p.18).

3. Research methodology selection

There are many arguments about the methodology approach due to the qualitative or quantitative research methods, which have been discussed in this section. Punch (2005) argued that the key point for any good researcher is to "*know that your choice of method should not be predetermined, rather you should choose a method that is appropriate to what you are trying to find out*". After all, we are taught that methods cannot be always right or wrong, only more or less appropriate. Also, the negative experience in statistics may predispose the research towards choosing qualitative methods. Therefore, this research project adopted an inductive approach that results in the selection of a range of research methods to be used during the research process see section 5.2.1. This study adopts an exploration which is open to many interpretations through the qualitative methods. This in turn consists of many different endeavours, many of which are concerned with the objective study of realities.

Wong et al. (2005, 149) confirmed that there is a lack of systematic and demanding methods by which to choose new building technologies. A number of the recent approaches have been criticized for emphasis of the quantitative and monetary considerations. The models were mainly concerned with the costs (i.e. purchase or maintenance), as these were easily measured, but did not consider other advantages such as better human comfort.

Therefore, a quantitative approach is beneficial in the selection of IB systems. However, this research argued with Wong which was concerned with exploring people's lives and everyday behaviour, which meant that a more qualitative method might be favoured. For Silverman (2013, p.11), the qualitative method eliminates the study of many knowledge concerned with what people do in their daily lives, perhaps in the home, at work, or another public or private place. The researcher felt the need to understand social behaviours, and the human experience. Nevertheless, I did not believe that quantitative research could cover the depth of meaning that seemed to be so important in understanding the social world. Therefore, a decision was taken before carrying out the fieldwork to start with a positivist mode of inquiry, believing that the relationship between the T.C.H.T. and ISs could be described largely by reference to qualitatively measured variables. This research was framed on the assumption of the fundamental role of the different stakeholders involved, to determine the required IS in the T.C.H.T., and this suggested the appropriateness of a qualitative approach for data collection and analysis in the fieldwork. The whole orientation of qualitative research, which is quite different to that of the quantitative, is that it is open ended and establishes research openings which can lead the researcher into unforeseeable areas of investigation in the lives of those it is researching. Also, it looks in depth at the behaviour in specific social settings, and so it is expected that a true picture will be provided as it really happened rather than at board population.

The appropriate methodological research, as for this research was mainly exploratory. However, as discussed, with the epistemological dimension the adoption of an exploratory research method only focuses on certain aspects of the research knowledge, and the selection of research methods should focus on the character of the singularity being investigated. Therefore, the research adopts a qualitative methodology according to the objectives of the research, and the data collection methods will be discussed in the following sections.

5.3 Research design

In order to achieve the research objectives and answer research questions, the research strategy should be appropriately designed according to the knowledge under investigation as a second step towards clarifying the research methodology. To understand how the researcher collects the data? This section explores the sources of evidence for the selected research methods.

5.3.1 Data collocation method

It is essential to identify the appropriate strategies to collect the required data for this investigation. The more methods used to confirm the findings, the more certain it is that these findings are valid. Accordingly, the research process consisted of the literature review and the case study.

1. Literature Review

The literature review provides and demonstrates appreciation of the current status of the knowledge of the topic, but it is not comprehensive. The review serves at least the following purposes in research:

- Stating the context of the subject, demonstrating understanding of the state of relevant knowledge and explaining the importance of the issue (see: Chapter 2 Why the Al-Kadhimiyah historical area was chosen; Chapter 3 What CH. is? To what extent does the T.C.H.T in Baghdad respond to the environment and social needs of its occupants? Are IS needed to improve the performance of the CHs? What T.C.H.T had that deserved to be conserved? Chapter 4 introduces the answer to the fundamental question concerning the concept of intelligent buildings, reviews what/why/when/ how IBs are?)
- Distinguishing what has been done from what needs to be done, in order to identify a space for this work, as shown in section 3.2.5, 4.2.6, and 4.3.6
- Comprehending the structure of the topic from a new perspective by answering what is the structure of the knowledge on this topic in Chapter 4
- Finding the essential variables related to the topic and enhancing and acquiring the subject (IS) see 4.3.6, 4.4.2
- Identifying the main methodology and research techniques that have been used. What is the appropriate methodology for this thesis? Why? (See section 5.2).

It is essential for all researchers to conduct a literature review to discover what relevant study has already been conducted and what developments may be achieved from the theoretical background. The literature review of this research project goes back over many years and includes academic and conference papers, books, articles, reports, technical specifications, and electronic resources. This research is cross disciplinary and focuses on two major areas: courtyard houses, and IB and IS, in Chapter 3 and Chapter 4, which provide details of the review undertaken for both the and ISs in buildings. Through these chapters, the researcher read the available

material from a different perspective, looking at the topic through an alternative lens, to provide an alternative focus and that is one way that knowledge is advanced.

2. Case study

This study proposes that the IB. should be integral to the T.C.H.T. Therefore, it is hoped that this research can inform practices by exploring the role of IS in improving performance of T.C.H.T. However, in the literature review in section 4.3., the nature of IS in the T.C.H.T was not clarified. The relation between IS and the T.C.H.T. is unclear and yet it can be seen through the role of these systems in improving or not the performance. Therefore, case studies are particularly suited to answering the research questions.

To answer the research question and to achieve the proposed objectives, the case study used a combination of interviews, a physical survey and visual observation supported by documents, to understand the general circumstances. The major research methods or styles are discussed in more detail in the following sections.

- **Interviews**

The research questions and strategy require that the investigation engages directly with the research participants and construes the case of study from their own viewpoint. This indicated a fieldwork approach. The best option for investigating the research participants' viewpoints is to ask them, so that they can give information in their own terms and in-depth. Punch (2005) and Bryman (2004) pointed out that the interview is recognized as one of the most powerful qualitative research methods for accessing peoples' meaning, understanding and interpretation of their behaviour and concerns and for providing richly detailed data. The interviews were designed to provide background information from key community leaders to cover the missing information in the literature to fill the gaps. This would balance the bias towards specific issues of the built environment in traditional society. A semi-structured interview is widely used in qualitative research and consists of a set of open-ended questions on the subject the researcher is studying, organised in themes, and with the option to explore other points that come up in the interview. The open-ended questions give the opportunity for both the interviewer and interviewee to talk about topics in depth, building on the previous conceptual framework of one to one or one to group. Wertz (2005, p.171) pointed out that the semi-structured interview is prepared so as to empathise with the interviewee's position and to offer further prompts geared to exploring the existential dimensions of that position.

Guest et al. (2006, p.78) pointed out that additional data are found when the researcher can progress the properties of the classification. The researcher views two different examples of interview, and so can be confident that the category is fulfilled. This study followed this indicator and classified the research interview into two categories:

- Architects interviews –the first type of interview was with architects. The aim of the meeting was to discuss the possible use of IS in generally and in Al-Kadhimiyah historical area specifically.
- Occupant interviews –the second type of interview was held between the researcher and house occupants in the Al Kadhimiyah historical area in Baghdad. The interview was meant to discuss everyday life of in Al-Kadhimiyah historical area.

The researcher planned to conduct the interviews either one to one or one to group. The objectives of this interviewing were to encourage interviewees to be open about the topic to permit new ideas not considered by the researcher; their respective views were discussed, such as those proposed using intelligent technology for improving the performance of the T.C.H.T in the future.

- **Documents**

Although the official documents might provide sets of plans for the existing conditions of the T.C.H.T., there is still a need to measure many physical features of the space inside and outside the dwellings, such as the layout of the traditional houses and the inhabitant's room to suit their way of living. Creswell (2003, p.103-110) argues that the use of documentary data can be helpful in offering more insights and in depth information about the research and so enhance the process of analysis.

The sources of this data were the Municipality of Baghdad, and the Directory of Archaeology and Heritage. This information consisted of different aspects such as reports and documents, including historic information about the establishment and growth of this area. There was a list of s. in Baghdad, especially in Al-Kadhimiyah, including:

- The owner of these houses
- Location and address
- The categories of T.C.H.T

- Available architectural drawings – simple hard copies, such as plans for these houses.

This item was very important when selecting the s. for physical survey.

- **Physical survey and visual observation**

A physical survey and visual observation by photographs alone would, of course, not be enough to make a final judgment. Both repeated observations and use of other techniques such as informal interviewing, counting how often people do things, and photographs, are necessary to validate the findings of all types of research methods used to collect data. Photographs for space exploration and people movement were required and photographs were used to record issues that might not be covered by other methods of the research. Al-Zubidi (2007) illustrated that physical surveys and visual observations gain information on the characteristics of the built and natural environment, and how these environments are used and cared for. She added that a physical survey is the process of taking data from a building on site, to enable the researcher to understand the context of the chosen case studies through direct observation, images, measurements, and sketches, which are crucial in conducting the spatial analysis for the chosen case studies. The physical survey and visual observation was for the T.C.H.T. in Al-Kadhimya historical to understand current condition of house and to draw a complete picture of this type of house. Architectural analysis through the physical survey provides a set of viewpoints to guide the collection and analysis of information for making architectural choices (Tang et al., 2004, p.2), and is used to support the analysis of the data collected from two types of interview.

The strength of using two main styles to collect the data was transformed into offering flexible and integrated information for holistic investigation. However, in the interview scope of the analysis, the objective was to enhance, strengthen and support the explorations and interpretation of the findings obtained from the physical survey. This increased the possibility of crosschecking the validity of the research findings. The combination of interviews, physical survey, and visual observation promotes understanding of the housing variables in the research settings and achieves credibility. The potential criticisms of each selected method provide a good understanding of what the limitations for a particular research method were in order to improve the design or data collection process

As discussed in previous sections, the methodological design and the choice of the study methods should the aims and objectives of the study and the research questions. Table 5.1 presents the research strategy that is used in this research and the method employed.

Table 5:1 Research aim and objectives as related with the selection methods, (Author)

Problem	Research Question(s)	Research Aim	Research Objective(s)	Sources of evidence	Data collection method
There is no clear picture of the possible role of intelligent systems in improving the performance of the courtyard house type	<p>1. What are the key features of courtyard houses and to what extent do these support the lifestyles of current and future users?</p> <p>2. What are the features and capabilities of intelligent systems and to what extents can these enhance or not the performance of courtyard houses with respect to the lifestyles of current and future users?</p>	<p>To explore the potential role of intelligent systems in improving the performance of courtyard house types in Baghdad, Iraq</p>	<p>1. To investigate the characteristics and features of the traditional courtyard house in Iraq</p> <p>2. To investigate the meaning, nature and application of intelligent systems in buildings</p> <p>3. To investigate the lifestyle of current users of traditional courtyard houses and how these buildings support their needs</p> <p>4. To examine the potential role of IS in improving the performance of courtyard houses</p> <p>5. To make recommendations on the possible applications of IS to courtyard houses</p>	<p>Literature review and Case study</p> <p>Literature review</p> <p>Case study</p> <p>Case study</p> <p>Case study</p>	<p>1. Reading and analysis various literature in the following items: Courtyard houses, and intelligent building and systems</p> <p>2. Semi-structured interviews, physical survey and visual observation, and documents</p>

5.3.2 Justification of research methods

It is important for any researcher to evaluate the chosen research methods in order to deal with the potential criticisms of each method at an early stage; therefore, researchers should have a good understanding of the advantages and limitations of a particular research method which can help researchers to improve the data collection process as a response to criticisms or concerns about the appropriate use of a particular method. There is one major research method whose advantages and limitations need to be considered in this research project. In 2001 Blaxter confirmed the following advantages for case studies:

- It collects from human experience and behaviour and links this to action and their insights as they contribute to change the meaning. At the same time it can be more persuasive and accessible
- It explains alternative meanings and interpretations to allow researchers to reveal how complex social life can be.
- It can give a data source from which further analysis can be done.

From a different perspective:

- The level of intricacy of a case study can complicate the analysis, which is especially important owing to the comprehensive aspect of the case study due to awareness of the connection between particular occurrences, variables and results
- Although the setting of the nature of the case can reinforce this type of research, it is hard to ascertain where setting starts and finishes.

In order to establish how IS in the T.C.H.T. might be used, it is useful and practical to conduct a case study that investigates the application of IS in real courtyard houses, and to assess and judge IS in a real case study. Nevertheless, there were many reasons that limited the practical test and technical evaluation.

- First, IS were not widely adopted and practically applied by most house types, so it was especially difficult to find appropriate house projects during the period of the research.
- Second, because of the high risk in Iraq and the strict schedule of travel, it was extremely difficult to obtain permission to test IS in real courtyard houses.

These factors are a great limitation to using other methods to analyse the data, such as simulation to assess real IB from real-world data. At the same time, the current

research did not use a survey method to represent a specific population because it is difficult to have a population of architects in Iraq, as explained in section 7.2, as there is no clear registration in the Iraqi Engineering Union. This is because many architects have left to work in other countries and these records have not been updated, so it was not possible to obtain the sample from the population.

Also, one of the key justifications for choosing the research methodology or approach is to consider what is the most suitable for the research questions. The questions I am asking (see Table 5.1) explore nature and therefore that means perhaps more exploration of home research was suitable because I am looking for details (for more detail, see section 5.2.1/ 3). This study adopts an exploration which is open to many interpretations through the qualitative methods. This in turn consists of many different endeavours, many of which are concerned with the objective study of realities. As the aim of the current research is to explore the role of IS in enhancing the performance of T.C.H.T, other methods such as finding similar houses with IS in them and comparing these with those in my study were outside the research scope. N-Vivo can be used to perform code-based analysis, and categorise the qualitative data into themes, tag it, retrieve it efficiently, and maintain a complex codebook (Richards, 2009). However, there was insufficient time to become familiar with this program, and the researcher found the program was more helpful to organize the data than analyse it. Moreover, the researcher had already started to analyse this data according to a coding which identified the main themes linked to the research questions, and therefore it was necessary to keep going in the way that had already been started.

5.4 Fieldwork

Fieldwork research was conducted for 14 weeks in Iraq starting from 1st March to 15th June, 2012, to collect data and information using different methods relevant to the research topic. This section clarifies what was happened in the fieldwork?

5.4.1 Field study phases

To show what was done in the field as a fresh phenomenon, the research was carried out four phases:

- **First phase** the preparation phase during the first month.

This phase included: preparing guidelines for interviews and translation into Arabic; preparation of an official letter and security permission to start fieldwork; and also explore the historical Al-Kadhimiyah in Baghdad city.

- **Second phase:** pilot study during the first month.

However, when preparing to pilot the study, the researcher shifted towards a more semi-structured style of investigation. This was confirmed by Wylie (2007, p.123), as the aim was to permit the phenomenon to reveal itself rather than imposing a fixed notion on it, to achieve a true or valid interpretation. This phase aimed to investigate the suitability of understanding the line of questioning used in the interviews and possible modifications of it by testing it with two occupants and two architects as a trial of the pilot study to determine the time for each interview and to check whether any modification was needed. Some corrections were then made according to the comments. These points were: cancelling parts of the ice breaker item, such as the name and the job of the occupant, since it was found that there were negative responses to such direct questions. The researcher got this information by discussing other questions with the interviewee, thus removing overlap between the questions. The interviewees found some questions were repeated in different ways. The changes to these questions⁴ relied on the pilot study with the occupants.

- **Third phase:** data collection during the 2nd, 3rd, and 4th month.

Semi-structured face-to-face in-depth interviews with 25 architects and 24 occupants were conducted, as well as 12 physical surveys with photos. How were these interviewees and houses selected?

The architects' interviewees were selected using the snowball technique. Noy (2008, p.329) defined snowball sampling as a purposive sampling procedure and data accessing method, where the researcher accesses informants through contact information provided by other informants, and is often used to find a hidden population. Snowballing is also called chain referral sampling, and is a type of purposive sampling. In this method, the participants' social networks are made

⁴ This list was used as a guideline and I hope the reviewers feel that the dialogue was just a general conversation.

available to the researcher so that others who might be able to participate in or contribute to the study can be contacted. Snowball sampling is frequently used to find and recruit less accessible groups, who might not be accessed via other sampling strategies. Also, records about the population of architects were found in the Iraqi Engineering Union; however, many architects have left to work in other countries and these records had not been updated, so it was not possible to obtain the sample from the population. However, the qualitative provide the information about what sorts of relevant things are happening and how rather than the number or population of relevant factors. The qualitative data does not permit statistical analysis because it has to do with meaning and interpretation rather than the hard see section 5.5.

The occupants' interviewees were chosen according to two stages based on the following reasons: the availability of time and effort, as the time was limited for the researcher due to the fact that she was only able to carry out the study during the morning, because the T.C.H.T. are located in unsafe areas as show in section 2.2.3 and 2.3.1, and the effort required to complete physical survey of these houses and take photos.

Nevertheless, we may consider the minimum number of interview needed for this research, and what number is appropriate to provide reliable information on the qualitative features of the current study. The researcher had decided how much time for field work to data collection (see section 5.4.2/ 3). The number of interviews was determined when the collected information started to be repeated and no new ideas were raised, which provided the confidence level required. The interview format generally permits prompting to lead interviewees to speak in depth, on and around the topic, to generate new ideas and insights not considered by the researcher. Thus, the number was determined. Galvin (2015, p.4) confirmed that the average number of interviews in building energy consumption conducted by 54 studies was 19.3 and this was reduced to 13.2 when separated into the population-representing groups, the most common is the (11-15) or (6-10) interviews included in the grouping, and is (8-17) interviews for the most common range of separated type. For example, Chiu et al. (2014, p.582) interviewed 17 but in groups of 10 and 7 in the same field. Therefore, the number of interviews was appropriate to provide reliable information for this study.

All the interviews were carried out over a three-month period. The interviews were weekly meetings held every Monday and Thursday. The interviews were held for at least 60-120 minutes to provide a wide variety of information.

The number of T.C.H.T, was determined for the physical survey according to the willingness of the occupants to be interviewed and permission to enter their houses, as well as the available time of the fieldwork, as shown in section 5.4.2., and the availability of documentation and information from the Municipality of Baghdad, as shown in section 5.3.1. This played a key role in the selection of the houses related to different size of house, and differing numbers of courtyard.

- **Fourth phase:** data analysis started during the 2nd, 3rd, and 4th month.

Recording and transcription of the data collection from both interviews and the physical survey were conducted in Arabic then translated into English. During this time the researcher was cautious not to change the meaning. However, interviewees were not given the opportunity to review the transcripts to verify that they were accurate, because it was not easy to rearrange a new meeting with them as the architects were very busy. Moreover, the occupants of these houses at that time may not have been available at other times. Also, this was because of other reasons related to safety and security due to the situation in Iraq and check points, and the time limitation for the case study, as explained in section 5.4.2. Analysis of an individual occupant's courtyard unit with interviews with occupants and architects was carried out alongside data collection. Table 5.2 shows a clear picture of the field work.

Table 5.2 Explanation of the field work including data, (Author)

	Method		Data	Reported in
1 Architects' government and practical office	Twenty five Architects Selected by snowball technique	Semi-structured interview	The aim was to discuss possible influence on the performance by IS in the T.C.H.T. in Iraq included: (1) experience with the CH, (2) the strategies that enhance the user comfort (3) the type of physical architectural elements that response to the environments (4) the development of these types of house in relation to artificial systems (5) architect's comments.	Chapter 6
2 Al-Kadhimiyah historic area	Twelve according to different size, and number of courtyards.	Physical survey with photos	The aim was to understand current condition of house and to draw a complete picture of this type of house by determining the following items: (1) The number of courtyards, levels in the house, and number and function of the rooms. (2) The orientation of the house, courtyard and spaces. (3) The location of different activities. (4) The type of services, also.	Chapter 7
3 Occupants of T.C.H.T. in Al-Kadhimiyah	Twenty four Occupants were selected two occupants for each house	Semi-structured interview	The aim was to discuss the everyday life of the current users through (1) general information of the occupants (2) activities/ place/ time. (3) Conflict and challenges (4) the evaluation of the existing systems/ performance (5) enhance the environmental performance (6) occupants priority and comments.	Chapter 8

5.4.2 Research obstacles

The research obstacles were as follows:

1) Safety and security

- The situation in Iraq

The researcher waited ten days to start interviews with stakeholders in April. There was a conference of Arab leaders during the last week of March and because of intensive security procedures, the researcher had to wait after the end of this conference. Unfortunately, the researcher could not use the internet because it was out of action for 15 days for security reasons before, during and after the few days of

the Arab summit. The activities of life were stopped again because of the conference of 5+1 being held in Baghdad. The situation in Iraq and especially the security situation in Baghdad was unstable because of political conflicts, and so the researcher focused on interviews and returned earlier to the UK to complete the transcriptions and translations for all interviews. Moreover, the researcher determined to conduct four interviews per week with transcriptions and translation. Unfortunately, they could not be done during the last period.

- Visiting special buildings

Permission was granted to visit the Municipality of Baghdad and the Directory of Archaeology and Heritage or visit traditional courtyard houses without official security permission from the Iraqi government, so the researcher prepared an official letter and security permission to get information and collect data for traditional courtyard houses in Baghdad.

- Data permission

However, these data contain plans that were not easy to acquire since the authority which owns this data refused to give it to anyone. This information cannot be used without the security's permission, and without a dedicated official and security letter, collecting these documents would have been impossible. It took six months before a final agreement was reached and the researcher was permitted to travel to her own country.

- Taking photos

At the time of the study, the city was under very tight control and taking photos without security permission from the Iraqi government was not allowed, so the researcher obtained an official letter and security permission to be able to do so.

- Recording an interview using a recorder

The researcher kept a digital record and used a digital camera. I am surprised that the interviewees were comfortable in speaking to me with the recorder. Some people, especially those in government or those who have relationships and interests with the private sector, did not permit their conversations to be recorded. However, notes or comments were taken by someone to assist in these instances when the interviewers refused permission to record the discussion. One of the residents did not allow the researcher to use a digital camera since it would disrupt their privacy, but other families did not mind being recorded.

- Secrecy of information

Although the level of transparency had increased from that of ten years ago and data has become more widely available and accessible in Iraq, and there are still some private and government sectors where you need security permission because data and information are still treated as a confidential matter. However, although the researcher had a letter from the Ministry of Higher Education to show that the researcher was a PhD student gathering data for research, she still faced this problem during the fieldwork in the historic Al-Kadhimiyah area, and in some architectural offices or universities.

- Check points

There were many check points, for example the Al-Kadhimiyah historical area contains one of the main religious centres in Baghdad. The check points forced the researcher to change her circulation routes and to lose a great deal of time when reaching her targets. These factors caused severe traffic jams and this became another serious obstacle, and cost time; for instance, it used to take a half hour to reach the historic area in Al-Kadhimiyah city or the university or other areas but at the time of the research it took two hours to get there. Figure 5.2 clarifies the different check points.



Figure 5.2: Check points in the Al-Kadhimiyah historical area (Author)

2) Environmental obstacles

The fieldwork was conducted during the spring and early summer season, with summer starting in March with a temperature during the daytime in Baghdad of between 45-50°C, especially during some days in June. Time was initially needed to adapt to the climate and the twice weekly phenomenon of dust storms as confirmed by section 2.2.1. which effected to have clear picture

3) Limitation of the data collection

This research deals with the T.C.H.T. in Baghdad. The insufficiency of existing data on the CH. in Iraq is a major obstacle to understanding the intelligence requirements of buildings in different sectors. There is a great deal of literature on Iraq by both Iraqis and others, mainly on its economy, social change, and the political problems. This can be found in publications by the United Nations and in government documents, reflecting one type of resource. Furthermore, most of the literature on the T.C.H.T is represented by old studies describing the situation of the T.C.H.T as they have developed, and regenerated architecture in Iraq is rarely found. However, although theses have been submitted surveying different aspects of the T.C.H.T, a case study is needed to gather data via field visits to courtyard houses. These were carried out to enhance understanding of the potential of intelligent systems in the T.C.H.T to enhance their performance. Official data available on the courtyard house type in Iraq is limited. Few of the assessed courtyard architecture requirements were found in governmental publications and the only source available for information was found in the Municipality/ Mayoralty of Baghdad; the majority of the documents, for example architectural drawings, especially of the T.C.H.T, are unavailable, or some were very old hard copies. Another limitation of the data was that it is impossible to determine the needs of intelligence. Extraction of the specific data was assessed to be an inaccurate process. Therefore, site visits were required and the existing literature on courtyard architecture in Baghdad was reviewed to ascertain observations.

4) Limitation the time for case study

The major limitation of this study was the issue of travelling, and the restrictions on visiting Iraq, which occurred only once during the study. There was also a restricted amount of time for the case study to be undertaken because I had permission for 12 months and when I stayed 14 weeks my sponsor informed me that I needed to return as soon as possible.

5.4.3 Research ethics

Mason (1996, p.166) noted two ways in which such ethical issues affect the qualitative researcher:

- The rich and detailed character of much qualitative research can mean a close interaction with the public and private lives of the individual
- The changing directions of interest and access during a qualitative study mean that new and unexpected ethical dilemmas may arise during the research

Therefore, all the architects and occupants involved in this research were informed about the research by a short comprehensive description of its activity and purpose. Consent was gained from both the architects and interviewed occupants concerning sharing their ideas, as well as the willingness of the occupants to be interviewed in their house and do a physical survey and take photographs for use in the study. Also, I asked permission to record each interview; however, a few occupants refused and in these cases the researcher's assistants were helpful in providing comments as much as possible. The researcher's assistants were asked to introduce themselves after giving a similar introduction of the researcher. The researcher prepared herself and tried to lead the direction of the dialogue in the interview in way that focused on the research purpose. Furthermore, the interviewer wrote notes before each meeting because the researcher gave the interviewee some points about the topic.

5.5 Data Analysis

The difficulties of qualitative research lie in managing the richness of different data (Bryman, 2004). The qualitative methods provide information about meaning and interpretation, rather than the number or population of relevant factors (Galvin, 2015, p.2).

Therefore, the information obtained from the fieldwork was analysed by breaking down unstructured data into manageable chunks.

Accordingly, analysing the data was divided into two stages:

- The preliminary stage, accordingly the data were classified into three categories related with architect interview, physical survey, and occupant interview. This was achieved by reviewing both types of interview in Chapters 6, and 8, and by describing the physical survey in Chapter 7. Accordingly, we will understand what the data says? then the finding was provided
- In depth, the thematic analysis approach was applied, and the data were regrouped according to the various themes. Then, the thematic text and issues

were extracted from what the data means, and the meaning of the current research was the last stage of analysis in Chapter 9 which bear closely on the research questions. Figure 5:3 clarifies the data analysis.

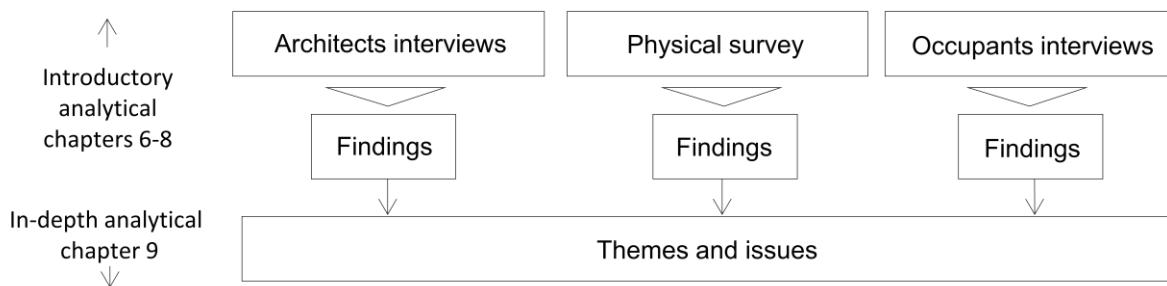


Figure 5.3: Shows the data analysis stages related with each chapters, (Author).

5.6 Summary

This chapter has concentrated on the methodology adopted and used for the research project. It discussed the philosophical assumption and research paradigms with the introduction of various scientific approaches which answered what the philosophical approach for this thesis? Why? This thesis is unlike other IS research. This thesis uses an inductive approach, by investigating the patterns in the data, and then seeking to explain and understand them. This thesis reflects an interpretive dimension to understand the specific relation between them and IS and illuminate the role of IS in the reason for this is that there is no clear picture of the possible role of IS in improving the performance of the T.C.H.T.in the Al-Kadhimiya. However, the position of this thesis is at the extreme place of the difference in the research paradigms. This approach is not being used via research in IT. Instead, it is considered more appropriate to take a philosophical approach to the thesis.

The chapter then highlighted on what the methodology had been used? Why? by introduction of various research methods then provided details of the research methodology and the selection of qualitative methodology to identify the key themes of the research, and which is the most suitable methodology for this study, because the research project adopted an inductive approach as shown in the paragraph above.

The third section was provided how the data was collected? The data were collected by semi-structured interviews with 25 architects and 24 occupants. Also,

there was a physical survey of twelve supported by documents to satisfy the aim and objectives of the thesis.

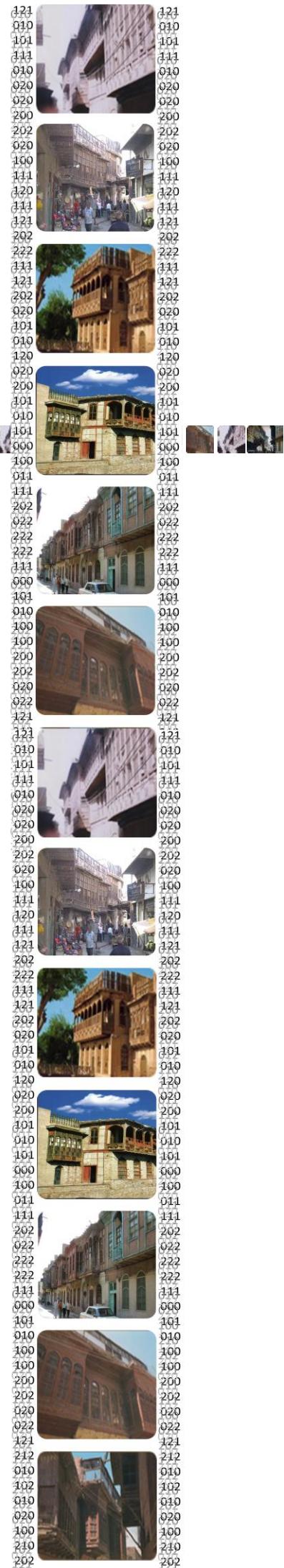
Also, this chapter pointed of what was happened in the fieldwork? By outlined the research process undertaken due to the different phases of fieldwork to achieve the investigation of the current research, the limitation and research ethic.

The chapter was ended by highlighting of data analysis which was divided into two stages. A comprehensive analysis of the total data begins in the next chapter.

Chapter Six: Architects interview



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6 Architects interview

6.1 Introduction

This chapter aims to present the findings on the first category of the field study with the data obtained from the architects by explore the possible use of IS in T.C.H.T.

The chapter is divided into three main sections. Section one focuses on the architect interviews. Section two refers to their professional experience with the CH type, and the chapter closes with emerged knowledge from the architect interviews.

6.2 Semi-structured interviews with architects in Iraq/ Baghdad

As seen in section 5.3.1, two kinds of interview were employed in this study. This section focuses on the first type of interview with the architects. The researcher had good opportunity to meet twenty five Iraqi architects that have experience with T.C.H.T in Iraq at the same time they worked with architectural office in or out of Iraq such as those from the Ministry of Housing, the Institute of Urban Planning, and different universities in Iraq, as well as the practical sector such as Dewan. However, section 5.4 explored how the architects were selected and why the number is appropriate.

The researcher had good opportunity to meet twenty five Iraqi architects that have experience with T.C.H.T in Iraq. The number of interviews was determined when the collected information started to be repeated. Only twenty five architects as we show in section 5.4.1 were selected for interviews from both genders; however, the researcher found many professionals who dealt with T.C.H.T and who consented to attend interviews and did not hesitate to support the researcher.

One to one interviews were held with professional architects with experience of historic buildings, especially the T.C.H.T., and there were also interviews with two architects together that had less experience with this type of house. The interviewees were numbered according to (Arch, x, 2012) for architects in the one to one interviews, and (Arch, x+x, 2012) for groups that contained two architects. According to this classification, the time of each interview was determined as in section 5.4.1.

The aim of the interview with the architects was to discuss the possible uses of IS in the T.C.H.T. in Iraq. The issues discussed between the researcher and architects

began with information about the study and closed with comments from the architects. The researcher used a template for the interview questions, which can be classified into four parts:

- First, there was an ice breaker, as the architects were asked to introduce themselves and talk about their experience.
- Second, the interviews covered general information about the T.C.H.T by describing the urban and design planning of the inner courtyard house as it enriches the traditional environmental performance. They also covered the types of architectural elements that are responsive to the environmental performance, and the current level of environmental comfort in a traditional courtyard house.
- Third, there was more specific information about the T.C.H.T development by: assessing the environmental performance of a T.C.H.T; considering possible improvements to the services in a traditional courtyard house that could help improve its performance; and focusing on the exact choice to increase the performance efficiency of the unit and the fabric, the appropriate services for the traditional courtyard house, and the characteristics for appropriate services in traditional courtyard house.
- Fourth, the interview was closed by asking if there was anything else to add.

These semi-structured interviews enabled follow up some questions to be asked, to provide greater depth of response, what follows is like to be break of those things some questions and issue are roles as a result of the interviews, whilst still following a framework. There is a framework or guidelines to ask things and you come with other things to add to the richness of it. This information is reviewed in the next section.

6.3 Iraqi architects' perspective

This section illustrates what the data collected from interviews with architects indicate. This data will be explained in the next items and linked to specific ideas.

6.3.1 *Experience with courtyard houses*

One of the key points and requirements of this study was collecting knowledge from those with experience in the field to provide greater validity of understanding, and to integrate this type of building. The researcher interviewed architects and started by exploring their experience, especially with the T.C.H.T., by asking them

what skills/professions they had. After this, they were classified into groups, as follows:

- Professional

These architects had long experience in architecture of around 20-50 years.

- Less experience

These architects had less than 20 years' experience in architecture.

Both types of architects had a combination of practical and theoretical experience.

Practical experience included those who had an architectural office or their own consultant bureau working with staff as consultants, or had been designers in architecture and urban design, either inside or outside Iraq for the Ministry of Housing, as the director of the basic design Institute or the Institute of Urban Planning, different universities in Iraq, and in the practical sector such as Dewan in the UAE, or Hill international office in Arbi. This firm specializes in architecture and interior design in Baghdad and other areas. Theoretical experience included those who had a PhD or MSc in architecture or urban design and had supervised many students in the same field as professors, assistant professors, or PhD students, at the same time as working in an architectural office. A description is given of the experience of each architect interviews, as shown in Table 6.1.

Table 6.1: Exploring the architects' experience

Architect code	Current sectors of work	How many years they work	Working with CH.			
(Arch. 1)	Architectural office, Al-Mothana University	Less than 15 years	Design			
(Arch. 2)	Institute of Urban Planning	12 years	Design			
(Arch. 3)	Architectural office	Less than 13 years		Rehabilitation		
(Arch. 4)	Architectural office, Univ. of Solaimaiya	15 years	Design			
(Arch. 5)	Ministry of Housing	More than 28	Design	Rehabilitation	conservation	
(Arch. 6)	Institute of Urban Planning	20 years	Design			
(Arch. 7)	The Directory of Archaeology and Heritage	20 years	Design		conservation	
(Arch. 8)	Consultant office of Baghdad university	More than 45 years	Design	Rehabilitation	conservation	consultant
(Arch. 9)	Universities of Baghdad	More than 32 years	Design	Rehabilitation	conservation	consultant
(Arch. 10)	Institute of Urban Planning	More than 26 years	Design	Rehabilitation		
(Arch. 11)	The Municipality of Baghdad	Less than 30 years	Design	Rehabilitation	conservation	
(Arch. 12)	Universities of Kora	More than 18 years	Design			
(Arch. 13)	Architectural office	Less than 14 years	Design			
(Arch. 14)	Architectural office	Less than 15 years	Design			
(Arch. 15)	Ministry of Housing	30 years	Design	Rehabilitation		
(Arch. 16)	Universities of	16 years				
(Arch. 17)	Universities of Baghdad	50 years	Design	Rehabilitation	conservation	consultant
(Arch. 18)	Universities of Al Technology	23 years	Design	Rehabilitation		
(Arch. 19)	Architectural office	18 years	Design			
(Arch. 20)	Architectural office	18 years	Design			
(Arch. 21)	The Municipality of Baghdad	More than 31 years	Design	Rehabilitation	conservation	consultant
(Arch. 22)	Architectural office	14 years	Design			
(Arch. 23)	Architectural office	Less than 15 years	Design			
(Arch. 24)	The Directory of Archaeology and Heritage	21 years	Design	Rehabilitation		
(Arch. 25)	Architectural office	10 years		Rehabilitation		

The experience of these architects includes: consultancy work planned in Iraq, especially in the historical area; contributing to many projects either as a supervisor or designer for a historical city, especially those with distinctive urban features; working with a team to develop the T.C.H.T. in Iraq, generally and Baghdad especially; working with a team to study and develop the T.C.H.T in historic areas such as the Al-Kadhimiyah, Al-Adhamiyah, and Bab- Al-Sheik sector; rehabilitating Al-Rashid street (one of the oldest streets in Baghdad); and, working in the mayoralty of Baghdad for the development or maintenance of historical and cultural projects.

Furthermore, some had worked in a team in the rehabilitation of the Al-Kadhimiyah historical area in Baghdad and the T.C.H.T of the historical areas in Al-Najef, Mosul, and Al-Basra. One was a member of the consultant team of the contracting company which implemented a residential complex in Suq Hamada, Baghdad, in the early 1990s. Another had worked in the mayoralty of Baghdad with Rifat Chadirji¹ before 1980 at a time of urban renaissance and many projects being executed, alongside Professor John Warren after the 1980s in developing and executing the traditional city surrounding the holy shrine. This supervised, designed, and studied the traditional residential unit with an interior courtyard specifically, and its whole fabric in general, in Al-Khadhyimia city and the Bab-Al-Sheik sector. The suggested project was accepted because it was a compatible project since it permitted modern requirements but kept the old; most important of all, it retained the ability for cars to enter the Old City through the creation of an underground garage to maintain the fabric of the old narrow alleys and shanasheels and other details. Also, one architect worked with the Iraqi architect prof. Dr Mohammed Makiya², and with Taglib al-Waili³. Another had participated in many architecture competitions with Maath Al-Alusi and German Architect Rani Khali to develop the "*Tikarta sector*" in Karkh, Baghdad. This competition was a part of the largest project to develop and rehabilitate the whole

¹Rifat Chadirji, is an Iraqi architect and author born in 1926. He was awarded the Aga Khan Award for Architecture 1986. He was influenced by both European ideas and local traditions. Chadirji was a pioneer in the Middle East at reevaluating the role of architecture in culture and politics. The results of his work have endured and include his visualisation of quickly altering architectural forms as mediators between social requirements and modern technology.

² Mohammed Makiya, an Iraqi architect, urban planner, and writer, was born in 1914 and died in 2015. He had Britain queen honor He studied architecture and civic design and obtained a B Arch in 1941, M Arch 1942 from Liverpool, and PhD Arch 1946 from Cambridge. He established the private Makiya Company between 1947-1953 which had many branches in Bahrain, the Sultanate of Oman, the Emirates, and London. He established the first architectural college in Iraq in 1959. At the beginning, he focused on residential, commercial and religion buildings, and then focused on urban planning and developed heritage buildings. He was a master of incorporating traditional styles into modern architecture (Makiya, 2001).

³ Taglib al-Waili, Iraqi architect and urban planner who has vast experience as a consultant engineer in the UAE and Canada, who has vast experience as a consultant engineer in the UAE and Canada (he worked with Hisham Al-Madfa on planning)

Karkh area. Such an idea was articulated by one interviewee who had designed two models, and one of them had won the competition and executed his model:

“At that time, I requested to work with Maath Al-Alusi voluntarily due to my love of these historical traditional places and to learn more. The competition was concerning with the urban design and every department designed one or more models for traditional houses with an interior courtyard, taking into consideration all the criteria present in the traditional houses, and emphasizing the number of levels in each house and the size of the spaces and others. I tried to add some modern processors compatible with the development of modern times such as using modern processes for services such as central heating and cooling system or splits. We used the same older methods such as badgeers and shanasheels with few modifications to fit the social, environmental, and technological changes” (Arch., 21, 2012).

One architect specialised in the history of Islamic architecture, history of architecture, architectural environment, or architectural technology, with experience in urban conservation, and the supervision of many students who worked in historic areas such as the Al-Kadhimiya historical area as a case study. One was an expert in T.C.H.T, by preparing a study of traditional buildings, including houses in old central Baghdad in Al-Kadhimiya and Al-Adhamiya, and had published research papers in the T.C.H.T field in the Al-Kadhimiya historical area, concentrating on the audio, lighting and thermal performance in the T.C.H.T. of both the general traditional fabric and the single unit. This architect had completed a great deal of research on traditional houses with an interior courtyard, including in the Al-Kadhimiya historical area, and had also participated in a workshop about the traditional unit and their mechanism in protecting the environment. Last but not least, some architects had lived in a T.C.H.T. for more than 50 years. However, some experience of architects in T.C.H.T is enough.

Also, the researcher asked if they had ever designed, implemented or built a CH. during their career. If so, they were asked what improvements and modifications they would make to the design.

The architect interviewees confirmed that they had built a CH. during their career, and had designed from one to several houses. Some of these had single or multiple courtyards, and were both large and small. Few architects lived in the home of an inner courtyard. These interviewees did not deal with courtyards as old houses, and

they used the positive points of these houses in terms of socially, functionality, formality and environmental aspects which helped to make the micro climate better.

Since the outside environment cannot be controlled at the present time, and since the designers and the occupants wanted the outside environment to be separated from the inside environment of the house at times, the same interviewees added a new overlook to this type of house to enhance the level of services and achieve comfortable use for residents. This involved being responsive to upcoming need and fixed techniques in its form. This might include the following items: a movable skylight, retractable roof or semi-thatched sliding roof with a kind of filter or glazed partitions; doors and windows that facilitate the control of the inner environment, link it with the inner space, and connect it with all the spaces of the house. This could be done without having to move from side to side, and a space could be created which was connected to both sides. It also allowed desirable sunlight and ventilation of the inner spaces around the courtyard. new system used the same method as in the past, with a few improvements and new technology, such as the Bad-Geer was modified by the addition of a water sprayer and moisture plates, which helped to enhance the efficient processing of hot air. They also tried to add some modern processes such updated services for central heating and cooling, splits, safety and control systems, a direct communication system and artificial lighting to increase user comfort. The green area inside the court was maximised to enhance the aesthetic and create a beautiful interior environment that brings comfort to all the residents and encourages their sociability, Furthermore, interviewees stated that they designed a courtyard with an isolated dome or roof. One interviewee decided to provide the courtyard with an isolated roof:

“I designed a house with a courtyard, but not in the same way and with the same specifications as a traditional inner courtyard. I used an isolated roof for the yard and modified it into an interior space. If you roofed the courtyard of the traditional house, you destroyed its rhythm with the environment as it was part of an integrated environmental system. The truth is, in our present time, no designer can take the decision to adopt the principle of the inner open courtyard without taking into consideration the design of the house within the fabric of the city” (Arch., 17, 2012). In this way, the CH. became fit for social, environmental and technological changes.

For those interviewee had not designed this type of house before, they indicated that they had used the concept for inward looking plans with different functions, such

as commercial, office, education, and hospital buildings. Even though these interviewees had not designed or executed any T.C.H.T referred that first, they thought that it would be difficult to design this kind of house in a modern location. The singular traditional house with an interior courtyard will lose much of its environmental, social, architectural, atmospheric and professional characteristics, and will be a house containing an interior courtyard but without other intellectual foundations and concepts. Besides none of them liked this type of house, and refused any ancient design, and any ancient intellectual or architectural ideas. Moreover, it was hard to convince clients to go with a traditional design theme because of the changeable needs of today. Finally, these houses are expensive even though when in use they reduce the costs of services in future. Therefore, it is not surprising that one an interviewee frequently mentioned cost as a recurring theme in his account:

“I didn’t design or execute any T.C.H.T Today, when suggestions come forward to inspire things from the past such as the use of the Bad-Geer, or to increase the thickness of the walls in modern designs, they face adverse reactions due to the high costs, so most clients refuse. The clients prefer not to increase the construction fees. They prefer to set limited amounts for future costs of services payable in small amounts and not at once” (Arch., 11, 2012).

From the architects’ experience with the T.C.H.T, we understand that this house type needs to be made more appropriate in terms of changing needs, even though each traditional unit worked correctly within its fabric socially, environmentally and economically.

6.3.2 The main strategies that enhance user comfort in traditional courtyard house

The information in this section confirms and supports what is in the literature. For example: To explore the main strategies that are used in the T.C.H.T in the historical area, the interviewees were asked how would you describe the urban and design planning of the inner courtyard house that enriches the traditional environmental performance.

The interviewees considered that fabric of the traditional city had generally created a microclimate that moderated the climate of the surrounding houses. The planning was unique and achieved great comfort for the residents of the city by encouraging

air currents to flow. They went on to add that an alternative was to line-up the homes in general without leaving spaces for heat transfer, making the whole city work as one unit that decreased the number of roofs exposed to direct sunrays, and increased the shaded areas. As a fabric, it worked positively within its environment.

The interviewees referred to the compactness of the T.C.H.T plus the central area; the compatibility between the fabric and the courtyard; and the integration of the CHs. so as to create spaces of variable height to ensure differences in temperature, so an air flow could be created. The generally compact urban fabric gave environmental protection from the high temperature outside the house for the spaces of the interior CH. by using the ploy of convergence and divergence between the adjacent houses to provide shade. One interviewee had worked with T.C.H.T in the Al-Kadhimiyah area, said:

“Compactness has a great relevance to urban planning in general and to the housing areas in particular. Then, we have the psychological aspect, variety, complexity, hierarchy, and others altogether which play a distinct role in controlling environmental performance first, then enriching it, second. On the other hand, to enrich the environmental performance the use of the CH. as an effective, compact unit in the urban design has an influential impact on the area specified” (Arch., 16, 2012).

Also, from the data collected in the field work which is similar to the literature, the architect interviewees focused on three different ideas, including:

- Environmental aspects

The architect interviewees pointed that the form of traditional house with an interior courtyard was closed by three sides reduced much of the solar gain on its external walls. Proper orientation of the house enables the use of natural energies. In the meantime, the interviewees highlighted the single traditional houses contain reactions and compatibilities on both a single and overall level, as well as multiple levels on the section level. The interviewees discussed the fact that traditional houses with an interior courtyard have several levels: some levels are used heavily in summer while others are abandoned in the summer. This confirms what is called “*the zoning levels*” (Arch., 20, 2012), and the level differentiation achieves thermal comfort. For example, this was emphasised by one interviewee:

“The thermal comfort was given the priority, and for this reason there were multiple spaces that formed the traditional unit, while the presence of multiple levels

gives the traditional unit flexibility. All the levels deal efficiently with gaining and losing heat and the creation of air currents” (Arch., 21, 2012).

Furthermore, the design of the house has spaces and many details that permit the circulation of the air for thermal-gain and loss. Also, the light and sunrays are filtered and play an important role in creating air currents such as the transitional space which are well protected against outside penetration, also achieves cooling air movement in accordance with the size of spaces and the effect on air movement generally, and inside the T.C.H.T. especially. Also, the shape and type of horizontal ceiling made from special materials reduces the heat. Also, secondary roofs are made as support to reduce thermal loads to the minimum by the reduction of gain and loss of temperature in different seasons. All this creates thermal comfort. Additionally, the variables of the highest spaces enrich the interior CH. and help its ventilation by giving thermal isolation. This was articulated by one interviewee:

“You can find the dome and vault which reduce the heat; besides, the columns that supported the dome are made of hollow jars of clay arranged one over the other. This is strong support and light at the same time. The secondary two metre high roofs in the T.C.H.T. especially in the Al Kadhimiyah historical area, are made by using empty jars of clay; these increase the fresh air and control the temperature” (Arch.LI, 18, 2012).

Last but not least, the interviewees clarified that the T.C.H.T have different forms of openings which differ in their locations. Each opening works to divert warm air and light without allowing strong sunlight to enter directly. The arcade-covered paths extend masses over the walkways to “create a new alleyway”. In order to reduce the mass of the house, the architect designed many spaces between the columns and arches that are used to store food and cool it, and thus they “work as refrigerators”. At the end, smaller details such as the arabesque found in all the slots that open to the outer spaces, and the use of decorations in the windows, reflect light and reduce direct sunrays. Even small mirrors in the walls and ceilings, and painting with light colours, has an impact on the reflection coefficient of light. Such an idea was articulated by one professional interviewee who illustrated the reasons behind her opinion:

“I think that the total plan, section and elevation through the design, elements and detail, besides the activities for the traditional house, have a good response for

weather conditions. We can say the traditional unit reflects the environmental performance" (Arch., 24, 2012).

- Social aspects

The architect's interviewees added that the T.C.H.T is in alignment with the culture and social of Iraq. Also, the adaptation connects the house through its openings with the sky and God. The house takes into account the lifestyle and social traditions of the society. The great dynamics lie in using spaces vertically and horizontally at any time of day or night and in all seasons by using a familiar technique. Furthermore, it provides a suitable zone for the family, such as the Diwan, the women quarters, the service locations; moreover, it is stable but flexible enough to deal with both space and furniture. The possibility of future separate zones for young families will emerge from within the extended family. The T.C.H.T gives plenty of room to accommodate all future eventualities and therefore it divides into several zones easily, which is a comfort to our Arabic society in general and Iraqi society in particular.

In contrast, the interviewees described how the change in social relationships over the years may be a point of weakness, since the unit is designed to facilitate strong social relationships, and there is no social-economic development of the community. For example, one architect interviewee who had lived in a T.C.H.T. for more than 50 years, said:

"From my point of view, the strengths outweigh the points of weakness concerning environmental, social, economic, architectural and structural aspects. Unfortunately, today there is a rejection of these traditional units since they represent a certain social-economic class of people and a fascination with western models without thinking. Our ancestors used to choose what was best for them and use it" (Arch., 18, 2012).

- Aesthetical aspects

The interviewees highlighted the most beautiful architectural values of the old district in Baghdad, especially the Al-Kadhimiyah historical area, since it represents a strong interchangeable relationship between: the dimensions in the presence of "positive and negative" spaces, the private and public sector; closed and open spaces; transitional spaces; the space relationships and space sizes; and, lastly, dimensional relationships. Other aspects of the relationship include: the proportion between the height and width of the road and the void and the mass for the houses;

shade and shadow; and the close relations between neighbours such as in Figure 6.1. Also, there is the low heights of all the T.C.H.T, and their human scale; the surprise element while walking inside a traditional area of the city such as the Al-Kadhimiyah; the house details; the unique wood art and brick work, and the better understanding and use of the climatic elements. The use of light colours with high reflecting coefficients reduces thermal loads especially on the direct external front elevations. Different sized interior courtyards are preferred both shaded and sunny courtyards to increase the difference in pressure and secure the wanted air flow.



Figure 6.1: Most beautiful architectural values of the old district in the Al-Kadhimiyah historical area such as shade and shadow; and the close relations between neighbours (PH.CH1+4, 2012), (Author).

Furthermore, these architect interviewees discussed the aesthetic aspects in these types of houses, especially in the Al-Kadhimiyah historical area, and therefore the traditional unit is linked with beauty for social or environmental reasons or both. These are, first, the different types of special spaces inside the traditional unit serving the resident and providing comfort, for example the “Ursi”, which is the living room, the biggest room in the house decorated with beautiful wood and mirrors. Second, there are the elements such as the “Shanasheel” which are a wooden glazed decorative element; it is aesthetically pleasing to passers-by and a barrier against sunrays. Finally, the details such as the wooden columns, wooden decorative roof which contains a small mirror with “an eye”, the decorative bricks are usually drilled or arranged in certain patterns that are used to form the domes. Moreover, there is the use of a stucco decoration with original decoration or geometric designs in the form of a line surrounding the niches of the main rooms to enrich the beautiful scene

inside. Lastly, the use of transparent or coloured glass in decorating the walls brings beauty and romance to these Baghdadi houses. This view can be explored in the account of one interviewee:

“When we visit the old district in Baghdad city you see amazing places and spaces which is a distinct architectural design with a private soul and decorative components” (Arch., 4, 2012).

To highlight elements that respond to environmental condition in the T.C.H.T. in the Iraq general and Baghdad special, the architect interviewees were asked what sort of architectural physical elements respond to environmental changes. These elements include:

- The Bad-Geer –the wind catcher

The interviewees confirmed that the Bad-Geer was an important element that affected and responded to the environmental condition. They were very frequently seen in the T.C.Hs in the Al-Kadhimiyah historical area.

At the same time, the interviewees pointed out that this projection was seen on roofs to intercept cooler, faster, less dusty air flows. The presence of the Bad-Geer and the natural air currents inside it provide continuous interior cooling, it maintains air flow and cools the house interior, it may not remove the heat from the air itself, but rather relies on the rate of air flow to provide a cooling effect, and rapidly cool and humidify the air. Such an idea was articulated in an account by an interviewee who had long experience with T.C.H.T.:

“The most important element that reflects our heritage and affects the CH. performance is the Bad-Geer. During the day when the inside temperature is lower than outside, hot inside air flows down the walls of the wind tower, lose heat, and enter fresher than the outside air into the room; it absorbs heat refreshing ambient air, and then is evacuated through a window. During the night, if the wind is not blowing, the wind tower functions as a chimney by sucking exhausted hot air from rooms and replacing it with fresh outside air entering through openings” (Arch., 6, 2012).

- Shanasheels

Also, the interviewees said that the “Shanasheels” were on the first floor and the level of the interior interfaces, and had a relationship with the space, which is the second element that responds to climate.

The interviewees explained that “*Shanasheel*” achieves different function: it works as an environmental system by allow air from three sides to enter, thereby helping to lower the temperature. Also, it is a way to provide environmental protection from sun and rain and also to control sunrays and the lighting colours so the light can reach the deepest spaces and provide shade. They play the role of air cooler as well as reducing the temperature since their wood absorbs humidity from the air during the night that will evaporate during the day time. Moreover, the “*Shanasheels*” provide a level of lighting regulation, as the spaces deflect direct sun light see Figure 6.2. There is a kind of filtration for sound and light, and a significant aesthetic effect. One architect interviewee expressed this idea in her account when saying:

“The slots found in the wooden frame will filter or adsorb all high audio frequencies and permit only low audio frequencies.⁴ The coloured glass and wooden carvings provide natural lighting, a view, beauty and refraction of light and serve to provide thermal comfort” (Arch., 7, 2012).

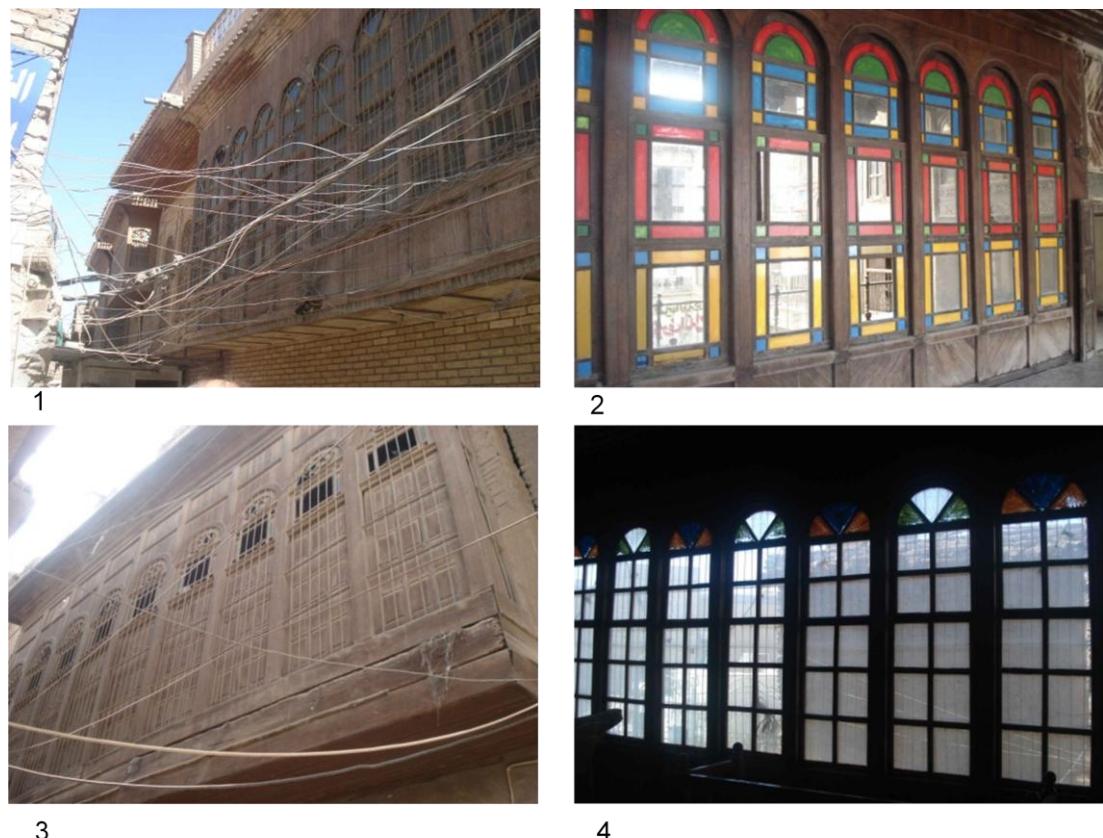


Figure 6.2: The “*Shanasheel*” is an element that response environmentally, socially and aesthetically that is distinctive to the Al-Kadhimiyah historical 1+2 (PH.CH10, 2012), 3+4 (PH.CH5, 2012), (Author).

⁴ This is known as the “*Acoustic diffraction phenomenon*.”

- Courtyard

The interviewees noted that the interior courtyard is another element that reflects the environmental and social aspect and it is essential a T.C.H.T. The courtyard provides constant cooling and natural ventilation and also serves as a light source.

The interviewees pointed out that the courtyard works as a “*cold-store*” at night, and stayed until late afternoon. The courtyard itself works as a cold air-catcher when the temperature drops at night on hot summer days, for example. Interviewees clarified that the courtyard is provided with elements such as a small garden in the centre of the courtyard with plants and fountains affected the climate, as it acted as a dust filter, enhanced the air by freshening and cooling it, and moistened the hot dry weather inside; it also improved the inner scene. Furthermore, just outside the garden is a special place where large water jars are situated. This was clearly expressed by one interviewee:

“A simple green area suitable for sitting in the shade, called the Bakjh, is where some trees such as calder, palms, pomegranates, citron and others are grown with roses to improve the shade. Such plants provide the inner space with O₂ and reduce the CO₂, and could be quite a good dust filter. Moreover, using water surfaces inside the courtyard, like fountains, or even a small swimming pool, cools and moistens the hot dry weather inside” (Arch., 21, 2012).

- Walls

The interviewees indicated that the presence of thick walls provides thermal isolation, while the temperature can be controlled through the thickness of the outside walls. This idea was emphasised by one interviewee who worked with a team to develop the historic area:

“The thickness of the walls, especially those on the ground floor, gives natural protection against the heat, and stop any loss of internal and external temperature” (Arch., 16, 2012).

- Materials

The same interviewees noted the use of natural and adequate building materials on horizontal and vertical levels, with high thermal capacity in general for the walls, ceilings and roofs, as well as columns. The building materials clearly not only absorb and store heat or coolness but also act as insulation, so once the heat or coolness

are in, they stay there. This idea was echoed by an architect with experience in T.C.HTs. in Baghdad:

“They also used bricks, soil and palm as a building material. The efficiency of these materials has an appropriate thermal capacity for all the above reasons; the house will save the heat according to the seasons” (Arch., 15, 2012).

There were no significant differences between this information and many others obtained from architects about this issue and those presented in the literature review. All the points above indicate that the courtyard is an excellent environmental tool for responding to different environmental conditions. From this huge positive perspective, we understand why the architects used the design principles of the T.C.H.T. However, if these architects are so positive in comparison with the negative perspective of the T.C.H.T, why did they not base their current design on them and why they add a new overlook to their new designs?

6.3.3 Adapting the traditional courtyard house

To understand if the T.C.H.T adapts with the changing needs, the architects were asked according to their experience how they would describe the current level of environmental comfort in the T.C.H.T., according to their strategies. Do you think this house type is comfortable or uncomfortable according to changing needs? Why?

In contrast with the previous section, 6.3.2, the interviewees indicated that over 100 years ago, the phenomenon of global warming did not exist and the Earth's temperature was under control, so all natural dealings were under control without mechanical interference. However, the rise in the Earth's temperature due to global warming has reduced the performance of the interior courtyard. Changing the weather creates a big problem in this type of house, particularly in the harsh weather. In this way, the great openness of all spaces towards the interior courtyard makes the environment unsuitable and harmful to health due to the great differences in temperature. It presents the phenomenon of dust storms in Iraq, which are hard to avoid with the traditional courtyard, and this is quite annoying. The architects thought the T.C.H.T would not be comfortable now, because it represents a system with the rest of the neighbouring buildings, and will not work separately. They thought also that people have changed their ideas, especially towards the passive system and the importance of the environment for the use of the courtyard; this reflects a rejection of

this type of house for many reasons, one of which is the level of comfort. Therefore, it is not surprising that one interviewee frequently mentioned:

"In the centre of the sweeping tide of the new technology and the current style of life which contrasts radically with the concepts of the social and climatic traditions that brought the traditional house into existence, I believe the traditional house is in a struggle for survival. It does not meet the required level of comfort with its simple environmental equipment." She also added: "The answer will be relative. In its time, when there were no artificial systems and no advanced technologies, the traditional house succeeded in its environmental performance because it worked in harmony with its environment and provided comfort to all who lived in it. Today, it is very difficult to provide comfort due to many modern changes" (Arch.3, 2012).

A different perspective from the architects was that they thought that the performance of such courtyards was ideal, especially as we are experiencing energy scarcity and the need to restore extraordinary, inspirational plans to reduce the use of energy and at the same time create an environment with a level of thermal comfort. One interviewee, who had supervised and planned a historical city, and had worked with T.C.H.T. in the Al-Kadhimiya area, said:

"I visited hundred of traditional units with an interior courtyard in Rusafa and Karkh such as in Alchriat, Al-Rashid, Al-Betawen, al-Kadhimiya, al-Fadhil, Adamyia, alSheik etc. sectors and from my point of view the real reasons behind neglecting or changing the activities of these traditional units are not environmental but economic or social reasons. The family who lives in these units wants to adapt to climate change and modify the unit to achieve thermal comfort" (Arch.21, 2012).

An architect's interviewee, who had lived in a T.C.H.T for more than five years, indicated that it was difficult to adapt the traditional courtyard design to the new lifestyle. For example, there was the complexity of family movements during the seasons, with the whole family having privacy from the outside world, but the individual having very little privacy due to the continuous movements of the family. Therefore, it is not updated to the present or the future users' needs and there is a lack of technological development of different forms (Arch., 5, 2012).

Interviewees noted that T.C.H.T has become a pile of rubble from neglect by their owners and they therefore need constant and regular maintenance of their building materials. A whole interconnected service system is needed in order for them to work

successfully. Some needed services are points of weakness if not treated properly, such as high humidity due to bad services. The interviewees mentioned that there has been a natural growth of the population and migration to and from the traditional locality. This was clearly expressed by one interviewee:

“Most traditional houses are overcrowded and so these houses are also sometimes noisy because each house has many families. The exaggeration of using spaces which middle-class citizens will be unable to secure is therefore difficult to develop and to extend” (Arch., 20, 2012).

As can be seen from this information, there were different perspectives concerning the T.C.H.T performance, and negative points of view compared with those seen in the previous section.

6.3.4 Development the traditional courtyard house/ active systems

When we discussed the development of the T.C.H.T. with architects, the interviewees were asked to answer how they would enhance the level of comfort in T.C.H.T, and whether this would be through some active systems.

The interviewees pointed out that there was no problem in using artificial systems to increase thermal comfort for the residents that would not consume a great deal of energy and increase sustainable architecture. The problem is not the addition of technological devices, but how they can be added in a way that retains the spirit and tradition of the house, while not destroying the architectural value. The industrial systems which are suitable for the traditional house in order to produce user comfort also need to be determined. At the same time, these interviewees added that the natural ecosystems needed to be improved as they were also important in T.C.H.T. such as the ancient cooling and ventilation system for the Bad-Geer. Such an idea can be seen in an account by one interviewee:

“Both the natural and artificial are important; the use of artificial systems is important but without killing the power of the T.C.H.T. concept. After any additional components, we must ask ourselves if they are suitable for the traditional house; technology is the answer but which type?” (Arch.11, 2012).

Also, the interviewees confirmed that artificial systems are not necessary to make the occupants more comfortable, or even to enhance their comfort. Artificial systems should be seen as having many problems, such as with noise, shape, location, cost, maintenance and waste (i.e. where and how to dispose of it) when they are non-

functional and by-influences, as well as how far they can serve the whole house compared by the traditional hidden system embedded in the CH. design. Also, artificial systems work within a certain climate and this was emphasised by one interviewee who worked in the ministry of housing:

"I believe the most important characteristic of the T.C.H.T. is independence from technological devices; it helps to create a local mini atmosphere. Practical thinking looks at the artificial systems as to be the second line of comfort to support the living environment when the latter is unable to defend itself and perform against the prevailing environment, and then the artificial system should be used" (Arch., 16, 2012).

Furthermore, the architect interviewees were asked about the characteristics they thought were important for appropriate services in the T.C.H.T., especially in Al-Kadhimiya historical area. The interviewees confirmed that the house's ability to use energy efficiently and at a low cost can provide thermal comfort for its residents. The most important characteristics for the new services systems in the T.C.H.T are providing environmental performance with minimum consumption of energy. For example, one interviewee said:

"The most important characteristic for the services in the traditional interior CH. is their ability to use energy efficiently, so the house can provide thermal comfort for its residents with minimum consumption of energy" (Arch., 23, 2012).

Interviewees noted the house's compatibility and ability to adapt for appropriate services with the local environment, such as temperature, humidity, wind movement and others. Any additions must not increase environmental pollution while minimizing new resources. There is less equipment which radiates heat and reduces negative energy and improves an atmosphere. It provides an excellent solution in respect to environmental considerations.

The interviewees stated that if a certain system is added, one must understand the basic plan for the traditional unit with the interior courtyard and its fabric, for example, the relationship between mass, space and slots (openings), and the additional system must make no aesthetic distortion or visual effect on the T.C.H.T. Furthermore, additions do not affect the protection of the houses, such as the structure, or affect human health, such as by excess noise.

Interviewees added that the requirements of living have changed so that the inner courtyard does not meet the requirements of most families, who require new technologies. To live in a traditional house, all service facilities must be modified to fit our modern age and our time. The interviewees discussed the infrastructure services system, which was a new idea about developing the courtyard proto type. The establishment of adequate services that indirectly connect with the central courtyard will improve the present traditional house, regarding the thermal, sewage, water and electricity systems, which must be adequate and efficient. Moreover, the availability of the service system should fit the size and number of occupants. New system types can be acceptable to today's users and be affordable, containing new green technologies.

Furthermore, they discussed how additions should be of very good quality and from reliable sources following world standards, and should also be self-sufficient in general, with a long-life and durability, but should also be adaptable and changeable, and expandable and flexible. To be clear, specific, continuity of interaction and stability creates a natural environment, reduces negative energy, and improves sustainable values. It has no aesthetic distortion or effect on the surrounding walls such as the proportions of the walls, and it could be flat and smooth, so no insects can live within the grooves of rough textures. Moreover, the building material does not distort or pollute the visual environment, or the environmental performance. Also, it should be low-cost energy, friendly to the environment, affordable, and replaceable. These systems can be developed and easily changed and modified in general. The maintenance of the added system must be known as should its repair in case of malfunction. The awareness includes how to use the added system and make it easy to use. The resident will set limitations, rules and specific attitudes about the use of the new system. Such as view can be explored in the account of one interviewee:

"In Iraq, maintenance is ignored by the state and people when buying new systems, which is a problem affecting the country as a whole" (Arch., 16, 2012).

Lastly, one interviewee highlighted that the state must be aware of the importance of the traditional units and must set a "*Control observer side*" that observes and supervises these units and educates the residents about their importance. The state must connect these units with public electricity, water, and sewage, and provide social security for the residents.

This different perspective was presented by one architect concerning the improvement by new systems and their characteristics, who confirmed:

- *“A socio-eco theme when designing and implementing services in courtyard houses.”*
- *“The main core of the house needs better spatial orientation in its shape, height and size, which can be multi-purpose so that the courtyard is the heart of the house and all services pass through it; the house then depends on the courtyard for survival.”*
- *“The traditional house can be understood as a raw element: we just need to reform and rediscover it by going back to our past way of life, its legacy, and the local culture and identity, to use it in new urban area developments or planning themes”* (Arch., 24, 2012).

Moreover, the architect interviewees asked what further improvements to services would help the occupants in the T.C.H.T. The interviewees stated that T.C.H.T have a hidden system so we need an integrated system of improvements, beginning with the infrastructure and ending in the small details of the house by the new concepts of sustainability, integrated with the design to give the house the power to survive. Modern technology is needed now in the traditional houses since the city plans have changed dramatically within the last fifty years. Simple technological solutions could help to improve the lifestyle in these ancient homes, such as a central heating and cooling system, adequate electricity, and water and sewage systems. One architect interviewee explained that:

“We need to use active systems that fit with the nature of the building. This system must be designed and not attached to the building, such as central air conditioning and heating systems which could be help the natural ecosystem in sudden emergencies (dust, high and low temperatures and humidity suffocating” (Arch., 3, 2012).

From a different perspective, the architects noted that it is difficult to find a solution to improve the lifestyle in the interior courtyard house without interfering or changing the urban planning of the whole city. It should be able to meet the contemporary needs of the population and at the same time face environmental challenges. Such an idea can be seen in an account by one professional interviewee who did consultancy work in Iraq:

“It is very difficult to modify or develop single traditional units with an interior courtyard. A complete sector must be developed and modified since the single unit with an interior courtyard cannot work by itself” (Arch., 17, 2012).

Furthermore, the interviewees were asked what they wanted to see in a new courtyard house. They considered that improvements for such a design would include the old principles of a T.C.H.T., mixed with contemporary ideas and details derived from a traditional old courtyard. The house would also preserve and renew an older district and try to rediscover it once more for social needs, such as the degree of privacy and the ecological approach, which applies to the needs of today. This is because the traditional courtyard was environmentally successful within the context of the traditions of its time. These interviewees confirmed that the T.C.H.T. has the ability to receive any new systems willingly. One new aspect about the new interior courtyard is the possibility of: using it as an open space to produce local natural energies, especially in dry hot zones, such as solar, air, and soil energies; renewing wind catchers (“badgeers”) through the formation of “air chimneys”; re-using the shanasheel and controlling their openings and closures electronically; and re-designing the light prisms and light shelves, so light can reach the deepest spaces in the house. There is also the possibility to use: electrophoto or “thermal cells” in the front and on straight roofs as sun barriers, and controlled-masks which are able to open and close in the walls and roofs. Summer shaded or semi-shaded spaces can be designed which connect with air chimneys as places for sleep or entertainment, and a central system can be used for heating and cooling. Also, the architects pointed out the need to improve the natural ecosystems, focusing on the area of service rooms, and to use insulating material for walls and floors in a way that does not increase any additional dead weight. We may also make use of advanced building techniques following old principles, but with modern techniques such as reflectors, coverings, barriers and others. The use of smart materials and the establishment of a moving roof that can close the interior courtyard during dust storms and rain will help to improve the atmosphere inside the house. The use of double foam-glazing means the foam can boil in the case of bright sun and block the negative sunrays. Therefore, it is understandable that this interviewee considered such an idea in her account:

“From my point of view, the traditional house used developed technological systems in its time, and will receive the new technological system such as high technology. I think the traditional house must not stop developing” (Arch., 18, 2012).

Also, one interviewee, an architect and senior planner, wanted to see a social life back in the courtyard, as well as details that can serve this type of activity (Arch., 19, 2012). Another interviewee was a member of the consultant team of the contracting company which implemented a residential complex in Baghdad. This interviewee mostly indicated in their account that any type of improvement and /or modification to the design should be directed towards the reduction of pollution for the benefit of the environment (Arch., 16, 2012).

In contrast, the architects confirmed that the new look of the CH, such as the addition of mechanical and sophisticated technological devices to the interior courtyard house, must be implemented in such a way that they will not destroy its traditional value. The shape, decorations, and style of these traditional buildings must stay. Their thick walls and beautiful decorations cannot be replaced, and must be kept as Iraqi heritage. This idea was expressed in an account by an architect who said:

“The T.C.H.T is like any other building in the world, in that the traditional house can use modern systems that raise the efficiency of its services like fire-warning systems and direct communications systems as well as automation, safety, and control systems. These systems must be added during the maintenance and rehabilitation of these houses without affecting or distorting their unique design. Today, with the housing crisis, many historical buildings have been rehabilitated instead of demolishing them and building new ones, and modern advanced systems for operation and services have been incorporated which help to save energy, so the orientation today is rehabilitation” (Arch., 9, 2012).

Interestingly, from the point of view of the architect interviewees, we explored how this type of T.C.H.T. could be developed and while also accepting the need for new technological systems.

6.3.5 Architects' miscellaneous comments

At the end of each interview, the architects were also asked to summarise in one sentence how they felt about the topic being discussed. They confirmed that the subject is interesting and wide in its environmental and social understandings. It mimics our architectural heritage and works to revive the beautiful distinctive

architectural features, especially in our present time, which is witnessing the emergence of many exotic alien ingredients imported from different environments that have distorted most of our architectural heritage features.

"I felt that this interview at first glance will weigh on my shoulders, but I felt so happy due to the quality of the questions that touched many sensitive issues on academic and applied levels since our country (Iraq) has distinct traditional architectural buildings which many ignored" (Arch., 7, 2012)

A few architects had contradictory feelings, experiencing both a sense of joy and a sense of frustration at the same time. The joy was because there are still a few people who are trying to re-understand the system of traditional housing within the context of the city, and therefore there is hope in the re-employment of our ancestors' ideas in a contemporary fashion. The frustration and sadness were caused by the state of our miserable traditional units, which have carried our heritage for generations. People have tried to adapt this heritage to the extreme local environment through architectural configurations and construction that create a successful social, environmental, health and security environment. Today, all our cities (especially old localities) are neglected to a grotesque and deliberate extent, which makes the remains of our traditional cities a real burden on the present generation and subsequent generations. This idea is expressed in an account by an architect:

"For a moment, I thought I had returned to the past where I lived beautiful moments of my life with unique architecture design, but unfortunately I returned to the reality and I was frustrated for the lack of awareness of our heritage and the attempt to erase it" (Arch., 18, 2015).

It should be mentioned that the architects pointed out that there are many who speak about this subject without having any real knowledge about it. This subject needs more elaboration; include services, improvements, and the concept of life-cycle, improvement versus rehabilitation, upgrading, and repair concepts, all of which are good issues. The importance is to show how to borrow the values of the spatial metaphor and integrate them with the age-spirit and its requirements and challenges, with how to develop a strategy, so that the T.C.H.T. will remain with its past history and its future at the same time. This was clearly expressed by one interviewee who had worked together with a team in the rehabilitation of the Al-Kadhimiyah historical area:

“You were marvellous and I was delighted with such a discussion even though it took more than one meeting to be completed. I am glad to have such an exchange of emotions when talking about the greater value of this distinct cultural field of science” (Arch., 21, 2012).

An architect interviewee indicated that there is no realistic solution about this type of house. Globalization will not encourage the modern architect to ignore and neglect his/her identity and history, but to develop it. This was articulated by one an interviewer:

“It is painful to discuss because no adequate and realistic solutions were found for this type of house. You can make others listen if they are alive, but no one is alive to listen” (Arch, 13, 2012).

At the end of their interview, the architects were also asked if there was anything else to cover. They confirmed that the secret of the creativity of the traditional house can be implanted as a whole or a part in our present time to interact with the environment and be in harmony with it, but that these houses also need some slight modifications to be adapt to changing needs and to the requirements of contemporary life. In contrast, one architect interviewee mentioned a different perspective of such an idea in her account:

“It is, from my point of view, difficult to develop one traditional unit without developing the complete fabric. The country needs a policy for the maintenance of traditional houses and rehabilitation of them and their locality. We need a policy to save our heritage” (Arch, 24, 2012).

Furthermore, they added that the discussion was a return voyage to our beautiful legacy. The subject is interesting because it mimics our architectural heritage and works to revive the beautiful distinctive architectural features, especially in our present time which is witnessing the emergence of many exotic alien ingredients imported from different environments that distort many Iraqi architectural heritage features. Also, they thanked all the people who supported this study. For example, one interviewee illustrated the reasons behind her opinion:

“I appreciate the concern of the researcher with this old-new subject, being renewable is a very important subject and we can enter it by using new approaches from far away from long glorified views that deal with our history and heritage” (Arch, 7, 2012).

What is interesting in the data above is that the architects had divergent views about this type of house.

6.3.6 Additional aspects

An additional issue emerged when the researcher discussed many aspects with the architect interviewees about the T.C.H.T., especially in the Al-Kadhimiyah historical area. This is presented below.

- **Rehabilitation making upgrade**

One interviewee had excellent experience with the T.C.H.T. generally and Al-Kadhimiyah historical area especially, and knew its planning very well, having surveyed its area several times. This architect interviewee indicated that in Al-Kadhimiyah, there were two projects:

The first project from 1978 to the 1980s occurred in two stages the first stage was to preserve certain units or houses with the fabric chosen due to it used to housing a large family, having residents of a distinct personality related to lifestyle, a certain historical period or a particular event or due to distinct architectural features. The group selected 45 units and restored, repaired and rehabilitated them. After the restoration of these 45 units, the state determined for each house approximately 714,285 GBP⁵ one million dollars at this time; unfortunately, the project stopped due to a defect in the budget and a loss of interest (Iraq-Iran war 1980 and other wars that followed). See Figure 6.3 an example for rehabilitate T.C.H.T in Al-Kadhimiyah historical area.

The second project was the development and enlargement of the area around the holy shrine in Al-Kadhimiyah and the addition of different services to suit the increase in religious tourism and visitors to the holy shrine. The rehabilitation idea depends on preserving the historical district in proportion with the new changes that have occurred at the same time, such as maintaining the old fabric while absorbing and adapting to the new changes. This was in order to maintain the effectiveness of the basic holy shrine and the development of other related criteria, including social, architectural, urban, environmental, and economic, not forgetting the fabric as a whole which would maintain these principles and strategies, and preserve the historical city (Arch., 21, 2012).

⁵ The government spent 1 million dollars for each house at that time. Current exchange rate 1GBP=1.4 US\$ according to exchange market on 1/3/2016

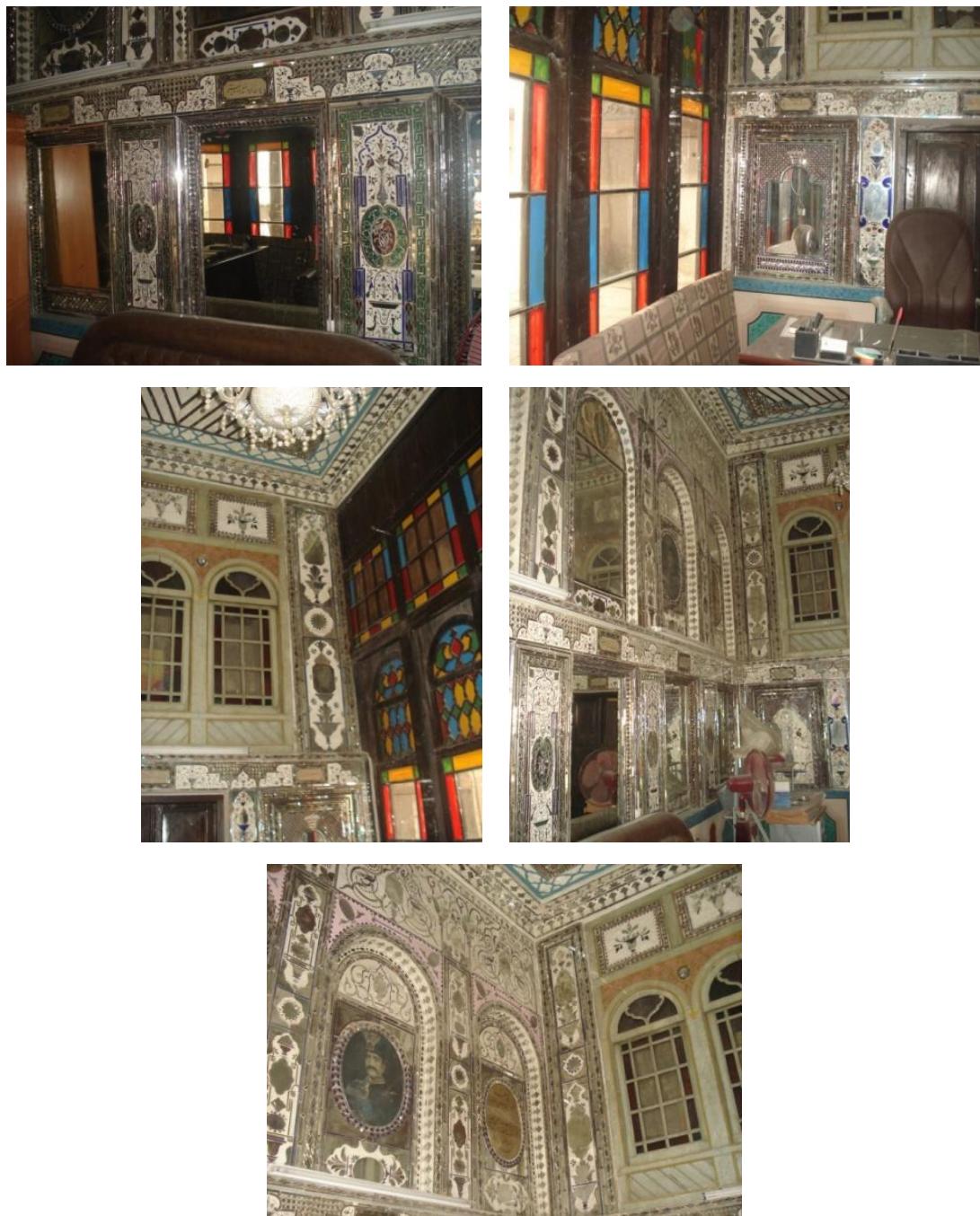


Figure 6.3: Example of the first refurbishment projects in a T.C.H.T. in Baghdad/ Al-Kadhimiyah (PH, CH.10, 2012), (Author)

- **Negative effects on the courtyard house type**

Another new issue emerged when preparing interviews with the architects. The interviewees said the T.C.H.T. had been negatively affected in many ways. First, there is the modern urban development of our cities and the changes in the city plans over the last fifty years; second, there is the increase in temperature of 15-25 degrees centigrade between day and night or between different seasons such as

winter and summer of 30-50 degrees centigrade, alongside the phenomena of dust storms during the last twenty years; third, there is the development of the riverside, which has increased underground water; fourth, there have been three successive wars; lastly, the green cultivated areas have been especially affected since 2003. This idea was articulated in an account by one interviewee:

"In reality, the present existing traditional unit is unable to fight the harsh environment because the split of old united localities into fragmented areas between modern buildings weakened their self-ability to face a harsh environment. The traditional unit worked compatibly with the whole fabric first, and with other functions, security, environmental services, and social and economic systems. All these are compatible with each other on the level of a single unit first and on the level of the whole fabric second" (Arch., 8, 2012).

Interviewees noted that the environment in general and individual houses in particular, suffer from neglect and aging; besides, a few of T.C.H.T have a new function, such as for commercial storage, while some have been remodelled in such a way that they have lost their identity.

From the above, it is apparent that it is time for the rehabilitation of the T.C.H.T, as the performance of many T.C.H.T has been affected, especially during recent times.

6.4 The possible uses of IS in the traditional courtyard house in Iraq

The previous section reviewed the professional perspective obtained from the architects, and now this section will distinguish between these possibilities to explore the findings. The data are classified as follows:

1. The strengths of the T.C.H.T

- Unique identity. The T.C.H.T. has a distinguished identity within an urban fabric. Also, there is variety and hierarchy, which together play a distinct role in first creating environmental performance, and then improving it. Moreover, it creates a special lifestyle and great dynamics which lie in using different types of spaces.

This idea was expressed in an account by an architect:

"The traditional courtyard house is a single identity that gives the ancient Arabic city its traditional meaning" (Arch., 5, 2012).

- Environmentally friendly, the T.C.H.T come from being environmentally friendly through the use of systems that depend on natural factors such as light, fresh air

and insulation of heat and external noise, in a positive way, and which also use environmentally integrated systems. As well as using just local and natural materials. This includes the contradiction between the general fabric and the interior courtyard house. For example, an interviewee said:

"I believe that the inner courtyard has become an urgent necessity in our present situation as a means of escape from the bitter reality that is full of noises, air pollution and other as a result of the Iraqi wars and their aftermath" (Arch., 23, 2012).

- Gaining and loss of heat, the thermal gain and loss in the T.C.H. as a slow process, compared to the external warm dry environment due to these houses containing an integrated system that works to reduce the temperatures. This then gives a sense of comfort especially throughout the heat of the day. In general, it loses heat faster than it earns it, because of the presence of vertical and horizontal air movement according to the different pressure caused by ventilation through different elements. For example, this an architect expressed a similar scenario in her account:

"The gaining and loss of temperature inside the T.C.H. is the most successful characteristic that makes it stand alone as a unique architectural design. This gain and loss of heat was studied perfectly and lead to clear thermal comfort suitable for residents in all levels and all spaces through all the year and during the day" (Arch.LI, 10, 2012).

- Environmental protection, the house provides protection from thermal radiation, because these units are surrounded on three sides by the neighbouring houses related to compactness, and these houses also act as tools that reduce the exposure from the sun and give the unit a specific environmental richness.
- Minimizing use of energy consumption, the courtyard houses were designed in a way that provides a good bio-climatic comfort which is the ability to live in it without using excess energy or advanced technological devices in specific time. It has more green and sustainable design schemes than today. Also, it is energy efficient in its design and implementation process through the structure, material, architectural elements and other which response to the environment without mechanical power. Therefore, the T.C.H.T. provided inner comfort to the user with minimum use of non-renewable energy. On this point, one an interviewee expressed a view:

"The world faces an energy crisis and everyone is searching for non-depleted energy resources and a way to stop using fossil fuels. Iraq is rich in fossil fuel energy sources but these can be depleted any day, so Iraqis in the old days used houses that economize on energy consumption and use environmental alternatives resources. The traditional units with an interior courtyard minimize the use of energy and provide natural ventilation and are heated by sun radiation, all of which prevents pollution. These units provide an environmental solution in a world running after energy alternatives as it is afraid of the depletion of fossils energy sources, so traditional units can be invested as a way to save energy" (Arch., 7, 2012).

2. The weaknesses of the T.C.H.T

In contrast with strengths of the T.C.H.T, the opposite sides were found through:

- Difficulty to control, the T.C.H.T has no controlling strategy on the environmental performance, and rather that it is direct contact with the external environment through the central yard which has resulted in an environment that is not protected from the outside climatic conditions, such as rain or dust, which then increases the chance of unwanted dust Figure 6.4 illustrates this points.



Figure 6.4: The weakness of T.C.H.T (Author) such as

- Difficulty to control rain water on winter according to use the traditional way to rain water drainage (1) (PH, CH4, 2012), (2) (PH, CH11, 2012)
- Difficulty to control dust storms on continuous days of the year (3) (PH, CH3, 2012), (4) (PH, CH9, 2012)

Furthermore, this lack of control allows the entry of the harsh climate directly into the house. One interviewee argued:

“The climate changes in the last years have affected the open yards. The negative point is that the traditional house is unable to face the surprise dust storms sweeping our summer from time to time. Also, they are unable to use the interior courtyard due to the rain and it is difficult to control the house as it needs much more time to clean it” (Arch., 9, 2012).

Moreover, modernization has emerged in different ways, which also indicates the difficulty of controlling the temperature, alongside the phenomenon of dust storms. There has also been an increase in humidity through a rise in the level of underground water (see section 6.4.5/ part 2). Figure 6.5 an example of T.C.H.T that effected by modernisation.



Figure 6.5: The weakness such as difficulty to control of underground water in sardab of T.C.H.T that arise according to the modernization (PH, CH10, 2012), (Author).

- Cannot standalone. It would be difficult to design this kind of house in a modern location as it would have to fit in with the plans of the locality and the whole city; it could not function alone. Unfortunately, the house cannot work alone, but only within its complex system of winding narrow alleys and different types of space within one locality through the compactness. It needs an urban fabric consisting of hundreds of similar houses to work according to its environmental purpose. These houses are part of a mutually dependent system, and all the houses work together. A traditional house with an interior courtyard cannot be built independently among modern houses, because it will never work as an

environmental unit. This view was expressed by an interviewee who had an MSc in the environmental architecture of the T.C.H.T in Baghdad, she said:

"It cannot survive alone without all its neighbouring houses that form its locality. A courtyard house by itself can do nothing without the help of its numerous neighbours" (Arch., 2, 2012).

- The individual houses in particular suffer from neglect and aging, and a few of the T.C.H.T have a new function in such a way that they have lost their identity.
- Also, the growing need for services, whether at home or of public services, is apparent.

The most striking result to emerge from the data is that there were strong rather than weak points in this T.C.H.T. As a result, this type of house has special characteristics and it is not easy to build similar houses because they would be very expensive and a professional builder is needed, as confirmed in section 6.3.1. I think this T.C.H.T deserves to be conserved. However, in section 6.4.5/ part 1, it was shown that the development project has presented the need for enhanced house performance for long time. Additionally, it confirmed the importance of the T.C.H.T even though these projects began in 1980. Therefore, the T.C.H.T has not become: (1) fit with changes in weather and climate condition, (2) adapting to changes in lifestyle for the current user, and (3) updated according to the changing need in technology. Now, with our local situation, I think it deserves improvement.

A new perspective on this CH was added by the architects, who thought it might be adapted to meet the changes in society and the environment, as well as the technical changes, to enhance the level of services and achieve comfortable use for residents. This involves being responsive to upcoming needs and fixed techniques, which confirms the performance in this T.C.H.T, and requires improvement (see section 6.3.1), because it is not updated to the present or future users' needs and there is a lack of technological development of different forms.

The development of the T.C.H.T as related to artificial systems was described through the advantages and disadvantages of adding new systems related to changing needs, and the possible characteristics for appropriate systems in the T.C.H.T. However, particular attention is required to provide these houses with long term improvement according to the changing needs, without having any effect on the architectural appearance by using artificial systems (see section 6.3.3- 6.3.4).

Obviously, a great deal of emotion was expressed by the architects concerning their attachment to this type of house and they talked about how they were nostalgic for the heritage and how it could be lost in spite of not living in this house, as shown in section 6.3.5.

The summaries of the architect interviews support the current research as being a mixed picture; some architects were used some dimmed, while other said things in the interview, and other did not add anything because there were many problems in this type of house. However, there is no clear picture, and there is nothing that support or not from the view of these architects. They had a perception of positive things but the practice does not suggest that they were using these principles anymore, because one suggested that perhaps there is no demand for these things and clients did not prefer them. Interestingly, people did not use the design and other they used. Is that about the perception or is the idea of what is good based on nostalgia and emotion which does not match with reality in the data experience or about the hard facts of performance. This is quite an interesting contrast because the first part was emotion about the heritage but the reality of things is the knowledge part for looking to the T.C.H.T, which is obviously too expensive to build or to provide maintenance. Also, it is reality to spend 714,285 GBP /1 million dollars to refurbish these houses and then leave them for a long time without any maintenance or redevelopment. Therefore, the possibility of use IS in the T.C.H.T to adapt to changing needs and deal with social and environmental, as well as other, aspects is still not clear. Such an idea was articulated in an account by one interviewee who had participated as a team consultant member in preparing a study of traditional houses in old central Baghdad in Al-Kadhimiyah and Al-Adhamiyah. This an interviewee clarified:

“The subject needs to be reviewed; to renew the idea to be in touch with modern life, the classic solution is not enough in the 21st century as we are in the age of nano technology, but with the power and spirit of the past, new standards need to be dealt with” (Arch., 13, 2012).

Thus, we need others' information to complete the whole picture of the possible use of IS in the T.C.H.T. This idea was confirmed by one professional architect who said:

“We only negotiate this matter theoretically and from our experience as an architect, but we also need information from authorized persons to do what we want

to improve. From their point of view, even they haven't the experience and imagination about the results of their decisions.” (Arch., 21, 2012)

6.5 Summary

This chapter has highlighted how the architects were selected, and has also reviewed the data collected from the architects in relation to different items, including their experience of CH, the main strategies to enhance user comfort, the adopting of the T.C.H.T, and the development of the T.C.H.T as related to artificial systems. Additional aspects also emerged from the new project in the Al-Kadhimiyah historical area and the negative aspects with this house type.

This chapter has illustrated the findings arising from the architect interviews around T.C.H.T. in Iraq in general and Baghdad specifically. The strengths of the T.C.H.T more than the weaknesses were apparent, which makes them deserving of conservation. On the other hand, it has weaknesses in performance of the house in different ways, indicating the need for improvement. However, the key view expressed in the interviews with the architects ascertained the need for improvement in house performance, and the possible use of IS in the T.C.H.T still not clear enough.

Also, we can question whether these houses still have the same features and characteristics. Therefore, the next chapter will explore the current condition of the T.C.H.T. in Al-Kadhimiyah as the case study area, and illustrates what had happened to these houses on the ground.

Chapter Seven:

Physical survey and visual observation



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7 Physical survey and visual observation

7.1 Introduction

This chapter aims to present the findings from the physical survey of the T.C.H.T in the Al-Kadhimiya historical area to clarify the current condition of this house type. Thus, the chapter is organized into three main sections. The first section refers to the T.C.H.T being selected for the case study. Section two describes the existing condition of this type of house, and the chapter closes with the emerged knowledge from the physical survey.

7.2 Physical survey for the traditional courtyard house in the Al-Kadhimiya

The physical survey with photos was used for twelve T.C.H.T which were selected in the Al-Kadhimiya historical area, and two occupants per house were selected. These houses were located in five neighbourhoods named Akked-Al-Kanjalle, Akked Al-Sada, Al-Bahea, Um Al-Noomy and Al-Anbareen. To understand how the T.C.H.T were selected for the physical survey; and who this number was determined see section 5.4.

The case studies were numbered according to type (PH, CH1, 2012), (PH, CH2, 2012) and so on. Table 7.1 clarifies the number of T.C.H.T related to the occupant interviewees in different neighbourhoods.

Table 7.1: Relationship between the numbers of T.C.H.T with occupant interviewees in five neighbourhoods, (Author).

	Neighbourhoods	Physical survey		Occupants interview	
		Number of house	Code of house	Number of interview	Code of interview
1	Akked Al- Kanjalle	4	PH,CH	8	1 and 2
			PH,CH2		3 and 4
			PH,CH3		5 and 6
			PH,CH4		7 and 8
2	Akked Al-Sada	3	PH,CH5	6	9 and10
			PH,CH6		11and 12
			PH,CH7		13and 14
3	Al-Bahea	1	PH,CH8	2	15 and 16
4	Um Al-Noomy	3	PH,CH9	6	17 and 18
			PH,CH10		19 and 20
			PH,CH11		21 and 22
5	Al-Anbareen	1	PH,CH12	2	23 and 24

The physical survey was helped to determine the following items:

- The number of courtyards, levels in the house, and number and function of the rooms
- The orientation of the house, courtyard and spaces
- The location of different activities
- The type of services, including electricity, lighting fixtures, cooling and heating equipment, water supply, drainage and sewage systems and possible e communication.

The visual observation by photograph covered the following:

- Some domestic activities which take place inside the houses
- The basic, visual qualities of things related to the built environment, such as treatment.

Visual observation to record people's activities and a photo with a physical survey were used to explore the meaning of the space and the environmental effects on built forms. This was done by measuring and sketching, and then drawing T.C.H.T using Auto-Cad. I spent a minimum five hours in each house to compete the physical survey and interview two persons.

The literature review presented different size of T.C.H.T in section 3.2.2; however, the current research focused on the first and second examples and excluded those T.C.H.T which had three and four courtyards because:

- The occupants of these houses refused to conduct the interview and permit the physical survey of the house
- It was very difficult to find this type of house on the ground. The availability of architectural drawings as well as background information was one criterion for the selection of a particular scheme for the purpose of this research. We found just one house with four courtyards according to the available documentation from the Municipality of Baghdad, and the Directory of Archaeology and Heritage
- In terms of 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 this house was divided from the original house

For these reasons, the T.C.H.T with three and four courtyards were not included in this research as all the investigated houses except for these had fewer than three

courtyards. Accordingly, the next section will describe the existing condition of the T.C.H.T in the Al-Kadhimiyah historical area.

7.3 Description of the traditional courtyard house type in the Al-Kadhimiyah

This section highlights what the data revealed in the physical survey. In order to obtain the maximum information of T.C.H.T in the Al-Kadhimiyah historical area to draw a picture for this house type. A description of the existing condition of the twelve T.C.H.T will be presented according to:

7.3.1 *House categories*

Table 7.2 shows an introduction and comparison of these houses according to the house categories of having one or two courtyards (see section 3.2.xx), and the size of the house which was large, being more than $150m^2$, medium $100-150m^2$, small $40-100m^2$ for the T.C.H.T that includes one courtyard as well as the level of each house. However, the T.C.H.T those includes two courtyards were usually big (see section 3.2.2).

Table 7.2: Comparative between T.C.H.T as a case study, (Author) Continued...

House	PH,CH1 and PH,CH4	PH,CH9	PH,CH10
Plan			
Direction of house	South west	South	South west
Number of house holder	2 for each part	2	5
The courtyard number	2 (one of each part)	2	2
The number of levels ¹	6 level for the biggest courtyard 5 level for the smaller courtyard	4 levels	6 levels
The number of rooms	8 for the smaller part with sardab and neem 5 for the smaller part with sardab	For the larger part, 16 with the neem 4 for the small part	21 rooms with the neem
Function of room	No specific spaces for specific activities	No specific spaces for specific activities	No specific spaces for specific activities
Services room number	Kitchen, toilet and bath for each part	Kitchen, toilet and bath for each part	2 kitchens, 2 toilets and 2 baths
Changing level	Rehabilitate, new services systems, modification of structure. Divided into two houses. Transformed the function of some spaces. Closed some translation spaces. Adding different types of modern device. Increased the thickness of the wall around 1.20-1.50m for some external walls. Floors and walls covered. Partial burial of the neem sardab	Refurbishing the sardab. Transformed the function of some spaces. Adding different types of modern device. Closed some translation spaces. Covered the courtyard with nylon sheets all the time	Covered the big courtyard by adding fixed bars and plastic sheeting. Transformed the function of some spaces. Adding different types of modern device. Increased the thickness of the wall around 1.20-1.50m for some external walls. All floors and walls was covered

¹ Levels include the roof

Table 7.2: Comparative between T.C.H.T as a case study, (Author). Continued...

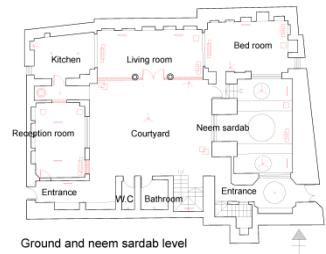
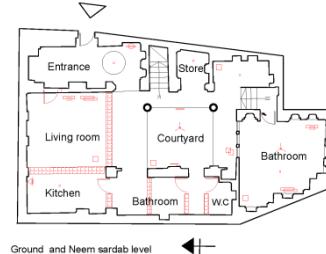
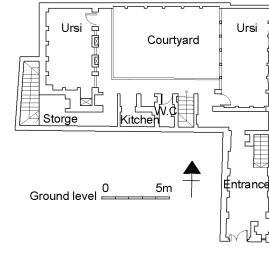
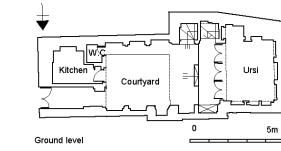
House code	PH,CH5	PH,CH6	PH,CH8	PH,CH12
Plan	   			
Direction of the house	South	South	South	West
Size	Small	Small	Small	Small
Number of house holder	2	1	1	2
The courtyard numbers	1	1	1	1
The number of levels	4	4	4	4
The number of rooms	6 with the sardab and neem	5 with the sardab	4 with the sardab	4 rooms with the neem
Function of room	No specific spaces for specific activities	No specific spaces for specific activities	Specific spaces for specific activities	No specific spaces for specific activities
Services room number	Kitchen, toilet and bath	Kitchen, toilet and bath	Kitchen, toilet and bath	Kitchen and toilets without bath
Changing level	Transformed the function of some space. Adding different type of modern device. Some floors and walls were covered.	Refurbishing the services systems and the structure. All floors and walls were covered. Adding different type of modern device. Covered the courtyard with fixed wood	Refurbishing all the houses. Transformed the function of some space. Adding different type of modern device. Closed some translation space. Covered the courtyard with dynamic plastic sheeting all the time. All floors and walls were covered. Burial of one sardab	Adding different type of modern device.

Table 7.2: Comparative between T.C.H.T as a case study, (Author)

House code	PH,CH2	PH,CH3	PH,CH11	PH,CH7
Plan				
Direction of the house	North	South	North and second entrance to the West	west-east
Size	Medium	Medium	Medium	Big
Number of house holder	2	3		5
The number of	1	1	1	1
The number of levels	4	4	4	5
The number of rooms	9 with the neem	8 with the neem sardab	6 rooms with the neem	21 with the neem
Services room number	Kitchen, toilet and bath	Kitchen, toilet and 2 baths	Kitchen and toilets with bath	2 kitchens, 2 toilets and 2 baths
Changing level	Refurbishing for services systems conserved the structure. Transformed the function of some spaces .Adding different types of modern device. Some floors and walls were covered	Transformed the function of some spaces. Adding different types of modern device. Closed some transition spaces. Adding dynamic steel bars and sheet nylon to the courtyard	Transformed the function of some spaces .Adding different types of modern device. Closed some transition spaces	Refurbishing the service systems and conserved the structure. Increased the thickness of external walls around 150-1.20m .Transformed the function of some spaces. Adding different types of modern device. All floors and some walls were covered. Covered the courtyard with fixed plastic sheeting and iron bars

7.3.2 Different neighbourhoods

Now, a review of the twelve T.C.H.T in Al- Kadhimiyah historical area will be given of each house in the order in which they are in the neighbourhood.

- **Traditional courtyard house case study (PH, CH 1) and (PH, CH4)**

These houses are located in the Akked Al-Kanjalle neighbourhood. The original house had two courtyards and a single elevation. One courtyard was medium sized and the second courtyard was small. The structural system was load bearing walls (1.20- 0.75m), and partitions (0.30m). The thickness of walls (0.90- 1.50m)² of the some outside walls and partitions (0.45m) were renovated.

Accordingly, the transformation meant that the houses were divided from their original courtyard house format. In each part, the floor of the interior court was covered with concrete and the tree was cut down. The individual drainage and water pipes, establish new electrical wires as confirmed in Figure 7.1, add central heating and cooling systems, and the sardab was maintained by adding an iron grid for the roof. One of these parts lost service places, and some places were also transferred, such as the Iwan was modified into a kitchen and the takta-boosh became a bathroom and had an added toilet. The electricity, drainage and water pipes were separated.

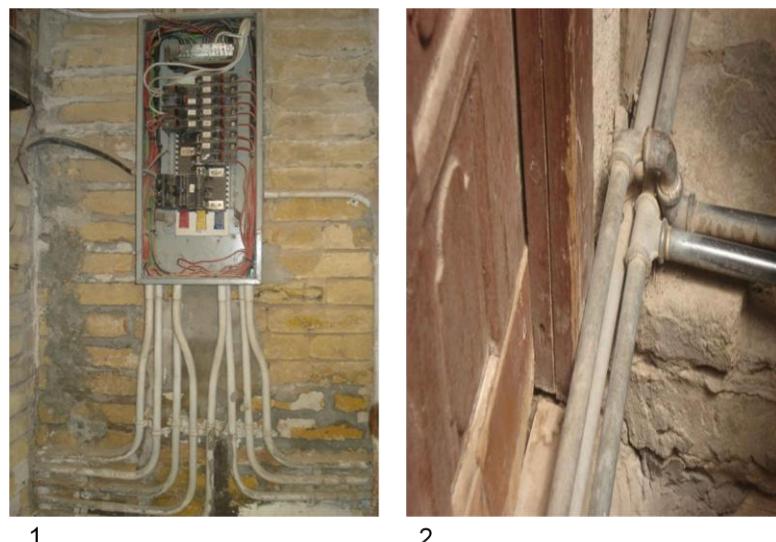


Figure 7.1: Refurbishing the T.C.H.T in the Al-Kadhimiyah for houses No. 1 and 4 (PH. CH1+4, 2012), (Author)

- (1) Established new electricity grid in T.C.H.T and new wiring for both houses.
- (2) Established new water pipe.

² The walls was built from brick which content from inside and outside liear and infelt in between includes soil and broken brick, and then added other layers as a covering to protect the old structure. (Arch, 2012, 23)

The large part was lit all the day because the sunrays reached every place in it, even the sardab, and cooking smells were distributed all over the house. In addition, in this part the high ceiling of the first floor, about six metres, created the problem of cooling or heating and therefore most activities were conducted on the ground floor most of time. They covered the wood partition of all the rooms on first floor around the interior courtyard with heavy plastic curtains to insulate them from the harsh climate and used a nylon sheet to cover the courtyard. Also, the occupants refurbishing this house by covered the courtyard floor, coverd the windows, painting the woindowes and doors as confirmed in Figure 7.2.



Figure 7.2: Refurbishing a T.C.H.T in Al-Kadhimiyah, House NO.1 (PH. CH1, 2012), (Author) by:
 (1) Courtyard floor covered by cement, with painted windows and doors;
 (2) Covered walls, and establishing a new drainage pipe.

Additionally, Figure 7.3 confirms that the occupants used air coolers and air conditioners for cooling and heating; there were also ventilation fans, and kerosene heaters as luxury electrical heaters were used. Moreover, they had a local generator as a personal electrical generator to supply them with electricity during power cuts. Surprisingly they did not use their own generator during the night because it was too noisy. They had added an electricity pump to bring water to the tank on the roof and they boiled it for hot water. The residents used computers, mobiles and the Internet and had two televisions. The families were likely to have an Internet connection.

Nine people³ lived in this large part (For more details about the family member which include the gender, ages see Table 8.1) which occupied the whole house, meaning all the spaces and levels. The family did not have specific activities for specific spaces or levels.

³ For more details about the family member which include the gender, ages see Table 8.1

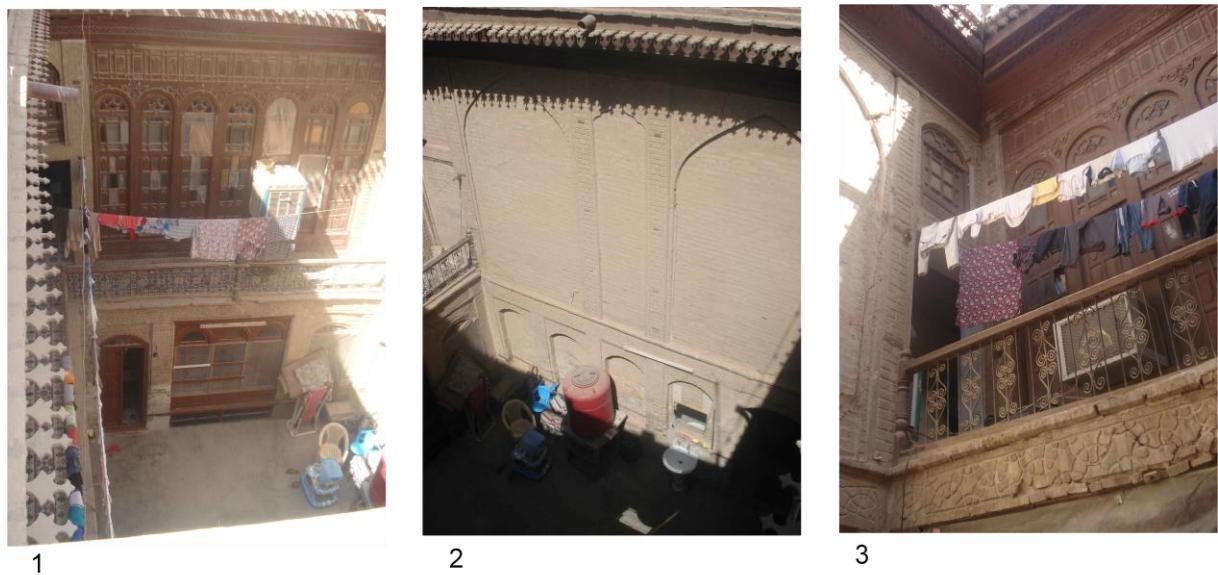


Figure 7.3: Different types of device added to the T.C.H.T in the Al-Kadhimiyah, House NO.1 (PH. CH1, 2012), (Author):

- (1) Adding air coolers on the first floor.
- (2) Adding a water tank on the ground floor.
- (3) Adding air conditioning on the first floor

In the other, smaller, part of the house, no direct sunrays entered the whole house and the sardab had a smell. Moreover, the generally high humidity affected the sardab walls Figure 7.4 confirmed that. The kitchens also suffered from increased humidity and fumes from food. Unfortunately, the many inscriptions in on the ceiling and walls affected the process of cleaning.



Figure 7.4: High humidity affecting the walls of the sardab in the T.C.H.T in the Al-Kadhimiyah, House NO.4 (PH. CH4, 2012), (Author).

Figure 7.5⁴ shows that occupants used split units for cooling and heating; there were also ventilation fans, and kerosene heaters as luxury electrical heaters. Moreover, they depended on local generators in the area, which were better than the personal generators since they saved money and energy, and reduced noise. The occupants used electricity pumps that brought water to the tank or the roof and they boiled it for hot water, and also used mobiles and had one television. This house used economical artificial lamps sometimes in the day time; especially when there were dust storms and the house became dark with no direct sunrays. The landline telephone was not working at the time of writing for this house, possibly because it had been neglected.

Five people lived there which did not use the first and second floor during the summer and focused on using the ground floor, and occupying the rooms on the first and second floors in winter, with the exception of the services room on the ground floor. The family had no specific spaces for specific activities.

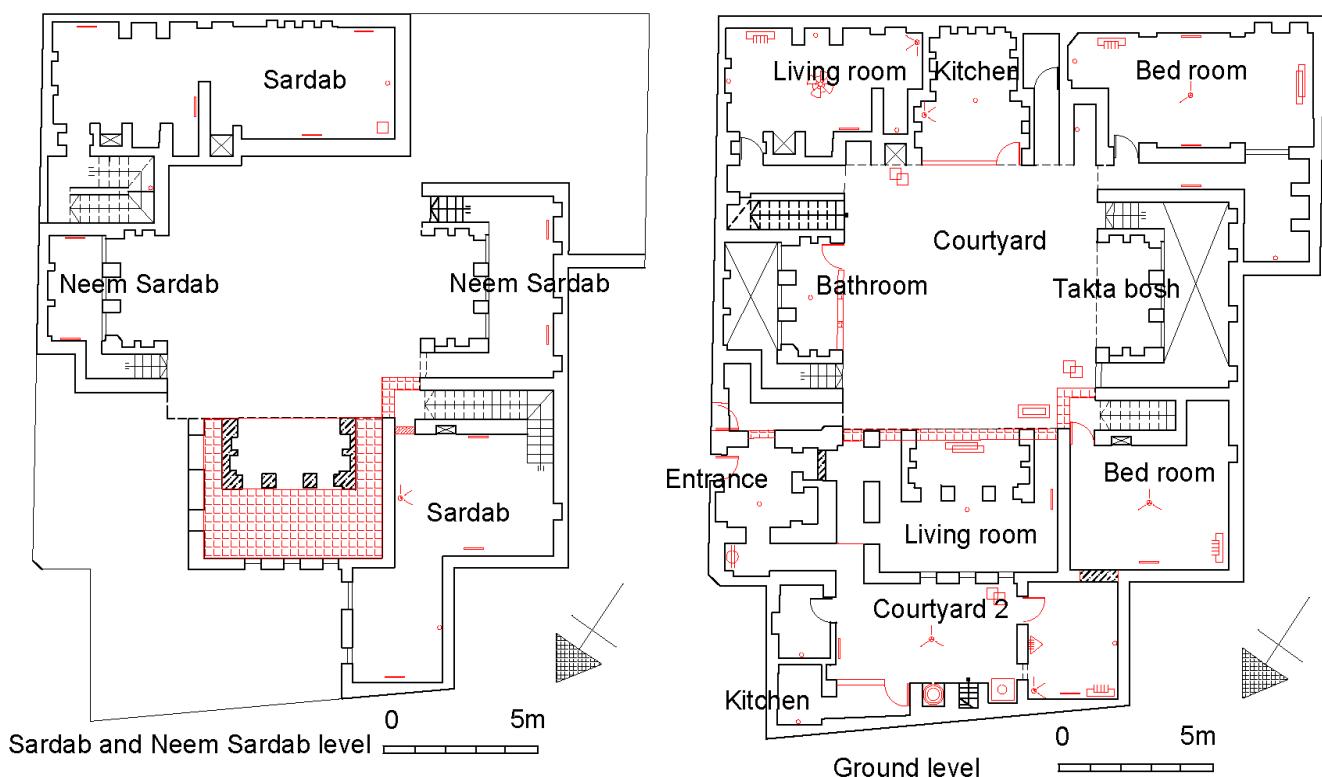
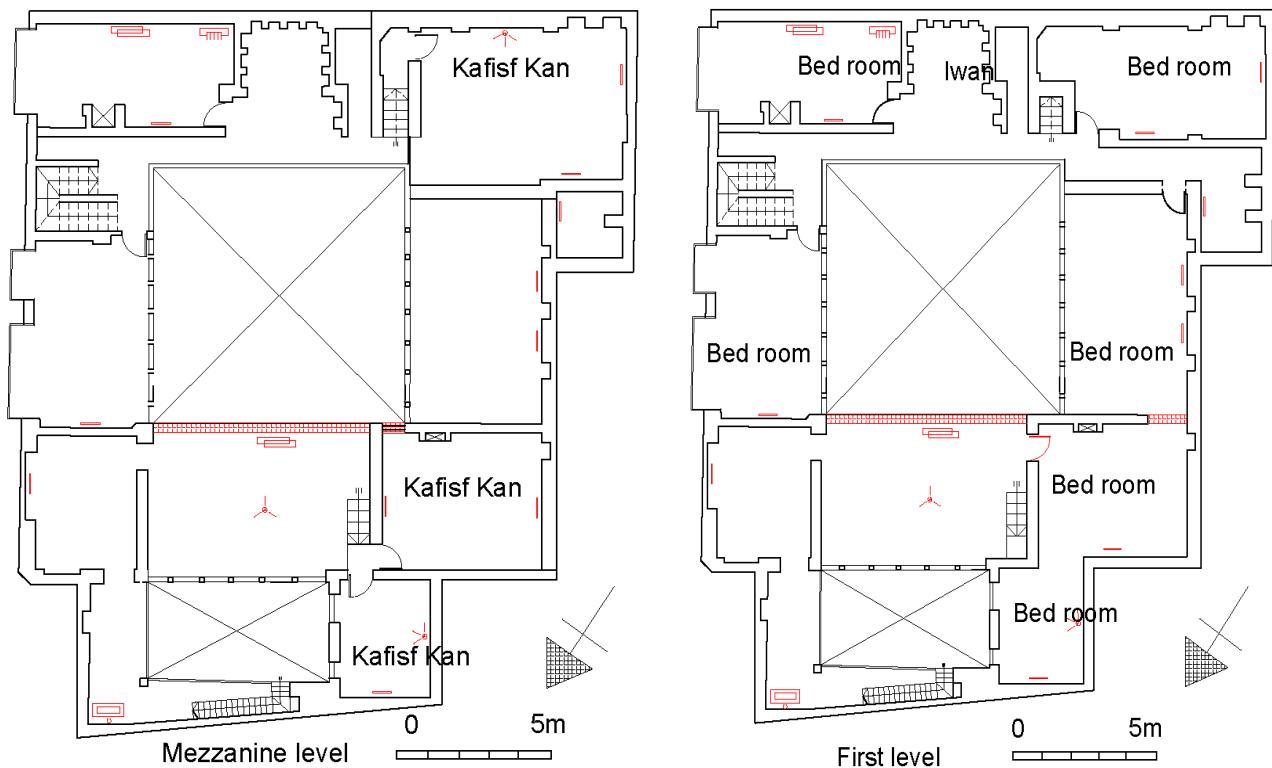


Figure 7.5: Case study houses No. 1 and 4: (Author drawing). Continued...

⁴ Figure 7.5 for both house number one and four



- Sardab means the basement.
- Neem sardab means the mezzanine level between the basement and ground level.
- Takta bosh means the space looking to the basement.
- Kafish-Kan means the mezzanine level between the ground and first floor.
- Ursi means the family room.
- Iwan means the semi closed space.
- Tarma means the semi open space.

Sample	
Lighting system	— (star) °
Ventilation system	◀ ▲ ▶
cooling and heating system	■ □ □
Water system	□ ○ ⊖
communication system	□
electric system	□
Pattern	
Moving	
Abounded	██████████
Adding	

Figure 7.5: Case study houses No. 1 and 4: (Author drawing).

- a. Direction of the house.
- b. The number of levels and spaces with space function.
- c. The transformation of the house space.
- d. Additional systems and the location of each modern device.

• Traditional courtyard house case study (PH, CH2)

This house is located in the Akked Al-Kanjalle neighbourhood. This house is on a rectangular plot with attached from four sides, except narrow colder linked with main door toward the longer side, and one comparatively big courtyard size with built up area. The slot size of courtyard, on first level was 60m², and on roof level was 48m².

The structure system for the outside is (0.90-0.75m) and inside walls is (0.30 m) by used fire brick.

It had individual drainage and water pipes and connecting it to the public supply, establishing new electric wiring, and transforming places such as the bathroom by covering the space with ceramics, the courtyard was covered with concrete and ceramics in this house. Also, one neem sardab was transformed to kitchen and other to living room. These changes are shown in Figure 7.6 and 7.7.

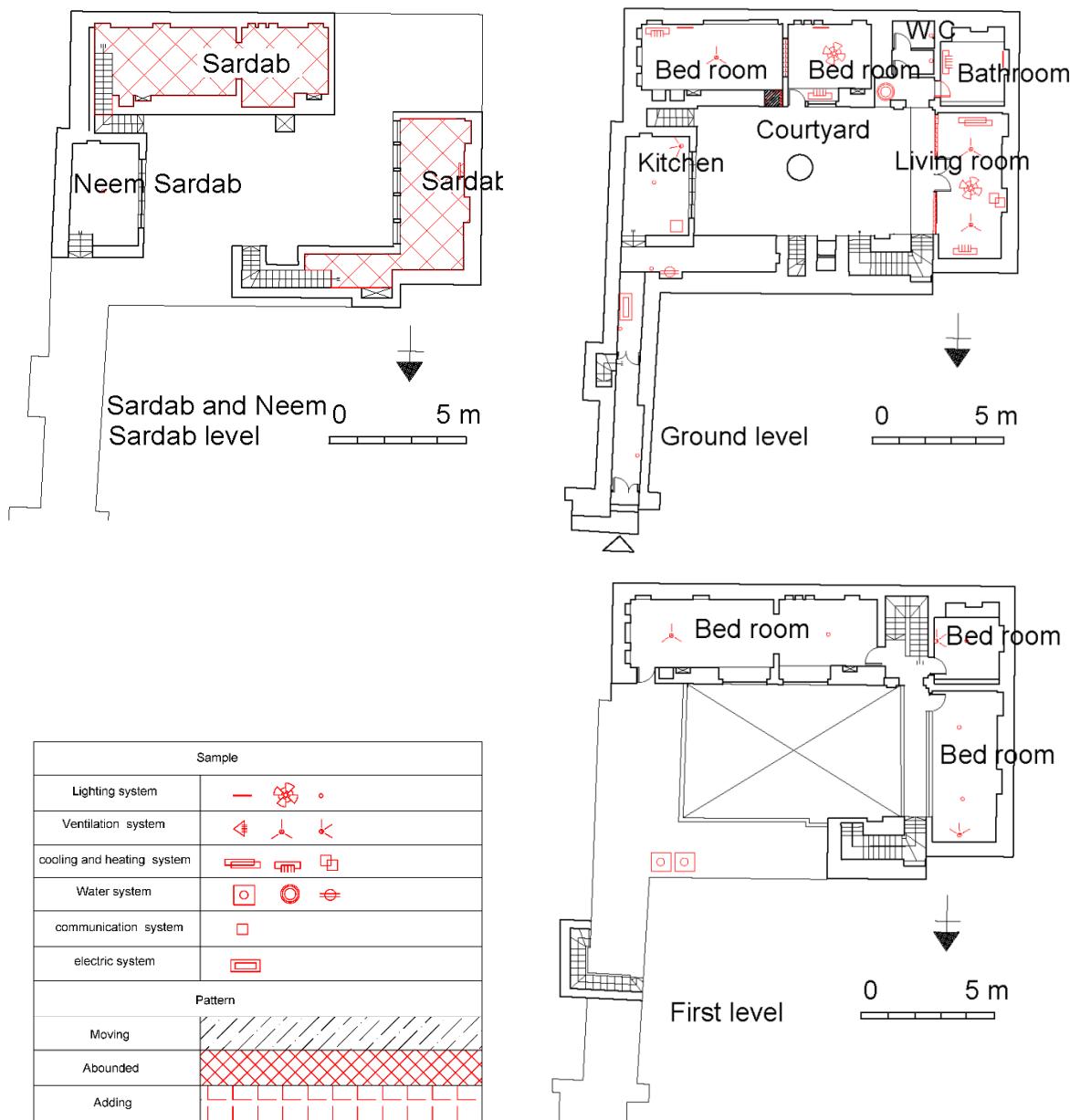


Figure 7.6: Case study house No. 2: (Author drawing)

- Direction of the house.
- the number of levels and spaces with space function .
- the transformation of the house space.
- Additional systems and the location of each modern device.



Figure 7.7: Refurbishing the T.C.H.T in Al-Kadhimiyah, House NO.2 (PH. CH2, 2012), (Author) by:

- (1) Courtyard floor covered by ceramics, with the fountain now a flowerbed;
- (2) Establishing new drainage pipes and new electrical wiring

The occupants had added fans, air coolers, electrical heaters, and a split unit for cooling, heating and ventilation. Moreover, they had two lines to the local generator to supply them with electricity during power cuts; if one line malfunctioned they had the second and so electricity was available all the time. They used an electrical stabilizer because the electricity was unstable. Also, they had started to use a new machine that used limited amounts of amperes, an electricity pump to raise the water to the tank on the first floor, and they boiled it for hot water. The residents had two televisions, two laptops, and mobiles, and the families were likely to have an Internet connection. They had also begun to add economical artificial lamps that used limited amperes, as confirmed in Figure 7.8.

Seven people lived in this house which used all the spaces and levels around the year, and no specific activities were conducted in specific spaces or levels, except the reception room.



Figure 7.8: Different devices added to the T.C.H.T in the Al-Kadhimiya, House NO. 2 (PH. CH2, 2012) (Author):

- (1) Adding fans and lighting.
- (2) Adding a TV and satellite in the living room.
- (3) Adding an air cooler on the ground and first floors; adding air conditioners on the first floor.
- (4) Adding a water tank on the first floor

- **Traditional courtyard house case study (PH, CH3)**

This house is located in the Akked Al-Kanjalle neighbourhood. In this house, the courtyard is almost square and of medium size. It has a single elevation. The structure system is load bearing walls (0.90-0.75m) for outside walls and (0.30m) for inside walls which built from fire brick.

In this house, the courtyard had been modified and adapted with steel bars and nylon rolls. It had high humidity, and the service spaces especially, such as the kitchens, suffered from humidity and fumes from food, which spread around the house. However, although the walls were strong, they needed maintenance. Different devices were added such as air conditioners, fans, self-charged fans for cooling and ventilation, and kerosene heaters as a luxury. They used an electricity pump that brought water to the tank on the roof and they boiled it for hot water. Moreover, they

had a line to the local generator, and they used computers, mobiles and the Internet as points in Figure 7.9 and 7.10

The occupation with eleven people occupied all the spaces and levels around the year except for half of the first floor, which was not used. The family did not conduct specific activities in specific spaces or levels.



Figure 7.9: Different devices added to the T.C.H.T in the Al-Kadhimiya, House NO. 3 (PH. CH3, 2012), (Author):

- (1) Adding air coolers on the ground floor.
- (2) Adding TV, satellite, and fans in the living room.
- (3) Adding a boiler on the ground floor.
- (4) Adding air conditioners on the first floor

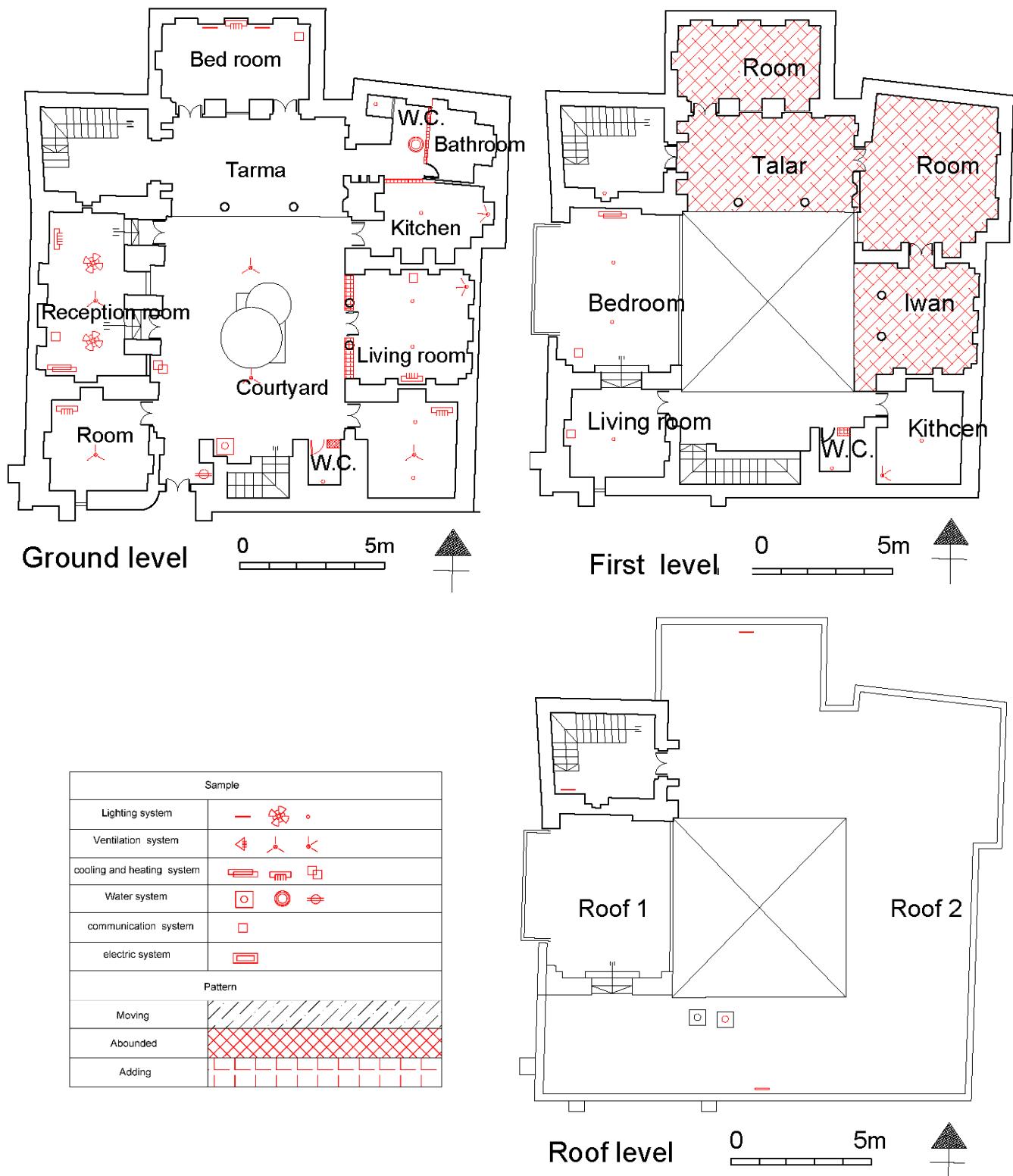


Figure 7.10: Case study house No. 3 (Authot drawing):

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.

- **Traditional courtyard house case study (PH, CH5)⁵**

This house is located in the Akked Al-Sada neighbourhood. This house plot is rectangular and has two elevations on different alleyways. There was one medium courtyard comparative with the plot area. It did, however, have strong walls which around 0.75m for outside walls, 0.60m for courtyard walls, and 0.30m for partitions all these walls were built from fire brick. Also, there were partitions from the wood in first floor around 0.10m.

Eight people lived in the house which occupied all the spaces and levels around the year and prepared the sardab for the pilgrims for the holy shrine around the year.

Figure 7.11 refers that the occupants tried to change the function of some places and closed other places, such as the iwan. The floor was covered with ceramic tiles, and they tried to maintain it regularly; however, the residents did not want to relinquish it even though it was very old and there was increased humidity and fumes from food in the kitchens.

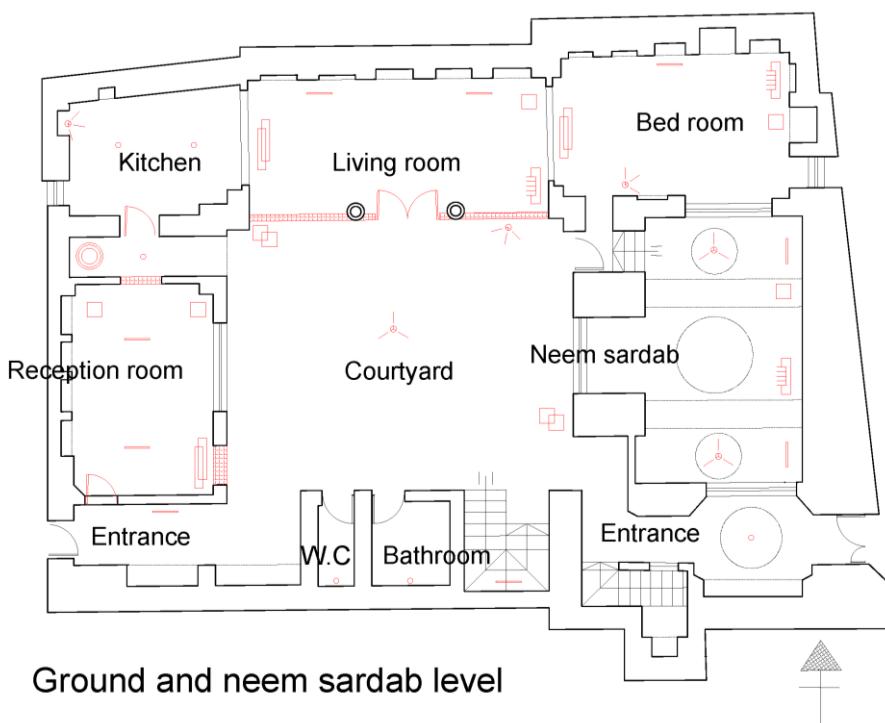


Figure 7.11: Case study house No. 5: (Author drawing)

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.

⁵ (PH, CH4) was explained with (PH, CH1) see section 7.3.1

The occupants had two lines for the local generator and their own generator so they had a guaranteed electricity supply in the case of malfunction. They used air coolers, air conditioners and split units, and electric heaters. Also, they used a water heater, a boiler, to warm the water in winter and an electrical pump for withdrawal and storage of water on the first roof; they also used filtering and cooled and heated drinking water to get pure drinking water. Furthermore they used computers, laptops, and mobiles and were likely to have an Internet connection. Also, they had started to use a new machine that used limited amounts of amperes and they used an electrical stabilizer because the electricity was unstable. Figure 7.12 shows examples for these devices.



Figure 7.12: Refurbishing, and different devices added to the T.C.H.T in the Al-Kadhimiya, House NO. 5 (PH. CH5, 2012), (Author):

- (1) Adding TV, satellite, radio, a laptop with internet connection in the reception room, and painting this room.
- (2) Adding a split unit in the living room, painting the wall, establishing new electric wiring.
- (3) Adding a fan and a water tank with a filter in the courtyard.
- (4) Adding economic lighting on the ground floor.

- **Traditional courtyard house case study (PH, CH6)**

This house is located in the Akked Al-Sada neighbourhood. This house plot and courtyard is almost rectangular.

This house was established new sewage pipes and connected the house to the public sewerage network, added new water pipes, water storage and a boiler. They had covered the entire floor with ceramics tiles as confirmed in Figure 7.13. Figure 7.14 shows that this family had added air coolers, fans, an air vacuum for cooling and ventilation, and kerosene heaters as luxury, electric heaters. They used an electricity pump to bring water to the tank on the first floor, and they boiled it for hot water, and used televisions, a computer, and mobiles. The families were not likely to have an Internet connection, so they used the Internet via a mobile or other private or public centre. The residents had a local generator line in the area and their personal generator for electricity supply. They had added a general protection system to keep a continuous electrical current with protection against any electrical malfunction, to avoid fire-related accidents, but in spite of this they had experienced a fire.

Seven people lived in this house which occupied all the spaces and levels around the year, and they did many activities in a specific space, such as the living room.

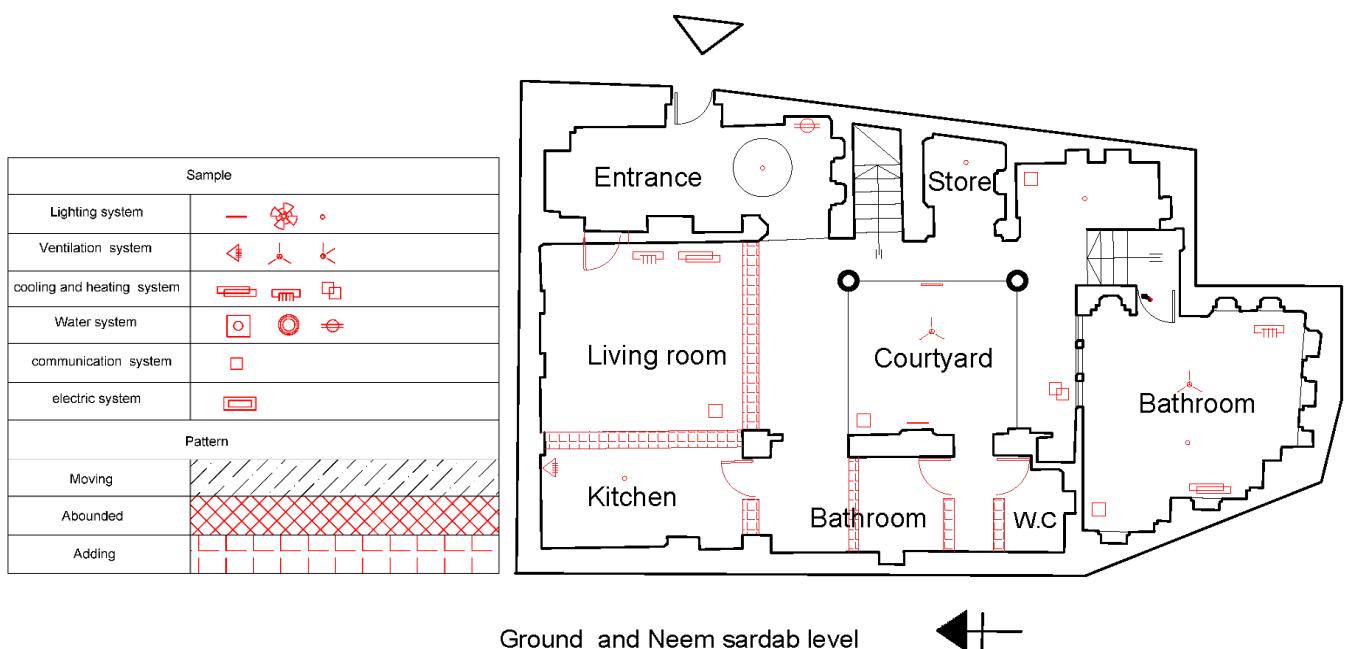


Figure 7.13: Case study house No. 6 (Author drawing):

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.



Figure 7.14: Example of refurbishing and types of device in the T.C.H.T in Al-Kadhimiya, House NO. 6 (PH. CH6, 2012), (Author):

- (1-2) Adding TV, satellite, DVD, and laptop with internet connection, and an air cooler on the first floor.
- (3-4) Establish new water pipe and new electric wiring to the whole house

- **Traditional courtyard house case study (PH, CH7)**

This house is located in the Akked Al-Sada neighbourhood. This house plot and central courtyard are almost rectangular. The structural system is load bearing walls (0.90-0.75m), and partitions (0.45-0.30m).

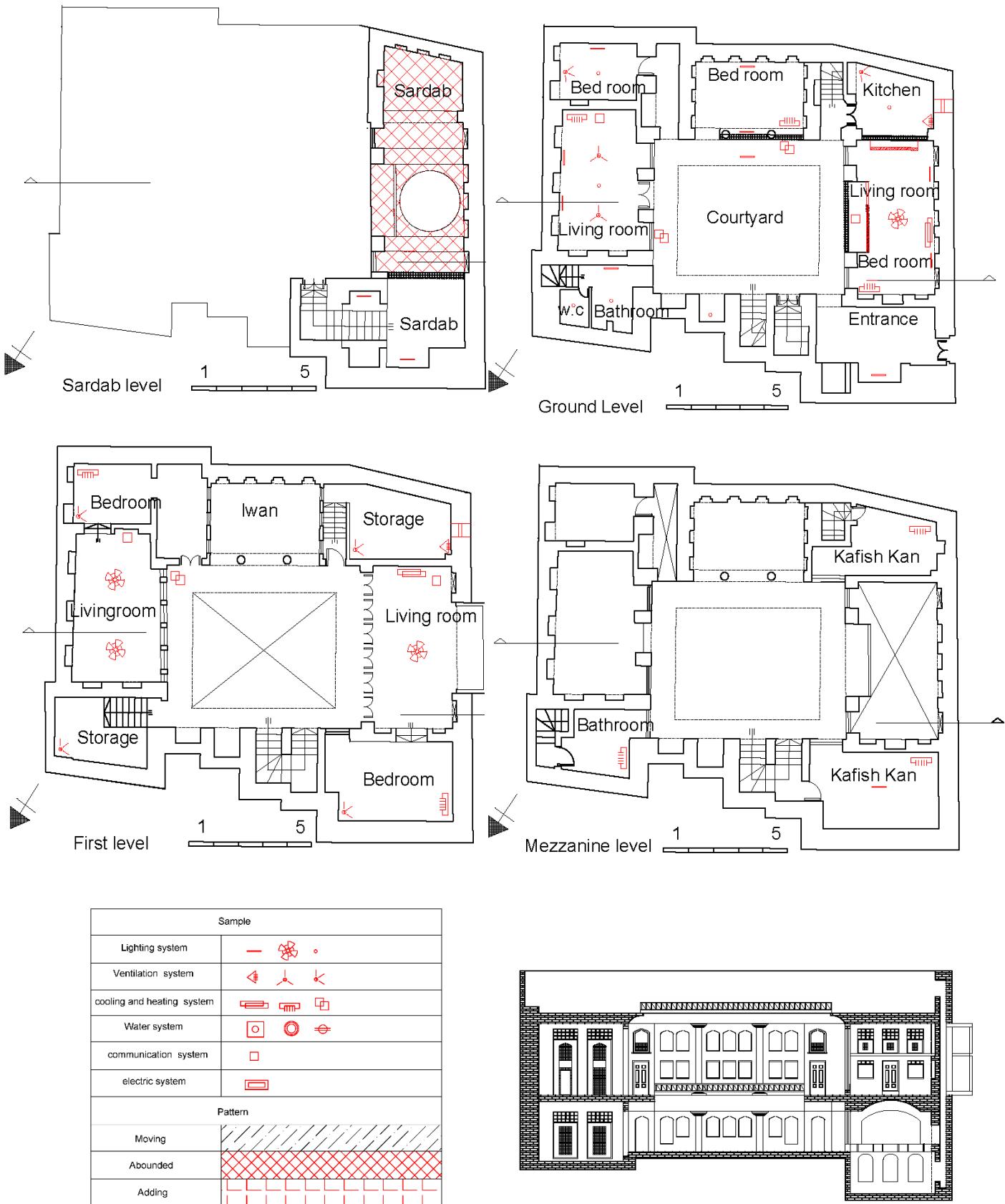
During the last 30 years, the family had bury part or all of the sardab and which affected the working of the bad-geers and air movement for these houses. Furthermore, the occupants transformed the function of many spaces such as the kafish-kan, the bathroom, and level such as the buried the sardab; they had also refurbished service places such as bathroom, a toilet and kitchen as clarified by Figure 7.15.



Figure 7.15: Refurbishing of the T.C.H.T in the Al-Kadhimiya, House NO. 7 (PH. CH7, 2012),
 (Author):
 (1-2) Bathroom and toilet. (3-4) Kitchen

According to the extended family, fifteen people lived in this house which used all the spaces and levels. A big family lived in this house which was divided into groups, with each group having its own space and separate cooking zone.

Figure 7.16 confirms that they had modified spaces such as the kitchen with added vacuums to improve ventilation. They had also modified part of the living room for this purpose. They had added strong and tight doors and windows for the same purpose, and covered the windows of all the rooms around the interior courtyard on the first floor with heavy curtains. Fibre plates were also used to cover all the walls on the first floor to insulate the rooms from the harsh climate, even though this affected the traditional appearance of the building from the inside and affected the natural lighting.



The residents used different devices such as fans, self-charged fans, and an air vacuum for ventilation, air coolers, split types, and electrical heaters for cooling and heating, and the local electricity supply from the local generator in the area. These were better than the personal generators since they reduced the noise. An electricity pump had been added to bring water to the tank on the roof and they boiled it for hot water. Just one computer was found and many mobiles and the Internet connection. This house used economical artificial lamps that used limited amperes. Figure 7.17 shows examples for these devices



Figure 7.17: Example of refurbishing and types of device in the T.C.H.T in Al-Kadhimiya, House NO. 7 (PH. CH7, 2012), (Author).

- (1) Adding TV, satellite, a fan in the living room.
- (2) Adding air vacuum on the ground floor.
- (3) Adding self-charged fans, a split unit on the ground floor.
- (4) Adding a split unit and lighting in the neem sardab.
- (5) Adding carton sheets from outside to all the rooms around the courtyard on the first floor.
- (6) Establishing new electric wiring to the whole house

- **Traditional courtyard house case study (PH, CH8)**

This property is located in the Al-Baheya neighbourhood. This property is on a rectangular plot with one courtyard on the side and attached from four sides, except narrow colder linked with main door. The structural system is (0.60m) and partition (0.30-0.10m) thickness which constructed by using fire brick.

This house was connected to the public drainage pipes, transforming the kitchen to bathroom and the ursi to the kitchen, and established new electric wiring, involved developing the individual drainage and water pipes, painting the walls and covering some walls with wood, and entire floor was covered with cement tiles, this house distinguished by very good structure. The living room walls were packed with wood sheets to preserve them and keep the bad-geer slot in the surface, while maintaining the openings, as the residents did not want anything in the house to be damaged. Also, the bad-geer is a hole surrounded by a very light structure near the basement, and can attract harmful moisture, see Figure 7.18 which confirmed that.



Figure 7.18: Types of refurbishment in the T.C.H.T in the Al-Kadhimiyah, House NO. 8 (PH.CH.8, 2012), (Author): by:

- (1) Walls covered with wood, and new devices added in the ursi.
- (2) Changed windows and door on the ground floor.
- (3) Establishing new sewage and drainage and connecting the individual house with public services.
- (4) Courtyard covered during the harsh weathers with nylon and plastic sheets.

This house had had a rise in the water table level which forced the residents to bury one sardab to stop the sewage flooding and prevent drainage problems, and to help save the walls. After the burial of the first sardab, the problem of moisture remained so the owner worked on the restoration and maintenance of a central second sardab at a depth of 3.70-3.80m; he had added some industrial systems such

as an electric pump to withdraw water from the basement to avoid the flooding. The occupants had covered the courtyard with nylon sheeting during winter to keep direct sunlight and rain from entering the house. The stairs were too high (28cm) and weak for the family members, who could not climb the stairs to the different floors on a daily basis. In addition, there was a high ceiling on the first floor, about six metres, for example in the ursi.

Also, in Figure 7.19 shows that this family had added different modern devices such as a split type for cooling and heating; there were also ventilation fans, an air vacuum and electrical and oil heaters. They depended on two lines from local generators for guaranteed electricity in the case of malfunction. They used a water heater, a boiler, to warm the water in winter and an electrical pump for withdrawal and storage on the roof; they also used filtering and cooled and heated drinking water to get pure drinking water. They had also added economical artificial lamps. The residents used a computer, mobiles, and the Internet, and had two televisions. They had added a general protection system to keep a continuous electrical current with protection against any electrical malfunction, to avoid fire-related accidents.

Three people lived in this house which was full occupation of all space and levels. This family had specific spaces for specific activities.

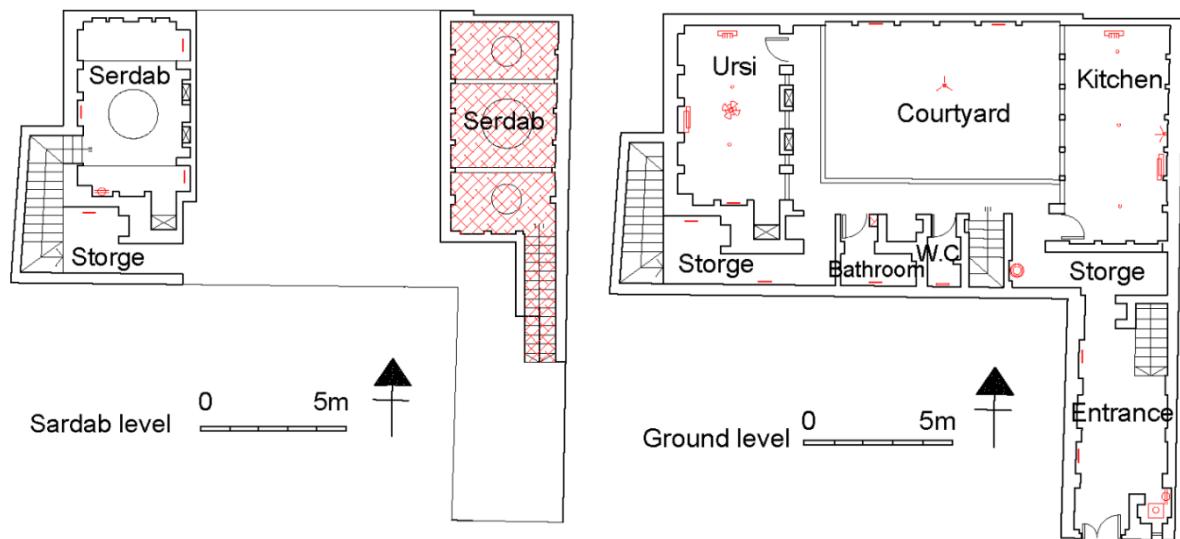


Figure 7.19: Case study house No. 8 (Author drawing). Continued...

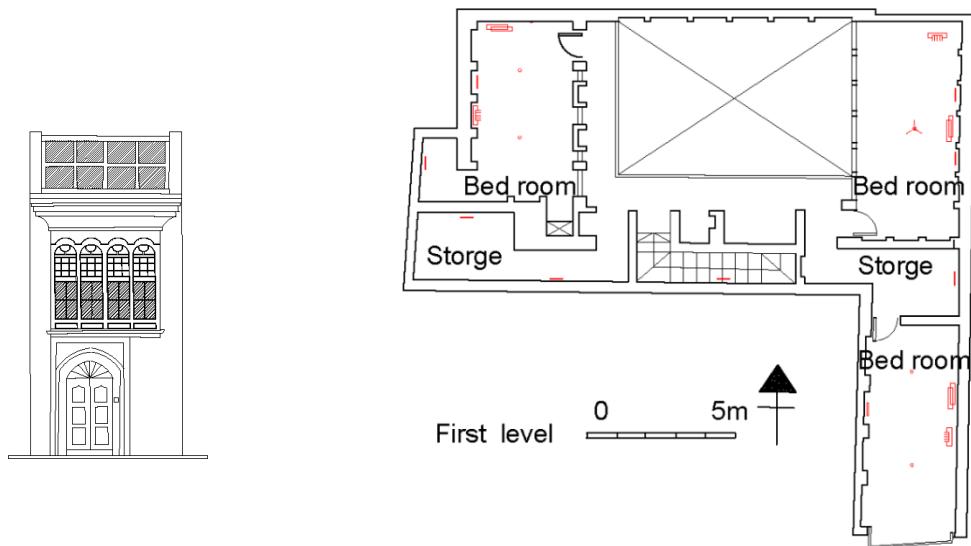


Figure 7.19: Case study house No. 8 (Author drawing):

- a. Direction of the house.
- b. the number of levels and spaces with space function.
- c. the transformation of the house space.
- d. Additional systems and the location of each modern device.
- H. Also the house elevation.

- **Traditional courtyard house case study (PH, CH9)**

This house is located in the Um Al-Noomy neighbourhood. This house is on a plot of two different sized parts with two courtyards. The smaller part is almost rectangular with a small courtyard alongside the alleyway, which its main elevation comprised of two entrances, one related to the second courtyard. The wall thickness was between (0.90-0.75m), and partitions (0.45-0.30m).

Figure 7.20 provides that the residents had abandoned the big courtyard and the spaces and places around it, and the structure had been hit by a rocket in the last war in 2003. The family used the smaller part with the small courtyard with a well structure; they had also transformed the storage area into a family sitting room and the tarma into a kitchen. It was occupied by five people who occupied all the spaces and levels in this part around the year and most activities took place in the living room.

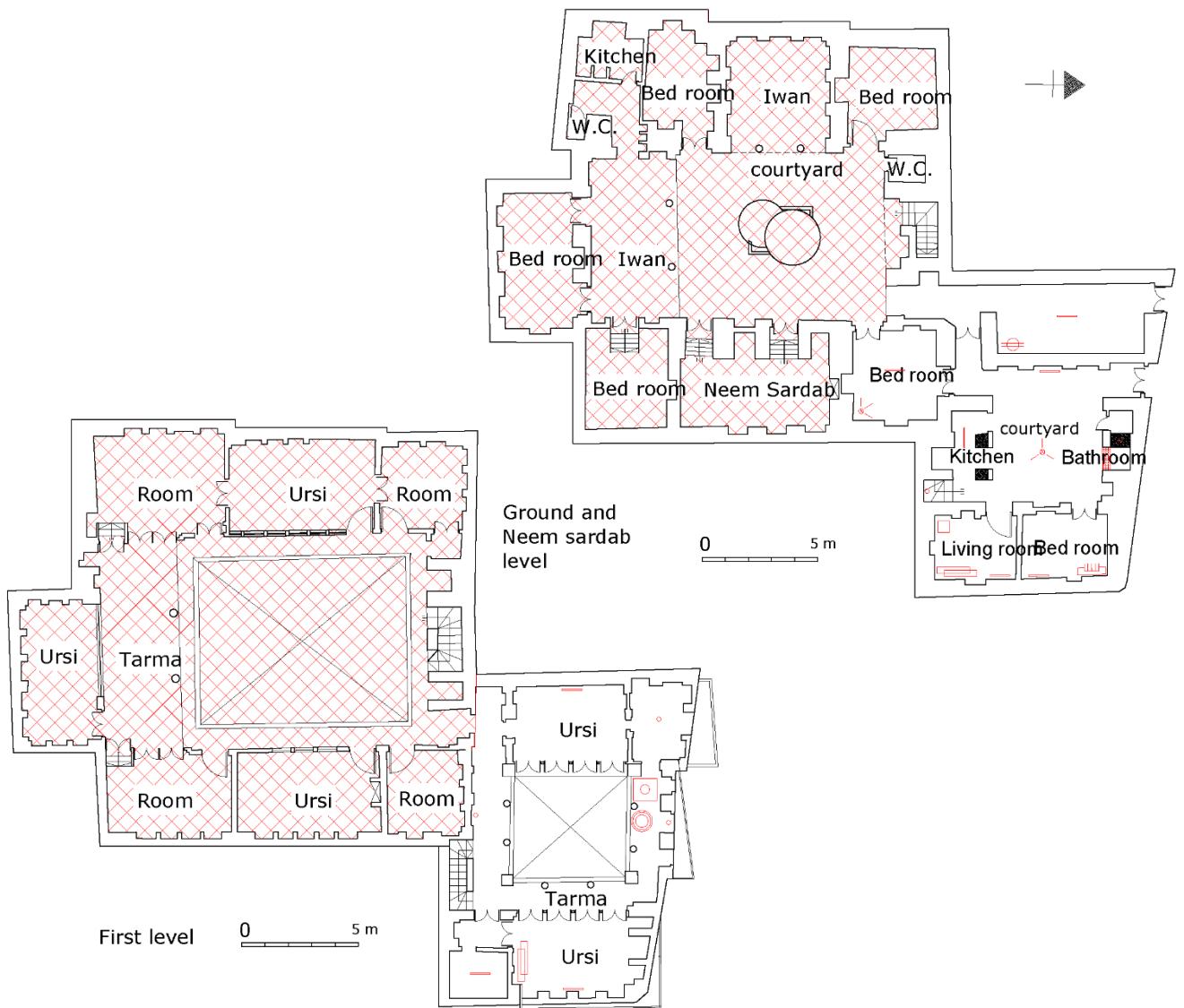


Figure 7.20: Case study house No. 9 (Author drawing)

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.

The occupants used split types for cooling and heating; there were also ventilation fans, and electrical heaters were used when the national electricity supply was present. They used the local generator line for electricity, which was better than the personal generator. The occupants used an electricity pump that brought water to the tank on the roof and they boiled it for hot water. They used a laptop, mobiles and the Internet and television. Figure 7.21 shows examples for these devices.

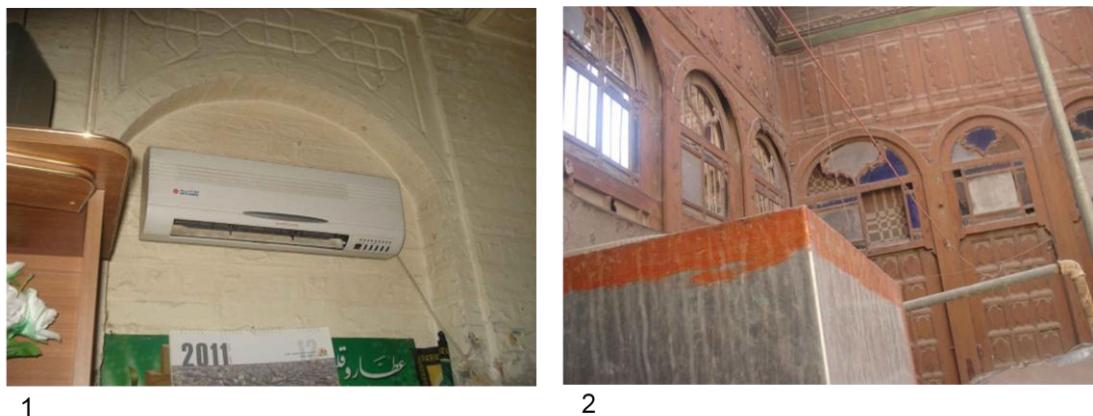


Figure 7.21:
Example of different devices in the T.C.H.T in Al-Kadhimiyah, House NO. 9 (PH. CH9, 2012), (Author
(1) Adding a split unit on the ground. (2) Adding a water tank on the first floor

- **Traditional courtyard house case study (PH, CH10)**

This house is located in the Um Al-Noomy neighbourhood and has two courtyards, one large and one small size, comparative with the built up area. The structural system is load bearing walls (1.50-0.90m) for the outside walls and (0.60-0.45m) for the inside walls, including a secondary roof (2.00m high)⁶. Also, the stairs were too high (25 cm) and weak for the older family members.

The new electric systems, and central cooling and heating systems were adding. They had also conserved the structure and construction systems. Figure 7. 22 confirms that a fixed cover made from plastic sheeting and steel bars had been added to the entire large courtyard by the government as a trial to control the harsh environment in terms of stopping direct sunrays, minimising the loss of the heat, and preventing rain from entering the house. Unfortunately, this affected the entry of sunrays to the house and inhibited the movement of fresh air.

⁶ The depth of secondary roof around 2.00m includes two layers of Hib which is a water container made by fire mud (Arch, 15, 2012)



Figure 7.22: Changing the physical environment of house such as closed the courtyard with fixed cover consist of plastic sheets and iron beams (PH. CH10, 2012), (Author).

Twenty-six people lived in this house which all the spaces were in use all year round. The women spent all their time on the ground floor, especially in the big courtyard. The family had tried to change the function of many of the places. The extended family in this house had five groups; each group had a cooker and a gas cylinder in a corner in the living room. This is where cooking took place, and so the smells for cooking went all over the house. All these changes are referred to in Figure 7.23



Figure 7.23: Case study house No. 10 (Author drawing). Continued...

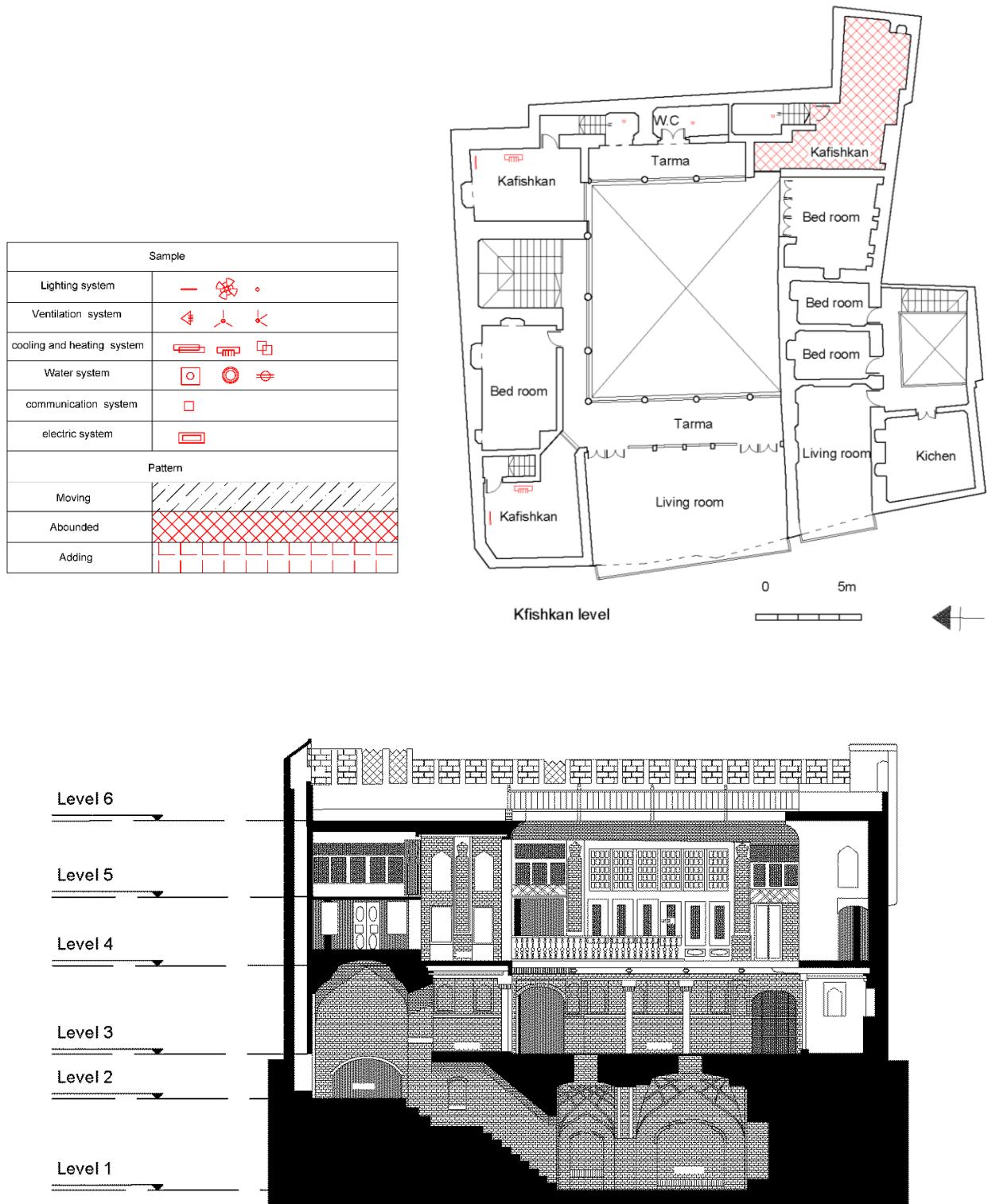


Figure 7.23: Case study house No. 10 (Author drawing)

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.
- Section clarify the number of levels of this house

Occupants used different types of modern devices such as air coolers, and air conditioners for cooling; there were also ventilation fans, an air vacuum, and kerosene heaters as a luxury, lighting also was added which confirmed by Figure 7.24. Moreover, they had self-charged fans for cooling to be used when the local or their own two small generators malfunctioned, in addition to the line with the local generator. There was also an electricity pump, boiler, and a tank on the roof for water. The residents used many televisions, computers and mobiles, and had an Internet connection. Unfortunately, the landline telephones were not working at the time of writing, perhaps because they had been neglected.



Figure 7.24:

Example of different devices in the T.C.H.T in Al-Kadhimiya, House NO.10 (PH. CH10, 2012), (Author)

- (1) Air cooler added to the first floor.
- (2) Adding a fan in the courtyard.
- (3) Lighting was added on the first floor.
- (4) Adding a fan and lighting in the sardab.

- **Traditional courtyard house case study (PH, CH11)**

This house is located in the Um-Alnoomy neighbourhood. This house plot is rectangular with one medium courtyard. It is located on two alleyways by linked with two main doors.

These families were comprised of 17 persons. The family members used each space and level in this house during the year, and each group in this family had its own space and a reception room to gather with family or receive guests. They had separate cooking zones, and arranged their space to maximise their comfort. The occupants changed the site around the old kitchen and used a room overlooking the alley, which had the appropriate openings for ventilation and a bad-geer as clarified by Figure 7.25.

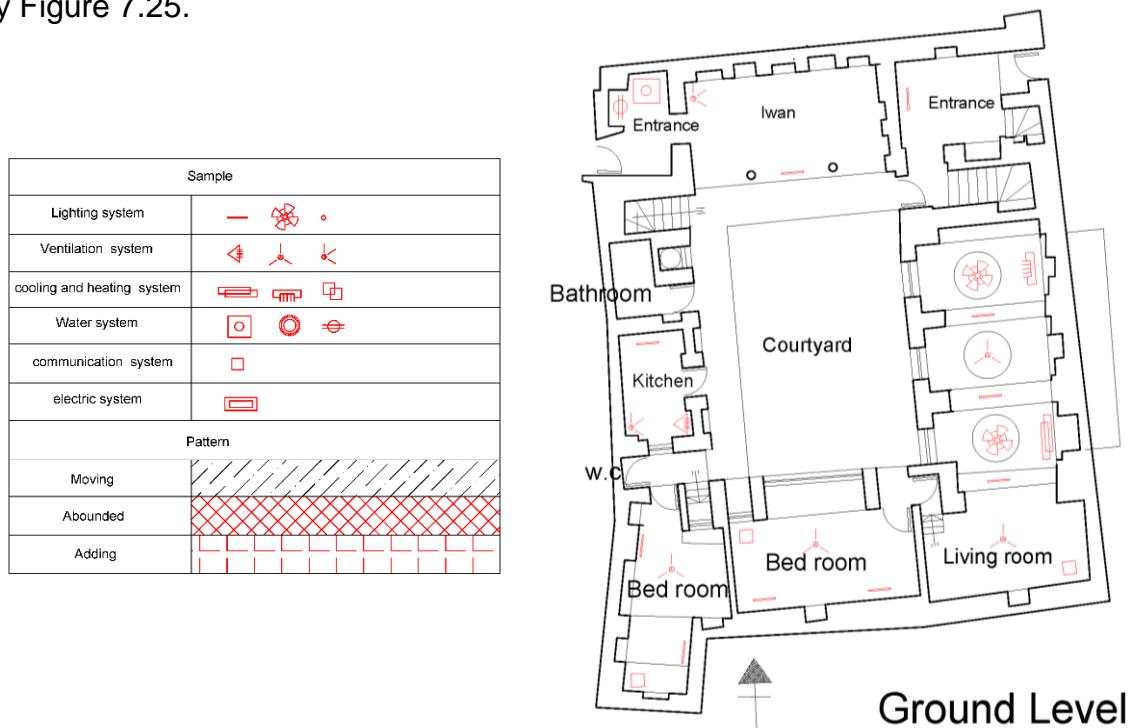


Figure 7.25: Case study house No. 11 (Author drawing):
a. Direction of the house.
b. the number of spaces with space function in ground floor.
c. the transformation of the house space.
d. Additional systems and the location of each modern device.

In this house as shows in Figure 7.26, the residents had had to bury part or all of the sardab to save the walls because of the rising water table. There had been a fall in one wall, which then had to be demolished as it was a wooden wall with windows looking onto the courtyard. It was replaced with tiles but this affected the interior lighting for that space. However, the overall structure was sound. The residents had tried to change the function of some of the places, and had added additional systems

such as air coolers, and split types for cooling and heating. There were also ventilation fans, an air vacuum, and kerosene heaters as a luxury, plus they had a local generator line for the electricity supply. The occupants had added a boiler to warm the water and an electrical pump for withdrawal and storage of water on the roof. The residents had computers, mobiles, the Internet and many televisions.



Figure 7. 26: Refurbishing, and types of device added to the T.C.H.T in the Al-Kadhimya, House NO. 11 (PH. CH11, 2012), (Author).

- (1) Adding economic lighting in the Iwan, painting all the windows and doors on the first floor.
- (2) Adding an air cooler on the first floor, and connecting to the generator line for electricity.
- (3) Adding a satellite dish to the roof, establishing new wiring.
- (4) Adding a fan and painting the walls and ceiling

- **Traditional courtyard house case study (PH, CH12)**

This property is located in the Al-Anbareen neighbourhood. This plot is rectangular. The house is small with a single elevation and all the spaces are open to a square small courtyard on the side. The thickness of the walls was (0.90-0.50m) using fire brick, and partitions (0.10).

The drainage system failed to connect with the public sewage systems, and this created a problem within the locality itself. There was a lack of manholes to get rid of dirty water in the courtyard, and increased humidity on the ground floor. There was no way for the water to escape when it came from the roof and this affected the walls. Using the sardab was impossible in these houses due to the higher level of humidity and consequent bad smells, and even the building materials were falling down. However, generally the high humidity affected the ground floor and the service spaces, see Figure 7.27 which confirmed that.



Figure 7.27: The high humidity affects the ground floor, House NO. 12 (PH. CH12, 2012), (Author).
(1) Courtyard (2) The service spaces

Five people lived in this house. Almost all the activities were conducted in the same spaces and levels in different seasons. The occupants used gasoline or wood/coal was sometimes burned in a steel container called a mankala, in the absence of electricity; kerosene heaters were used as a luxury for heating. They had mobiles and one TV. Also, the occupants used air coolers, fans for cooling and ventilation, and their own small generator, which was malfunctioning. They had no electricity pump, tank or boiler for hot water, but they used economical artificial lamps, all these is provided by Figure 7.28.

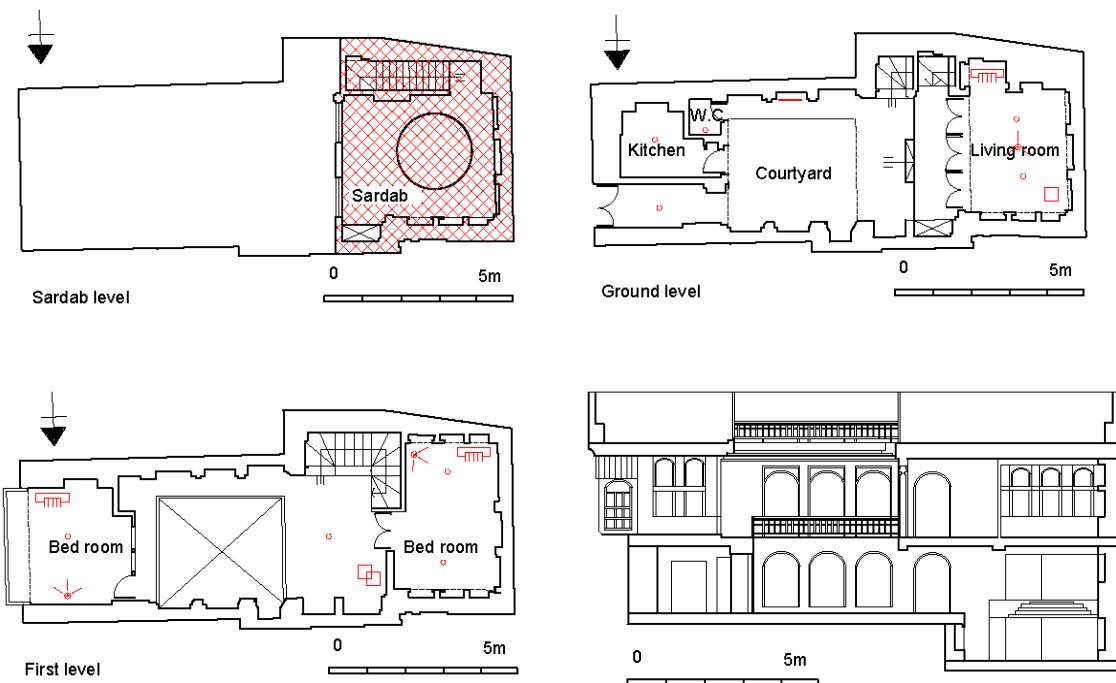


Figure 7.28: Case study house No. 12 (Author drawing):

- Direction of the house.
- the number of levels and spaces with space function.
- the transformation of the house space.
- Additional systems and the location of each modern device.

Now the clear picture about each house was done. The next section will summarise these information then clarified the findings from physical survey.

7.4 The existing condition for the T.C.H.T in Al-Kadhimiya

The previous section described the twelve T.C.H.T used in the case study. Table 7.2 is quite revealing in several ways related to the description of each house in different neighbourhoods. However, the most obvious findings to emerge from the physical survey were found in the house features.

- Usually, the T.C.H.T was enclosed from three sides by other houses and had one elevation with a main door. In two out of 12 houses, there were two elevations linked to the main doors toward different alleyways as show in Um Al-Noomy and Akked Al-Sada neighbourhoods, and also 2/12 houses had no elevation as show in Akked Al-Kanjalle and Al-Bahea an example of neighborhoods that attached from four sides however, they had a main door linked to the alleyway which contacted with the house at the long lobby.

- In all neighborhoods, these houses there were more than two levels and roofs on around 4-6 include: ground floor as street level; upper floors such as first, second or mezzanine (Kafish-kan), and roof; and lower floors such as mezzanine (neem sardab) and sardab.. an example of T.C.H.T with 6 levels see PH,CH 9 as clarified in house section.
- In spite of all 12 T.C.H.T 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 fair 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 0.90-0.60m, and the interior walls were 0.45-0.30m in all the houses.
- In spite of 12 T.C.H.T having different directions, we found that most the spaces, places, and levels were lit during the day, except for those spaces that had divided in Akked Al-Kanjalle neighbourhood and all the houses had air movement; however, there was an odour from the service places.
- In all these houses for five neighborhoods, some level, place, space was not in use for different rezone.
- The sardab in some houses weren't used just for storage such as these in Akked Al-Kanjalle neighbourhood, or were not in used for the same rezone but in specific season such as Um Al-Noomy. In few house the sardab were burial due to the raising of water table such as in Al-Bahea neighbourhood ,
- In spite of the many rooms and different levels for each house, there were just a few service rooms and one house was without a bathroom, as show in Al-Anbareen neighbourhood.
- The families in nine out of 12 houses occupied all the places, spaces and levels all year, and just three families occupied specific spaces for specific seasons in Akked Al-Kanjalle, Um Al-Noomy and Al- Anbareen neighbourhoods.

- There were no specific functions for specific rooms, except in one house in Al-Bahea neighbourhood.

It has also highlighted the additional different equipments which had been added by the residents in all T.C.H.T of those five neighborhoods:

- Ventilation equipment had been added to service rooms without exception, and also in other rooms in these houses, such as fan, air vacuum.
- The heating and cooling equipmentst had been added on different levels and places of the all house, such as split unite, air cooler, oil and electric heating.
- Lighting equipment had been added to all level, space, and place, especially those using minimum energy consumption.
- Water device and storage added on the ground floor and first or roof for all T.C.H.T, except one house in Al-Anbareen neighbourhood which had none of server water or device such as water pimp, boiler, tank, and filter.
- E-communication devices had been added in all houses such as T.V. and mobile, and satellite. 11 out of 12 had a computer except for those houses in the Al-Anbareen neighbourhood, and just 7/12 had an internet connection, distributed in five neighbourhoods.
- In all houses of five neighbourhoods the generator line was added, also changeover and the stabilizer for some electricity device had been added.
- All houses had been refurbished by the government, owner or tenants. For example new water pipes in all the 12 T.C.H.T has been established. Also, new sewage and drainage had been established in 8/12 houses.
- Also, in each of the houses in different neighbourhoods was with new electric meter and new wiring had been establish.
- Also, the services places were refurbished such as these houses in different neighbourhoods.
- In all twelve T.C.H.T floors and walls were covered.
- The last but not least, 4 out of 12 specially these houses in Akked Al- Kanjalle, and Um Al-Noomy neighbourhoods the structural of sardab were conserved.
- Additional changes for example of these houses that had two courtyards, change in house form such as the house had been divided see PH. CH1+4 in Akked-Al Kanjalle neighbourhood.
- Also, closure of courtyard had occurred in Um Al-Noomy neighbourhood.

These findings give a picture of the existing condition of these T.C.H.T in the Al-Kadhimiya historical area of five neighbourhoods. The key issue extracted from the physical survey is that T.C.H.T without exception had been changed and refurbished, however this change in different level. From one side, the changing level reflects attempts to enhance the house performance through thermal comfort, air purification, and air movement, and others, to fulfil changing needs in environmental aspects such as differences in climate elements. Also, the changing level stimulates social needs which had affected the lifestyle in terms of space usage by families, according to increases in the number of family members related to the extended family. Also, new facts were found such as the levels of house, the attached these houses from four sides or, these houses that had two elevation located in different alleyways.

We have 12 T.C.H.T of specific historical areas in five neighborhoods, as shown in Table 7.1. However, these houses had different features with a context requiring different aspects to enhance the performance. Also, in these 12 houses the level of change was different, for example (PH, CH12) this house in the Al-Anbareen neighbourhood had seen little change, compared with houses in different neighbourhoods such as (PH, CH8) in the Al-Bahea neighbourhood, which had seen a lot of change, or between houses in the same neighbourhood. In Aked Al-Kanjalle, (PH, CH1+4) and (PH, CH3) also had different requirements to improve the performance.

7.5 Summary

This chapter has clarified how the twelve T.C.H.T, were selected according to the the willingness of the occupants to be interviewed and to have permission to inter their houses; available time for the fieldwork, and available documentation. This was done by measuring and sketching, and then drawing T.C.H.T using Auto-Cad which was determined the number of courtyards, levels in the house, and number and function of the rooms, the orientation of the house, courtyard and spaces, the location of different activities, the type of services. Also, some domestic activities take place inside the houses, and the basic, visual qualities of things related to the built environment. Then, this chapter also described the existing condition of the T.C.H.T in the Al-Kadhimiya historical area by physical survey and visual observation of twelve houses. The last part illustrated the findings from the physical survey by focusing on different issues.

The main points taken from the physical survey were that the T.C.H.T had been altered without exception, in an attempt to adapt to change needs in environmental and social aspects all which effected on the lifestyle. Therefore, the T.C.H.T in these five neighborhoods had different features and contexts which meant that they had different requirements. However, one can ask whether different conditions of the T.C.H.T. in the Al-Kadhimiyah historical area according to different level of change, as shown in section 7.4, create different kinds of lifestyle for the current users or if the occupants still have the same lifestyle. Therefore, to clarify this point, the next chapter will focus on the everyday life of the current users of the T.C.H.T in the Al-Kadhimiyah historical area.

Chapter Eight: Occupants interview



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8 Occupants interview

8.1 Introduction

This chapter aims to present the findings obtained from occupants which describe the everyday life of the current users of the T.C.H.T in the Al-Kadhimiyah historical area. Thus, the chapter is divided into three main sections. Section one highlights the occupant interviews selected for the case study. Section two reviews the information collected for the current users in the T.C.H.T in the Al-Kadhimiyah historical area in Baghdad city, and the third section provides the emerged knowledge from occupant interviews.

8.2 Semi-structured interviews with occupants of the traditional courtyard house in the Al-Kadhimiyah

As shown in section 5.3.1, there were two types of interview: The second type of interview was held between the researcher and house occupants. Thus, this section introduces the occupants.

The interviews were conducted with twenty four occupants of both genders (male and female) of different ages between 15-79 years, of different levels of social-economic status (rich, average, and poor); different level of education such as knowing how to read and write like housewife to professional work such as professor who were living in T.C.H.T. The interviewees were numbered according to (Occ, x, 2012), with individual occupants through one to one interviews and (Occ, x+x, 2012) for groups that contained two occupants.

As mentioned in section 7.2 and Table 7.1, the interviewees lived in twelve T.C.H.T selected from five neighbourhoods as a case study. The interviewees were chosen according to two stages which were explored in section 5.4.

The interviews with the occupants held in these twelve houses started with general information as an ice breaker between the researcher and the occupants, and then moved to discuss the specific information related to the everyday life of the current users of T.C.H.T. in the Al-Kadhimiyah historical area. It closed by adding some notes from the occupants. The information obtained from the occupant interviews is presented in the next section.

8.3 Occupants' perspectives of the traditional courtyard house type in the Al-Kadhimiya

This section clarifies the data collected from the occupant interviews that lived in these twelve T.C.H.T, as described in Chapter 7. The interviews with the current users of these houses considered different items, which are now reviewed thematically. Table 8.1 introduces the twelve T.C.H.T in Al-Kadhimiya according to the information obtained from the occupant interviews.

8.3.1 *General review of the occupants*

- **Number of occupations in the T.C.H.T.**

To find out how many people lived in these types of houses and how much they were occupied, the researcher discussed who went to work or studied outside the house, and who stayed in the house.

The researcher found that 3-26 people lived in this type of house according to extended family. As can be seen from Table 8.1, the number of occupants in the T.C.H.T located in the Al-Bahea neighbourhood such as the PH, CH 8, was fewer than in houses located in the Al-Kanjaili, Al-Sada, and Al-Anbareen neighbourhoods. Also, the number of occupants in the T.C.H.T located in the Um Al-Noomy neighbourhood was more than from others such as the PH, CH10.

Usually, children over 4 years old go to school and working adults or those in college went outside the house. Furthermore, the housewives stayed at home with the older people, small children and grandparents also stayed at home.

- **Skills/profession**

The researcher interviewed occupants and asked to determine what skills/profession do you have? The occupant interviewees confirmed that they had different skills, and some had finished secondary school, some had a bachelor or diploma degree in education, economics, management, or linguistics, and others had a master's degree in management; some had a basic level of education, and others they were able to read and write.

Table 8.1 Introduction to the twelve T.C.H.T. in Al-Kadhimiya, (Author)

House code	The ownership	The occupation type	Number of occupants	Gender			Age	
				M ¹	W ²	C ³	Adult	Children
PH,CH1	Government/ conserved	Tenant more than 10 years	9	3	3	3	28-65	Under 6
PH,CH2	Government/ conserved	Tenant more than 28 years	7	2	2	4	27-69	Under5
PH,CH3	Government/ conserved	Tenant began 30 years years	11	3	3	4	19-72	5-16
PH,CH4	Government/ conserved	Tenant / since 2003	5	3	1	1	18-53	4
PH,CH5	Government/ conserved	Tenant/ began 30 years	8	1	2	5	31-64	4-15
PH,CH6	Government/ conserved	Tenant/ before 6 month ⁴	7	1	2	4	18-43	5-16
PH,CH7	Government/ conserved	Tenant/ for 40 Y ago	15	7	4	4	18-68	7-16
PH,CH8	Private properties/conserved	Owner/ since birthday 60 y ⁵	3	1	2	-	29- 63	-
PH,CH9	Private properties/conserved	Tenant since birthday 38Y	5	2	1	2	35-73	Under7
PH,CH10	Government/ conserved	Tenant from 1972	26	9	6	11	18-79,	3 months to17
PH,CH11	Government/ conserved	Tenant began 42 years	17	3	4	10	23-67	New bourn-15
PH,CH12	Private properties/conserved	Tenant before 12 years	5	-	2	3	over 40	3-7

¹ Man² Woman³ Children⁴ However they lived in other T.C.H.T more than 15 years⁵ the ground father was born here 1890

- **Time spent living in the house**

The interviewees were asked to indicate how long they had been living in their house and how long they were planning to spend there.

Many residents had lived in this T.C.H.T. in Al-Kadhimiya since birth, which was between 38-65 years ago, or since marriage. For the minority of them, their father or grandfather had been born in the house around 1890. One of family had moved to their house six months ago. But they had experience of living in an old classical courtyard house for 15 years. Besides, many of the occupants moved for these houses between 10-40 years ago. This idea presented by occupant interview who lived in Um Al-Noomy neighbourhood house PH, CH9:

“I lived in this house 38 years ago (since my birthday) and my father born in it (65 years ago). My grandparents (God bless their soul) lived in this house until their death” (Occ, 17, 2012).

The interviewees planned to stay in these houses as long as they could and never leave. The minority of respondents would stay unless the owner increased the rent, or they would stay in it until the state ordered them to leave, but in the same area. Two families planned to stay in it but not continuously and to move away from it after they finished from built the owner houses in the same area. One interviewee and her daughter in law that lived in Akked Al-Sada neighbourhood house PH, CH5 said:

“I lived in this house 20 years ago, but I am a tenant and not an owner. I planned to stay in this house as long as I can” (Occ, 9+10, 2012).

According, Table 8.1 above shows as these houses were owned by the State and the occupants were just tenants or they owned and occupied by the owner.

8.3.2 *Everyday activities/ place/ time*

- **Place – time**

The resident interviewees lived in those twelve T.C.H.T were asked to describe the best times they had ever had in their courtyard house during different days/seasons, and the worst. What qualities did each of them have? Where?

The interviewees said the best times for the occupants to be in the courtyard house were during the summer in the interior courtyard, and in other spaces such as the iwan, and the uris on the ground floor, at any time. The late afternoons during summer were the most wonderful times in the courtyard; most activities occurred in

the interior courtyard during the late afternoon to sunset in the region close to the underground level. Moreover, the interviewees added that the sardab and the neem-sardab in the noon and afternoon were the favorite spaces for any family, and these were used all the time, especially to hide from high temperatures; they did not feel the heat in these spaces because of the natural air movement creating a breeze. Similarly, the same interviewees confirmed the mornings to afternoons in winter were beautiful in the morning if spent in the interior courtyard, which is warm, and near all the other rooms, or in any room on the first floor. For example, one interviewee who had been living in Al-Bahea neighbourhood a house PH, CH8 for more than 60 years said:

“In summer the interior courtyard is very comfortable, with cold moving air and no need for fans on the ground floor or the basement. Once on the ground floor, one or two windows may be opened to make the ursi very comfortable. Also the sardab and the neem-sardab are warm in winter and cold in the summer” (Occ., 15, 2012).

The interviewees said the worst times, both past and present, were in the winter, which was a relatively hard season for them. They were tired due to the cold and the courtyard was closed. However, the time between noon and sunset in summer was also very bad because it was so hot, and the family were forced to go up to the rooms on the first floor since they were too hot and faced direct sunrays. For this reason, the family stayed in the sardab. This situation was completely reversed in winter. Such a view can be explored in the account of one interviewee who had lived in PH, CH 4 of Al-Kanjalle neighbourhood for 10 years:

“The bad time in winter is from dawn to 10 am and from sunset to dawn, because the house is so cold. They were strongly affected, especially in the night, and suffered when using the bathroom and the toilet that opens directly onto the interior courtyard especially during the rain time. Besides, the afternoon in summer is terrible due to the high heat and the continuous rise of temperature” (Occ., 8, 2012).

- **Place – activity**

Interviewees were then asked where they gathered and interacted with family members. Obviously, from the information that was collected from the interviewees, all the residents gathered in the courtyard all the time in the spring and autumn. They mentioned that in the summer, the family met in the interior courtyard and spent the majority of their time there. Moreover, they gathered in the living room ursi on the

ground floor and also used the sardab all the time if possible. One interviewee in Akked Al-Sada neighbourhood house PH, CH5 explained:

“We gathered and interacted in the interior of the courtyard house (as confirmed in Figure 8.1) from morning until noon and from sunset to the late hours of night, after washing its floor with water to cool the air. We also used the neem sardab from noon until sunset, in summer” (Occ., 9, 2012).



Figure 8.1: The occupants used the courtyard for eating and gathering in the T.C.H.T in the Al Kadhimiyah (PH.CH.5, 2012), (Author).

Interviewees gathered in the interior courtyard from lunch time to tea time, and in all the spaces of the ground floor, as well as the iwan a semi-open space on the ground floor, in winter. Also, a significant number of interviewee referred families gathered in the living room, where guests were also received. The living room was used, especially in winter, for most activities such as eating, sleeping, receiving guests, chatting, watching TV, and sitting, among others. In the past, at night, all the visitors were received in the living room. Just one family used the neem-sardab after modifying it into a living room for all seasons due to its large size and capacity to provide all necessary services from light, cooling, heating, TV and other services. This interviewee, who was with her husband and had lived in PH, CH2 house Al-Kanjalle neighbourhood for 40 years, said:

“We gathered in the neem sardab after it was modified as a living room because it is cold in summer and warm in winter, although a fan and a split air conditioner are used to cool it on hot summer days (Occ., 3+4, 2012). See Figure 8.2.

The interviewee mentioned that the entire interior courtyard was the breathing space for all the family, and it was an entertainment area for the housewives. The majority of the housewives stayed alone in the house after everyone else had gone

to work or school, so they met their neighbours and prepared meals together; new or special dishes were circulated to all neighbours for an opinion. During such meetings, a date was established for them to visit the market and buy clothes and jewellery.



Figure 8.2: Modification of the neem sardab to a living room used for family gatherings in the T.C.H.T. in the Al-Kadhimiya (PH, CH2, 2012), (Author).

Also the researcher was designed to explore where the family members practised hobbies and interests. The interviewee occupants practised hobbies in the sardab and neem-sardab in summer, for example, engraving wood. Interviewees had a special part of a bedroom located on the first floor which they used for private hobbies, as they needed a quiet environment for reading and studying or working on a computer. This means the bedroom is being used solely for private hobbies. Other rooms which could be used by the occupants were the living rooms, such as the ursi, and the iwan on the ground floor. Usually, the housewives continuously spent their time in the living room ursi, on activities such as reading the holy Quran, embroidery, sewing and preparing for meals in winter. Also, most activities took place in the interior courtyard in summer and when the climate was good in winter. Similarly, in winter half of the occupant interviewees focused on the room on the first floor in order to participate in their interests. This was clearly expressed by one interviewee lived in PH, CH6 Akked Al-Sada:

"We use any room on the first floor in winter where there is good lighting and ventilation, especially the rooms which have windows to the alleyway, for activities to control out and inside the house at the same time making baskets from reed and palm leaves, telling traditional stories or using the computer. In spring and autumn

we focusing on courtyard for watching TV, listing to the radio" (Occ., 11+12, 2012).
As confirmed in Figure 8.3



Figure 8.3:

The occupants used different places and spaces to practise their hobbies (PH.CH.6, 2012), (Author)

- (1) Using the first floor for playing on the computer in winter.
- (2) Using the courtyard for watching T.V and listening to the radio in moderate times

As the sleeping pattern changed according to the day and season in the T.C.H.T. the interviewees were asked how they would describe their sleeping pattern and possible changes to it.

In summer, the majority of interviewees had stopped sleeping on the roof many years ago during the night, except for few of interviewees who slept there with their families, because of the continuous presence of dust and dust storms, and the problems with security after the events of 2003. However, one interviewee and his wife in Al-Kanjalle neighbourhood used the interior courtyard for sleeping in at night because it was very large and safer than the horizontal roof. Nevertheless, interviewees considered that sleeping in the roof was healthy and comfortable on clear nights, so the occupants sprayed the roof with water to keep it cool, especially if there was no electricity supply, whether from the national grid or from local generators. Such an idea was articulated in an account by one interviewee lived in Akked Al-Kanjalle neighbourhood house PH, CH3:

"We used it when the electricity supply was cut off. We used to get our mattresses and pillows and go to the roof to prepare our beds; we slept in iron beds. Sometimes, my grandmother brought us our supper to the roof; and she told us bedtime stories."
(Occ., 6, 2012).

Moreover, the sardab is used for an afternoon nap because it has an appropriate temperature, as is the room on the ground floor if there is an electricity supply. For some T.C.H. in the Al-Kadhimiyah historical area, the sardab is now impractical for sleeping because of its humidity and odour, and because of the presence of ground water. This was articulated by one interviewee and her sister in law who lived in the Al-Sada neighbourhood house PH, CH7:

“We never use the Sardab for sleeping or any other activities because a large part of it is affected by the nearby alleyway where the sewage leaks and there are odours. The second part has flooded from time to time” (Occ., 13+14, 2012). This was provided by Figure 8.4



Figure 8.4: The abandoned sardab as a result of the high humidity and odours in the T.C.H.T in the Al-Kadhimiyah (PH, CH7, 2012), (Author).

Also, resident interviewees in those twelve houses had bedrooms on the first and ground floors, or the second floor. Usually the occupants used these rooms for sleeping in winter, both day and night, and in the bedroom *kafish kan*, which is at the level between the first and second floors in winter as shown in Figure 8.5.



Figure 8.5:Using the room on the second floor with a low ceiling of around 2.00m for sleeping in winter (PH, CH4, 2012), (Author).

The other interviewees with families moved to the rooms on the ground floor. In different sized of T.C.H.T interviewees preferred to use one room for each family member for sleeping, but because of the electricity limitations, they could not control the heating or cooling of all the spaces in the house. This forced them to use one or two rooms so they had no privacy. This idea can be seen in the account of one interviewee and his wife who lived in the Akked Al- Kanjalle neighbourhood house PH, CH1:

“We use one room for all activities such as sleeping, living etc. because we cannot adapt all the rooms and so all the others are abandoned. This affects the relationship between the parents, as the husband and wife have an unmarried daughter and son sleeping in the room with us. Sometimes my son slept in a nearby hotel because he found the house was either too cold or too hot” (Occ., 1+2, 2012).

8.3.3 Conflicts and challenges

This part gives examples of how the occupants may have environmental problems.

- **Dealing with weather problems**

The hot season is much longer than the cold season in Iraq. To explain how the occupants deal with the different seasons, the interviewees were asked how they dealt with the problem of hot and cold weather.

During the heat, the interviewees remained on the ground floor and added fans, air coolers, and a split, or air conditioners, to the first floor as well. They avoided the

heat by using the basement. Furthermore, they washed the courtyard and used self-charged fans or hand-fans sprayed with water. In the winter, ten of the respondents used the spaces on the first floor, but this did not mean that the ground floor was neglected as it had been carpeted, and there were also oil and gas heaters, and sometimes electrical ones. Interviewees said that during the year, most parts of these houses had no electricity. The corridor and the courtyard were warm in the winter mornings and they used kerosene heaters at night. For example, an interviewee who lived in Al-Baheia neighbourhood house PH, CH8 mentioned such ideas in his account:

"In hot weather, we use the basement from the afternoon to the evening but we mostly rely on natural air movement, and in the morning we use the spaces on the ground floor, like the kitchen, uris, iwan and others. In winter, we focus on the spaces located in the south" (Occ., 16, 2012).

- **The services in the traditional courtyard house**

The interviewees were asked how they would describe the services in courtyard house, and what sort of additional services the occupants used, such as electronic and communication systems like the internet, and how these could help them.

The interviewees from two different houses indicated that the old sewage system had recently become blocked in one house in the Al-Anbareen neighbourhood, and the dirt was passing through open channels from the house to the central canal in the alley. Obviously, this affected health and odour levels, and there was leakage onto the street. These residents also found that insects were continuously invading the house. This situation affected those on the ground floor. The other interviewees said that the new sewage systems in the individual house were working and they could control them. However, the other interviewees indicated that the sewage and sanitation systems between the individual house and neighbourhood were not connecting or had bad connection and also needed continuous maintenance. For example, one interviewee lived in Al-Anbareen house PH, CH12 who alluded to such practices in her account:

"Unfortunately, the connection of the public sewage system with their alleyway sewage system was not correct or not connection and thus adversely affects the sanitation in the house, such as the emission of odours and humidity. The flooding of the sewage water, all kinds of water, rain water, washing water and sewage water

remain inside my house so we need to set aside an amount of money for sewage repair and cleaning every month" (Occ., 24, 2012).

The same interviewees who lived in Al-Kadhimiyah historical area pointed out that the water supply was good in winter, but unfortunately in summer it was weak. Furthermore, the water supply had been cut from some houses for a long time due to the old rusty pipes. There was no problem with the hot water, especially after the addition of heaters.

The interviewees from all five neighbourhoods focused on the electricity being absent from the house for a long time, and the only problem was the continuous power cuts in national electricity and the dependence on local electricity generators. The electricity supply is unstable and some electrical wires and electrical foundations were decayed or neglected because they used new electric wires to connect with local and individual generators as well as in corrector of changing the electricity supply made a fire. Most interviewees in the twelve houses from different neighbourhoods frequently considered electrical issues in their accounts such as:

"Our big problem is the absence of the electricity supply and sometimes we stay without it for many days or it comes for 2 hours a day. Also, the electricity supply is currently sometimes unstable, especially that supplied by the local electrical generator, and this has led to fires breaking out, but now there is an electrical change over and stabilizer to avoid this" (Occ., 11+12, 2012), Figure 8.6 confirmed that.



Figure 8.6: Using change over and a stabilizer to provide a stable electricity supply and to avoid power cuts (Ph.Ch.6, 2012), (Author).

The occupant interviewees for T.C.H.T. in all neighbourhoods except Al-Anbareen highlighted that the residents used computers or laptops and the Internet helped them access the world as shown in Figure 8.7. The families were likely to have an Internet connection especially in the Akked Al-Kanjalle and Al-Sada neighbourhoods,

and other neighbourhood they used the internet via a mobile or other private or public centre.



Figure 8.7: Using the different devices for communication in the T.C.H.T. in the Al-Kadhimiyah, (Author):

- (1) Adding a TV and computer on the first floor (PH, CH6, 2012).
- (2) Adding TV and satellite in the living room/ ground floor (PH, CH7, 2012).
- (3) Using a laptop in the living room (PH, CH7, 2012).
- (4) Adding a computer in the ursi on the first floor (PH, CH10, 2012)

• Frustrating aspects of environmental performance

To consider the particular environmental performance in the T.C.H.T., the occupants were asked what they found most frustrating about living in their house and how they dealt with such situations.

All but one of the interviewees indicated that the ventilation in the house was comfortable due to the presence of the Bad-Geer, while the ventilation in the house was good due to the courtyard, except for times when continuous dust storms affected the ventilation and cleanliness of the house. For example, the interviewees who lived in the Al-Bahea neighbourhood house PH, CH 8 said:

“Except for the problem of continuous dust storms preventing natural ventilation and making the air stifling in summer, the Bad-Geer is still working and makes life easier for us. We see these types of houses as healthy and comfortable. And we are convinced that the house is a good environment, despite the difficulties” (Occ., 15, 2012). The impact of dust storm was shown in Figure 8.8

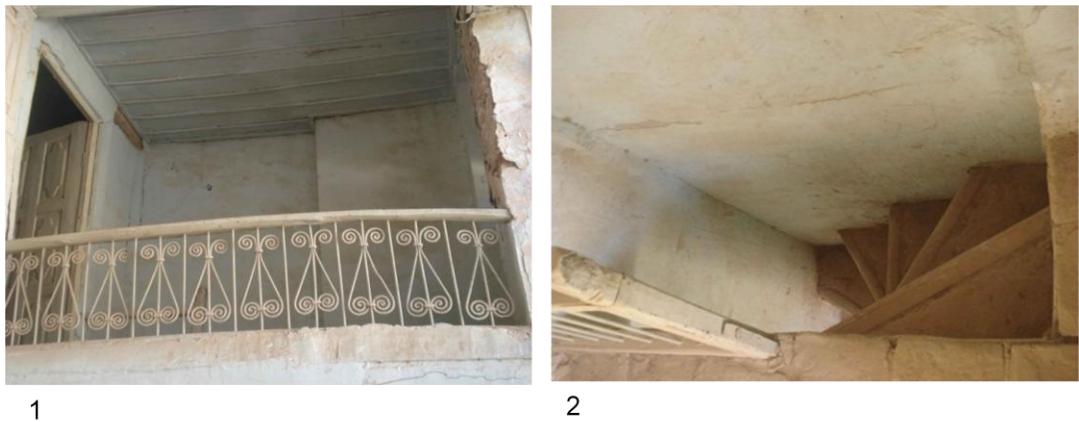


Figure 8.8: Gathering of dust in the T.C.H.T in the Al-Kadhimiya (PH, CH 8, 2012), (Author).
(1)The space on the first floor, (2) The stairs between the ground floor and sardab

In contrast, one interviewee who had been living in a small courtyard house in Al-Kanjalle neighbourhood house PH, CH4 said:

“When all the family came and gathered to see the oldest persons with their spouses and children, the atmosphere was breathless even with an air cooler in summer. So, between noon and sunset, the atmosphere was suffocating, especially when there was no electricity supply” (Occ., 8, 2012).

The interviewees from different neighbourhoods shared one bathroom and one toilet in the same house, and only one house interviewee was without a bathroom and hot water, and had no water reservoir. Generally, the water is reduced in this city, especially in summer, so they used the free public baths nearby during winter. This was emphasised by one interviewee from Al-Anbareen house PH, CH12 who said:

“Most of the time, we go to the holy shrine and we use the free hot baths to wash ourselves and our clothes by hand. The authorities of the holy shrine do not mind people using the baths. In the past, we gossiped and arranged a day for the public bath; usually, after the bath, we sit in a large hall where we dine and have tea, and we stay there for 5-6 hours approximately. During summer, we are sometimes forced to bring water from my parents’ house, and another time I washed clothes in the houses of relatives” (Occ., 24, 2012). See section 7.3.2 house number 12

The interviewees pointed out that the high humidity, especially in the underground and ground floors, and the damage to the minority of these houses, put them under pressure and therefore they dealt with moisture by repeatedly painting the walls or covering them with wood. Also, they used continuously sterilized and burned incense in the house during the summer to make the house smell nice. This view can be explored in the account of one interviewee who had lived in house PH, CH8 Al-Bahea neighbourhood for 60 years:

“I painted the walls every two years and treated them as far as I can to solve the problem of humidity, and we sterilize to prevent anyone becoming ill, especially the children” (Occ., 1, 2012). Figure 8.9 confirmed that.



Figure 8.9: Types of refurbishment of the T.C.H.T by painting the walls every two years (PH, CH.8, 2012), (Author)

The interviewees pointed out that the covering of the courtyard with a tent in summer and plastic in winter affected air movement and caused the spreading of unwanted smells from kitchen or toilets. Some of the occupants tried to use an air vacuum, but one interviewee and his wife, who lived in Akked Al-Kanjalle, refused to add an air vacuum for two reasons: firstly, they disliked changing the style of their historical building because they were tenants and not owners, and secondly it was very difficult to add this vacuum as the thickness of the wall was more than 150cm.

Similarly, the same interviewees said they were under most pressure during the harsh weather, when families could not use the courtyard and all movement stopped; they felt as if they were paralyzed at these times. They dealt, however, with these situations by using modern devices to achieve user comfort, and in winter everyone

settled down in their room until the rain stopped, and then began the task of cleaning the courtyard. This was a problem to them because there were no proper drainage rain canals, so the water had to be drained by them outside the house.

The interviewees from different neighbourhoods indicated that some houses in this area were rented out to unknown persons, so the residents had been robbed several times. For example, this idea can be seen in the report from one interviewee and her husband in Akked Al-Kanjalle house PH, CH1:

“My husband used a room on the first floor overlooking the alley and the house, so he can observe the movement of entrants into the alley or anyone entering the house. This room is like a watch tower and my husband is a night guard” (Occ., 1+2, 2012).

The interviewees stated that the kitchens in these houses were inefficient so the occupants used the courtyard for cooking and washing dishes to avoid smells coming from the kitchen; in one house, there was no opening to renew air inside the kitchen. Also, two housewives from Akked Al-Kanjalle did not use the kitchen when they prepared strong smelling food and instead used the room on the first floor. For example, this was emphasised by one interviewee and his wife in house PH, CH1 who said:

“When my wife prepares fish, she moves to the first floor and instead uses a room there which has been modified for this purpose, so the smell does not disturb the whole house” (Occ., 1+2, 2012).

- **Types of problem at night**

The researcher discussed the problems that the occupants faced during night. In general, the interviewees indicated that the unavailability of electricity was the main problem, especially at night, since it affected sleep quality. The whole family slept in one or two rooms in order to make use of one air cooler or heater, because the electricity supply were limited and therefore affected their privacy, extreme darkness, and lack of entertainment such as TV; the occupants also missed old social contacts. The interviewees had no access to a small electrical generator all night, as it sometimes malfunctioned. This affected not only the lighting but the services in the house, so the residents had to set a certain amount of money aside for gasoline, which was sometimes difficult to obtain.

The interviewees pointed out that the presence of dust at night in summer made the atmosphere suffocating. Moreover, in winter, it is so cold but using simple heaters continually will warm the whole house. When the electricity supply was cut, the residents used kerosene for the heaters, which removes the fresh air, and makes healthy air harder to achieve. This was clearly expressed by one interviewee from Al-Anbareen neighbourhood house PH, CH12:

“On winter nights, the cold can be defeated by using kerosene heaters as confirmed by Figure 8.10 and carpets, and by the closure of all slots and openings. These heaters produce bad smells which sometimes affect the air quality. We do not have enough oxygen in our rooms” (Occ., 24, 2012).



Figure 8.10: Using a kerosene heater in winter creates a problem in the night (PH.CH.24, 2012), (Author).

The interviewees preferred the daytime because insects such as mosquitoes came from the open sewage channels in the middle of the alleys, or from the flooding of the sardab. Noises due to the movements of rodents and scorpions at night are annoying and frightening.

It should be mentioned that the environmental challenges due to modifications were determined according to the type of courtyard house. For example, for the interviewees problems had arisen because their original T.C.H. had been divided into two after the 1980s, although each part retained its own courtyard. The house in its original planning had been divided into winter and summer quarters, so now the family found it difficult to heat or cool; there was also an absence of special service places.

In contrast, just one interviewee in a T.C.H.T had two courtyards which had not been divided. This is an example of a small family in a large house, so the family had neglected the bigger courtyard due to the difficulty in warming or cooling it, or keeping it tidy, as well as controlling insects and rodents. Therefore, all activities were concentrated on one courtyard. One interviewee expressed such a scenario in his account that lived in Um Al-Noomy neighbourhood house PH, CH9:

“Today, we use the smaller courtyard as a kitchen for cooking, and washing dishes and clothes but new sewage pipes was added and ventilation was needed. The room opening on to it was used for sleeping and as a living room, so all activities were concentrated on one courtyard” (Occ., 17, 2012).

- **The cost of services**

The cost of utilities is a form of financial analysis for the electricity supply, the water supply and drainage, but also guides the decisions for the limitations of the utilities. To explain the cost of utilities services for the T.C.H.T. in the Al-Kadhimiyah historical area, the interviewees were also asked to illustrate the costs of utilities and say whether they thought the cost was high.

- **Electricity supply**

The occupant interviewees mentioned that the cost of electricity units from local generators was very high compared with other services, because the national electricity was unavailable. The very high cost of electricity from private generators was due to the lack of electricity on an on-going basis; however, this was a problem for all Iraqis now. The cost of one ampere from the private sector was very expensive, as was the cost of the electrical supply. The cost of one electricity ampere for 24 hours for 30 days was 30 thousand Iraqi dinars, and a family of four needed at least 5-6 amperes; there were also bills from the government for the national electrical supply. Many occupants owned a small electrical generator but one interviewee and his wife in Akked Al Kanjalle house PH, CH1 did not use it very much:

“We have a private generator but I cannot use it every day for many reasons, such as the cost of gasoline and the fact that it needs repairs, maintenance and oil, and we cannot this afford all the time” (Occ., 1+2, 2012).

- Drainage

The costs of sewage and sanitation were reasonable with the new sewage pipe because the occupants had no problems with this type. However, the old sewage system had become blocked from time to time in a few houses and needed maintenance; in this case, the cost was high, so the residents needed to set aside an amount of money for sewage repair and cleaning every month.

- The water supply

The interviewees in these courtyard houses confirmed that the cost of water supply was reasonable at the time writing; however, a small number of interviewees always bought drinking water so the water in the pipes was generally used for cooking and washing.

However, one interviewee from the Al- Anbareen neighbourhood house PH, CH12 expressed that:

“Everything is expensive to me because the rate of unemployment among youths is so high. Therefore, the private electricity costs too much but the price of water and a sewage unit is also high” (Occ. ECC, 24, 2012). In contrast another interviewee in the Al Bahea neighbourhood house PH, CH8 said:

“The cost of all services was appropriate in the T.C.H.T. It is much less than the cost of modern houses that do not have an interior courtyard. Because these houses are cold in summer, have natural lighting and fresh air, they are well isolated from the harsh weather and others” (Occ., 15, 2012).

8.3.4 Evaluation of existing environmental performance

- Health / satisfaction

To investigate healthy lifestyle, the interviewees were asked what they regarded as a healthy lifestyle. They were also asked to describe the environment in which they were living. A healthy lifestyle means being comfortable in the place where you live throughout the year. The residents' interviewees in the twelve T.C.H.T. confirmed that a healthy house is a house one can control environmentally; it is warm in winter and cold in summer with a good ventilation system and natural sunlight.

At the same time, interviewees added that the healthy house should be protected from dust, direct sunlight and rain, and have no humidity, including a good structure. Moreover, interviewees said the healthy lifestyle must have healthy drinking water,

hot water, water reservoirs and water pumps, and the sewage system must be good. It must have a phone and an internet connection, and good furniture. Also, interviewees preferred that it should not be too large, so no one can control it, nor be so small that it gives no comfort to its residents. The following comments were supplied by interviewees from Akked Al- Kanjalle house PH, CH4:

"It is a house with natural air movement, the atmosphere is fresh, and so we do not feel suffocated especially in the afternoons in summer. Sunlight should enter it for a time during the day; it is warm in winter and cold in summer. A healthy lifestyle is a place free from dust, with no humidity or insects, and it is easy to clean and repair" (Occ., 8, 2012). This confirmed in Figure 8.11



Figure 8.11: High humidity due to different causes leads to an unhealthy house (PH, CH4, 2012), (Author).
 (1) In the ursi on the ground floor. (2) In the room on the first floor

So, interviewees believed that their T.C.H.T. was healthy. However, other interviewees wanted to move to another house because they thought these types of houses were unhealthy. They indicated that treatment of certain problems had to be addressed to achieve a healthy lifestyle. Occupant interviewees described how the whole environment that they lived in was good and they thanked God for that. They saw no psychological struggle in living in these houses, even though some people who used to living in modern houses might. One interviewee who had lived in house PH, CH9 Um Al-Noomy for 15 years expressed this in her account:

"A healthy lifestyle includes living in peace without any material and psychological damage to a person or the way of living because the last one has a negative effect

on the psychological condition of the person and then affects the way of living" (Occ., 18, 2012).

- **Environmental comfort**

When we discussed the current level of environmental comfort in these types of houses, the interviewees were asked if they found their home comfortable or uncomfortable, and why.

The interviewees considered the T.C.H.T to be comfortable and healthy in the summer as the air moves continuously, from alleyways to the courtyard and from the roof, the Bad-Geer, extended to the sardab and kitchen, despite the intense heat in the summer. One can control the natural ventilation system so it is cold. This notion was upheld by one interviewee in the Al-Bahea neighbourhood house PH, CH8:

"The fresh air moves continuously inside the house if there are no dust storms, making summertime comfortable. The most important point is that the house is open and all the spaces open onto each other, so one can move between spaces without noticing an extreme change in temperature between one space and another" (Occ., 15, 2012).

Other interviewees considered that these houses were comfortable in winter when the sun comes to all spaces of the house; at the same time, most interviewees except one said that these houses were very cold in winter and heating the house was neither easy nor controllable. Warming the house, with all their efforts, was still difficult. The interviewees could not recall a bad time in this house and loved the house, both day and night, winter and summer. In contrast, another interviewees and her husband who lived in a house that had been modified from another function indicated that this type of house was uncomfortable and unhealthy in both summer and in winter. This was because it was very difficult to control the environmental condition. For example, this interviewee from Akked Al-Kanjalle house PH, CH2 said:

"Let's be realistic. In this time, we do not prefer living in this house. The temperature reaches 60C on some days in the summer, while in winter we suffer a lot due to the freezing cold. It is very difficult to control such a large sized area. The dust storms are regular and the rain makes our lives miserable. Even when we use a heater, the house stays cold, and we get sick in winter when we move around the house" (Occ., 3+4, 2012). Figure 8.12 shows the size of courtyard slot comparative with the house built area



Figure8.12: The size of the courtyard slot in the T.C.H.T in the Al-Kadhimiya making the environmental condition hard to control (PH, CH 8, 2012), (Author).

All the interviewees considered these types of houses to be comfortable for a number of reasons. First, the occupants had a strong relationship with, and sense of security from, their neighbours, and therefore the occupants all felt like one big family. Second, the T.C.H.T was near the holy shrine of the great Imam-Abu Hanifa, and this seemed for the residents to make the T.C.H. as blessed as the whole area. Third, these houses were close to the market and city centre and near to places where many members of the family worked. Fourth, the economy of the rent suited their income. Fifth, for the interviewees that had lived more than 20 years in this type of house had good memories in it, so they felt comfortable about. Furthermore, most of respondents argued that the features of the interior courtyard had a special aesthetic, such as the shanasheels, the coloured glass windows, the arabesques, the arches and all the Islamic decorations around the house. In this way, the occupants felt healthy, physiologically comfortable and appreciated the privacy of these special characteristics. For example, one interviewee who had lived in this house since birth from Al Bahea neighbourhood house PH, CH8 noted that:

“When I sit in this courtyard which has well-established gardens with roses and fruit trees, with a central fountain, it is very comfortable. There is a special aesthetic for an Eastern house especially when one watches the shanasheels, during the reception of guests, one can go upstairs and watch the guests through the shanasheel without being seen” (Occ., 15, 2012). Some of details for this house present in Figure 8.13.



Figure8.13:

The aesthetic of the T.C.H.T in the Al-Kadhimiyah was physiologically comfortable (PH, CH 8, 2012), (Author).

- **The most comfortable / uncomfortable season**

To focus on which time is comfortable or not, the interviewees were asked which season was the most comfortable or uncomfortable, and why. The interviewees preferred the spring and the autumn, which are great seasons, especially for children. Generally, when the sky is clear and the temperature moderate, with the presence of a Bad-Geer and the low sunbeam angle there is no need to heat or cool the house.

The interviewees confirmed that the summer was better than the winter, which was freezing. The winter and rainy season was uncomfortable due to the difficulty in warming the houses and the high humidity; one interviewee and her mother in law who lived in Akked Al- Sada house PH, CH5 said that:

“We need to use modern devices on an on-going basis, which makes electricity costs low. The winter is terrible due to the cold and the smell coming from the kerosene heaters” (Occ., 9+10, 2012).

Similarly, the same interviewees described the summer season as the relatively most comfortable for many reasons. First, the house was cool and had the most convenient temperature due to the natural ventilation and movement of air across the yard and Bad-Geer. At night, only with an air cooler or other such device was the house comfortable. Also, the air currents moved through the Bad-Geer, and all the levels of the house, due to the differences between positive and negative pressure in the courtyard and alleys, roof and floor, and also between the shaded and light spaces. Second, the direct sun did not enter in summer because of the yard

proportions, and at the same time the house did not need to be lit during the day. Third, the sardab, which is the space used in very appropriate times during the afternoon, alongside the courtyard, is comfortable in the later afternoons for being able to control the outside the house and know who is in there. Therefore, it is understandable that some of the respondents considered such as idea in their accounts. This was expressed by one interviewee who had lived in Al-Baheia neighbourhood house PH, CH8 for 60 years:

"There are spaces which are suitable for living in without the use of air conditioners, especially if we stay inside the sardab during the afternoon. We can sleep in this cool place and on the roof in summer, and it is marvellous. The summer is better since we use the courtyard and can open all the windows. In my humble opinion, I am comfortable in this house, but I need another where I can find more comfort. This is my real life and I am satisfied with it" (Occ., 15, 2012).

In contrast, the nervous interviewees indicated that the summer was uncomfortable. For example, one, a housewife in PH, CH.6, said:

"Summer is the worst season due to the continuous cuts in electricity and dust storms; we must use other classic methods to fight the heat or cold" (Occ., 11+12, 2012). This was confirmed in Figure 8.14



Figure 8.14:

The uncomfortable time for the occupants in T.C.H.T in the Al-Kadhimiyah (PH, CH.6, 2012),
(Author):

(1) During harsh weather the courtyard was closed. (2) During increasingly frequent dust storms.

On the other side, only interviewees from the Al-Anbareen neighbourhood house PH, CH12 indicated that the house was usually uncomfortable at any time. This idea was articulated in an account by one interviewee:

“Do you believe there is comfort in this house? If you believe such you are completely wrong. No comfort at all. The summer and winter are very bad; whether we are feeling comfortable or not is not the issue. We adapt ourselves and we have no alternative” (Occ., 23, 2012). Figure 8.15 indicators why she said that.



Figure8.15: The lack of maintenance of the T.C.H.T in the Al-Kadhimiyah led to an uncomfortable environment (PH, CH 12, 2012), (Author)

- **Vertical level – comfort**

The fieldwork also explored which levels of the house were the most comfortable and why. The interviewees preferred to use and stay in the ground floor. It was comfortable in the summer especially when the courtyard was open. Since it was large, wide, and cool due to the air movement, and only needed fans if there was a dust storm. The occupants have control over every part, both external and internal, and they can see everyone who enters or leaves the house. All the service rooms, such as kitchen, bathroom and toilets, were on the ground floor and one can move easily in it. It is easy moving between the spaces and other floors, and the doors and windows were better as the courtyard linked with all the house parts, and the families did not need to continually use the steep stairs. However, the same interviewees clarified that the ground floor was uncomfortable in winter due to the high humidity and extreme cold, so the occupants needed to heat the house. Such an idea was articulated by an interviewee who had lived in house PH, CH3 Al-Kanjalle neighbourhood for more than 50 years:

“The ground floor is semi-comfortable in the winter after making amendments such as processing humidity and the addition of space heaters and carpet” (Occ., 5, 2012).

Also, the interviewees mentioned that the first floor was only comfortable in winter, as it had direct spaces for sunlight to enter directly to it in winter and air movement in summer time. The proportion of the courtyard helped that. Moreover, it was warm and not humid, and also more private. One interviewee in the Akked Al-Kanjalle neighbourhood pointed out that the rooms on the second floor were too hot in summer, so the situation was reversed completely in winter. This family abandoned their room on the second floor most of the time and shared rooms with others, so they lost privacy. This idea was articulated in an account by one interviewee who lived in PH, CH4 Al-Kanjalle neighbourhood:

"It is difficult to cool or heat it; even the clothes stored on the second floor are so hot that they need to cool them a bit before wearing them, so we neglect this floor in summer and share our other rooms. The ground floor is easy to adapt and can be cooled or heated easily compared to the first or second floor" (Occ., 8, 2012).

As noted before, interviewees and their families used all the rooms without exception because there were too many members of the family, and too many families under one roof. This increased the noise, especially during weekends and holidays, as the house was full with relatives, guests and children. No one could find a minute for relaxation or calm and so the houses were uncomfortable. In contrast, for two respondents, the entire house was neglected except for the ground floor or one courtyard with rooms around it, because it was difficult to cool or heat especially with repeated electricity cuts. It was very expensive to control the thermal comfort in it. One interviewee with her husband, a resident in the Akked Al-Kanjalle neighbourhood house PH, CH2, said:

"The cost of electricity from local generators is high. We cannot afford more than 5 amperes, which is enough for the fans and two air coolers. This is why most rooms are abandoned" (Occ., 3+4, 2012).

• Time comfort

The researcher discussed with interviewees which time of day or night is the most comfortable for them and why. The interviewees explained that the problem was in seasons. The majority of respondents, except two, described how the nights in winter were harsh and very cold and the mornings and afternoons were warm. The younger housewives interviewees stated that in the daytime they had freedom of movement in the house although it had many families. At the same time, a significant number of interviewees highlighted how in the past the nights in summer had been beautiful,

and were very quiet and comfortable when sleeping on the roof. Now, the nights are hot, especially with no electricity, and so many of them could not use the sardab or the roof for sleeping for various reasons. The movement was difficult due to the absence of light from many spaces in the house; in the day time it was light as, the sunlight enters almost all parts of the house. Also, there were noises at night from the use of local or personal electrical generators. For example, one interviewee and his wife living in Akked Al-Kanjalle house PH, CH2 said:

“Day is better as the dawn is very quiet. I enjoy lying in bed and hearing the Holy Quran and the call for the dawn’s prayer from the nearby mosque. At night we have no electricity and we have no security. I feel comfortable during the day more than at night. My sleep is disturbed at night due to electricity cuts. Sometimes I depend on self-charged fans so I can sleep” (Occ., 3+4, 2012).

One interviewee, who had lived for more than 50 years in PH, CH3 house Akked Al-Kanjalle, explained a different point of view of why the night was better:

“In the night, it’s secure and nobody can guess what’s in there or how many people is inside the house because there are no large openings on the ground floor” (Occ., 5, 2012).

Other interviewees from different neighbourhoods indicated that they were comfortable at any time. In contrast, other interviewees indicated that their families were always uncomfortable. For example, one interviewee from the Al- Noomy neighbourhood house PH, CH 11 alluded to such practices in his account:

“As I mentioned before, we occupy all the rooms, so even if one is uncomfortable, we have no alternatives. Also, I have no privacy. In our home, there is no privacy at all” (Occ., 21, 2012).

• Room and space comfort

We discussed which rooms were the most comfortable and why. The interviewees preferred the uris as a living room, as the most comfortable space for the majority of the time; its roof was low, so it could be easily cooled or heated, and the natural lighting was good. Other services, such as cooling, ventilation and communication were also good, and therefore it was used for all activities and the occupants had nice memories in it. This space was located on the ground floor overlooking the courtyard. In one large house, we found a winter and summer ursi, and one of them on the first floor had been beautifully decorated. The respondent said that in the past

we called it the dewakana and it was used for the male family members and other guest men. Additionally, the interviewees added that the iwan was semi-closed, as it had been modified into a comfortable living room space which was still connected with the other parts of the house and so allowed for the control of all of the spaces. For example, an interviewee who had lived in PH, CH4 for ten years in Akked Al-Kanjalle said:

“The ursi is cold in summer and warm in winter so we rarely use heaters or air conditioning inside it at any time of year; also it has large windows. The family gather in it due to the presence of the TV and it controls all other spaces. Also, we can control the house in general and the movement between the outside and inside in particular, as it has good links with the other spaces and is close to the kitchen and the bathroom” (Occ., 8, 2012).

The interviewees indicated that the interior courtyard was more comfortable than other spaces in these types of houses due to its low temperature; it was also at the centre of the house. The respondent who had a well sardab added that the most comfortable spaces in summer were the sardab, especially when the temperature was high and the electricity supply had been cut. All the respondents described that the rooms on the first floor were not comfortable in summer, except for when they modified them by adding fans, air conditioner and heaters. They also benefitted from a lack of insects which could be on the ground floor. Just one interviewee in the Al-Bahea neighbourhood house PH, CH8 clarified that all the rooms were comfortable all the time:

“The entire house is comfortable for me all the time; the rooms and spaces facing the east are more comfortable in summer, while those spaces facing west are more comfortable in winter, especially the rooms on the ground floor” (Occ., 15, 2012).

In contrast, another interviewee who lived in the Um Al-Noomy neighbourhood house PH, CH10 referred to the fact that most of the rooms were uncomfortable in their house:

“As an extended family, I, my wife and three sons with their wives and many kids live in this house so there are many people. All the rooms are occupied and if there is one uncomfortable room, we cannot replace it. You must adapt to the room” (Occ., 21, 2012).

8.3.5 Enhance the environmental situation

- **Enhancing comfort-active systems**

In this section, the Interviewees were asked how they enhanced their comfort in their houses, or made themselves more comfortable, and whether they used active systems. Interviewees confirmed that using artificial systems enhanced their comfort in the T.C.H.T giving them more relief and enabling them to live in a healthier environment. These Interviewees mentioned the systems they used to improve the sanitation drainage to remove odours and blockages, control the movement of air and bring fresh air, as well as using alternative systems to the unhealthy kerosene heaters. They were able to keep the house at a certain level of temperature that controlled the heat or cold, decreased and reduced the humidity, and made life comfortable. They kept the places tidy, had available water especially in summer and a continuous supply of healthy water, There was an internet network, and ways to discharge and drain rain water, plus systems to increase the natural lighting and allow fresh air, especially in dust storms. They needed security or partial closure of the courtyard by automatic way, enhanced the ventilation in the kitchen, avoided smoke and fire, by changing the electricity and saving electrical wires. This idea was expressed in an account by a housewife living in a house that had been modified from the original house, which had two courtyards in Akked Al-Kanjalle neighbourhood house PH, CH 4:

“Sure, adding artificial equipment is useful in bringing comfort for the residents. I want a system that brings me fresh air in dust storms and I want to avoid the humidity in my sardab. We want the sardab back in the service of the family. It is very important in the summer and if I have these systems I will be happy” (Occ., 8, 2012).

In contrast, the interviewees stated that using active systems caused problems. One interviewee in the Um Al- Noomy neighbourhood house PH, CH11 said:

“How can we use the active systems without electricity? You must provide electricity and electricity has been a problem in Iraq since 1990 till now” (Occ., 21, 2012).

- **Possible improvement living solutions**

To explore the possible improvements for this type of house were asked what they thought were the possible solutions and an appropriate selection to improve living in a traditional courtyard house, and why.

The interviewees confirmed that the government must improve the national electricity first, so the residents could use more electrical devices. This was clearly expressed by one interviewee who had lived in house PH, CH11 Um Al- Noomy for 38 years:

“Electricity must be brought to the house firstly, and then one can think to add new systems to make life better for us” (Occ., 21, 2012).

At the same time, a significant number of interviewees indicated that the traditional can be more efficient by using new technology, and the traditional Baghdadi house can receive technology easily. For example, this was emphasised by one interviewee who worked as a professor in a university and lived in PH, CH3 Akked Al-Kanjalle:

“We and our house accepted all the additional modern technologies as highlighted in Figure 8.16 to enhance the performance and effectively control all spaces” (Occ., 5, 2012).



Figure 8.16: Adding different modern devices to avoid the harsh weather and enhance the performance (PH, CH3, 2012), (Author)

- (1) Adding air condition units on the ground floor,
- (2) Adding fans in the living room on the ground floor

The interviewees suggested the possible use of automated systems, in particular environmental treatment and improvements to the environmental performance. This is because the environment in Iraq is so harsh, especially at certain times, with heat and cold and the recent frequent phenomenon of dust and moisture which are hard to control, in addition to the emission of odours. It was thought that smoke detectors would be useful. The interviewee pointed out that the use of such systems would help to purify the air and make the atmosphere of the house more suitable for human comfort. As the dust storms decreased the natural lighting, the electrical lighting would help them to remain sociable, and to know and communicate with the outside

world, and to reduce fire risks in the house. This last aspect was important as many of these old houses would burn quickly. In this way, the interviewee added that there is a need to manage all the systems and find any error in them, because it was not surprising for the systems to stop suddenly. The solution was the addition of a retractable roof for the interior courtyard which could be closed during inclement and harsh weather. For example, one interviewee who lived in Um Al-Noomy house PH, CH10 explained one of the reasons behind his decisions:

"I've added systems such as a split air-conditioning unit for heating and cooling and other systems to improve the performance, but I would like to add more sophisticated systems, so as not to affect the home and keep it and increase its sustainability and make us feel more comfortable and we use all the space, without exception" (Occ., 20, 2012). Some of adding these device were confirmed in Figure 8.17.

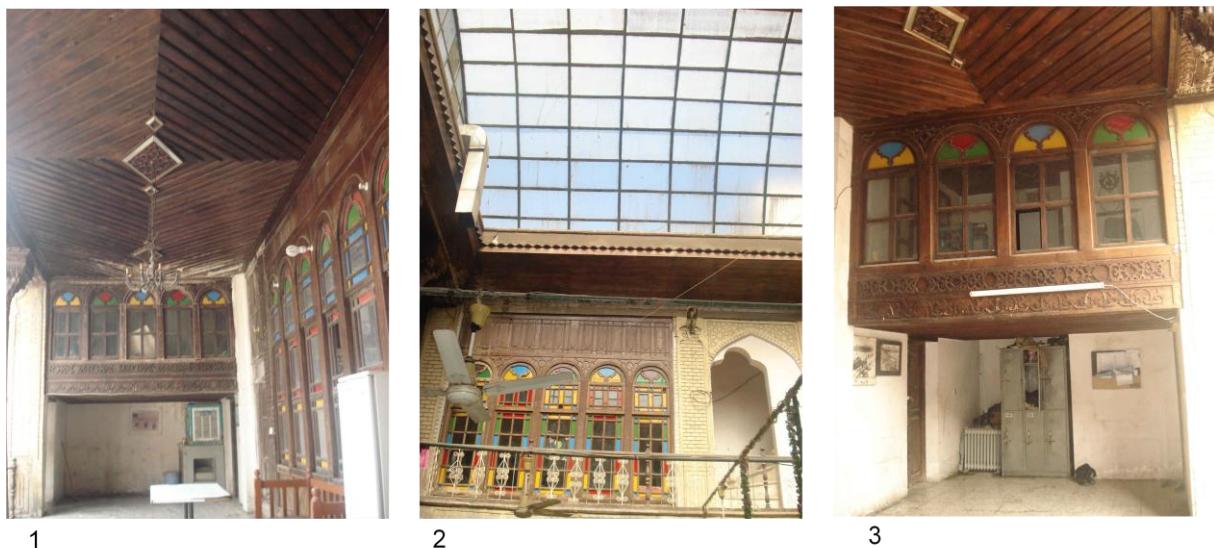


Figure 8.17: Different devices for improving the performance in the T.C.H.T in Al-Kadhimiyah (PH.CH.19, 2012), (Author)

- (1) Adding a ceiling light and air cooler on the first floor.
- (2) Adding fans and ducts for central cooling and heating to the courtyard.
- (3) Adding wall lighting in the tarma on the first floor

These interviewees suggested many choices for these systems. First, there was the addition of simple systems; second, there was the addition of electronic systems so they can use all the neglected spaces in the house. Third, low-energy consumption and low cost systems were important to many of these interviewees. This idea emerged in the account of one informant and his wife who lived in Aked Al-Kanjalle house PH, CH1, and worked as a branch manager for Al-Jamhuria newspaper, and was a retired civil servant:

"I am excited to add these systems, advanced technological and controlling systems are a good idea. I saw such a system on the internet, and today, we use light bulbs to introduce good lighting but consume little energy. We use self-charged fans; they are comfortable, useful and not expensive" (Occ., 1+2, 2012).

A similar example was given by another interviewee who worked as an employee in the care home orphanage of the department of welfare from Al-Anbareen neighbourhood PH, CH 12. She said:

"Using low cost systems like photovoltaic cells⁶ will fix the electric problem and then electricity will be generated without any expense or hassle" (Occ., 24, 2012).

In contrast, one interviewee and her daughter in the Akked Al-Sada house PH, CH6 considered automatic systems to be unhealthy; nevertheless, they had many such systems in their house:

"I don't mind adding the equipment but at night I like to control the equipment myself, and even by day partially because electronic systems make me lazy. I want systems that let me move around and stay busy all my day, so I will not be fat. I hate to stay without work. It is healthier this way" (Occ., 11+12, 2012).

At the same time, the interviewees indicated a desire for such systems and therefore they needed time to become aware of how to use and maintain or repair these systems. For example, one interviewee lived in Akked Al-Kanjalle house PH, CH4 alluded to such practices in his account:

"Perhaps we need to take some time to live with the new system so that we see it in your computer" (Occ., 7, 2012).

On other side, only the interviewees from the Al-Noomy neighbourhood could not decide if this system would be useful or not for them. This view can be explored in the account of one interviewee who had lived in PH, CH11 house for more than 40 years:

"I have no idea if there is equipment which works without human interference; you are the expert and please take the decision" (Occ., 21, 2012).

The interviewees indicated that their T.C.H.T was efficient and healthy, but needed a few of modifications, which may or may not be simple. The important point is that this technology will make the space highly efficient with the minimum of energy.

⁶ Such as use generating electric power system from special boards depends on sun

During the day in the summer time, the temperature sometimes reaches 60°C, especially in the afternoons, so these interviewees both need and want modern technologies added to the house. This was emphasised by one interviewee in the Al-Bahea neighbourhood house PH, CH8:

"The summer is extended to seven months or more in Iraq, and July and August are the hottest. In winter, the temperatures are very low for 45 days and as the residents lack technological support, it is very difficult to pass that period. We need a good ventilation system and modern automatic warm-cooling technology control (it has an electronic brain) to get thermal comfort and save energy. Also, we need an adequate provision of water and electricity with some devices that provide protection against any electrical malfunction, so no fire accidents can occur" (Occ., 15, 2012).

Furthermore, the interviewees wished to install the internet so they could maintain contact with the world through it. One interviewee and his wife in Akked Al Kunjalle house PH, CH1 said:

"We can raise the educational, cultural and cognitive level of a person through keeping in touch with the world and getting information. We believe its presence will widen our world and give us knowledge. We encouraged everyone to follow the latest inventions and scientific news of the world" (Occ., 1+2, 2012).

All the interviewees who had a sardab wanted to make some amendments to the basement. For example, one interviewee in the Al-Bahea neighbourhood house PH, CH8 expressed such as an idea:

"Using the same processes that have been used previously by the engineering company that dealt with traditional houses, they installed networks above the wooden roof in the Sardab and set up the pillars of iron, and dragged damaged wood, I think my houses have very good wood and probably better than the new wood currently used" (Occ., 15, 2012).

8.3.6 Occupants' priorities and miscellaneous comments

When the interviewees were asked what their priorities were, they said that their dream was to live in a healthy comfortable space with their children. Through the diagnosis of the problems with these houses, and the solutions to them, one can produce a house which can be considered very comfortable at different times of the day and different seasons. It will also deal with improvements to the performance of the house and increase the efficiency of its services through rehabilitating the present

system. The interviewees agree with the idea of adding new systems without human intrusion. This view can be explored in an account by one interviewee who lived in the Al-Bahea neighbourhood house PH, CH8:

“My wish is to use some kind of automated systems in the home which maintain the architectural features and keep it from external influences” (Occ., 15, 2012).

The interviewees were asked if they wanted to raise any other points. The interviewees said that there was no care or attention by the government for such T.C.H.T. This traditional heritage house was rare and part of a great civilization and culture must be to identify such examples. One interviewee with her daughter in law from the Akked A-Sada neighbourhood house PH, CH5 explained in their accounts that:

“It is impossible to build houses like this these days due to the lack of professionals and builders as they were before, so we need the government to put aside an amount of money to repair our historical house. It is the owner through maintenance as part of our heritage, then people will not desert them, and families can stay in them their whole life. You cannot form a relationship between families and neighbours except if you live in such houses with its narrow alleys” (Occ., 9+ 10, 2012). Figure 8.18 confirmed that



Figure 8.18: The architectural appearance of the T.C.H.T in the Al-Kadhimiyah (PH, CH 5, 2012), (Author).

The interviewees, who were living as tenants in these houses, indicated the most important aspect was to own the house, so the occupants could control the repairs and maintenance, and develop, control and save the house; otherwise, the state

needed to repair, maintain and preserve these historical houses continuously. This was articulated by the wish of one interviewee who had lived in Akked Al- Kanjalle house PH, CH3 for more than 30 years as a tenant:

“I would love to own this house and we were promised repairs, but nothing comes from all these promises” (Occ., 6, 2012).

One interviewee confirmed that these types of houses had great features that were suitable for the hot weather, and the use of such designs in future should be encouraged after making some adjustments in proportion to the environmental changes. An interviewee who lived in Akked Al-Kanjalle house PH, CH1 said:

“I believe modern architecture must have their inspiration from our heritage in designing our modern houses. We need to use arabesques, arches and Islamic decorations in their designs. Bricks must be used instead of cement blocks that are not fit for our hot weather” (Occ., 1+2, 2012).

Another interviewee from the Al-Bahea neighbourhood indicated that it is very important to make these houses sustainable to save energy, as well as to maintain good social relations. The traditional appearance of the houses as historic and heritage buildings needs to be maintained with the help of professional people who can handle the conventional and traditional home features without affecting this type of architecture. This interviewee explained his idea who lived in PH, CH8 Al-Bahea neighbourhood:

“It is important for me is to keep this house and its sustainability, and restore the basement if I had the opportunity to use craftsmen, such as workers from ancient Karkh, and as a legacy of civilization for future generations. And the emphasis on the use of the basement and reuse it for Bad-Geer is distinct in these homes with minimum consumption” (Occ., 15, 2012).

8.3.7 Additional aspects

Other aspects were revealed from the interviews when we discussed the existing situation in the T.C.H.T with occupants in the Al-Kadhimiyah historical area.

- The limitations or constraints that need to be replaced**

In general, when we focused on the services problems of T.C.H.T the interviewees highlighted some limitations or constraints that need to be replaced, such as:

The interviewees were tenants, as the government owned many of these houses. The state had spent about one million dollars on each house to make it a historic

monument. Most of these houses were historic or heritage houses, so the families were limited in terms of what they could change. This was emphasised by one interviewee, a housewife who lived in Akked Al Kanjalle house PH, CH3:

“This house belongs to the state, we want to repair it but the contract is very difficult. The walls are decorated with distinct inscriptions and architectural landmarks that I hate to destroy or to change the heritage. I love to keep the house as a historic monument” (Occ., 6, 2012).

The interviewees confirmed that all these houses, and had been abandoned by their original owners for 40 years now; some parts houses had decaying equipment and there was no one to help the occupants to improve these houses. It is useless to make small changes without repairing the whole house such as these houses in Figure 8.19.



Figure 8.19:

Some T.C.H.T in the Al-Kadhimiya had been abandoned by their original owners, (Author):

- (1) In the large part of the house with the big courtyard (PH, CH. 9, 2012).
- (2) In the ursi/ living room on the ground floor (PH, CH. 4, 2012).
- (3) All houses (PH, CH. 3, 2012).
- (4) Some service places (PH, CH. 7, 2012)

In contrast of that other houses had continually maintenance by the owners or the tenants as confirmed by Figure 8.20.



Figure 8.20:

Other T.C.H.T in the Al-Kadhimiyah had continual maintenance by the owners or tenants, (Author).
 (1-2) Painting of the doors and windows by the tenants to add protection from insects (PH, CH. 1, 2012).
 (3-4) Refurbished the finishing of floors and walls on the ground floor, connecting to the public drainage pipe, and adding a new water pipe by the owner (PH, CH. 6, 2012)

Furthermore the interviewees, on different occupants living in these houses, refused to spend money on a house that was not theirs. Also, it is difficult when a consensus has to be reached between at least two householders.

Although the interviewees indicated that the greatest limitation was the continuous interruption of national electricity, which paralyzed all activities without exception for all 12 courtyard houses; life was difficult without electricity, and some spaces were not used as efficiently as others, either because of a continuous cut in electricity or because people felt they were depressing. Of course, all families sleep in one or two places, as neither the children nor the adults can carry out chores, studies or reading

at night if the electricity is not working. All the work for housewives was affected by the absence of a special place or space to do it in. Moreover, the instability of the electricity was a potential or in corrected of changing the electricity supply current make a fire hazard. This was emphasised by one interviewee who had lived in PH, CH10 Um Al-Noomy for 30 years:

“The strong and big constraint for me is when there is no electricity, as freezing cold, extreme heat, and dust storms prevent us from doing a lot of work inside the house, especially my wife” (Occ., 20, 2012).

The interviewees indicated there are changes in the political, social, and environmental situation that prevented them from using certain spaces such as the roof or sardab. Moreover, there were economic limits to their use of cooling or heating and lighting systems, or to their simultaneous use of different machines, because of the limited use of amperes from the local generator. For example, one interviewee who had lived in the Al-Anbareen neighbourhood house PH, CH12 for 15 years illustrated that:

“When we depend on electricity from private generators heating becomes so expensive and we're not able to heat all over the house at same time” (Occ., 23, 2012). Figure 8.21 confirmed the breakdown of generator in the current house.



Figure 8.21:

The continuing breakdown of the generator in the current house meant an unstable electricity supply and a lack of continuous heating or cooling in the house (PH, CH. 24, 2012), (Author).

The resident interviewees referred to the continuous noises from local or private generators during the year. One interviewee and his wife who lived in Al-Kanjalle house PH, CH1 said that they did not use a private generator in summer at night:

“We avoid using our small electrical generator since it makes a loud noise and we prefer to stay in a dark and hot atmosphere rather than disturb our neighbours” (Occ., 1+2, 2012).

- **Government involvement**

Interviewees who had been living for more than 20 years in the Al-Kadhimiya historical area, especially in the Al Bahea, indicated that the government maintained few of the traditional houses. An Indian company repaired the houses and covered the inside walls. The thickness of each outside wall is 150cm. New water pipes and reservoirs were added to them. All the sardab were repaired and new electrical lines were installed. Many houses were connected to the main sewage system. During the rehabilitation of a few traditional courtyard houses in the 1980s, especially in Akked Al Kanjalle, central cooling and heating systems for the whole house were established, but the misuse of this system by past tenants made it useless to them and now they needed a large amount of money to be fixed. The plans were abandoned suddenly for no reason before completion, and the state put the houses up for rent. The tenants (from 1970 to present day) neglected some of these houses and let them decay. One of the ideas repeatedly mentioned by one interviewee in the Al-Bahea neighbourhood house PH, CH8 was that:

“An Indian company repaired the houses but not in a very good way. We can see differences between the old and new building materials. Anyway the sardab were repaired and many systems added such as cooling, heating and new sewage system and others” (Occ., 15, 2012). See Figure 8.22 which explains the refurbishing of one house as a case study.



Figure 8.22: Refurbishing the sardab of the T.C.H.T/ Al-Kadhimiya by an Indian company (PH. CH10, 2012), (Author)

It should be mentioned that the environmental challenges due to modifications were determined according to the type of courtyard house. For example, for the interviewees' problems had arisen because their original T.C.H. had been divided into two after the 1980s by government, although each part retained its own courtyard. The house in its original planning had been divided into winter and summer quarters, so now the family found it difficult to heat or cool; there was also an absence of special service places. This idea is expressed in an account by a couple of families who lived in Akked Al-Kanjalle house PH, CH1:

"The first house, as we believe, was the winter quarter, and the sunrays do not enter it due to the incorrect division, so my neighbour suffers from cold in winter. The second part was for summer, and this is where we live, so we find it difficult to cool it. The second main problem is the absence of a kitchen, while the other house has the original kitchen" (Occ., 1+2, 2012). Figure 8.23 provide how the occupants change the Iwan into the kitchen.



1



2

Figure 8.23: The transformation of the Iwan as a semi-closed space into a kitchen in T.C.H.T (PH.CH.1, 2012), (Author).

- (1) From the inside, the space contained oriental ornaments which are difficult to clean.
- (2) From the outside, the space used a nylon sheet because of the limitations on making changes

In contrast, just one interviewee in a T.C.H.T had two courtyards which had not been divided. This is an example of a small family in a large house, so the family had neglected the bigger courtyard due to the difficulty in warming or cooling it, or keeping it tidy, as well as controlling insects and rodents. Therefore, all activities were concentrated on one courtyard. One interviewee expressed such a scenario in their account who lived in Um Al-Noomy House PH, CH9:

"Today, we use the smaller courtyard as a kitchen for cooking, and washing dishes and clothes but new sewage pipes was added and ventilation was needed. The room

opening on to it was used for sleeping and as a living room, so all activities were concentrated on one courtyard" (Occ., 17, 2012).

- **Repair and maintain**

Another new issue was revealed when we discussed how the occupants enhanced the comfort in their house. Two interviewees clarified that the owners refused to repair the house, or the occupants had no money to repair and maintain it. Also, a significant number of respondents and their families tried to save money to repair most of these houses. This idea was articulated in an account by one interviewee who was the owner of a house in the Al-Baheya neighbourhood house PH, CH8:

"Our house is better than any house in the neighbourhood because we took good care of it; we tried to repair it as our budget permits us. This year I spent ten million Iraqi dinars on it. We buried part of the sardab due to the high level of underground water and the sewage and water systems" (Occ., 15, 2012).

The damage to one house in the Um Al-Noomy neighbourhood house PH, CH9 occurred to the large courtyard and its spaces due to the recent damaging political events in the country. Since 2003, the family had been unable to use it and lacked the money to repair it fully. The interviewee said:

"During the last war, a rocket fell near my house and damaged a part of it and we rebuilt this part on our own expenses; however, we could not rebuild the entire house" (Occ., 17, 2012). See Figure 8.24 which clarified that.



Figure 8.24: Damage to the large part of the house with the big courtyard in the Al-Kadhimiyah (PH, CH9, 2012), (Author).

- **Memorial experience**

The new issues which emerged during the dialogue with occupants revealed that one house in Akked Al-Kanjalle was the house of the “Astrebady family”, and was the house that the former Prime Minister of Iraq, Nori Al-Saeid, used for shelter in 1958. In the 1970s, the Iraqi government wanted to turn it and its neighbouring houses into museums or “historical classical houses”. Another house in the Al-Anbareen neighbourhood had been visited by different famous persons such as the president of the government. A few of these houses had been conserved as heritage houses, and were selected as a sample setting, such as all the houses in Akked Al-Kanjalle, two houses in Akked Al-Sada and the same number in Al-Anbareen, and one house each in Al-Bahea and Um Al-Noomy. See Figure 8.25 confirmed that.



Figure 8.25:
Special memories in the T.C.H.T in the Al-Kadhimiya, such as these in (PH, CH 10, 2012), (Author).

Lastly, interviewees highlighted that there has been a great deal of research on this house and they had been visited by several workforces over the years (since the house was owned by the state). There had been a large number of talks and suggestions, but nothing practical had occurred. The occupants paid for maintenance from their own money and were promised compensation which never arrived. The families had no idea why they bothered with all this work without doing something good, or providing money for them to do it. For example, one interviewee who had lived for a long time in the Um Al-Noomy house PH, CH5 neighbourhood with her daughter in law said:

“Many proficient persons visited our house and suggested different ideas to develop and enhance our comfort; unfortunately we didn’t receive any thing they promised. We put aside a certain amount every year for maintenance. The state should do the same” (Occ., 9+10, 2012).

- **Socio-economic state**

Another new aspect which emerged when preparing interviews with the occupants was the different levels of socio-economic status of the occupants in terms of ownership of the house, being tenants, or they owned this type of house, for reminding this house in city center. Also, depending on their properties (such as who had built a new house in the same area, or they had a textile factory or small shop for candy), they had a monthly income, but some did not have a steady job. Furthermore, regarding the number of family members who had a job in each house, it was found that the majority of adults had a job, such as a tailor in a nearby factory, a servant or helper for old persons, an employee in an orphanage run by the Department of Welfare, Mayoralty of Baghdad, a retired civil servant who was a branch manager at the Al-Jamhuria newspaper, a tourist policeman, a researcher, an owner of a small mobile vending shop selling sweets to children, and an owner of a food and textile factory making towels outside the area. Also, one made baskets from reeds and palm leaves and sold them, as well as drawers, and other patterned designs. The last but not least depends on the type of furniture and device in this type of house, and the house type.

However, we can consider those who lived in these types of houses were rich in other ways. First, the occupants had a strong relationship with, and sense of security from, their neighbours, and therefore the occupants all felt like one family. Second, the T.C.H.T. was near the holy shrine of the great Imam-Abu Hanifa, and this seemed for the residents to make the T.C.H.T. as blessed as the whole area. Third, these houses were close to the market and city centre and near to places where many members of the family worked. Fourth, the economy of the rent suited their income. Fifth, they had good memories of being in it.

8.4 The everyday life of current users of the traditional courtyard house type in Al-Kadhimiyah

This section now presents the findings of this investigation. As shown in Table 8.1, an introduction to the T.C.H.T in the Al-Kadhimiyah historical area from the data collected from the occupants will now be presented thematically. This table is quite revealing in several ways, from the comparative data, it is apparent that:

- 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

- 11 out of 12 houses were tenants and just one house was occupied by the owner in Al- Bahea neighbourhood.
- The residents in these houses were not just from the middle or poor classes, but were rich also according to different criteria, such as owning a T.C.H.T which is in city centre with a factory, or in a few cases all the family members had a job and a monthly salary, or, regarding the house type related to maintenance, furniture, and others. However, we can consider that those who lived in these types of houses were rich in terms of security, their strong social relationship, and being near the city centre and work.
- The number of occupations in these T.C.H.T according to the household was not related to the size of the house, as we found there was a small family living in a big house, such as PH, CH9. Also, there were big families living in medium houses, such as PH, CH 11 in the same neighbourhood of Al-Anbareen.
- There were different genders living in these types of houses.
- All these houses were occupied by variously aged children and adults, as well as older people, except for one house which had no occupant children in Al- Bahea neighbourhood.
- The occupants had different levels of education, starting from a basic ability to read and write, to a professional researcher.

Turning now to the experimental evidence on section 8.3.1 include:

- The occupants occupied the house 24/7 around the year of twelve houses in different neighbourhoods.
- Many residents had lived in this T.C.H.T 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 with his wife lived in Al- Kanjalle neighbourhood, saying:

“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). However, younger occupants had left these houses for different reasons.

The everyday activities for the current users of T.C.H.T. in the Al-Kadhimiyah historical area in terms of the relationship with place, time and possible changes

were described according to the place-time and place-activities this changed effect of the original lifestyle through the seasonally movements (see section 8.3.2). Strong evidence of this was found when:

- The occupants moved continually from place and space to other at different times in the twelve T.C.H.T in different neighbourhoods.
- The occupants did different activities in the same place or the same activities in different places.
- The families used all the spaces and levels all year, and other families used specific spaces for specific seasons such as those families that live in A-Bahea, and Al-Anbareen neighbourhoods.
- Occupancy rate emphasises the importance of this type of house; the occupants partially occupied these levels, places and spaces during the day.
- No specific activities were done on specific levels, places, and spaces except for house in A-Bahea neighbourhood.
- The occupants were focused on using different spaces and places during the day for their activities
- The occupants were focused on using different levels during a specific season to perform their activities

Also, the most interesting aspects of T.C.H.T. is how they addressed environmental conflicts and struggles due to dealing with weather problems, T.C.H.T., frustrating aspects of environmental performance, types of problem in the night and the cost of services all which expressed that problem with house performance that effected on the space occupancy (see section 8.3.3). The findings show that:

- The occupants used all the levels, places, and spaces of the house at specific times around the year.
- The occupants had tried to change the physical environment, such as closing the open spaces in specific seasons.
- They used heavy clothes in winter and the opposite in summer
- The occupants used oriental carpet in winter and removed in summer.
- The occupants used the places and spaces that faced the sun in winter, and avoided them in summer.
- The occupants sprayed the courtyard with water on summer days, and opened the windows on summer nights.

- The occupants gradually stopped using some levels, places, and spaces for different reasons such as the roof in summer, the sardab in winter, and others.
- The service rooms were the most communally used in the T.C.H.T. and these suffered from high levels of humidity, and increased odour levels during usage or smoke when preparing food.
- They used different modern devices in different seasons in whole house. See section 7.3 clarifies the location of different modern device in each house.
- The occupants used the TV and mobile as their main devices, as well as the internet for communication and information.
- Each family had connected with a private and/or general generator in addition to the national supply; two of these families had a private line, and two lines with general generators, and changeover had been added in all the houses.
- New sewage and drainage, and new pip had been established houses.
- Also, the occupant's changes in some space functionality or closure of some transition spaces had occurred.
- The occupants used incense specially in sardab during the winter
- Last but not least, the walls were painted continually, or covered with plastic sheets or with wools in winter.
- All the occupants in each house shared one bathroom, one toilet, and one kitchen. except house in Al-Anbareen neighbourhood without bathroom.
- There seemed to be difficulty with ventilation and lighting during dust storms, water shortages in summer, and difficulty with thermal comfort around the year.
- Also, there was difficulty with security as the occupants were burgled many times.
- Al occupants had obstacle with humidity in T.C.H.T in the Al-Kadhimiyah historical area is due to three rezones: in the sardab, it is because of the recent rise in the water table as a result of modernization to the river side, on the ground floor, it is because of rain water not draining correctly, in some service places, it is due to adaptations to services which have not been correctly installed. Almost all previous aspects had bad maintenance or a lack of service systems which caused high levels of humidity.

Furthermore, the previous paragraphs in section 8.3.4 provide significant evidence of the evaluation of the environmental performance as related to health/satisfaction and environmental comfort linked to the season, day or night time, levels, room, and place which interestingly found:

- The occupants found that the health of the house was related to the level of service due to the level of control of house performance.
- Not all the house was comfortable around the year. Some levels, places and spaces were comfortable at specific times.
- The hot and cold weather were uncomfortable, and the first floor was uncomfortable during the daytime in summer and night in winter; the ground floor was uncomfortable during the summer between the afternoon and sunset, but the day was generally better than the night time.
- The spaces and places on the ground floor were more comfortable than those on the first floor in summer, and the ursi was more comfortable than other rooms. The service rooms were uncomfortable during usage time.
- There was difficulty using different devices at specific times due to increased energy consumption.

Additionally, the current study referred to the enhancement of the environmental situation according to the use of comfort-artificial systems and the possible improvement living (see section 8.3.5). Therefore the different issues presence which includes:

- The occupants without exception had tried to enhance the house performance by adding different modern devices to the house; however, they still had problems with the house performance
- The occupants required systems that would help them to enhance the environment, such as enhancing the thermal comfort, reducing the odour level, and reducing energy consumption. These would also enhance the social aspects, such as increased communication with others
- The occupants agreed with adding new systems to their houses if they were easy to use, and inexpensive, among other factors
- The occupants were happy to add new systems in these types of houses as part of modernization.

Also, the other interesting point to find according to the occupants' priorities and comments in section 8.3.6 were:

- To live in healthy and comfortable environment for them and their children through control of the lighting and ventilation during the dust storm, the thermal comfort during the harsh weather, the humidity during the rainwater or during the

heavy usage of places, the E-communication during the heavy usage, energy consumption in different time, and other. Turn to 8.3.6 the occupants confirmed that A healthy lifestyle means being comfortable in the house where you live throughout the year.

In section 8.3.7, the final interesting points to note from the additional issues are linked to repair and maintenance, government involvement, memory, and socio-economic status:

- Limitations of changing this type of house as show in PH.CH12
- The attention paid to these houses by the government since 1980
- The need for continual improvement.
- Most of these houses had different historical values
- To return again to Table 8.1, that confirmed of the residents in T.C.H.T were not just from the middle or poor classes, but were poor and middle class regarding the number of family members who had a job in each house.

We have summarised the different views expressed, and seen that there is similarity and difference in the comments from the occupants in the twelve T.C.H.T in the five neighbourhoods of the Al-Kadhimiyah historical area. There was also a mixed perception according to the data obtained from the occupants in relation to different facts. There is quite an interesting perspective concerning their emotion about this type of house, in which many occupants had been born, married or had children, held an excellent job, or other reasons. However, the reality of things is that part of the difficulty living in the T.C.H.T was that the occupant was not the owner. On the other side, there is difference and similarity between the classified comments of occupants in different neighbourhoods and the physical survey of these houses that were occupied by the interviewees, such as occupants (15 and 16), who occupied PH. CH8. These occupants or occupants (21 and 22) lived in house PH. CH11.

The key question is what the overall picture is or what is the nature of this type of house? While there is no clear picture, there is also no uniform one. Yes, there is similarity between these twelve T.C.H.T in the same area of Baghdad, but at the same time there is a lot of difference between the five neighbourhoods, as shown in Table 6.1. What can be seen in this small area of Baghdad with this kind of house is that there is nothing uniform about them, so the whole idea of T.C.H.T is that there is a lot of variation even within a small area. There is a difference between

neighbourhoods and the houses in the same neighbourhood. The occupants had the same needs in this house or different needs to be valid even the government triad to rehabilitee and have the ability to rebuild this type of house. What is base of rehabilitate them that can be bigger questioning which I can say technique perhaps. Yes we can have a system but the other biggest question is if the T.C.H.T really needs the intervention because it seems the clients do not, such as those who said it was too expensive to build such houses with very thick walls, and what about other opportunities.

In the end, this information helps us to understand other details of the T.C.H.T in Al-Kadhimiyah which can enable the IS to make a difference. Also, because there is variation in the houses, there can be no uniform approach to applying IS in the T.C.H.T.

8.5 Summary

This chapter has explored how the occupants were selected, and review of the occupants lived in this type of house which was presented according to what the data say started to general review of occupants in T.C.H.T., everyday activates/ place and time, conflicts and challenges, evaluation of environmental performance, enhancement of environmental situation, occupants' priorities and other miscellaneous, and additional aspects. Then, it has presented what the findings through the everyday life in this type of house. It is interesting to note that in the current study there are different lifestyles and different activities for people to do.

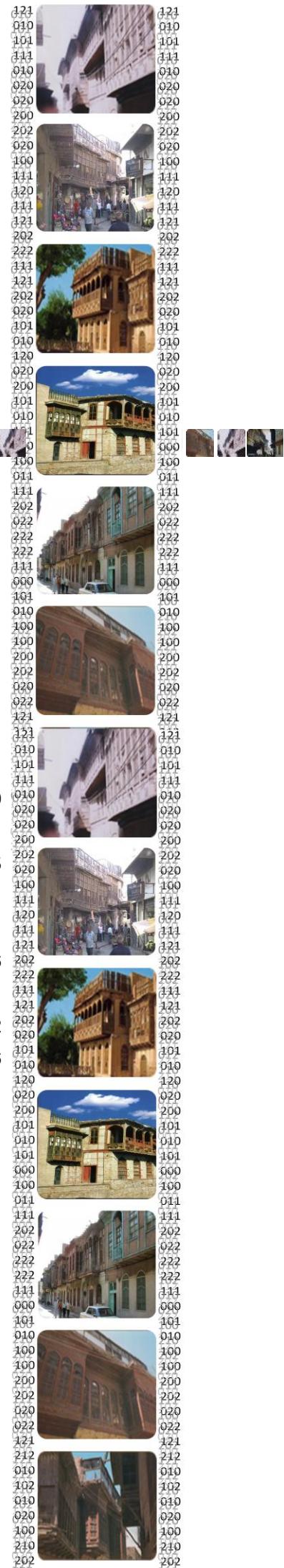
The total picture was completed from the physical survey, in parallel with the occupant interviews. It can therefore be seen that, in general, the key issues of these T.C.H.T in the Al-Kadhimiyah historical area in Iraq as found in the interviews with architects, and these with the residents in Al-Kadhimiyah, and were in alignment with those arising from the results of the physical observation of the houses. However, one can ask whether the different kinds of lifestyle for the current users in 8.4 are affected by different conditions of T.C.H.T. in the Al-Kadhimiyah historical area as shown in Chapter 7.4. The strengths and weaknesses of the T.C.H.T. as confirmed by architects are shown in Chapter 6.4. The next chapter is a second stage of analysis will discuss in depth and explore what these findings mean.

Chapter Nine:

Research findings and discussion



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9. Research findings and discussion

9.1 Introduction

This chapter aims to crystallize the emerged knowledge with the intention of use the ideas extracted in the current study to provide research findings. Through explores in depth the ideas arising from three different sources and the interrelationships between these, the T.C.H.T and possible linkages with IS., driven by the research question.

This chapter was classified into two main sections: first section refers to environmental control, challenges and social struggles. Second section focuses on the IS related to T.C.H.T.

9.2 Environmental control, challenges and social struggles of the traditional courtyard house

This section is the start of the second stage of the in depth analysis which explores what the data mean. In Chapters 6-8, an overall picture was sketched of T.C.H.Ts in the Al-Kadhimiyah historical area in Iraq that provides the first stage of analysis. It was found that many issues expressed in the interviews with architects, and issues expressed in the interviews with occupants, were in accordance with the physical survey. Also, there were issues expressed in both interviews, and the occupants as the main source were in accord with the views of the architects. These different issues can be interpreted and converge around a core of three themes for the current study. Each theme reflects the detailed features of the main idea in connection with the new ideas which arose.

9.2.1 *Partial control of the built environment*

Partial control of the environment means the ability of the building fabric response and human level response to achieve control of the environment, and make modifications in response to different environmental condition but at specific times. In other words, it means what the occupants have at their disposal to maintain control of the environment. The following two issues explore this theme, and Figure 9.1 summary of the key relationship that were identified

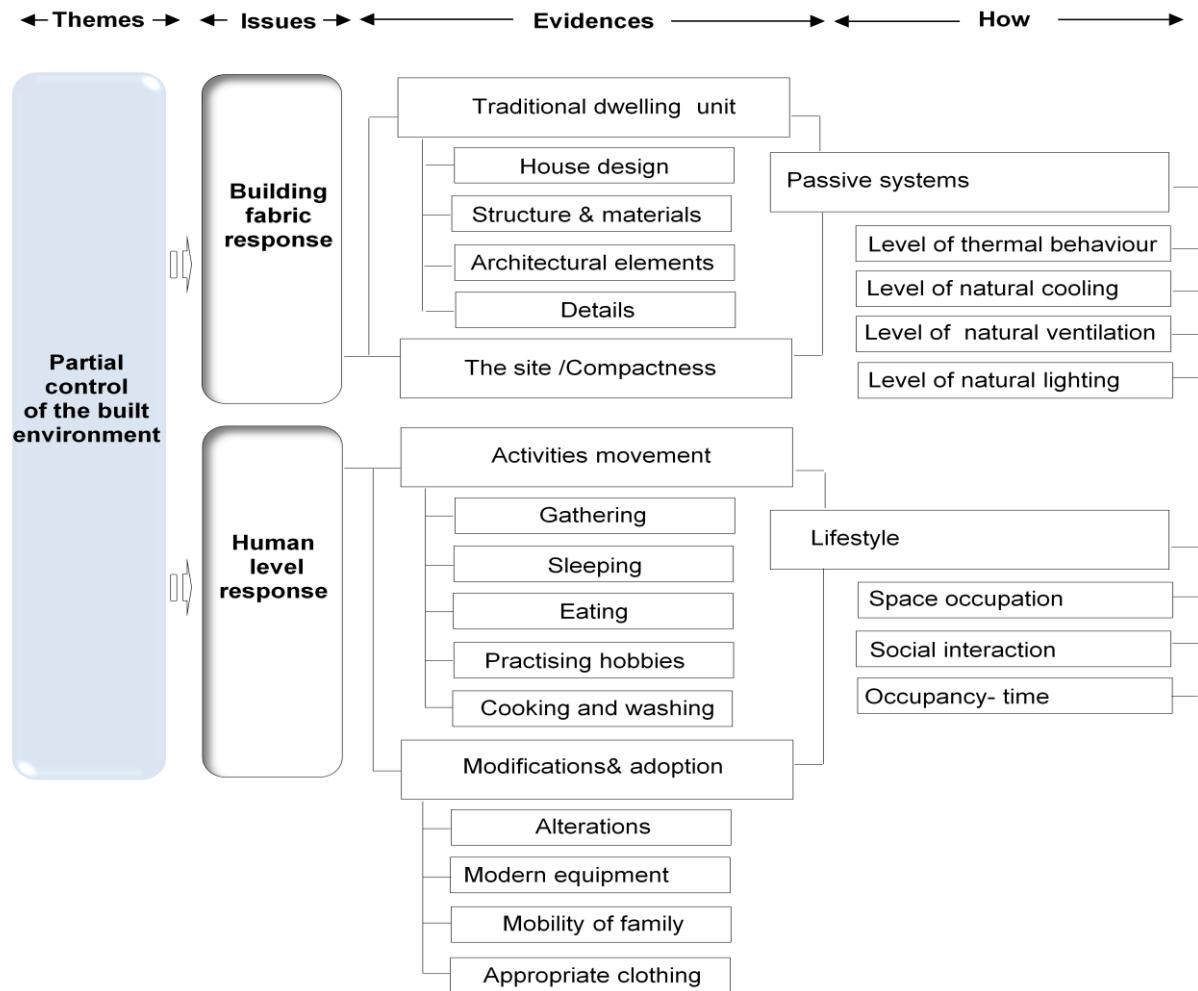


Figure 9.1: Partial control of the built environment related to main issues in the T.C.H.T in the Al-Kadhimiya historical area, (Author).

1. Building fabric response

This means what is in the building that allows a response to environmental conditions. The building fabric response achieves partial control of the environment through its passive systems. The systems of this type referred to in this study are the assembly of natural and architectural components which convert elements of the climate and deliver heating, cooling, ventilation, and lighting without mechanical power (Agha, 2015, p.30)

The evidence from the three different sources –architects, occupants and physical survey were in accordance with the literature review, which explored the building fabric response through the following items:

- **The traditional dwelling unit**

It is further classified as:

- **House design**

The design of these houses accounts for environmental factors and controls of the local environment conditions which are designed to maximize its massive cooling potential in summer and its power to warm in winter. The whole house design helps to create a localised mini atmosphere by minimising undesirable thermal gain in summer and loss in winter. It creates an environmental transition of heat and light in the space between the outside and inside of the home, providing appropriate lighting during the day, and moving the air around during the year. All these lead to achieving an excellent system for cooling, heating, ventilation, and lighting for the dwellers of the T.C.H.T in the Al-Kadhimiyah, working without the use of mechanical power and so providing thermal comfort.

- **Structure and materials**

Here, this means the elements that are used to move the load from the house to the foundation by the style or method of material used in the house. The structure and materials of the T.C.H.T control of the changes in arid environmental conditions.

The use of a heavy weight structure of thick brick walls¹ for the T.C.H.T in the Al-Kadhimiyah 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 heat 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 T.C.H.T in Al-Kadhimiyah (see Table 7.1), and by also an architect with practical and theoretical experience in T.C.H.T in Baghdad:

“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” (Arch., 6, 2012).

Furthermore, the T.C.H.Ts in the Al-Kadhimiyah were built with local building materials, in addition to using natural resources for the elements in their structure, such as brick, stone, wood, mud, gypsum, clay, soil, and palm. These are highly

¹ These walls consist of outer and inner layers with a soil-filled centre, and are also covered with liner (Arch., 21, 2012).

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 T.C.H.T 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.

- Architectural elements

The architectural elements in the T.C.H.Ts in the Al-Kadhimiya include: the courtyard, the shanasheel, and the bad-geer that control of the local environment conditions in this arid zone area (see Figure 9:2).



Figure 9.2: The shanasheel as architectural element, in the T.C.H.T in the Al-Kadhimiya, creates the passive system which contributes of partial control of the environments, (Author): (1)(PH.CH. 5, 2012), (2)(PH.CH. 12, 2012)

These elements enable direct sunlight to be gained, help the adoption of sunrays, and provide a level of lighting regulation. It diverts warm air and light without allowing strong sunlight to enter the whole house directly in winter, while avoiding it in summer. It has the ability to reduce high temperatures and transfer heat in the summer, by intercepting cooler air and providing continuous interior cooling. It works as a cold-store at night, when the temperature drops on hot summer days, for example. It maintains air flow, provides good cross ventilation during the day, and less dusty air flows. Insulation from external noise is successfully minimized by

blocking all high audio frequencies through filtering or absorption, and only low audio frequencies are permitted.

It seems possible that the building fabric response employs a combination of architectural elements to bring all the desired natural elements together, and secure communications with the sky and sun, wind, and temperature. This is achieved through the location, direction, shape, size, and three dimensions, as well as the fact that the construction of these architectural elements is from natural materials. In this way, these architectural elements provide lighting, ventilation, and cooling and heating systems without mechanical power in the T.C.H.T in the Al-Kadhimiya and so provide thermal comfort.

- Details

Lastly, the details and decorative level in the T.C.H.T in the Al-Kadhimiya are also response of several variable environmental conditions and are capable of dealing with the local environment. These features include: the finishing of floors, walls and ceilings; the shape, size and type of finishing; the presence of a small garden and fountain; several different-sized slots in all the levels; small mirrors and tiny pieces of coloured glass; the use of light painted colours, and ornamentation, among others as confirmed by Figure 9.3. Such details are used so the light can reach the deepest house spaces, places and levels, and they also reduce the surface and air temperature, and humidity, as well as storing heat or retaining coolness in different seasons. This view can be explored in the account of one interviewee who lived in these houses:

“The T.C.H.T in Baghdad maintains and enhances comfortable conditions with a distinct architectural design and a private soul and decorative components such as the mirror, ornaments, light colour and many others” (Arch.LI, 10, 2012).

The building fabric response due to these details leads to an excellent natural environment for the dwellers of the T.C.H.T by non-mechanically powered cooling, heating, ventilation, and lighting systems, which again thermal comfort.



Figure 9.3: The details create the passive system which contributes of partial control of the environments in the T.C.H.T in the Al-Kadhimiyah, (Author). (1) Mirrors (PH.CH. 10, 2012), (2) Slots (PH.CH. 3, 2012) (3) Coloured glass (PH.CH. 8, 2012), (4) Coloured glass (PH.CH. 10, 2012)

- **The site/ compactness**

There are specific characteristics connected to the conciseness of the urban fabric, which creates coherence between the traditional dwellings; these are joined to hundreds of similar houses built closely and compactly together. This formation of a united compatible fabric due compactness is a response to the local environment. This view can be explored in the account of one interviewee who had experience of CHs and worked with them to rehabilitate and develop T.C.H.T in the Al-Kadhimiyah, especially:

“All the traditional units in Iraq are connected together and there is a relationship between the mass and the vacuum and other factors which is a response to the different environmental conditions” (Occ., 9, 2012).

The line-up of these T.C.H.Ts in the Al-Kadhimiyah, does not leave any space for heat transfer, and therefore the undesirable thermal gain in summer is minimized, by decreasing thermal loss from the inside to outside. Also, it creates natural air flow and provides appropriate lighting, making the whole fabric work as one unit. Therefore, the building fabric response through the coherence of the surrounding unit is a natural way to provide ventilation, cooling and heating in the T.C.H.T through the present systems that work without mechanical power. This, in turn, enhances thermal comfort. One architect interviewer who had published a few research papers in the T.C.H.T. field in the Al-Kadhimiyah historical area, noted:

“The urban plan of historic area in Baghdad was spontaneous, because of certain environmental circumstances that give us intelligent solutions according to ancient time measurements. It provides the residents with all their needs and comforts them in an efficient way” (Arch.LI, 7, 2012).

It is interesting to note that the building fabric response created passive systems in T.C.H.Ts. which encourage thermal comfort in this type of house. Thermal comfort is the state of being subjectively satisfied with the temperature of the environment (Al-Zubaidi, 2002). Passive systems can be classified as follows:

- **Level of thermal behaviour**

It uses a balance of heat loss and gain² to achieve thermal comfort (Raman et al., 2001) that provides inner comfort for the occupiers by allowing only slight temperature changes, reduced to the minimum, for thermal loss from inside to outside, in response to changes in environmental conditions. This balance maximizes the massive cooling potential in summer and power to warm in winter, by enhancing the thermal insulation. Thermal gain and loss is a slow process in T.C.H.Ts. compared to the external environment that works to reduce changes in the temperature. One idea mentioned by an architect interviewee, who is a consultant of developing T.C.H.T, said:

“In Iraq, T.C.H.T loses heat faster than it earns, but, during the day, it gains heat very slowly. This gain and loss of heat was studied perfectly and lead to clear thermal comfort” (Arch, 20, 2012). Thermal behaviour of T.C.H.T in Al-Kadhimiyah was achieved by responding to changes in temperature on the outside. It provided thermal comfort without mechanical power.

² Heat gain and loss –heat gain is the transfer of heat from outside to inside, while heat loss is the opposite.

- **Level of natural cooling**

This occurs when the occupants employed non-technical methods from indoor spaces to maintain a comfortable indoor temperature (Gratia and Herde, 2004). Natural cooling is linked with shading, the stack effect,³ and thermal inertia⁴ by keeping this T.C.H.T in Al-Kadimiya cooler than other houses. This depends on natural resources such as soil, sun, brick, and wood, all of which help drive this procedure through air movement to cool the places and levels in this type of house. These methods respond to changes in the environmental condition. For example, an interviewee who had been living in a T.C.H.T/ Baghdad for more than five years, explained:

"In summer, the Baghdadi house was cool and had the most convenient temperature due to the movement of air across the yard and from the bad-geer. Therefore, it has the ability to reduce high temperatures and provide a comfortable atmosphere for us" (Arch., 16, 2012).

Natural cooling of T.C.H.T in Al-Kadimiya enhances the air movement as a method of cooling the house that definitely changes the temperature. This method led to natural cooling without mechanical power, and thus enhanced thermal comfort.

- **Level of natural ventilation**

Such ventilation occurred by the supply and removal of air through an internal space but without the use of any mechanical power (Gratia and Herde, 2004). Natural ventilation in T.C.H.T of Al-Kadimiya is linked to the air flow⁵ and air cross⁶ to achieve fresh air.

The air movement of the T.C.H.T in Baghdad is created by different pressures at different times in response to the environmental conditions, and the natural ventilation improves the air by purifying it and enhancing thermal comfort without mechanical power.

- **Level of natural lighting**

This type of lighting refers to the light emanating from natural resources (Ochoa and Capeluto, 2006). Natural sunlight enters through skylights so that the levels,

³ The stack effect is the passage of air in and out of the space as a result of different air density, caused by the temperature during the day and night.

⁴ Thermal inertia is the ability of the house space to store heat via natural resources.

⁵ Airflow is the motion of air currents around the outside of house that flows through the urban fabric.

⁶ Cross air is when two or more different sources of air movement cross naturally in the house.

spaces, and places do not need to be lit during the daytime, in response to the environment. Natural lighting enhances the level of lighting of the T.C.H.Ts in Al-Kadhimiyah during the day, again providing thermal comfort.

Therefore, this study has shown how passive systems act to promote thermal comfort in this type of house in Al-Kadhimiyah by creating level of thermal behaviour, natural cooling, natural lighting, and natural ventilation. This was illustrated by one interviewee who had lived in a T.C.H.T their whole life:

“When I visit my son who lives in a contemporary house, he turns on all the modern devices in summer or winter all the time; however, in my traditional house, I can live in it without using excess energy, and I use these tools at specific times such as the afternoon in summer, or on winter nights” (Occ., 6, 2012).

Similarly, this was confirmed by one interviewee who had worked together with a team in the rehabilitation of the Al-Kadhimiyah historical area:

“The interior courtyard house in Baghdad is a successful architectural achievement to solve environmental problems and comfort the people. It provides an environmental solution in a world running after energy alternatives. Baghdadi house can be invested as a way to provide thermal comfort without energy” (Arch., 21, 2012).

The building fabric response created passive systems of T.C.H.Ts. in Al-Kadimiyah which enhance thermal comfort in this type of house. Therefore, the passive systems contribute to the achievement of partial control of the environment, and so it is understandable that an architect interviewee expressed a similar scenario in her account:

“The courtyard was open towards the inside of the house, and had good natural environment, which could be controlled” (Arch., 10, 2012).

Thus, this house has its own high personality and interaction with the local environment to achieve an excellent natural environment for the dwellers of the T.C.H.T. in Al-Kadhimiyah. However, the presence of such passive systems in T.C.H.T may not be enough for the current users to achieve appropriate environmental performance in this house type. The following sections deal with how the occupants dealt with this gap in sufficiency.

2. Human level response

This response concerns what the occupants did in a T.C.H.T which helped them deal with the climate and weather change as a human response to the environment, according to each family's needs. The human level response achieves partial control of the built environment through the lifestyle of the current users. This study interprets lifestyle as the way of life (Shahril et al., 2012, p. 305) related to the role of everyday different activities in terms of the relationship with places,⁷ spaces,⁸ and levels⁹ during different times,¹⁰ and the possible changes in the need to control the environment. The control of the environment is about the user remaining in the most comfortable built environment.

The human level response is explored in the next steps according to the evidence emerging from the occupant interviews in accordance with the physical survey. These include:

- **Activities movement**

This means the flexible movement of different activities in different places, spaces, and levels. The occupants used different places on different levels for the same activity; also, they did different activities in the same place in response to the changing climate factors and weather conditions. Such a view can be explored in the account of one interviewee with her daughter, who lived in Aked Al-Sada in the Al-Kadhimiya she said:

“We used the living room, especially in winter, for most activities such as eating, sleeping, receiving guests, chatting, watching TV, and sitting, among others” (Occ., 11+12, 2012).

These movements of different activities from one place to another in the T.C.H.T in the Al-Kadhimiya are explored in Table 9.1 through:

- Gathering – the residents gathered in the courtyard, the iwan, the neem sardab and the sardab, as well as the living room and ursi, all of which were located on different levels.

⁷ The places include the living room, bedrooms, kitchen, and others.

⁸ The spaces refer to open, semi-open, semi-closed and closed spaces.

⁹ Levels are either vertical or horizontal.

¹⁰ Different times means the time of day and night, summer and winter.

- Practising hobbies – the occupants practised hobbies in the sardab and neem-sardab, the courtyard, living rooms, the rooms on the first floor, and the ursi on the ground floor.
- Sleeping – the families used the living room, the sardab and neem sardab, the bedrooms located on the first or the second floor, the kafish kan or the roof.
- Eating – the residents had meals in the neem sardab, and the ursi located on the first or ground floor. They slept on the roof if they used it for sleeping, or in the courtyard.
- Cooking and washing – usually, the housewives used the kitchen or the courtyard; also, they cooked in a room on the first floor.

It seems that the flexibility of different activities around the year, as clarified in Table 9.1, was a part of their everyday life in the T.C.H.T in the Al-Kadhimiya, which brings a great dynamic to the environmental treatment.

Table 9.1: Flexibility of different activities during the year related to the space, place, and level in the T.C.H.T in the Al-Kadhimiya, as reflected in the lifestyle to achieve partial control of the environment, (Author).

Levels, places and spaces	Activity with Time	Gathering			Hobbies			Sleeping			Eating			Cooking washing		
		Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer
Under ground level	Sardab	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Neem Sardab	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Ground floor	Courtyard	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Takta-Boosh	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Living room (Ursi)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Iwan	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Bedroom															
	Kitchen															
	Bathroom															
Upper floor	Kafish-kan															
	Bedroom															
	Iwan	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Rooms (winter Ursi)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Roof	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

• Modifications and adaptations of the space and users

This refers to approaches which allowed better user control and customization of the environment (Sinclair et.al 2012, p.35). In other words to what the occupants themselves did to the spaces, places, levels in all T.C.H.Ts in the Al-Kadhimiya, which is a part of the environmental treatment. Modification and adoption is part of the human level response for different environmental conditions, and is explored in the following items:

- Alterations

Here, this means the way in which the residents adapted the T.C.H.T in the Al-Kadhimiya to deal with the changing environmental conditions. Alteration linked to modification and adaptation, such as modifying the physical built environment for open space, adding new protective materials or machines, or changing the environmental performance of a place, space or level, and performing maintenance with respect to the families' needs, depending on the different seasons. For example, in cold weather, the occupants covered the courtyard with nylon sheeting, added wood or fibre plates, and covered the doors and windows of all the rooms around the interior courtyard with nylon, in winter, they also used oriental carpets, as shown in Figure 9.4.



Figure 9.4: Modification and adaptation through alterations caused by way of life in T.C.H.T in the Al-Kadhimiya on cold day to achieve partial control of the environment, (Author).

- (A) Covering the windows or walls around with : (1)Wood sheet in summer from outside (Ph.Ch. 7, 2012); (2)Nylon in winter from inside (PH.CH. 1, 2012); (3)Blanket in winter from inside (PH.CH. 6, 2012) to provide thermal comfort
- (B) Using oriental carpets to provide thermal comfort (1) (PH.CH6, 2012), (2) (PH.CH5, 2012), (3) (PH.CH9, 2012)

In hot weather, the residents in the T.C.H.T in the Al-Kadhimiya set up a tent covering the courtyard in summer. The residents kept the windows closed during the day, and open throughout the night. The occupants had added some desert plants in the slots of the window and sprayed the natural material with water. They also washed the roof and the yard bricks with water immediately before sleeping at night as confirmed by Figure 9.5. Also, water was used in the summer in the lower slot of the bad-geer, extended to the sardab.



Figure 9.5: Modification and adaptation through alterations caused by way of life in T.C.H.T in the Al-Kadhimiya on harsh weather to achieve partial control of the environment by as a part of lifestyle:

Covering the courtyard with nylon sheeting in winter, (Author).

(1-2) (PH.CH. 8, 2012) or tent in summer to avoid harsh weather (3-4) (PH.CH. 3, 2012)

Also, the residents of these houses type opened the qakhma¹¹ during the day and night in the short transitional seasons of spring and autumn, as shown in Figure 9.6, and repeatedly painted the walls. Also, they closed the slot of the bad-geer during dust storms and covered it with a grid. At the same time, they continuously sterilized and burned incense, and they also added chemicals to the sardab around the year.

¹¹ The qakhma is a vertical sliding window used in the T.C.H.

This view can be explored in the account of one interviewee, who had lived in this type of house in the Al-Kadhimiyah for 38 years:

“We deal with moisture by repeatedly painting the walls or covering them with wood. Also, we continuously sterilize and burn incense in the house to make the house smell nice” (Occ., 17, 2012).



Figure 9.6: Modification and adaptation through alterations caused by way of life in T.C.H.T of the Al-Kadhimiyah on moderate days to achieve partial control of the environment by opening the windows for appropriate ventilation, (Author). (1) (PH.CH4, 2012) (2) (PH.CH7, 2012)

These alterations were caused by way of life in the T.C.H.T in the Al-Kadhimiyah, to implement environmental treatments for a specific time, and were then removed or changed; as such, they were dynamic from time to time depending on the different environmental conditions.

- Modern equipment

This refers to technological devices which the residents had added to their houses according to each family's needs. Different modern technical equipment was used by the occupants to modify and adapt the houses at different times of the year to support the human level response in different spaces, places, and levels of the T.C.H.T. in the Al-Kadhimiyah. This will now be determined.

The occupants dealt with harsh weather in different seasons by using modern devices such as split unit, air-condition/ window type, air coolers, air vacuums, oil heater, electric heater, artificial lighting, water filtration, boilers and electrical pumps.

From this we are exploring how lifestyle in terms of the changing environmental conditions leads to the environmental treatment for cooling, heating and ventilation,

lighting, water, and other aspects such as electricity, and communication, as confirmed in Figure 9.7.

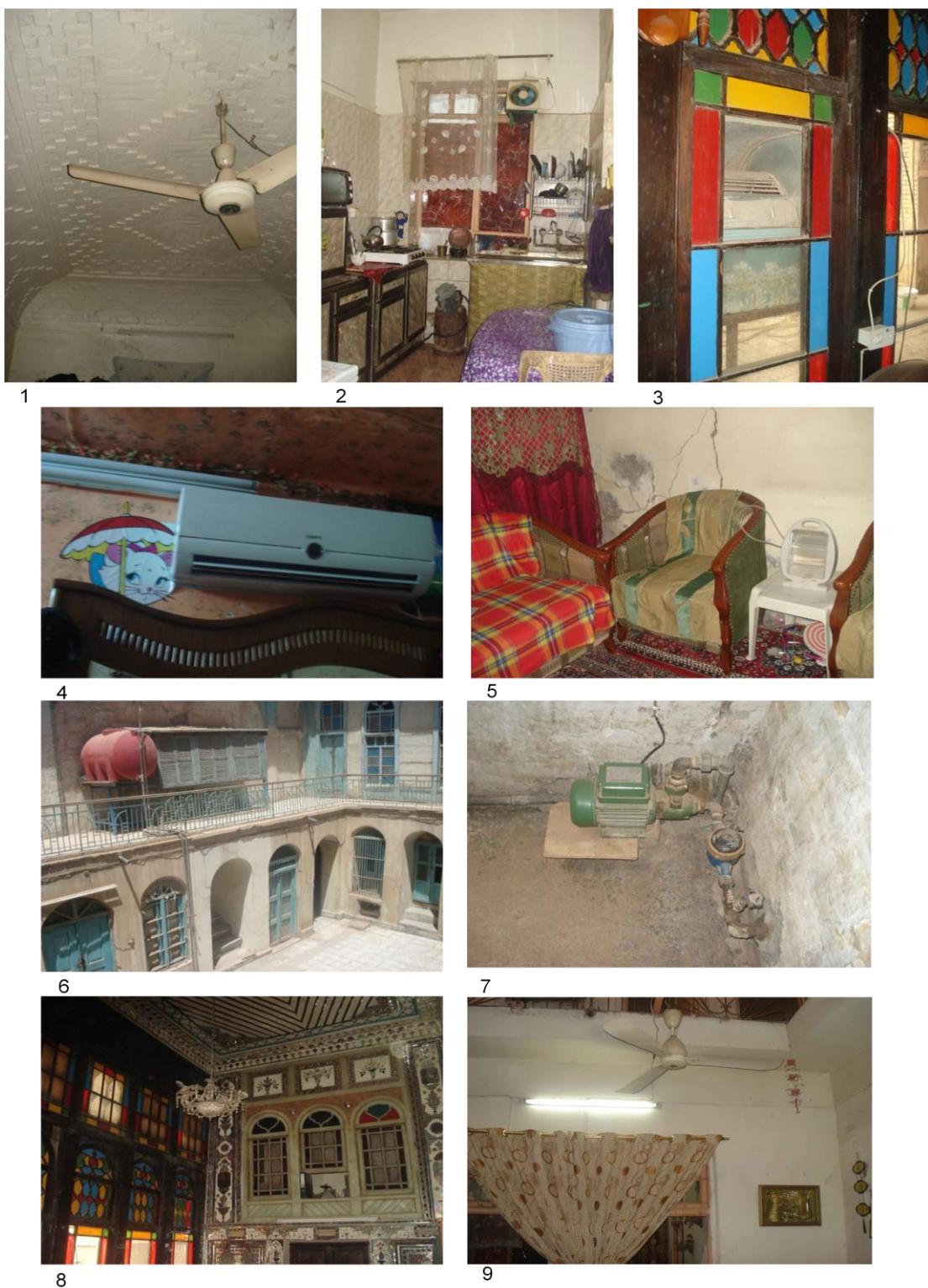


Figure 9.7: Modification and adaptation linked to modern equipment, reflecting the lifestyle to achieve partial control of the environment in the T.C.H.T. in the Al-Kadhimiyah, (Author).

(A) Supporting ventilation during space usage (1) (PH.CH. 3, 2012), (2) (PH.CH. 6, 2012), (3) (PH.CH. 10, 2012)

(B) Improving cooling, heating in different weather (1) (PH.CH.7, 2012) (2) (PH.CH.9, 2012)

(C) To available water in summer (1) (PH.CH.2, 2012), (2) (PH.CH.4, 2012)

(D) Enhancing lighting in dust weather (1) (PH.CH.10, 2012), (2) (PH.CH.6, 2012)

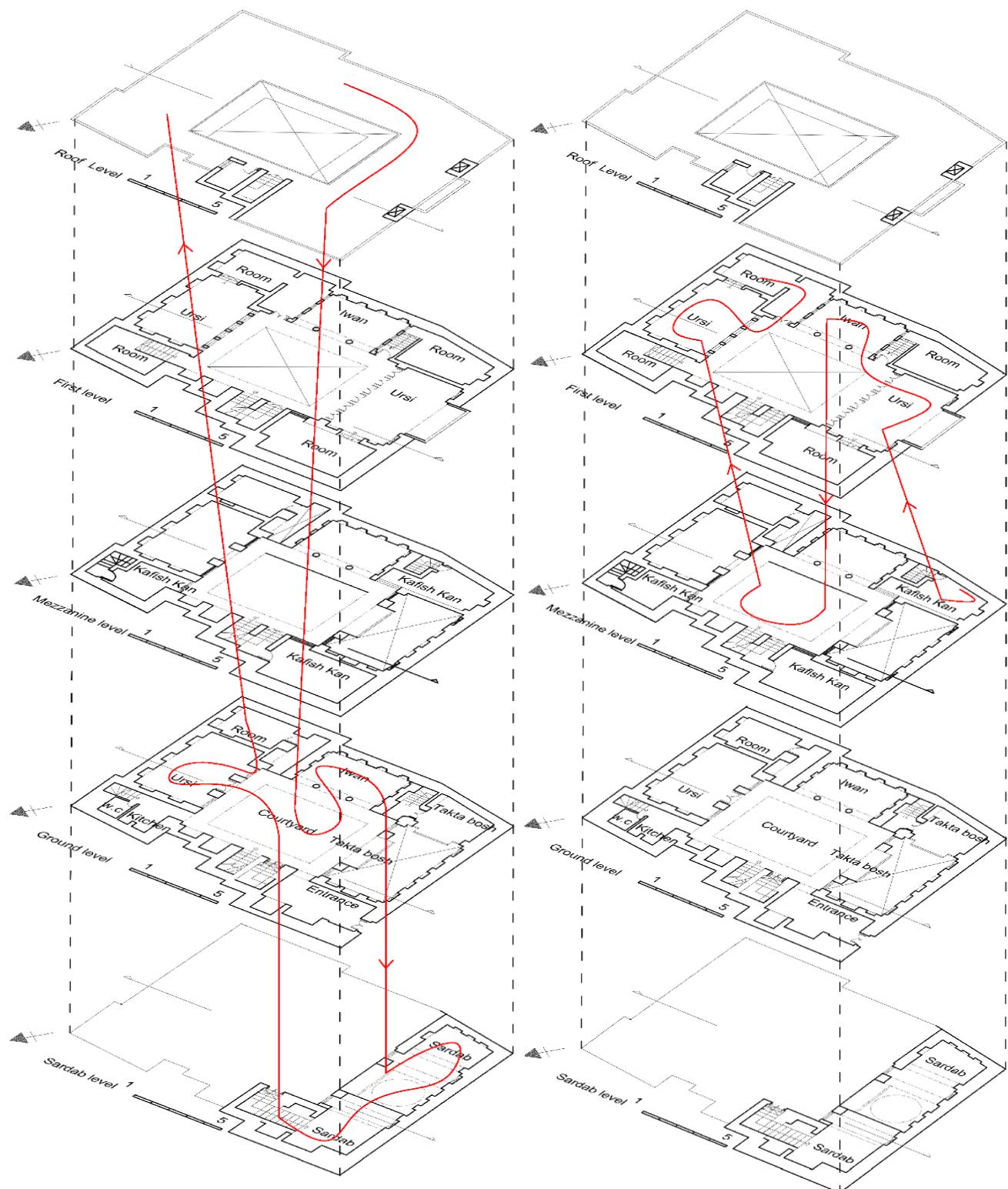
- Mobility of family

This term concerns how the occupants used their houses in different seasons/day. Family mobility in the T.C.H.T in the Al-Kadhimiyah showed vertical movement in the house section, and horizontally in the house plan, during different seasons and on different days, as shown in Figure 9.8 that agree with information in Table 9.10. This was a part of the modification and adaptation in the T.C.H.T to achieve the human level response.

The evidence confirms that, in summer, the family's mobility started from the roof or in the interior courtyard, and stayed there until the afternoon. The families used the ground level, and then moved to the neem-sardab or the sardab. They stayed in the sardab until sunset and then moved to the courtyard, and then back to the roof again. The first and the second levels were not in used in summer. The residents partly abandoned the first floor and focused on the ground floor and basement for their activities in summer. In winter, the families used the first and the second levels as well as the ground level for the courtyard and the toilets. The sardab and the neem-sardab were not used in winter. They preferred the first floor and second floor if available, and the Kafishkan, in winter. At the same time, they used the spaces and places facing the sun in winter, and the wind in summer. For example, one interviewee with her daughter-in-law, who lived in the Aked Al-Sada neighbourhood, mentioned such ideas in her account:

"We avoided the heat by using the sardab. Furthermore, we focused on using the first floor in winter, and I prefer the ursi on the ground floor which avoids the sun in summer; however, this does not mean we ignored the ground floor" (Occ., 9+10, 2012).

Therefore, family mobility reflected the way of living in the T.C.H.T in the Al-Kadhimiyah, and was part of the environmental treatment.



(A) Looking for appropriate thermal comfort in summer by moving between sardab, ground, and roof levels

(B) Looking for appropriate thermal comfort in winter by moving between first, second levels and sometime ground

Figure 9.8: Mobility of the family through the vertical and horizontal movement in the T.C.H.T in the Al-Kadhimiya during different seasons is a part of the lifestyle to achieve partial control of the environment (PH.CH7, 2012), (Author).

- Appropriate clothing

This term refers to the means by which the residents themselves adapted to the different environmental conditions. Appropriate clothing is a part modification and adaption to promote the human level response. The residents wore heavy clothes in winter, and wore light clothes in summer, but also sprayed themselves with water at this time. Therefore, appropriate clothing is another type of environmental treatment concerning the current lifestyle in the T.C.H.T. in the T.C.H.T in the Al-Kadhimiyah

It is interesting to note that the current users in the T.C.H.T. in the Al-Kadhimiyah had very different kinds of lifestyle and there was a mix of activities for people to do. However, what is clear is the change in use in these houses, as there is now more movement all around the house to find a comfortable thermal level, or about other factors, all of which act as an indicator of the occupants having difficulty controlling the environment. This different lifestyle was created due to changing needs. The current lifestyle in T.C.H.T can be clarified according to:

- **Space occupation**

Space occupation means the use of space according to intensity¹² and frequency¹³. The uses of space, places, and levels, whether full or part time around the year, have become part of the lifestyle for the current users in the T.C.H.T in the Al-Kadhimiyah historical area.

The lifestyle arising from the current space occupation is outlined in the following:

- For partial occupation of house spaces, places, and levels around the year: for two of the 12 houses studied in the fieldwork, the occupants had seasonal movement between different levels, and this movement is confirmed by Al-Azzawi (1996A and 1996B). This happened with small families such as those of five persons living in a small T.C.H.T with one courtyard or a big T.C.H.T with two courtyards. In these cases, partial occupation sustains the lifestyle for the current users which use the space only part of the time around the year.

¹² Intensity is the quality or state of being intense (Ching and Binggeli, 1989).

¹³ Frequency is the rate at which residency occurs over a particular period of time (Ching and Binggeli, 1989).

- For full occupation of house spaces, places, and levels around the year: the findings illustrate that for ten of the 12 houses, the residents had no seasonal movement between different levels. This happened with different families of 7-26 persons. Full occupation reflects the lifestyle of the current users which use all the spaces around the year.

- **Social aspects/ Extended families**

There was a rational expansion of the family as part of the social family relationship, which is a comfort to T.C.H.T society, as provided by Yang (2007). An extended family was created by a large number of individual and reached up to 26 persons in one T.C.H.T, for example. As a part of the current lifestyle in the T.C.H.T in the Al-Kadhimiya related to family size, all these families had been created by family extension in accordance with the requirements of the family's size in the T.C.H.T. Thus, there are different age include children and adults, and older people at home; at the same time there are varied of education and knowledge

- **Occupation time**

The existing way of life in the T.C.H.T in the Al-Kadhimiya involves many people living in these types of house, often the extended family. Usually, the housewives stayed at home with the older people and small children, and the grandparents also stayed at home. Therefore, this type of house was occupied 24/7 around the year.

It is clear that the most interesting point in the lifestyle of the current users in the T.C.H.T in the Al-Kadhimiya is environmental treatment. The lifestyle exists because of the need to achieve thermal comfort, avoid rain water, smoke, and dust filling the house, keep the house warm or cool, retain the coolness of the interior attained at night, and reduce thermal gain from the exterior. This, in turn, encouraged cross-ventilation and air-movement, which helped to cool the interior and avoid humidity and odours. All acted as specific environmental treatments that give partial control of the harsh weather, which was dynamic in different places and levels at different times. Therefore, another important finding in the current study is that the lifestyle of the current user in T.C.H.T in the Al-Kadhimiya had partial control of the environment. However, it needs to be ascertained if these environmental treatments provide appropriate environmental performance in the T.C.H.T. Also, formations emphasised the lifestyle for the current user, influenced by the house performance, which ascertained the need for improvement to house performance

9.2.2 *Environmental challenges*

Environmental challenges occur when facing a situation and fighting difficulties in controlling the climate, and weather conditions, in the built environment. Simply, this means knowing what it is in the environment that needs to be controlled. This study has explored this theme through nine issues, as presented in Figure 9.9.

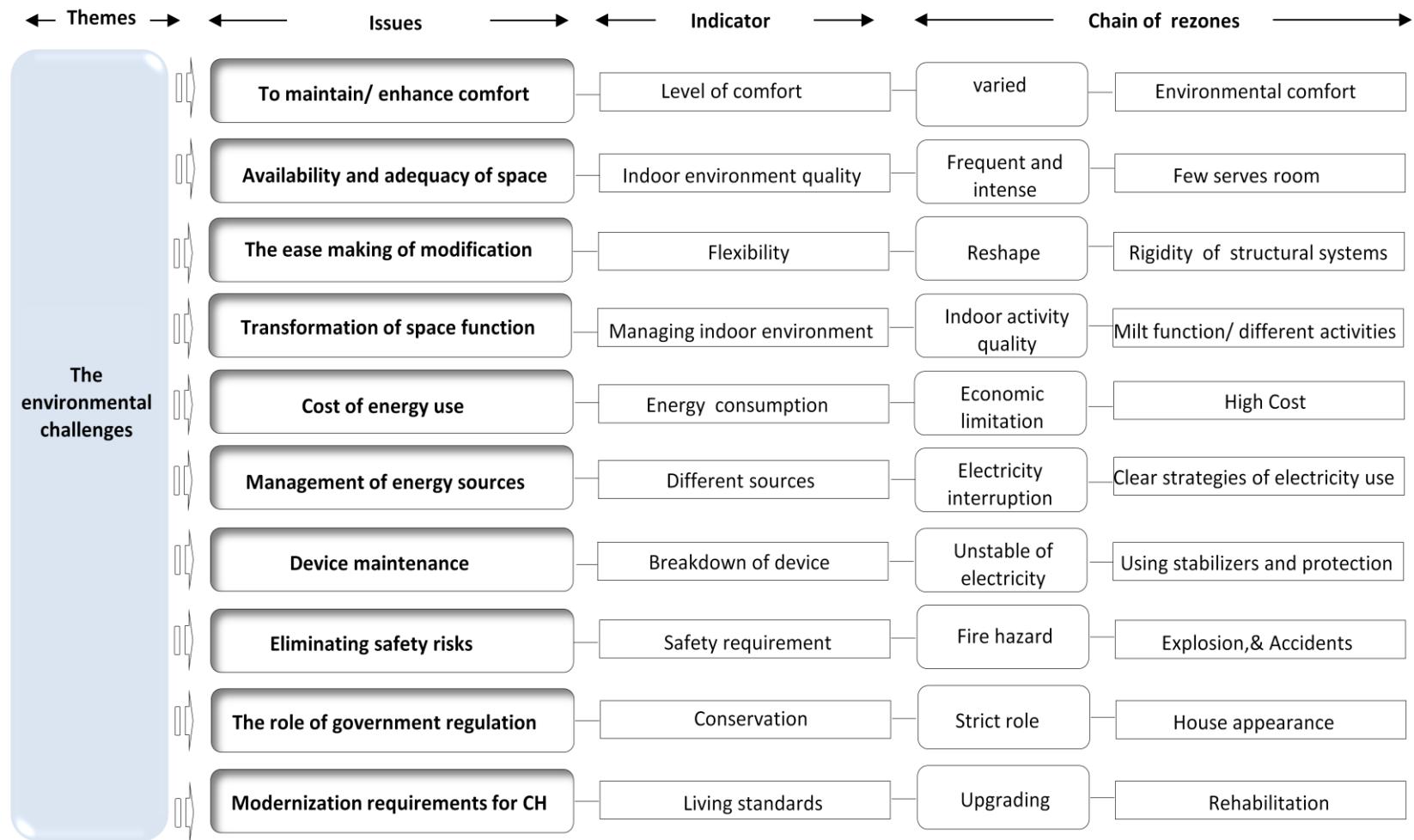


Figure 9.9: Environmental challenges explored as ten issues in the T.C.H.T in the Al-Kadhimiyah, (Author).

1. To maintain/ enhance comfort

The inability to maintain comfort, or experiencing discomfort of environmental performance led to environmental challenges in the T.C.H.T. in the Al-Kadhimiyah through the level of comfort. Here, level of comfort refers to a healthy or unhealthy lifestyle depending on a comfortable or uncomfortable house. A comfortable house is one which can be controlled environmentally on different levels, and in different places and spaces throughout the year; this includes thermal comfort, the quality of light, air and water, odour level, and sound insulation.

This issue of environmental comfort is explored via evidence from the occupants as a main source and in accordance with the architect interviews, the physical survey. The following ideas were discussed and identified.

- **Thermal comfort**

Both spring and autumn were great seasons in T.C.H.T.s as the sky has a clear sunbeam angle and moderate temperature. In the T.C.H.T. in the Al-Kadhimiyah. The winter is very cold especially on the ground floor and in the spaces and places on the first floor; in the sardab, winter days were comfortable while the nights were uncomfortable. The kafish-kan and the second floor were comfortable in winter. The summer season was relatively the most comfortable due to the most convenient temperature, as were the spaces and places on the ground floor, and the neem sardab and the sardab. The spaces and places on the second floor and the kafish-kan were uncomfortable in summer. However, the very hot summer also meant that the time between noon and sunset was poor because of the heat.

- **Lighting**

The T.C.H.T in the Al-Kadhimiyah did not need to be lit during the day; however, a few spaces and places have no access to daylight during the day; also, it was dark during the daytime dust storms. At night, movement was difficult due to the absence of light caused by the interruption of the electricity supply.

- **Ventilation**

Fresh air moves continuously inside the T.C.H.T in the Al-Kadhimiyah making summertime comfortable, except for the time between afternoon and sunset in summer. However, the occupants had difficulty controlling the dust and so the atmosphere became breathless. The presence of dust storms during the year and

especially at night in summer made the atmosphere suffocating and more uncomfortable than in the past. One interviewee, who had lived for 50 years in a traditional house in the Aked Al-Kunjalle neighbourhood, said:

“Changes to the climate, especially after the 2003 war, badly affected us. We were surprised by dust storms three times a week. It is difficult to control the house and it makes our lives miserable” (Occ., 5, 2012).

Also, there were problems with ventilation, especially in the service spaces, and this put the residents under pressure through increasing the humidity and odour levels, as a result of the lack of air movement (see next section availability and adequacy of space).

• Humidity

The rainy period was uncomfortable for the occupants in the T.C.H.T in the Al-Kadhimiya because of the increase in humidity in the ground floor as confirmed in Figure 9.10. The sardab and neem sardab were uncomfortable due to high humidity of underground water level which sometimes led to bad smells. Therefore, it is understandable that one interviewee considered such an idea in her accounts:

“At present, the sardab produces high humidity consequently leading to bad smells, and a less healthy and comfortable house” (Occ., 24, 2012).



Figure 9.10: Increased the humidity in the ground level leads to environmental challenge for living in T.C.H.T in the Al-Kadhimiya, (Author). (1) Living room (PH.CH.1, 2012), (2) Kitchen (PH.CH.8, 2012)

• Sound insulation

The T.C.H.T in the Al-Kadhimiya achieved sound isolation from the outside during the day, while separating the family from the noises surrounding the house. This evidence is linked to one interviewee who had researched sound in the T.C.H.T. in the Al-Kadhimiya historical area with a professional team. She said:

“The Shanashel is one of the elements that minimized the external noise by reducing it successfully. I had this result from my application research in T.C.H.T” (Arch., 7, 2012).

However, there were continuous noises during the year, especially at night, from the use of electrical generators which pressured the residents.

• Water

The water supply was good in winter, but in summer it was weak and sometimes unavailable in T.C.H.T. in the Al-Kadhimiyah. There was no problem with the hot water, except during the interruption of the electricity supply. Drinking water was affected by the availability of the water supply.

From this, our understanding of the current level of comfort in the T.C.H.T can be developed as we can see the variation on different levels, places, and spaces around the year, as shown in Table 9.2. This difference in levels of comfort had caused great discomfort and an unhealthy environmental situation for part of the time; however, this affected the house performance. Therefore, different levels of comfort can be seen as the manifestation of environmental challenges.

Table 9.2: Comfortable times and levels within the T.C.H.T in the Al-Kadhimiyah, (Author).

	Winter		Spring		Summer		Autumn	
	Day	Night	Day	Night	Day	Night	Day	Night
Sardab		•	•	•	•	•	•	•
Neem Sardab		•	•	•	•	•	•	•
Ground floor		•	•				•	•
Kafish-kan	•	•	•	•			•	•
First floor	•		•	•			•	•
Second floor	•	•	•	•			•	•
Roof		•	•				•	•

2. Availability and adequacy of space

It means the balance between the number of people and place or space usage. The lack of available and adequate space presented an environmental challenge in the T.C.H.T in the Al-Kadhimiyah related to indoor environment quality. These interesting issues that emerged from the interviews with the occupants were crosschecked by a physical survey to note that indoor environment quality was affected by the frequent and intense usage of current service rooms, which suffered from increased humidity and fumes from food, as well as the spread of food smells and smoke from the kitchen, and odours from the toilet and bathroom, which reflects

the lack of available rooms to accommodate all eventualities. Figure 9.11 confirms this. This evidence refers to the fact that the service rooms were most commonly in T.C.H.Ts. There were too few service rooms in all of the T.C.H.Ts. The occupants shared one bathroom and one toilet in the same house, and one house was even without a bathroom, as shown in house number 12 (see Chapter 7.3.11). Also, the occupants shared one kitchen.

As shown, the residents had had difficulty caused by lack of control of the indoor environment quality of current service rooms in the face of frequent and intense use of service rooms, which contributed to the difficulty in controlling the environmental performance of this house type. Therefore, such difficulty is a part of the environmental challenges of living in the T.C.H.T.



Figure 9.11: Lack of adequate space leads to environmental challenges through the difficulty of controlling the indoor environment quality when living in the T.C.H.T in the Al-Kadhimiya, including increased humidity and odour level, (Author).

- (A) In kitchens (1.) (PH.CH.5, 2012), (2.)(PH.CH.4, 2012)
- (B) In the toilet or bathroom (3.) (PH.CH. 4, 2012), (4.) (PH.CH.10, 2012)

3. The ease of making modifications

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

The evidence from the occupants, architects and the physical survey accord with the literature review in showing that the T.C.H.Ts in the Al-Kadhimiya historical area were built by as heavy structures linked to load bearing walls (see Section 9.2.1). 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.

4. Transformation in space function

Such transformations concern changes to the function of spaces, places, and levels in the T.C.H.T in the Al-Kadhimiya, according to family needs. This transformation can directly or indirectly influence the environmental challenges by managing the indoor environment.

Significant evidence emerged from both occupant interviews and the physical survey, which confirmed that in the T.C.H.T in the Al-Kadhimiya the indoor activity quality such as with houses that contained more than two household, each group had created a cooking space in a corner in the living room so that one space was multifunctional; this confirms the difficulty in managing the indoor environment in terms of odour levels and moisture.

What is interesting in this is that the mismanagement of the indoor environment is linked to indoor activity quality in the T.C.H.T. in the Al-Kadhimiya, which could have

an important effect on house performance. Therefore, the inability to manage the indoor environment shows the environmental challenges in the T.C.H.T.

5. Cost of energy use

Energy use is an important environmental challenge in terms of consumption, which represents an important indicator not only in T.C.H.T in the Al-Kadhimiyah but around the world generally, and in Iraq especially.

This issue was presented by the occupants and was in accordance with the physical survey, in that the residents were limited in their use of energy through economic limitation to their use of service systems. This was due to the cost of electrical utilities being very high compared with other services (see 8.3.4 cost of utilization). Almost all T.C.H.Ts studied in the Al-Kadhimiyah used a new device that needed minimum amounts of amperes, such as self-charged fans, economical artificial lamps, as shown in Figure 9.12, and mini split units which require limited electricity amperes; all this was an attempt to decrease energy consumption.

Clearly, this indicates that energy consumption in their use of service systems showed economic limitation, which probably affected house performance. Therefore, unclear strategies of energy consumption are part of the environmental challenges in the T.C.H.T.



Figure 9.12: An attempt to reduce the energy consumption in the T.C.H.T in the Al-Kadhimiyah, which contributed to the environmental challenge, (Author). (A)Using economical lamps (1) (PH.CH.8, 2012), (2) (PH.CH. 6, 2012). (B) Using economical device (3) (PH.CH.5, 2012), (4) (PH.CH.1, 2012)

6. Management of energy sources

Also, the use of different sources of energy is a significant environmental challenge which was the greatest problem in terms management. It reflects an important indicator in Iraq generally and in the T.C.H.T in the Al-Kadhimiyah especially.

The evidence from both the occupants and the physical survey were supported by the literature review. It shows different resources were required to supply electricity in the T.C.H.T in the Al-Kadhimiyah, as confirmed by Figure 9.13. Due to the frequent unavailability of the national electricity supply, the occupants had to use electricity from generators which could be private, and/or local. Therefore, each house had at least two different resources which need management between them especially at night.



1

2

Figure 9.13 Using different resources for electricity supply inductors of environmental challenges in the T.C.H.T. in the Al-Kadhimiyah, (Author). (1)(PH.CH.1, 2012), (2.)(PH.CH.4, 2012).

Interestingly, the mismanagement of different sources shows how unclear strategies between different resources of electricity supply in the T.C.H.T in the Al-Kadhimiyah could impact house performance. Thus, management of energy sources have led to environmental challenges.

7. Device maintenance

Maintenance was another important issue linked to the environmental challenge of living in T.C.H.T in the Al-Kadhimiyah., and was found by breakdown of device.

This issue was presented by the physical survey and was in accordance with the occupants, in that using stabilizers and protection of electricity devices gives an indication of the unstable electricity supply (confirmed by Figure 9.14). This grated big problem of breakdown of different device in T.C.H.T.



Figure 9.14: The electricity was unstable in the T.C.H.T in the Al-Kadhimiyah as a result of the use of different sources, which is a part of the environmental challenges, (Author).

- (A) Using stabilizers and protection confirmed that the electricity was unstable in the T.C.H.T
- (1.) (PH.CH. 2, 2012), (2.) (PH.CH.7, 2012)
- (B) Breakdown of different device confirmed that the electricity was unstable in the T.C.H.T
- (3.) (PH.CH. 2, 2012), (4.) (PH.CH.7, 2012)

We can see that the breakdown of devices gives an indication of the lack of maintenance of these devices, which might have created difficulty in house performance. Therefore, in this study, one of the more significant findings to emerge is that not maintaining devices was one of the frustrating aspects of living in a T.C.H.T in the Al-Kadhimiyah, and a part of the environmental challenge.

8. Eliminating safety risks

To be free from the risk issue had created directly or indirectly environmental challenges due to the need for safety requirements. The evidence from occupants was in accord with the physical survey, which showed that some houses had suffered a fire for different reasons, such as explosions of materials in the alleyways

of different neighbourhoods. Also, there was a potential fire hazard for the T.C.H.Ts in the Al-Kadhimiyah historical area due to the changes in the electricity supply current, as illustrated in Figure 9.15.

From this, it can be seen that poor safety features had led to accidents by fire hazard in the house, and so safety was another environmental challenge in living in the T.C.H.T.



Figure 9.15: Safety issue show the potential fire hazard during the changes in the electricity supply current as an environmental challenge in the T.C.H.T. in the Al-Kadhimiyah (PH.CH.6, 2012), (Author).

9. The role of government regulations

Government regulations concerning conservation were found to be important in shaping the environmental challenges of living in the T.C.H.T. The evidence from the occupants showed that the T.C.H.Ts in the Al-Kadhimiyah historical area studied in the fieldwork had been conserved by the government as historic or heritage houses. 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-Kunjalle 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.

10. Modernization requirements of the courtyard house

Modernization in this case means adapting to modern ideas or methods according to modern needs; 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 both architects and occupants was in accordance with the physical survey and showed that the government or the owner had rehabilitated a T.C.H.T in the Al-Kadhimiyah between 20-50 years ago according to the modern style. 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. This view can be explored in the account of one architect interviewee who worked with the occupants to develop these traditional dwellings:

“The courtyard is not updated to the present or future users’ needs and there is a lack of technological development of different forms” (Arch.LI, 5, 2012).

Also, one of the ideas repeatedly mentioned by one interviewee in the Al-Baheya neighbourhood was that:

“An Indian company repaired houses in the Al-Kadhimiyah 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.

9.2.3 Social struggles

We can perceive social challenges as changes to ethics or behaviour and emotions, as they relate to the inhabitants’ way of living, which was a high priority. These changes occur irrespective of ability and are often aligned with three issues, as illustrated in Figure 9.16.

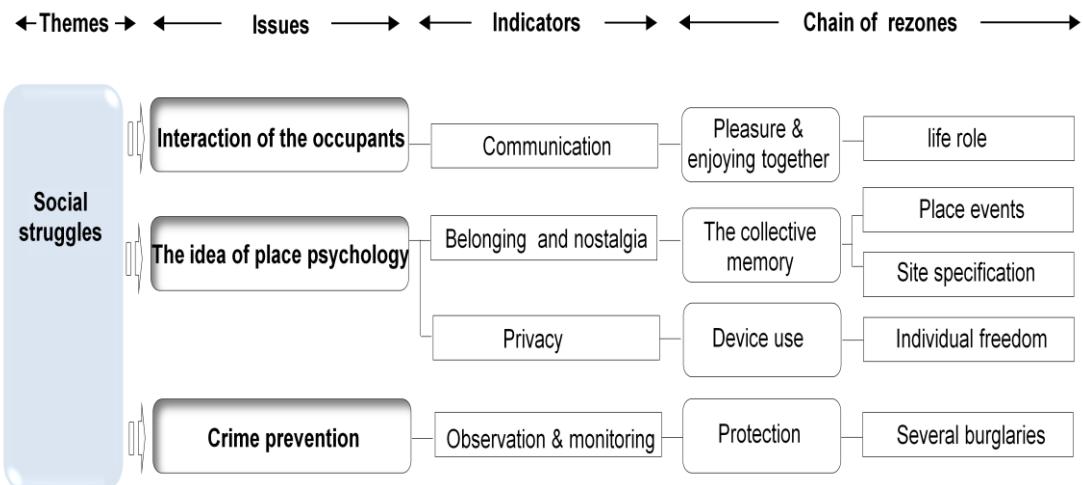


Figure 9.16: Social struggles aligned with three issues in the T.C.H.T in the Al-Kadhimiya, (Author)

1. Interaction of the occupants

The change of life rule reduces people's interaction, which is an important phase of social struggles through communication. The evidence on this issue emerged from the occupant interviews, and confirmed that for the family members in the T.C.H.T in the Al-Kadhimiya, including women who spent more time outside the house for work or study, both day and night, has led to changes in social relationships over the day/year. This means that now these relationships are less compatible as the family has no time for pleasure or enjoying time together. For example, one interviewee with her husband who had lived in the Aked Al-Kunjalle neighbourhood said:

"I haven't seen my son in law for one month because he was sleeping when I leave the house to go to work, and I'm sleeping when he is back later because he had night work" (Occ., 2012).

Also, the availability of the bathroom in the T.C.H.T. in the Al-Kadhimiya led the occupants to reduce using public bathrooms that provide different facilities, such as sauna, spa, and massage. Furthermore, when the ground telephones were not working, or when there was disconnection during heavy usage, the occupants lost communication with others.

It is apparent from this that the lack of communication for family members or with others represented a reduction of pleasure or enjoying time together. Therefore, miscommunication refers to the fact that there are social struggles of living in the T.C.H.T.

2. The idea of place psychology

This represents the interrelationship between place and human effect (Scannell, 2013, p. 134), 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 (Bennett, 2015). Nostalgia is a longing or wistful affection for a period in the past (Scannell, 2013, p. 257). 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 evident, or site specification passed from one generation to the next. For example they had lived in this T.C.H.Ts in the Al-Kadhimiyah since birth or marriage. For some of them, their parents had been born in them around 1890. One house was the house of the Astrebady family, and this house belonged to the former Prime Minister of Iraq (1958), Nori Al-Saeid. 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 left 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. ECC, 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 T.C.H.T. as show in Figure 9.17. Therefore, the belonging and nostalgia represented the social struggles of living in the T.C.H.T.

Privacy refers to freedom from disturbance. The evidence from the occupants revealed that the occupants in the T.C.H.T in the Al-Kadhimiyah 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 Aked 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 T.C.H.T.



Figure 9.17: The belonging and nostalgia had presented social struggles of living in to the T.C.H.T. in the Al-Kadhimiyah, (Author).
 (1-2) (PH.CH.10, 2012), (3-4) (PH.CH. 8, 2012), (5.) (PH.CH. 7, 2012), (6.)(PH.CH.4, 2012)

3. Crime prevention

Security was also another environmental challenge in living in the T.C.H.T, and relates to observation and monitoring. In this study, the security issue was presented in evidence from the occupants in accordance with literature review, and this is summarised now. After 2003, problems with crime across Al-Kadhimiya and the T.C.H.Ts in this area were prevalent, with several burglaries having occurred. One possible explanation for this is that there were obstacles to monitoring, which made crime easier. Therefore, the lack of observation monitoring led to this further social struggle.

9.2.4 *Traditional courtyard house performance in the Al-Kadhimiya*

This section explores new issues raised through the multi-faceted relationship between the different issues and themes in the previous section 9.2.1- 9.2.3, as related to what the T.C.H.T has and needs; this is clarified in Figure 9.18.

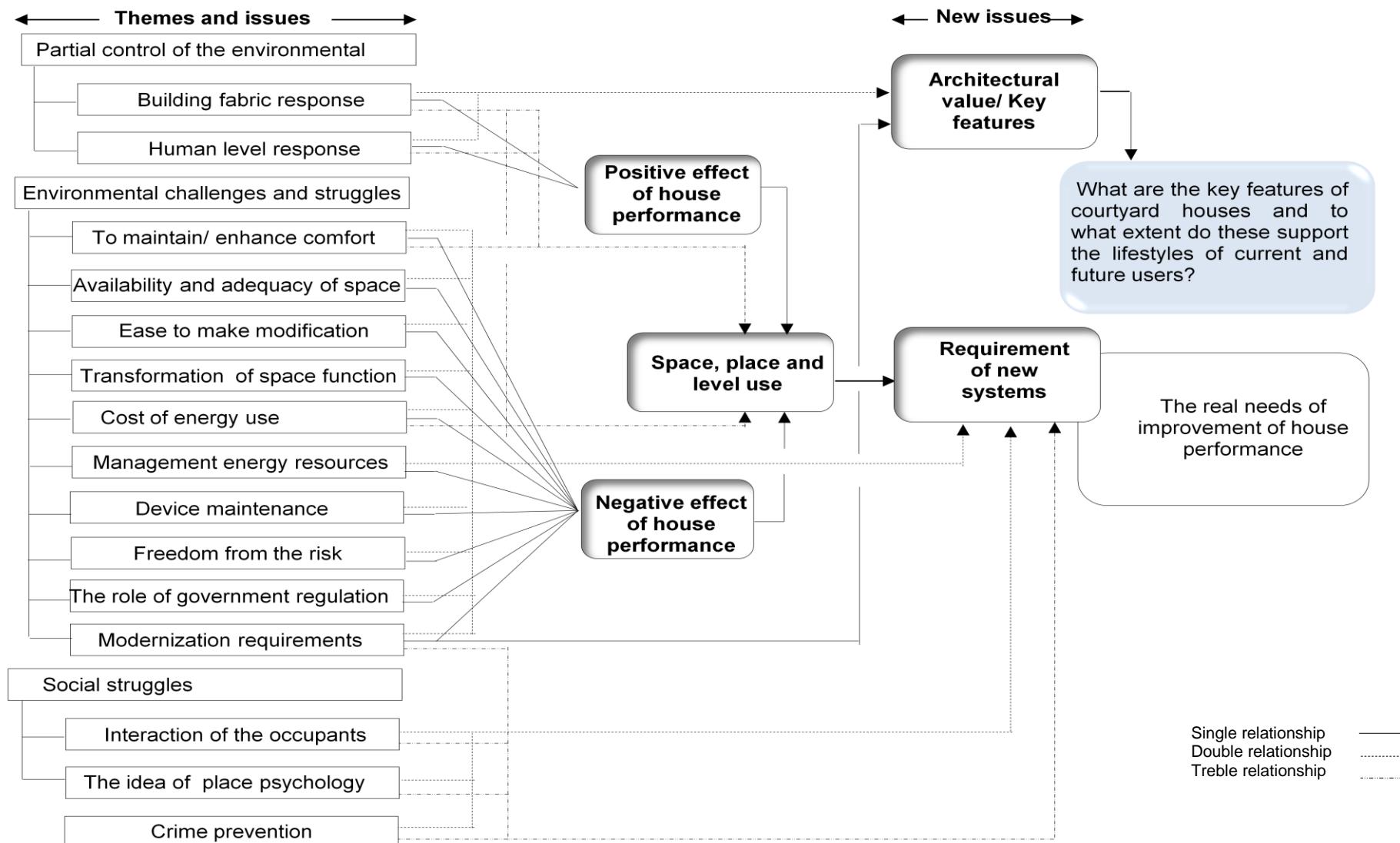


Figure 9.18: The multi-faceted relationship between the different issues and themes related to the first research question, (Author).

- **Architectural value – Key feature**

The building fabric response is related to the human level response and has a positive effect on the T.C.H.T performance in terms of its passive systems related to lifestyle. Passive systems create a mini atmosphere by enhancing the level of natural lighting, ventilation, cooling and heating (see section 9.2.1/1); all of these are likely contribute to the traditional courtyard house performance. This was clearly expressed by one interviewee who had worked together with a team in the rehabilitation of the Al-Kadhimiya historical area:

“The main strategies for T.C.H.T in the Al-Kadhimiya have positively created mini atmosphere. This is why no one objects if someone says the traditional unit reflects the environmental performance” (Arch, 21, 2012).

This is parallel with the aspect of lifestyle and involves specific environmental treatment (see section 9.2.1/2). These environmental treatments provide the T.C.H.T in the Al-Kadhimiya with appropriate lighting, cooling, heating, and ventilation according to the family's needs, supported by passive systems in delivering appropriate house performance (HP). It seems possible that environmental treatments and the passive system led to a level of control of the environment and then improved the HP by partial control of it.

Furthermore, the lifestyle of the current users is an important aspect of the T.C.H.T in the Al-Kadhimiya through the environmental treatment related to the passive systems through the use of natural energy, which is an important phase in this type of house. As a result, the impact of external changes to conditions is reduced in that they attempt to provide a comfortable atmosphere for the occupiers through encouraging energy conservation. This therefore incurs minimum costs for the use of energy for heating, cooling, ventilation, and lighting, and reduces the energy consumption of artificial systems through a reduction in the amount of energy consumed in a process.

Similarly, the role of government regulation in terms of conservation means that occupants are constrained by these regulations and must retain the house appearance; now, we understand why the government assisted in the refurbishment of the T.C.H.Ts. in the Al-Kadimiya historical area (see Chapter 2.4).

Therefore, the passive system is the key feature of the T.C.H.T in the Al-Kadhimiya which definitely supports the lifestyle of the current users, and is likely to do so for future users. This significant finding formulated new different issues, and clarifies the strong architectural value of the T.C.H.T.

- **Limited space use**

From a different perspective, the building fabric response or human level responses related to maintain/ enhance comfort or manage energy use affect space use through passive systems or lifestyle, related to the level of comfort or energy consumption. As shown above, the passive systems in terms of thermal behaviour, natural cooling, ventilation and lighting are linked to partial control of specific spaces, places, and levels according to specific times. This in turn is related to the varied of level of comfort in the house, because the whole house does not have equal performance, and so the occupants had difficulty controlling all the spaces and levels at different times. Every family and all the work done by the housewives was affected by the absence of a special place or space to do it in. This is in spite of the building fabric response achieving a great natural environment for the dwellers of the T.C.H.T in the Al-Kadhimiya, and having a positive effect on the HP. without the use of mechanical power. It also therefore provided a reduction in the use of energy by partial control of the temperature, air, and lighting inside the house through these means. The occupants had issues with the management of energy use, which had a negative effect on the HP. by energy consumption. Also, the lifestyle created environmental treatment and is linked to partial control of the environment; however, the level of comfort still varied in this house type because these treatments were at specific times according to specific places, spaces and levels. Regarding the human level response through modifications and the adoption of modern technical equipment, this equipment was of limited use because of issues with energy consumption. Some spaces were not used, and the residents felt as if they were paralyzed at these times because the human level response was affected by energy consumption. Therefore, the space in use was affected by the house performance.

Similarly, factors linked to modernization requirements have created unequal HP and affected space use, such as those linked to maintaining and enhancing comfort, the availability and adequacy of space, ease of making modifications, transformation of the space function, management of energy use, maintenance of devices, eliminating safety risks, and the role of government regulation.

The result of not upgrading the living standards has led to unequal HP and different levels of comfort, a lack of indoor environment quality, mismanagement of the indoor environment, unclear strategies for energy consumption, and poor regard for safety features. Therefore, the limited space use is related to HP.

Also, in this study the idea of place psychology or interaction between the occupants is also related to maintaining and enhancing comfort, the ease of making modifications, the transformation of space function, the management of energy use, the maintenance of devices, being free from risk, the role of government regulation, and modernization requirements, all of which affect space use. This was caused by the unequal HP, so the occupants phased their space use, and this in turn reduced communication, feelings of belonging and nostalgia for the place, as well as creating a lack of privacy. Space use is therefore confirmed as a limitation due to the unequal HP.

- **Requirements for new systems**

The first new issue has been seen as maintaining/enhancing comfort related to availability and adequacy of space, the ease of modification, the transformation of space function, the cost of energy consumption, management of energy resources, the maintenance of devices, eliminating safety risks, the role of government regulation, and modernization requirements for CH, due to the difference in level of comfort related to lack of indoor environment quality, inflexibility, mismanagement of the indoor environment, unclear strategies of energy consumption, lack of monitoring, no safety features, and living standard requirements. All of these have had a negative effect on HP and caused great discomfort and an unhealthy indoor environmental situation for part of the time, or for specific places, because not all the house had an equal environment all year round. It therefore needs new systems to refine the internal environmental performance and achieve equal performance of the whole house around the year. This other significant new issue is found in the current study as the requirement for new systems.

Also, the building fabric response and human level response is related to partial control of the environment through lifestyle, and is in turn related to passive systems. Accordingly, the occupants in T.C.H.T in the Al-Kadhimiyah need new systems because they have difficulty controlling the whole house around the year.

Furthermore, new systems were needed because the occupants in the T.C.H.T. in the Al-kadhimiya had social struggles of living in this house type. The factors creating this need are: the interaction of the occupants, the idea of place psychology, the major concern about protection, the need for communication and a sense of belonging, nostalgia, privacy, and observation and monitoring needs.

Similarly, the partial control of the environment related to environmental challenges and social struggle affected space use. In spite of the ability to partially control the environment by creating an appropriate environment in all the spaces, places, and levels at specific times, or in specific spaces, places, and levels around the year (which affected space use), there were still some places and spaces which were vacant at different times. The residents still faced challenges with their unequal environmental situation that definitely affected the performance in the T.C.H.T. At the same time, the occupants abandoned these spaces and levels to leave an uncontrolled environment, thus affecting space performance at specific times. The unused space had a hostile environment due to the lack of appropriate temperature, fresh air, or sunlight, leading to the social struggle of living in this house type. These issues were related to the difficulty of fully controlling the environmental performance in specific spaces, places, and levels at specific times. This represents an important issue related to HP. as this affected the use of space because residents could not adapt all the spaces, places and levels all year round, and so some spaces were abandoned. Thus, one possible explanation is that the house requires new systems to enable the whole house to become habitable around the year; this will probably enhance the space use by enhancing the HP.

However, as stated the current level of environmental performance in the T.C.H.T was unequal in the whole house around the year. This represents the real need to improve HP for the current occupants by adding new systems to the T.C.H.T in Al-Kadhimiya. Therefore, the improvement of HP will probably improve the architectural value and enhance the space use.

The development of better building technology is conducted with the aim of improving the performance. An overview of the literature related to IS research indicates that previous research efforts have dealt mainly with performance and environmental improvement. For example, Wong and Lie (2006, p.1110) highlighted that development of the BP is a key determinant in any acceptance of the IB as is feasible through IS. Smith (2002, pp.36-58) indicated that IS has been employed to

reflect the BP and properties of improvement. Arkin and Paciuk (1997, pp.471-479) stated that IBs enable a BP to be quantified in terms of the IS and as a result enhance their performance. The enhancement of the building performance presented in the previous literature is linked to the IS, which affects the environmental performance of building. As we mentioned above, the performance of the T.C.H.T needs improvement by adding new systems. Therefore, the IS could represent the type of new systems required in the T.C.H.T. However, the current study will explore the role of enhancing T.C.H.T performance by using IS, and this is addressed in the next section.

9.3 Tradition courtyard houses and intelligent systems

This section explores what the date means in the current research? As explored in section 9.2.4, the T.C.H.T in the Al-Kadhimiya needs improvement in terms of performance. Intelligent systems cause great change and enhance the HP. and probably achieve improvements in it. To understand how IS in T.C.H.Ts enhance performance; we need to understand the interaction between them through three stages. This is explored in the following sections.

9.3.1 *The nature of intelligent systems in the courtyard house*

Chapter 4.3.5 illustrated that there are different types of IS in buildings, and now we need to explore which of them might be appropriate for T.C.H.T. in the Al-Kadhimiya. The use of IS should address their roles in the T.C.H.T, which has its own nature compared with other dwelling houses, and has general and specific requirements for intelligent systems. The nature of these systems in the T.C.H.T is as follows:

- **Complex and simple**

Chapter 4 (section 4.3.1) clarified that the degree of complexity for IS could be complex or simple and which of them is more appropriate for the lifestyle of the current users in the T.C.H.T. According to the lifestyle of the current users related to extended families (see section 9.2.1.2), there are children, adults, and older adults at home; all will use these IS without exception. Therefore, the systems must be suitable for use by different of persons different ages. Also, there is different level of education and knowledge in the T.C.H.T and these people are not professionals in dealing with IS.

After identifying the age of the users, education and knowledge is another significant limitation for the operation of IS in the T.C.H.T. Therefore, simple to operate IS are required according to the lifestyle of the current users. The IS should be simple and communicate easily, so that in operating them the users are inspired to make environmental improvements, for example light switches or remote controls for the TV. If complex systems are installed, these could be neglected or used less by the current users, who prefer simple to operate systems. This idea was confirmed by a housewife and her daughter who lived in a T.C.H. in the Akd-Al-Sada neighbourhood. They said:

“Adding new systems to our house is good idea. However, we need time to learn how to use or operate these systems, so we prefer an easy system, but at the same time one which is easy to maintain” (Occ, 2012, 11+12).

Therefore, the simple operation of IS is more appropriate for the lifestyle of the current users to enhance the performance in this type of house.

For the future users, the age and education and then the lifestyle could be different, and the degree of complexity may change too. However, adding simple or complex IS has no impact on the socio-economic status of the occupants.

- **Full systems and applications**

Section 4.3.2 covered the types of IS. The prospective use of IS in the T.C.H.T in the Al-Kadhimiya to enhance their environmental performance could be achieved by appropriate types of ISs, either as a full system or as applications. Turning back to the architectural value of the T.C.H.T, adding IS as applications could give more flexibility and minimise the impact on the structure and materials due to it having wide walls. However, it requires reshaping of the space use generally and might be against function of space and activities movement especially (see section 9.2.1).especially (see section 9.2.1). Adding full systems may require changing the house, which might affect the house structure, which could in turn lead to demolishing the T.C.H.T in the Al-Kadhimiya as it was built more than 100 years ago due to the load baring wall. This illustrates the difficulty of modifying the T.C.H.T; as a result, the environmental challenges will increase (see section 9.2.3/3). On other side, adding full systems is very expensive as need to add in one-step which affects the budget of the occupants in this type of house compared to applications that could be added step by step and have less immediate economic effect.

Thus, IS should be applications rather than full systems to enhance the performance by reducing the environmental challenges, which is suitable for T.C.H.T, for example washing machines for water systems.

- **Integrated and un-integrated**

The prospective use of IS in the building must consider the relationship between different systems and whether these should be integrated or not. As clarified in section 4.3.3, the potential use of non-integrated systems could increase the environmental challenges in T.C.H.T in the Al-Kadhimiyah linked to management of energy use and maintenance of devices, with the result that energy consumption and the breakdown of devices will increase. Both will affect the lifestyle of the current users, and which certainly increase the limitation of space use and in turn increase the social struggle caused by limited communication between the occupants, and loss of privacy. However, the potential use of integrated systems will enhance the HP in the opposite way, and also enhance the space use. An integrated system offers considerable advantages to the building user which will reduce the number of applications, thus reducing the impact of such systems on the architecture value. There would also be no concerns about the total cost of adding such systems compared with un-integrated systems which need specific applications for each system. However, there are difficulties in achieving an integrated system which may be classified as technical, for example using a smart TV as part of the communication systems, security and access control systems, monitoring and safety systems and others (see section 9.3.2). Any problems with an application would be for non-critical functions, which affect operation in an emergency. During such a time, the user may not be able to watch TV, change channels, or show the outside image when needed; similarly, they may have difficulty connecting devices, and so may not be able to use specific systems.

Therefore, a mix of systems in one application is needed in the T.C.H.T. in the Al-Kadhimiyah. There should be integration between the systems according to the changing needs of the users' lifestyle, and this is the biggest advantage of using integrated IS to enhance the T.C.H.T performance.

- **Wired and wireless**

In Chapter 4 (section 4.3.4), it was clarified that the relation between components for IS can be wired or wireless. The most interesting finding in the current study is the

architectural value/ key feature of the T.C.H.T., as mentioned in section (9.4). Additional ISs should have minimum visual impact for specific reasons in the T.C.H.T related to the role of government regulation; because there is the need to conserve this house type (see section 9.2.2/9). Thus IS needs wireless access points between components such as wireless routers to give internet access for devices and to avoid any negative visual effect. The other justification of the use wireless rather than wired is to keep houses safe because these houses are old and need protection. Indeed, using wired access points could have a negative impact on the T.C.H.T in the Al-Kadhimiya appearance and so will contradict government regulations. This may also increase the environmental challenges and reduce the level of control of the environment linked to the passive systems. This idea was expressed in an account by an interviewer:

"The main thing that should be taken care of when improving the T.C.H is to make them any improvements invisible, (covered, buried, or hidden inside architectural elements) (Arch., 4, 2012).

As we confirmed in 9.2.1, the T.C.H.T in the Al-Kadhimiya had thick walls and an inflexible structure (see section 9.2.2/3). Using wired communication faces the obstacle of thick walls and is not appropriate with this feature of load bearing walls. At the same time, frequent reconfiguration could also affect the lifestyle of the current users by creating difficulty of movement or flexibility of space use related to the number of family members or arrangement of furniture, or a change in function. Thus, the application and space needs change frequently. Therefore, wireless communications are particularly attractive for the houses such as this T.C.H.T in the Al-Kadhimiya, as requirements can be efficiently met with less change in the house, and in keeping less cost for apply comparative with weird systems that need a lot of change, at the same time in keeping with the dynamic lifestyle.

However, the wireless communication was hard to apply in T.C.H.T as these houses type contained from 4 to 6 levels (see section 7.4) and the radio frequency might not reached between all levels to serve a wide range frequencies, so that a single antenna and wireless router was not enough. Having too many wireless signals criss-crossing each other creates the potential for confusion, unreliability and other problems.

From this, we explore how the components of IS can be wireless to reduce the environmental challenges, and then enhance the HP, as well as considering which are more appropriate for the T.C.H.T.

- **Sensors and actuators**

To control the operation of ISs, Chapter Four (Sections 4.3.4) pointed out that there are actuators and sensors; we need to explore which of them might be appropriate for IS in T.C.H.Ts in the Al-Kadhimiyah, in respect of the lifestyle of the current users and who will use these systems. The lifestyle of the current users is related to occupation time in the T.C.H.T (see section 9.2.1.2), because of the 24/7 year round occupation. The operation of ISs in the T.C.H.T in the Al-Kadhimiyah for the current users needs to be actuated for daily use to achieve the required level of comfort. Also, as there are different ages living in the houses, using the actuators that controlled by an adult is more appropriate; this includes such as those for the internet, TV channels, and others. From a different perspective, using actuators also definitely helps the residents to conserve energy, as it reduces energy consumption then reduce the total cost of systems due to controlled usage during occupation periods for specific spaces, places, and levels. However they need continuous monitoring by an adult especially when there is not a clear schedule of interruption of the electricity grid.

In the case of the sensor, these will run all the time to achieve the required level of comfort, even during the non-use of spaces, places, and levels, and so they represent a cost and increased energy consumption issue. Also, they require continual maintenance, and might need to be connected to the internet all the time. They therefore require an efficient network with continuous energy which increased the total cost of applying such systems. However, with actuator, all this cost will be avoided

Also, there are some exceptions, for example applications for water systems, which need to have sensors that work when the electricity is available, especially at night, so that the hot water is available even when other systems are unavailable. Also, systems monitoring and maintenance with sensors is required because the occupants have no schedule for cutting or changing the electricity supply and it is not easy to determine the priority and the numbers for electrical equipment. One occupant living in the Al-Baheya neighbourhood said:

“We need strategies to control the available hot water especially in winter, to control each electricity supply, we used change over; however, it needs continuous monitoring” (Occ. 15, 2012).

However, the actuator is more appropriate than a sensor with this type of lifestyle. For future users who are likely to have a different lifestyle, operational control may be different.

The nature of IS in T.C.H.T. in the Al-Kadhimiyah was examined. However, the priority of these systems needs to be clarified to complete the potential role of IS in enhancing the performance of the T.C.H.T.

9.3.2 *The priority of intelligent systems in the courtyard house*

The previous section attempted to clarify the nature of IS in the T.C.H.T. in the Al-Kadhimiyah. As we mentioned in section 4.3.2, this study nominates the categories of BRE global (cited in Holden, 2008) according to the potential applications, and associated technologies, that include: energy use, environmental control, communications, security and access control, life-safety systems, systems monitoring and maintenance, and lifts and escalators. This section is the second stage in determining the role of ISs in enhancing the performance of T.C.H.T in the Al-Kadhimiyah and which ISs are needed, as well as whether these systems need to be permanent or temporary.

As we discussed in section 9.3.4, the partial control of the environment was achieved by passive systems and lifestyle. Therefore, an environmental control system is required for full control which will enhance the environmental performance of the T.C.H.T in the Al-Kadhimiyah by supporting the passive systems and environmental treatments used in the current lifestyle. Similarly, the environmental challenges which hinder environmental control are linked to different levels of comfort, lack of indoor environment quality, and mismanagement of the indoor environment; as a result, an environmental control system is also required, which will probably enhance the HP by enhancing the level of comfort, reducing the effect on frequent and intense space use, and enhancing the indoor activity quality. Environmental challenges are linked to high energy consumption, and difficult use of different sources, and therefore an energy use system is required to reduce the bill by reducing economic limitations, providing stable electricity and managing different systems.

Environmental challenges are associated with the use of different resources, and energy consumption by the addition of systems for monitoring and maintenance. These are required to enhance the HP by monitoring and managing the energy use for all systems, and the management of the use of different resources will then decrease the effect on the unstable electricity supply. Environmental challenges are linked to the available lifestyle, the need for conservation, while social struggles are linked to privacy which requires environmental control, energy use, communications, and systems monitoring and maintenance. This will likely promote upgrading of the house, reduce the effect of strict roles, and enhance the individual freedom. Social struggles are linked to belonging and nostalgia, and due to lack of communication between the occupants, a communication system is required in the T.C.H.T in the Al-Kadhimiyah as a part of everyday modern life. This will probably enhance the collective memory, and achieve pleasure or enjoyment in being together. Similarly, to provide communication between the components of each system, a communication system is also required for this reason.

Environmental challenges are linked to the safety requirement, and life-safety systems are required to reduce the risk of fire. Social struggles are linked to observation and monitoring and the need for a security and access control systems in T.C.H.T in the Al-Kadhimiyah, to decrease the level of crime. Currently, there are no data to confirm the need and it is also impossible to add lifts and escalators because of the architectural value for this type of house, and they must be integrated or added through the design process.

Therefore, ISs need to be permanently added according to the lifestyle of current occupants' needs in the T.C.H.T in the Al-Kadhimiyah. These are:

- Energy use systems, because the issue of energy has become a global issue in Iraq especially, as seen in Chapter Two section 2.2.2, and observed in other parts of the world. Increasing energy fees and reducing energy conservation is an important aspect regarding the need for this system in the T.C.H.T that reduces energy consumption. Therefore, better energy use could be achieved by using all applications, as shown in Chapter Four, section 4.5, for example wireless router, multi split unit, boiler automation and chiller control, washing machines and others. Such machines can monitor their household energy usage, control usage and conserve resources, by utilising both renewable energy and storing energy. This ensures maximum energy efficiency of different resources.

- Regarding environmental control systems, it was seen in Chapter Two section 2.2.1 that the climate and weather condition continuously changed, which was an issue for the residents on both the social and health levels, and so it is an essential consideration in the T.C.H.T. Now, versatile environmental conditions have caused thousands of Iraqis to seek medical assistance, as they have begun to suffer from breathing difficulties, eye and sickness problems, and there is a higher incidence of asthma, sunstroke and sunburn (IAU et al., 2013). Also, another justification for permanently adding environmental control systems is that the level of infrastructure, especially in Al-Kadhimiyah as shown in section 2.2.2, has problems concerning the availability of water, the sewage system, and integration between the public and private systems in this historical area. Therefore, environmental control can be achieved by: (1) controlling water by adding washing machines, dishwashers, drying machines, boiler automation and chiller control, and pumps with a smart float switch. These all control the available water at difficult times, enable maximum water efficiency, and save cold and hot water; (2) controlling lighting automatic emergency lighting, and Plume, which achieves good quality light and efficient lighting usage, and implements a quality of light compatible with natural lighting, and strong light; (3) controlling ventilation by supplying clean air through the smart chimney hood, which leads to the creation of a variable air flow and increased air movement. This cleans the air by recirculation, controls humidity, reduces the level of odours and removes them, and prepares airflow in real-time. It also controls grease, smoke, and steam, and odours spread from food, all without extra noise; (4) controlling the temperature with, and a multi-split unit that which controls indoor temperature by cooling and heating the air, and maximizing thermal comfort.
- Also, there is a need for communications systems as a part of everyday life in the T.C.H.T. in the Al-Kadhimiyah. Section 2.2.2 confirmed that the telecommunications system has a significant effect on the lifestyle, and this system needs to be added to the T.C.H.T. It should be easy to control, have flexible connections, able to transfer data between devices in the home faster, monitor a particular occurrence, promote communication with others, communicate with different systems, and control devices, provide a social boundary, and communication with others, update information, allow users to access many features, offer a depth of picture, and connect with different TV channels or radio stations. It should bring the latest movies with high resolution and the sound of music into every corner of the house.

The application of such systems could be a smart TV, a mobile, a wireless router, portable Bluetooth speakers, a DVD player, smart accessories, a digital satellite, and others.

- Security and access control. In Chapter Two section 2.2.3, it was shown that there is difficulty with the security situation in Iraq in general and Baghdad especially. Therefore, this system is another important system which needs to be added to the T.C.H.T in the Al-Kadhimiyah to protect the residents from crime by the use of a smart TV and digital camera.

There is also a temporary need for other systems in order to change the situation in Iraq; these systems are:

- Systems monitoring and maintenance. The actual need for this system will probably decrease when the situation becomes stable and will depend on clear strategies for the electricity supply. The application of such systems could achieve water availability 24/7 and decrease maintenance from 24 hours a day, detect the level of water within a tank, and monitor and control household appliances via automatic push messages when an appliance has finished or if a fault has been detected. It may also transmit the perfect cooking temperature, monitor optimum temperature choice, store images, alert occupants, and keep the application running at the optimum level over many years, observe electrical outlets for poorly or non-functioning devices, or turning off power to a receptacle by using smart fridge, smart cooker, and automatic transform switch, and smart camera, fire alarm, smart oven, mobile, multi split unit, all will provide
- A life-safety system. The actual need for this system will certainly reduce when the political situation is resolved and there are no material explosions or an unstable electricity supply. This system achieves food longevity, suppresses and controls fire and smoke, avoids food burning when cooking, transparently monitors household energy management by adding applications such as a fire alarm, smart fridge, refrigerator, smart cooker, and automatic transform switch, smart camera, fire alarm, and smart oven.

All these systems above would enhance T.C.H.T performance and then sustain the lifestyle of the current users by maximum space use. Table 9.3 illustrates ISs using different application companies such as Bosch, Siemens, and others, as suggested in Chapter 4.6., which could be applied in the T.C.H.T. to achieve the required level of system service and enhancing the performance in T.C.H.T in the Al-Kadhimiyah.

However, the need for these systems may change in the future according to the lifestyle of the residents related to changing needs. These systems, therefore, are needed in terms of priority; however, we still need to know how these systems could be added to the T.C.H.T. in practice.

Table 9.3: IS by using different applications that could enhance T.C.H.T performance in the Al-Kadhimiya, (Author)

Systems	Energy use	Environmental control	Communication	Security and access control	Life-safety systems	Monitoring and maintenance
Application	Efficiency/ Low energy Management of different resources Self-produced energy Controlling usage Integrated with passive Conserving of natural resources Qualified lighting Water available Filtration & purify Thermal comfort Reduce odours Insulated acoustic	Connected between the Connections with other applications Updating of information Connection with others Visually , audience entertained Observation and monitoring Access control	Connected between the Connections with other applications Updating of information Connection with others Visually , audience entertained Observation and monitoring Access control	Access control Safety feature Smoke control Fire control	Scheduled time Diagnosis the failure	
1 Washing machines	•	•	•	•	•	•
2 Dishwasher	•	•	•	•	•	•
3 Drying machines	•	•	•	•	•	•
4 Boiled automation & chillers	•	•	•	•	•	•
5 Clean air recirculation module	•	•	•	•	•	•
6 Plumen	•	•	•	•	•	•
7 Smart chimney hood	•	•	•	•	•	•
8 A smart phone	•	•	•	•	•	•
9 A Smart TV	•	•	•	•	•	•
10 Solar energy sheets	•	•	•	•	•	•
11 Pumps with a smart float switch	•	•	•	•	•	•
12 Multi split unit	•	•	•	•	•	•
13 Solar DC Mini-Split Unit	•	•	•	•	•	•
14 Smart cooker	•	•	•	•	•	•
15 Automatic emergency lighting	•	•	•	•	•	•
16 Automatic transfer switch	•	•	•	•	•	•
17 Wireless routers	•	•	•	•	•	•
18 Smart camera	•	•	•	•	•	•
19 Smart fire alarm	•	•	•	•	•	•
20 Smart refrigerator	•	•	•	•	•	•
21 Smart Fridge	•	•	•	•	•	•
22 Smart oven	•	•	•	•	•	•
23 Digital satellite	•	•	•	•	•	•
24 DVD player	•	•	•	•	•	•
25 Portable Bluetooth speakers	•	•	•	•	•	•
26 Smart accessories	•					

9.3.3 The courtyard house as a container for intelligent systems

In order to complete our understanding of the interaction between IS and the T.C.H.T based on the role of ISs in the T.C.H.T in improving the performance by using the latter as “containers”, we need to explore how IS could be added to this type of house.

Smith (2002, pp. 35-58) pointed out that buildings may include the total components of IS, whereas some might only incorporate basic building systems, some in IBs. According to Pennell (2013, p.305), the integration of ISs distinguishes IBs from those that contain IS to enhance the building performance. Turning to the nature of IS in the T.C.H.T as addressed in section 9.3.1, these can be wireless, applications, integrated, simple, and actuators. From this we understand that the T.C.H.T had intelligence through the integration between systems; in this way, adding IS to the T.C.H.T will transform it into an IB.

Chapter 4.2.3 illustrated that there are two types of IB as containers of IS: through retrofitting (Kroner,1989, p. 322) or new design (Kroner,1997, pp. 386-392). The focus on adding IS in our existing house type is a question of suitability, rather than creativity. Such an idea supports Alwaer and Clements-Croome (2010, p.800), who note that an IB does not need to be one with solely advanced technologies; rather, it may be one with strong values.

The T.C.H.T in Al-Kadhimiya were built before 1918, and the options for the T.C.H.T are for them to be retrofitted or to have a new design related to the architectural value/key features in the Al-Kadhimiya historical area, as shown in section 9.4. This is supported by the findings of Chapter 3.4 in which it was found that the T.C.H.T should be conserved because it has many advantages and it is not easy to rebuild for different reasons. The possible application of IS in T.C.H.Ts. by retrofitting will achieve a strong value through improving HP. and then achieving maximum space usage.

In this way, the T.C.H.T becomes a container for ISs, so the potential for retrofitting could be a significant part of a development and refurbishing project, as shown in Chapter 2.4. However, there is limited use of ISs with the lifestyle related to partial space occupation, which could be interpreted with caution because adding these systems will clash with environmental treatment as a part of the lifestyle (see section 9.2.1/2). However, the possibility of using a new design in the T.C.H.T could be appropriate for those houses with no architectural value or a poor, deteriorating,

slum structure. As mentioned above, adding ISs to the T.C.H.T. makes them containerized and then achieves a level of intelligence; the benefit of such a change will be linked to house performance. This will be explained next.

9.3.4 Intelligent systems and house performance in the Al- Kadhimiyah

The interaction between the IS and the T.C.H.T. as a base for the role of IS in this house type for the current users was explored in three major steps, as follows. First, the nature of ISs in the T.C.H.T was explored as wireless, applications, integrated, simple, and actuators according to the relation between components, type of IS, the relation between different ISs, the degree of complexity, and the operation of ISs, as illustrated in section (9.3.1).

Second, the priority of IS in the T.C.H.T was explored in terms of energy use, environmental control, communications, and security and access control as permanently needed systems. Also explored were the life-safety systems, systems monitoring and maintenance as a temporary systems need, but there was no need for lifts and escalators, see section (9.3.2).

Third, there was the possibility of applying ISs in the T.C.H.T. by using the latter as a container by retrofitting those T.C.H.T which had a high architectural value, and creating a new design for those with limited architectural value and poor structure, as confirmed in section (9.3.3).

In Chapter 1.2.4, building performance is how far a building fulfils the current and future needs of its users, and its effect on society and the context in which it is used. The literature has clarified that the building performance could be enhanced by the level of building intelligence through "*Intelligent amenities quotient*" (Arkin and Paciuk, 1997), "*Intelligent amenities quotient*" (Wong and Li (2006) and Frances Duffy, a world renowned architect of IB (cited in Kroner 1997, p.383), "*User evaluation*" (Preiser and Schramm, 2002), "*Performance criteria*" (Wong et al., 2008; Wong et al., 2005; So and Wong, 2002; and Smith, 2002). However, the current research nominates Arkin and Paciuk, depending on the "*Intelligent amenities quotient*", as being more appropriate to the T.C.H.T, and potentially enhancing the HP. using the example of integrating ISs to enhance the level of intelligence. This is instead of the other ways which depend on assessment of the available ISs as part of existing IB components. Therefore, the level of intelligence here means the

integration between ISs in buildings. We therefore need to understand how this intelligence in a building is created and then the level can be improved.

The current study agrees with Arkin and Paciuk's (1997) suggestion about the development of the level of intelligence in commercial and office buildings through the level of integrated systems, which includes three levels as described in Chapter 4.3.3. However, the current study suggests using the same classification of the level of intelligence with a slight difference in a dwelling generally, and the T.C.H.T specifically which includes:

- A high level of intelligence giving optimum integration between ISs, including the multiple aspects of operation and communication management by APPS, such as a smart phone, which can be used in the future to monitor and control household appliances when the applications involve being able to connect and operate in this way.
- A mid-level of intelligence gives integration between the main ISs which is performed by different systems such as environmental control, energy use, communication, and others.
- A low level of intelligence by the integration of sub systems covering specific systems, for example, the security and access control systems, or energy use systems.

Turning back to section 9.3.1, it was found that the T.C.H.T requires more than one integrated systems. Therefore, the T.C.H.T achieves a medium level of intelligence and this will have a great impact on the T.C.H.T in terms of the house performance, with respect to the families' needs according to the lifestyle of the current users. To achieve greater enhancement of the level of intelligence and achieve the third level, this requires a high level of integration between those ISs which will be added to the T.C.H.T to optimize their performance.

Arkin and Paciuk (1997, p. 473) confirmed that an IB achieves enhancement of the building performance by integrated systems, and improves the internal environmental condition for the building occupants. Therefore, the capability of additional IS to the T.C.H.T will certainly help the residents fulfil the varied T.C.H.T performance, by:

- Enhancing the level of control over the environment by providing full control of the environment though supporting the passive systems while maintaining energy conservation and environmental treatment.

- Reducing the environmental challenges by maintaining/ enhancing comfort through improving the level of comfort, reducing the effect of the unavailability and inadequacy of space by the richness of indoor environment quality, and reducing the difficulty of making modifications by decreasing the limitation of rigidity. Also, reducing the effect of the transformation of function by managing the indoor environment for activities, management of energy use of different resources; reducing total energy consumption then reducing the bill, enhancing the maintenance of devices by the use of different sources and then reducing occurrences of device breakdown, achieving freedom from risk by providing safety requirements for occupants, then reducing the fire accidents. Lastly, reducing the effect of the role government regulation by promoting conservation and then saving the house appearance, and providing modernization by developing the house living standards for further upgrading and rehabilitating this house type.
- Supporting the response to the environment through enhancing the building fabric response and promoting the human level response by enhancing: the thermal behaviour, natural cooling, natural ventilation, and natural lighting through maximising daylight, preheating and cooling incoming air, maximising air fresh, maximising useful solar gain, providing an appropriate temperature, conserving resources, and others.
- Decreasing the social struggle by enhancing the occupant interaction due to improvements in the communication for pleasure or enjoyment together. Providing strong place psychology through developing a richer sense of belonging and nostalgia for these types of houses, besides achieving privacy by refining individual freedoms. Also, reducing the crime by improving observation and monitoring, which will be likely to reduce the level of crime.

In this way, adding ISs will enhance the HP. 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 will in turn enhance family life, which is very important for them to achieve user comfort (see Figure 9.19).

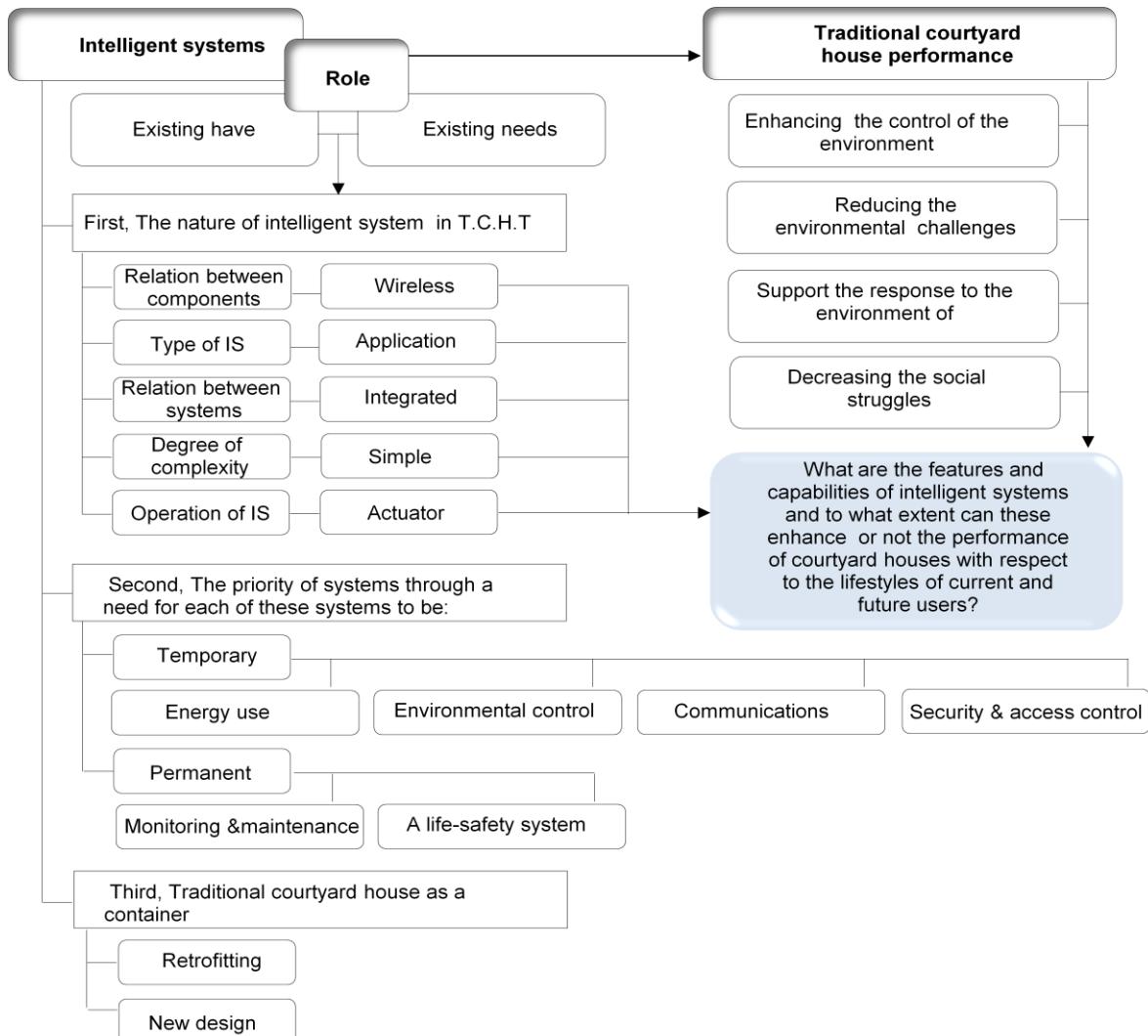


Figure 9.19: The interaction between the T.C.H.T in the Al-Kadhimiyah and ISs as a base role of such systems in this type of house to enhance the performance related to the second research question, (Author).

However, for the future users, the parents planned to stay in these houses as long as they could and never leave. Many younger occupants had left these houses for different reasons. For example, an interviewer and her husband alluded to such practices in their account:

“In the past, we were a very big family, now the number of family members reduced continuously; however, we were born and will die in this place” (Occ., 3+4, 2012).

Therefore, the future users could be older people, and then the lifestyle for future users is likely to be different. Accordingly, future users are likely to have a different

lifestyle and so the level of intelligence may change; thus, the potential need for ISs might change too due to the nature of IS, as illustrated in Figure 9.20.

In this way, the study has examined the potential role of IS in improving the performance with respect to the current and future users.

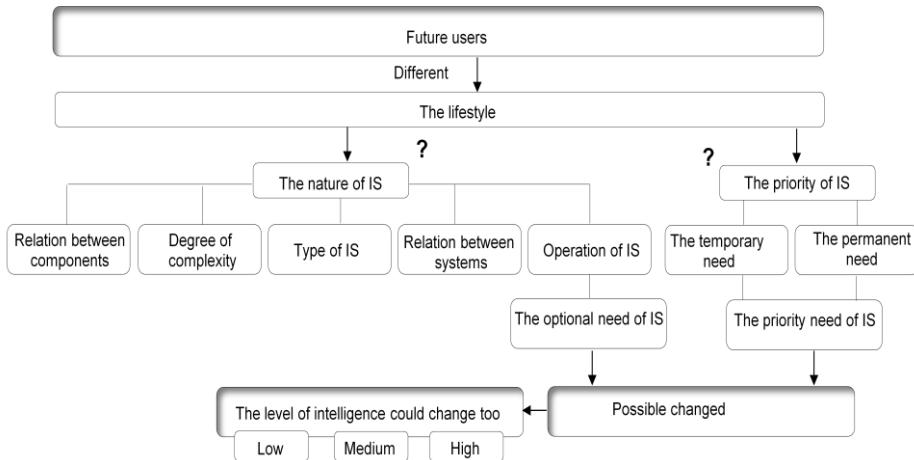
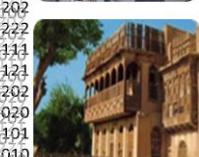
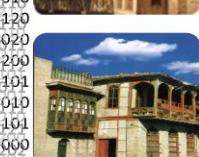
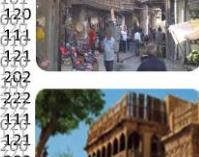
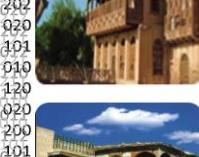


Figure 9.20: The level of intelligence in the T.C.H.T in the Al-Kadhimiya for future users, (Author).

9.4 Summary

This chapter has clarified what the data say by presenting explanations and the issues obtained from the different resources in the fieldwork, and cross-referencing these with the three main themes: partial control of the environment, environmental challenges, and social struggles (see section 9.2). It then explored the new issues including architectural value, limitation of space use and required new systems according to single, double, and treble relationships for those themes and issues, these are strong architectural value, limitation space use, and requirement of new systems. This chapter then explored what these data mean by clarifying the relationship between the new issues in current research with ISs to deliver their potential role in relation with ISs in the T.C.H.T areas to enhance the performance (9.3). The optional role of IS in the T.C.H.T for the current users has three major aspects, as demonstrated in an illustrative scenario. First, there was the clarification of the nature of ISs in the T.C.H.T; second, there was the prioritisation of systems according to whether the need for each of these systems was deemed permanent or temporary; third, there was their possible application to the T.C.H by using the latter as a container. However, future users may have a different lifestyle, and therefore the level of intelligence could change, and accordingly the potential need for ISs, and their operation, could change too.

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10. Summary and conclusion

10.1 Introduction

This chapter gives an overview of the main conclusions of the study, which has investigated the role of intelligent systems in the traditional courtyard house type. It provides a summary of the work undertaken, the completion of the research aim and objectives, the contribution to knowledge, the limitations of the research, and recommendations for further work.

This research was conducted to provide information that directly answered the two main research questions:

- *What are the key features of courtyard houses and to what extent do these support the lifestyles of current and future users?*
- *What are the features and capabilities of intelligent systems and to what extents can these enhance or not the performance of courtyard houses with respect to the lifestyles of current and future users?*

The study focused on identifying what the T.C.H.T have and needs according to the current and future users in term of house performance, all of which are main factors and the interrelationships which have the potential role on using IS in this type of house. The specific objectives of the research project were:

- *To investigate the characteristics and features of the traditional courtyard house in Iraq*
- *To investigate the meaning, nature and application of intelligent systems in buildings*
- *To investigate the lifestyle of current users of traditional courtyard houses and how these buildings support their needs*
- *To examine the potential role of IS in improving the performance of courtyard houses*
- *To make recommendations on the possible applications of IS to courtyard houses*

10.2 General summary

The research reported in this study was founded on the need to enhance the T.C.H.T in terms of house performance, as being essential to the potential role of IS in improving the performance of courtyard house types in Baghdad, Iraq. It

concentrated on the IS, as the most effective aspect behind improving the performance of the T.C.H.T particularly. This research explored how IS can be used to enhance the performance in the T.C.H., according to the lifestyle of the current users and possible changes for future users. The precise tasks completed with respect to the objectives of this research are summarised below as the questions raised, according to the aim of each chapter.

- **Why were specific issues in Iraq explained?**

The various issues and the chosen context of Iraq are thought to be appropriate to the research due to their connection to house design, lifestyle and building performance. These features include the climate having uniquely different elements, because Iraq suffers from a changeable climate and weather conditions, which occur with greater frequency and intensity, and cause further environmental decay in the country (Darwish et al., 2013). Also, the infrastructure is related directly to this study; however, this factor has been affected during the last 30 years for different reasons (UN, 2003) and (IAU et al., 2012). Lastly, security was another issue that has a significant effect on the study, since the last decade, the level of conflict with the security situation in Iraq in general and Baghdad especially has had a widespread effect on the lifestyle (JAU, 2013). However, these environmental changes, level of services and security need to be controlled and provide a proper and comfortable healthy interior environment for people in the building, and so eliminate the challenge of the harsh environment and general situation in Iraq (see section 2.2).

- **Why Al-Kadhimiyah historical area was chosen?**

The historical areas in Baghdad city that contain the T.C.H.T are those such as old Rasafa and Karkh or sub-city centres, such as Al-Adhamiya and Al-Kadhimiyah (Ihsan Fethy, 1976) the last area was chosen as a case study. Perhaps the most important factor that makes the study area suited to this investigation is the presence of a government plan to refurbish courtyard house types, which has prompted the investigation into the potential relevance of IS in this regard. The Iraqi government refurbishment and development projects especially in the Al-Kadhimiyah historical area for the T.C.H.T was based on modifying and transforming the social and environment aspects, which means this type possesses significant historical architectural values (see section 2.3.2).

- **What the courtyard house is?**

The term “*Traditional courtyard house*” is used here to mean the houses known in Baghdad as the “*Oriental*”, or “*Open*”, older than 1918, because of their differing architectural and constructional characteristics. The current study introduced the T.C.H.T, which has an inward looking plan concept consisting of a courtyard around which all habitable rooms and spaces are grouped. Hence, these rooms and spaces look inwards onto a private and secluded open space, through which they obtain sunlight, daylight, and natural ventilation. Different aspects of the T.C.H.T can be seen through the traditional type in Iraq and its components, which incorporate special features. The T.C.H.T is categorized by: form, size, number of courtyard (s) and materials. However, what distinguishes this type of house in Iraq is its size, and there are different sizes: small, around the 40-100m², medium, between 100 to 150m², and large, greater than 150m² (Al-Jawadi (1986, pp.12-31). Sometimes, it is distinguished by the number of courtyards, grouped into: one two, three and four courtyards (Al-Azzawi, 1984). The houses consisting of two courtyards or more are usually different in terms of the size, especially medium, and large, increasing to 300 m². The categories of these houses have different components of the T.C.H.T, which in turn can be classified into three groups: first, the courtyard and the transitional space; second, usable spaces; third, architectural elements. However, other distinguishing T.C.H.T. components of the Iraq are its two types of basement; the sardab and the neem sardab (see Section 3.2).

- **To what extent does the T.C.H.T in Baghdad respond to the environment and social needs of its occupants?**

T.C.H.T categorizations and components gave specifications to the house design which have specific characteristics. The current research has illustrated that the most significant characteristics of the T.C.H.Ts were that they responded to the environment through passive systems assembled as natural and architectural components, which convert elements of the climate and deliver heating, cooling, ventilation, and lighting without mechanical power (Agha, 2015). Also, when we consider the lifestyle in this type of house which is response to the environment too, we see that it is a way of life strongly related to the role of everyday different activities in terms of the relationship with places, spaces, and levels at different times. Any possible changes concern the need for appropriate thermal comfort. Furthermore, the T.C.H.Ts responded to the social cultural aspects in term of both privacy for each

sex, and also for extended families due to the family structure being a part of the lifestyle in this house type.

As mentioned before, there has been change in the climate and weather conditions, and the level of services and security issues in Iraq. Therefore, the T.C.H.T has difficulty controlling performance related to passive systems, which are not enough to support the lifestyle of current users, or cope with any possible changes there may need to be for future T.C.H.T users. Accordingly, because of the lack of information on the T.C.H.T in Iraq on these factors and the interrelationships necessary to refurbish and implement IS for this type of house, the first research question was raised.

- **Are intelligent systems needed to improve the performance of the T.C.H.T?**

The T.C.H.T is one type of CH which has been transformed and developed in different ways, being influenced by different factors (Schulz, 1982). These factors impact on planning and design of dwelling units, and these are: cultural and religious influences, society and the structure of families, economic and technological factors, and the local climate; all these provide historic continuity.

The contemporary CH is the other type of CH which was intended to accommodate the flexible requirements of families and households with changing needs. It was explained through categorization linked to the form, which is detached, semi-detached, and row (FAT 2009). These forms were designed in clear shapes such as L, z, I, U, and T shapes (MacIntosh, 1973) and (Burnett, 1986: 309); the sizes of the contemporary CH are small, around 45m², medium, 64, 68 m², and large, around 78m²(AJ, 1978). This type of house includes one or two courtyard(s). This means it is easier to control them, especially if the size of the courtyard and house is consistent. The components of the contemporary CH are classified into two groups: first, usable spaces and architectural elements. The contemporary CH was adopted to accommodate residents' requirements for the modern lifestyle through the following items: design provides flexibility with the layout and size of spaces, which enables future extensions to the house for economic and practical reasons (Delda, 1974). The structure of the contemporary CHs was achieved using the concept of two bay plans which permitted owners to decide how they were used in the houses (Davies, 2008). Also, they are designed according to Lifetime Home Standards in which the ground floor could become self-contained if residents were to become

physically disabled (Colquhoun, 2008). Also, the contemporary CH was built with advance services systems to control the house performance, and at the same time these systems were flexible in use according to residents' needs (Goh, 2010). Therefore, the contemporary CH is flexible and adapts to changing needs, compared with the T.C.H.T, which helps us to understand why IS are needed in this type of house (see Section 3.3).

- **What does the T.C.H.T contain that should be conserved?**

The earliest identified T.C.H.Ts go back no further than 140 years in Iraq, and the latest houses built entirely in the traditional style date back only about 70 years (Warren and Fethi, I, 1982). The advantages of the T.C.H.T are demonstrated at the level of the historic urban fabric, and the individual dwelling unit includes high density low rise structures compared with other dwelling houses (Yang (2007). Distinguished features and characteristics of the T.C.H.T, especially in Iraq, are as seen in Section 3.2.5. The T.C.H.T achieves space standards which are value for money as affordable housing (PRP, 2007). The grouping of T.C.H.Ts has facilitated and encouraged social contact and interaction between neighbours (Al-Qaisi, 1984). The compactness of urban planning is an energy conserving and environmental protection concept which is an essential part of the CH. This was achieved by efficient use of both the utilization of land and sun, excellent insulation, solar gain and loss, and the usage of traditional local natural materials, and others (Passive Solar House, 1982; MOYA, 1983). These advantages are the significant aspects in the T.C.H.T which deserve to be conserved; they should not be demolished or rebuilt but should be rehabilitated extensively and professionally.

Also, it has been seen that there are disadvantages to the T.C.H.T. The size of T.C.H.T was very big compared with other types of CH, and difficult to control. Overcrowding as a result of the rapid growth of cities in area and population (Al-Rahmani 1986) has had an effect on the level of infrastructure and then this leads to stress on service systems, as well as a rise in environmental pollution (Yang ,2007). Regarding lack of maintenance, it should be pointed out here that T.C.H.T. were compulsorily purchased in Iraq in 1958 and have been used in this way since that time (Warren and Fethi, I, 1982). All of these factors have had a negative effect on house performance. These represent the best possibility for the refurbishing and development of a practicable modern regionalism of reliable high quality, able to provide for this CH type, and improve its environmental performance and up to date

with changing needs, such as those of the modern lifestyle and new technology, and changes in weather and climate conditions which required rehabilitee and IS could be a significant part of this development (see section 3.4).

- **What is an intelligent building?**

Many attempts to formulate a specification for an IB have been made. Focusing on the word intelligence may give an different interpretation in connection to IB. In order to fully understand what the term IB is, definitions have been explained, presented, and compared to comprehend the notion of IB, classified according to technical systems such as those of Wong, et al. (2008A), Zou, et al. (2011) and others. Moreover there is also a focus on user needs, such in as Chan et al. (2009) and Clements-Croom (2013). It has focused on performance according to the changing needs of user requirements (see Section 4.2.1). From this, we understand that the concept of IB developed largely as a container of IT through specific components which include: systems, structural, services, and management (Alwaer and Clements-Croome, 2010). The possibility of an IB being a container was illustrated through retrofitting of existing types of building or a new design (Kroner, 1989 and 1997) (see section 4.2.3). As a result, the operational definition of IB which is considered to be the ability of the building to use intelligent systems (IS) to monitor the information from the different environmental situations, and then to assess, and dynamically respond to changing needs, thus improving performance to obtain a comfortable living environment and improved occupancy. The most significant points is that an IB has been widely used for different kinds of function. Kroner (1997, p. 382) stressed that a building classed as intelligent covers the living and working contexts and others. These IB have tended to be offices and commercial, public, and education buildings, as well as health care facilities and others. It has been applied in dwelling houses, such as the INTEGER Millennium house in Watford, but not in the T.C.H.T. Therefore, there is a lack of information concerning the T.C.H.T.

- **Why do we need an intelligent building?**

The incorporation of IT such as a system into buildings means significant changes can be made to performance, as well as adaptations to changing needs linked to the nature of the buildings. 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 (CABA, 2002). 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 (Holden, 2008). The building is able to receive and adopt new technology according to changing needs (CABA, 2002). It can be planned to notify of the need to replace materials and components, and this can include the ability to self-repair (Kroner, 1997). Last but not least, the benefit of IB is monitoring for energy use, water, electricity, and others (CABA, 2002B) (see section 4.2.4).

The goal of IB is enhancing the building performance (BP) for new designs or retrofitting existing buildings; this achieves the optimum performance by balancing environmental, social and economic aspects. However, the previous literature has presented the benefits of IB of different types in different functions such as offices, or dwelling houses, especially those where someone lives alone. Therefore, the benefit of the T.C.H.T as an IB is as yet unclear, which could assist occupants to adapt to the changing needs of user requirements in term of enhancing the T.C.H.T's performance.

However, all IB contain varying amounts of IS and the amount of these systems that need to be present for a building to be described as intelligent is not known or easy to determine. All buildings will contain some device that provides a form of automatic response to external changes, but they may not necessarily be described as IB. It is because of this difficulty to precisely say when a building becomes intelligent that the focus is on IS, for example the technologies or systems that contribute to making buildings intelligent.

- **When is a building intelligent?**

We need to consider how these buildings are intelligent in ways that differ from non-IB, and focus on how IS are important components of the IB. This was provided by exploring the nature of IS in buildings, in terms of: the concept of system intelligence, and whether they are complex or simple systems (Himanen, 2004); types of intelligent system are full of systems (Wong and Li, 2006 and 2008) or applications (Holden, 2008); the relation between intelligent systems as integrated (Arkin and Paciuk, 1997) or not; the relation between intelligent systems components could be wired or wireless (CIBSE, 2000); lastly, the operation of intelligent systems comprises a control system which is the last aspect to explore concerning the nature of IS in buildings through sensors (CIBSE, 2002) and actuators (Li and Yu 2011,

p.2090) (see section 4.3). The investigation of the nature of IS in a building was explored through different options as a result of cross, interaction and combination between the complexity of IS, the type of IS, the relation between IS and the components, and the operation. However, we must determine which of these options is appropriate to the T.C.H.T related to lifestyle and why they should be considered. Therefore, the second research question was raised.

- **How does an intelligent building work?**

To explore how an IS works, we must consider and understand the meaning of this type of system in buildings by focusing on the possible applications of the IS. Many companies such as Bosch and Siemens, LG, and others have presented applications which could be used as IS in a building. Possible applications that are part of energy use systems can achieve the management of energy usage and efficiency energy, reduce energy consumption, and provide renewable energy such as washing machines, boiled automation, clean air recirculation module, plumen lamps, multi split units and others. The possible application of IS to environmental control systems could be: washing machines, dishwashers, drying machines, boiled automation and chiller control, as well as pumps with a smart float switch. These applications could be part of water systems which achieve control of the environment and conserve the water in the building in terms of the availability and management of cold and hot water. They may also include multi split units, clean air recirculation modules, and smart chimney hoods. These applications could be part of cooling, heating and ventilation systems to achieve control of thermal comfort, purify the air and reduce the odour level through conservation and integration with the natural resources in the building. Furthermore, automatic emergency lighting, and automatic transfer switches can be employed. This application could be part of lighting and electricity systems to achieve control of the level of lighting comfort in combination with the existing need for lighting. Other possible applications could be part of the communication system connected with other systems to achieve control of the use of different applications in buildings, and interaction between occupants and with others, and to update the information. These include smart phones, wireless routers, a smart TV, a DVD player, and portable Bluetooth speakers. Other applications could be part of a security and access control system in the building to reduce crime, such as a smart TV, and a smart camera. The applications could be part of life-safety systems in a building to promote good health and a safe life, such as a smart fire

alarm, automatic transfer switch, smart refrigerator, and smart oven. Applications can also be part of systems monitoring and maintenance through monitoring household energy management. They can raise an alert if replacements are needed, and may also be able to self-repair, or undertake pre-emptive and corrective maintenance. Applications with these abilities are boiled automation and chiller control, smart phones, multi split units, digital cameras, bagless vacuum cleaners, smart fridges, and smart ovens. Lastly, the potential use of lifts and escalators can provide easy movement between different levels, such as a smart lift and a smart escalator (see Section 4.4.1).

From this, we understand that an IS has the function of controlling and responding. Therefore, we can introduce an IS as a recognizable whole that has different applications linked in a systematic way. It can determine boundaries, the environment, and intent and has evolving capability. This system has the ability to communicate with other systems which could connect to the internet. However, what needs to be clarified is which applications may be suitable for houses according to the nature of IS in the T.C.H.T. To clarify which of these applications is needed according to changing requirements, we need to explore which systems are needed for the lifestyle of the current and future users in the T.C.H.T. Therefore, we need more clarification by conducting further investigation through a case study, and this needs an appropriate methodology.

- **What is the philosophical approach for this thesis? Why?**

The key philosophers of science and their views are provided as follows: Inductive and deductive (Smith, 2002). However, few modern philosophers of science accept first approach. For example, in IT, So and Wong (2002), Wong and Li (2006), Wong et al. (2008) and Alwaer and Clements-Croome (2010) alongside many others in IT research have used the detective approach which has provided the conclusion. With this research there is no clear picture about using IS in T.C.H.T and we have no supporting theoretical background for such a relationship. Thus, detective approach may not be helpful to provide the aim and objective related to the current research by exploring something (see section 5.2.1).

Therefore, this thesis, unlike many others in IB research, holds to a realist, inductive perspective that results in the selection of a range of research methods to be used during the research process. It is reasonable to begin from a specific

relationship which is no clear picture of the possible role of intelligent systems in improving the performance of the courtyard house type and move onto the proceeded by collecting factual data through exploring the knowledge on small of existing T.C.H.T in specific historical area of Baghada/ Al-Kadhimiya and specific architects in Baghdad, leading to formulate the theories through whether or not the IS enhance the performance of T.C.H.T for the lifestyle and people lived there. This approach is less capable of being represented via research in information technology. Therefore, the current study has moved beyond research traditions in IB literature. One of the key justifications for choosing the research approach is to consider what is the most suitable for the research questions. The inductive approach instrument allowed an exploration of new knowledge. The questions I am asking explored nature and therefore that means perhaps more exploration of home research was suitable because I am looking for details. Therefore, the unavailability of the information about IS in the T.C.H.T was a significant limitation for using inductive approach. To gain a better understanding of the potential role of IS in T.C.H.T especially, we need an appropriate research methodology.

- **What is the appropriate methodology for this thesis? Why?**

Methodology is procedures and principles which enable the collection and assessment of data (Hart, 2013). Research methodology has been broadly categorised as quantitative and qualitative (Holliday, 2012). Therefore, this research project adopted an inductive approach that results in the selection of a range of research methods to be used during the research process. This study adopts an exploration which is open to many interpretations through the qualitative methods. This in turn consists of many different endeavours, many of which are concerned with the objective study of realities. The whole orientation of qualitative research is that it is open ended and establishes research openings which can lead the researcher into unforeseeable areas of investigation in the lives of those it is researching. Also, it looks in depth at the behaviour in specific social settings, and so it is expected that a true picture will be provided as it really happened rather than at board population (see section 5.2.2).

In order to establish how IS in the T.C.H.T. might be used, it is useful and practical to conduct a case study that investigates the application of IS in real courtyard houses, and to assess and judge IS in a real case study. Nevertheless, there were many reasons that limited the practical test and technical evaluation. First, IS were

not widely adopted and practically applied by most house types, so it was especially difficult to find appropriate house projects during the period of the research. Second, because of the high risk in Iraq and the strict schedule of travel, it was extremely difficult to obtain permission to test IS in real courtyard houses.

- **How data were collected?**

Different research methods focus on the collection of data, such as the literature review, and the case study. For IB-strategy research, standard surveying (Hutton, 1990), interviewing (Dahlberg et al., 2008), modelling can be used (Fellows and Liu, 1997). In current research, the data were collected due to:

First, literature reviews around the topic which started the context of the subject, demonstrating understanding of the state of relevant knowledge and explaining the importance of the issue (see Chapter 2, 3, and 4). Distinguishing what has been done from what needs to be done, in order to identify a space for this work, as shown in section 3.2.5, 4.2.6, and 4.3.6. Comprehending the structure of the topic from a new perspective. Finding the essential variables related to the topic and enhancing and acquiring the subject (IS) see 4.3.6, 4.4.2. Identifying the main methodology and research techniques that have been used (see section 5.2).

Second, case study, the relation between IS and the T.C.H.T. is unclear and yet it can be seen through the role of these systems in improving or not the performance. Therefore, case studies are particularly suited to answering the research questions. The case study used a combination of interviews, a physical survey and visual observation supported by documents, to understand the general circumstances. Semi structure interview were include two types: the first type of interview was with architects. The aim of the meeting was to discuss the possible use of IS in generally and in Al-Kadhimiyah historical area specifically. The second type of interview was held between the researcher and house occupants in the Al Kadhimiyah historical area in Baghdad. The interview was meant to discuss everyday life of in Al-Kadhimiyah historical area. The physical survey and visual observation was for the T.C.H.Ts. in Al-Kadhimiyah historical to understand current condition of house and to draw a complete picture of this type of house (see section 5.3.1).

- **What was happened in the fieldwork?**

Fieldwork research was conducted for 14 weeks in Iraq starting from 1st March to 15th June, 2012, to collect data and information using different methods relevant to the research topic. The research was carried out four phases:

First phase the preparation phase during the first month included: preparing guidelines for interviews and translation into Arabic; preparation of an official letter and security permission to start fieldwork; and also explore the historical Al-Kadhimia in Baghdad city.

Second phase pilot study during the first month. This phase aimed to investigate the suitability of understanding the line of questioning used in the interviews and possible modifications of it by testing it with two occupants and two architects as a trial of the pilot study to determine the time for each interview and to check whether any modification was needed. Some corrections were then made according to the comments.

Third phase data collection during the 2nd, 3rd, and 4th month. Semi-structured interviews with 25 architects were selected using the snowball technique, and 24 occupants were conducted according to: the availability of time and effort, as the time was limited for the researcher due to the fact that she was only able to carry out the study during the morning, because the T.C.H.Ts. are located in unsafe areas, as well as 12 physical surveys with photos were determined according to the willingness of the occupants to be interviewed and permission to enter their houses, as well as the available time of the fieldwork, and the availability of documentation and information from the Municipality of Baghdad

Fourth phase data analysis started during the 2nd, 3rd, and 4th month (see section 5.4.1).

- **How the data were analysed**

The information obtained from the fieldwork was analysed by divided into two stages: The preliminary stage, accordingly the data were classified into three categories related with architect interview, physical survey, and occupant interview. This was achieved by reviewing both types of interview in Chapters 6, and 8, and by describing the physical survey in Chapter 7. Accordingly, we understood what the data means, and then the findings were provided. In depth, the thematic analysis

approach was applied, and the data were regrouped according to the various themes. Then, the thematic text and issues were extracted from what the data means, and the meaning of the current research was the last stage of analysis in Chapter 9 which bear closely on the research questions (see section 5.5).

- **What the data collected from the interviews with the architects said**

As a first stage of analysis to the data collection, we reviewed the professional perspective obtained from the architects as a first categorize which distinguish between these possibilities to explore the findings. The data are classified as follows:

The strengths of the T.C.H.T are its unique identity, which plays a distinct role in first creating environmental performance by its present passive system, and it creates a special lifestyle and great dynamics which lie in using different types of spaces. Also, the T.C.H.T is environmentally friendly through the use of systems that depend on natural resources in a positive way, as well as using just local and natural materials. The thermal gain and loss in the T.C.H. is a slow process compared to the external warm dry environment, and gives a sense of comfort. The house provides protection from thermal radiation, because these units are surrounded on three sides by the neighbouring houses related to compactness. The courtyard houses were designed in a way that provides a good bio-climatic comfort which is the ability to live in it without using excess energy or advanced technological devices in at specific times. The weaknesses of the T.C.H.T are that it has no controlling strategy for the rain or dust, high temperatures, and other issues. Unfortunately, the house cannot work alone, but only within its complex system of winding narrow alleys and different types of space within one compact locality. The individual houses in particular suffer from neglect and aging. Also, the growing need for services, whether at home or of public services, is apparent.

The most striking result to emerge from the data is that there were strong rather than weak points in this T.C.H.T. As a result, this type of house has special characteristics and it is not easy to build similar houses because they would be very expensive and require a professional builder, as confirmed in Section 6.3.1. I think this T.C.H.T deserves to be conserved. However, in Section 6.4.5/ part 1, it was shown that the development project has presented the need for enhanced house performance for long time, since 1980. Therefore, the T.C.H.T does not fit with changes in weather and climate condition, nor does it adapt to changes in lifestyle for

the current user, and so it needs to be updated according to the changing needs in technology. Now, with the local situation, I think it deserves improvement. This idea is represented by a new perspective on this CH was added by the architects. This involves being responsive to upcoming needs and fixed techniques, which confirms the performance in this T.C.H.T, and requires improvement. The development of the T.C.H.T as related to artificial systems was described through the advantages and disadvantages of adding new systems related to changing needs, and the possible characteristics for appropriate systems in the T.C.H.T. However, particular attention is required to provide these houses with long term improvement according to changing needs, without having any effect on the architectural appearance by using artificial systems (6.3.4). Obviously, a great deal of emotion was expressed by the architects concerning their attachment to this type of house and they talked about how they were nostalgic for the heritage and how it could be lost it in spite of not living in this house (6.3.5).

- **What we found from the data obtained from the architects**

The summaries of the architect interviews support the current research as being a mixed picture, and there is nothing that supports or not from the view of these architects, because there were many problems in this type of house. They had a perception of positive things but the practice does not suggest that they were using these principles anymore, because one suggested that perhaps there is no demand for these things and clients did not prefer them. This is quite an interesting contrast because the first part revealed their emotion about the heritage, but the reality of things is the knowledge part for looking to the T.C.H.T, which is obviously too expensive to build, or about the hard facts of performance. Also, in reality the houses required 714,285 GBP/ 1 million dollars to be refurbished, and then they were left for a long time without any maintenance or redevelopment. Therefore, the possibility of using IS in the T.C.H.T to adapt to changing needs is still not clear (see section 6.4).

- **What the data revealed in the physical survey indicated?**

The most obvious idea to emerge from the physical survey as a second category was found in the T.C.H.T in the Al-Kadhimiya. The T.C.H.T was enclosed on three sides by other houses and had one elevation with a main door. In two out of 12 houses, there were two elevations in Um Al-Noomy and Akked Al-Sada neighbourhoods, and also 2/12 houses had no elevation, as shown in Akked Al-Kanjalle and Al-Bahea neighbourhoods. These had a main door linked to the

alleyway which connected with the house at the long lobby. In all neighbourhoods, these houses there were more than two levels and roofs on around 4-6. In spite of 12 T.C.H.T having different directions, we found that most of the spaces, places, and levels were lit during the day, except for those spaces that had been divided in Akked Al-Kunjalle neighbourhood, and all the houses had air movement; however, there was an odour from the service places.

In spite of all 12 T.C.H.Ts 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 all these houses in the five neighbourhoods, the structural system was a load bearing wall and the material used was fair 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. However, in the other houses in all the neighbourhoods, it was between 0.90-0.60m, and the interior walls were 0.45-0.30m in all the houses.

In all these houses for five neighborhoods, some levels, places, and spaces were not in use for different reasons. There were just a few service rooms and one house was without a bathroom, as show in Al-Anbareen neighbourhood. There were no specific functions for specific rooms, except in one house in the Al-Bahea neighbourhood.

The additional different equipment had been added by the residents in all T.C.H.T on different levels and places of the all house of those five neighborhoods which include: ventilation equipment, heating and cooling equipment, and water devices and storage, except for in one house in the Al-Anbareen neighbourhood, which had no water server or device, e-communication devices, or electric supply. All houses had been refurbished by the government, owner or tenants. For example, new water pipes in all 12 T.C.H.T had been established. New sewage and drainage had been established in 8/12 houses. In each of the houses in different neighbourhoods, a new electric meter and new wiring had been established. The service places were refurbished in houses in different neighbourhoods. In all twelve T.C.H.T, floors and walls were covered. Last but not least, four out of 12, especially houses in the Akked Al- Kanjalle and Um Al-Noomy neighbourhoods, the structure of the sardab had been conserved.

- **What we found from the data obtained from the physical survey**

The summaries from the physical survey of 12 T.C.H.Ts gave the picture of the existing condition of these houses, which were in five neighbourhoods of the Al-Kadhimiyah historical area. The key issue extracted was that T.C.H.Ts without exception had been changed and refurbished, in an attempt to respond to changing needs in environmental and social aspects. We have 12 T.C.H.Ts of specific historical areas in five neighbourhoods. However, these houses had different features with a context requiring different aspects to enhance the performance. Also, in these 12 houses the level of change was different, and so there were different requirements to improve the performance (see section 7.4).

- **What the data obtained from the occupants said**

This investigation obtained data from occupants in twelve T.C.H.T selected for the physical survey. 10/12 houses were owned by the government except those in the Al-Baheya and Al-Anbareen neighbourhoods. All 12 houses were conserved for different reasons. 11 out of 12 houses were tenants and just one house was occupied by the owner in the Al-Baheya neighbourhood. The residents in these houses were not just from the middle or poor classes, but were rich according to different criteria, such as owning a T.C.H.T with a factory, having a monthly salary, and others. However, we can consider that those who lived in these types of houses were rich in terms of security, their strong social relationship, and being near the city centre and work.

The number of occupations in these T.C.H.Ts according to the household was not related to the size of the house or neighbourhood. There were different genders living in these types of houses. All these houses were occupied by variously aged children and adults, as well as older people, except for one house which had no occupant children in the Al-Baheya neighbourhood. The occupants had different levels of education.

The occupants occupied the house 24/7 around the year of twelve houses in different neighbourhoods. Many residents had lived in this T.C.H.T 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.

The everyday activities for the current users of T.C.H.Ts. in the Al-Kadhimiyah historical area in terms of the relationship with place, time and possible changes were described according to the place-time and place-activities. This changed the effect of the original lifestyle through seasonal movement (see section 8.3.2). Strong evidence of this was found when: The occupants moved continually from one place and space to another at different times in the twelve T.C.H.T in different neighbourhoods. The occupants did different activities in the same place or the same activities in different places. The families used all the spaces and levels all year, and other families used specific spaces for specific seasons such as those families in the Al-Baheah and Al-Anbareen neighbourhoods. The occupants were focused on using different spaces and places during the day for their activities.

Also, the most interesting aspects of T.C.H.Ts. are how they addressed environmental conflicts and struggles due to dealing with weather problems that affected space occupancy (see section 8.3.3). The findings show that: The occupants used all the levels, places, and spaces of the house at specific times around the year. The occupants had tried to change the physical environment of space, such as closing the open spaces in specific seasons. They used heavy clothes in winter and the opposite in summer. The occupants used oriental carpets in winter and removed them in summer. The occupants used the places and spaces that faced the sun in winter, and avoided them in summer. The occupants sprayed the courtyard with water on summer days, and opened the windows on summer nights. The occupants gradually stopped using some levels, places, and spaces for different reasons such as the roof in summer, and the sardab in winter. The service rooms were the most communally used in the T.C.H.T and these suffered from high levels of humidity, and increased odour levels during usage. They used different modern devices in different seasons in whole house. The occupants used the TV and mobile as their main devices, as well as the internet for communication and information. Each family had connected with a private and/or general generator in addition to the national supply, and changeover had been added in all the houses. New sewage and drainage, and new pipes had been established in the houses. Also, occupants had made some changes to some space functionality or closed some transition spaces. The occupants used incense especially in the sardab during the winter. Last but not least, the walls were painted continually, or covered with plastic sheets or with wool in winter.

All the occupants in each house shared one bathroom, one toilet, and one kitchen, except for a house in the Al-Anbareen neighbourhood which had no bathroom. There seemed to be difficulty with ventilation and lighting during dust storms, water shortages in summer, and difficulty with thermal comfort around the year. Also, there was difficulty with security as the occupants were burgled many times. All occupants had issues with humidity in the T.C.H.T in the Al-Kadhimiyah historical area for three reasons: in the sardab, this was because of the recent rise in the water table as a result of modernization to the river side; on the ground floor, it was because of rain water not draining correctly; in some service places, it was due to adaptations to services which had not been correctly installed. Almost all previous aspects had bad maintenance or a lack of service systems which caused high levels of humidity.

Furthermore, there was significant evidence of the evaluation of the environmental performance as related to health/satisfaction and environmental comfort linked to the season, day or night time, levels, rooms, and places, as described in section 8.3.4. Interestingly, the occupants found that the health of the house was related to the level of service due to the level of control of house performance. Not all the house was comfortable around the year. Some levels, places and spaces were comfortable at specific times. Both hot and cold weather were uncomfortable, and the first floor was uncomfortable during the daytime in summer and night in winter; the ground floor was uncomfortable during the summer between the afternoon and sunset, but the day was generally better than the night time. The spaces and places on the ground floor were more comfortable than those on the first floor in summer, and the ursi was more comfortable than other rooms. The service rooms were uncomfortable during usage time. There was difficulty using different devices at specific times due to increased energy consumption.

Additionally, the current study referred to the enhancement of the environmental situation according to the use of comfort-artificial systems and the possible improvement living (see section 8.3.5). Therefore, different issues were present, including: the occupants without exception had tried to enhance the house performance by adding different modern devices to the house; however, they still had problems with the house performance. The occupants required systems that would help them to enhance the environment, such as enhancing the thermal comfort, reducing the odour level, and reducing energy consumption. These would also enhance the social aspects, such as increased communication with others. The

occupants agreed with adding new systems to their houses if they were easy to use, and inexpensive, among other factors. The occupants were happy to add new systems in these types of houses as part of modernization.

Also, the other interesting point to find according to the occupants' priorities and comments in section 8.3.6 were: The desire to live in a healthy and comfortable environment through being able to control: the lighting and ventilation during dust storms; thermal comfort during harsh weather; humidity during rain storms or during heavy usage of places; E-communication at times of heavy usage; energy consumption at different times, and others.

In section 8.3.7, the final interesting points to note from the additional issues are linked to repair and maintenance, government involvement, memory, and socio-economic status: Limitations of changing this type of house are as shown in PH.CH12. Attention had been given to these houses by the government since 1980 because of the need for continual improvement. Most of these houses had different historical values.

- **What we found from the data obtained from occupants**

We have also summarised the different views expressed, and seen that there is similarity and difference in the comments from the occupants in the twelve T.C.H.Ts in the five neighbourhoods of the Al-Kadhimiyah historical area. There is quite an interesting perspective concerning their emotion about this type of house, in which many occupants had been born, married or had children, held an excellent job, or other reasons. However, the reality of things was the difficulty of living in the T.C.H.T. On the other side, there were differences and similarities between the various comments of occupants in different neighbourhoods and the physical survey of these houses that were occupied by the interviewees.

The key question is what the overall picture is or what is the nature of this type of house? While there is no clear picture, or there is no uniform one. Yes, there is similarity between these twelve T.C.H.Ts in the same area of Baghdad, but at the same time there is a great deal of difference between the five neighbourhoods. What can be seen in this small area of Baghdad with this kind of house is that there is nothing uniform about them, so the whole idea of T.C.H.Ts is that there is much variation even within a small area. There is a difference between neighbourhoods and the houses in the same neighbourhood. The occupants had the same needs in

this house or different needs to be valid even though the government had tried to rehabilitate them and had the ability to rebuild this type of house. The basis of rehabilitating them is a bigger question and perhaps depends on the technique. Yes we can have a system but the other important question is if the T.C.H.T really needs the intervention because it seems the clients did not, as there were those who said it was too expensive to build such houses with very thick walls, and suggested other alternatives.

In the end, this information helps us to understand other details of the T.C.H.T in Al-Kadhimiyah which can enable the IS to make a difference. Also, because there is variation in the houses, there can be no uniform approach to applying IS in the T.C.H.T. (see section 8.4)

- **What does the data collection from three different resources mean?**

As a second stage of analysis, the research issues were explored from the previous three different resources. The themes which emerged included:

(1) Partial control of the environment means the ability of the building fabric response and human level response to achieve control of the environment, and make modifications in response to different environmental conditions at specific times. Building fabric response means what is in the building that allows a response to environmental conditions. It is achieved through a traditional dwelling unit linked to house design, structure and materials of this house type, the architectural elements that the house has, and details such as site/compactness, as the T.C.H.T is joined to hundreds of similar houses built closely and compactly together. It is interesting to note that the building fabric response achieves partial control of the environment by passive systems in the T.C.H.Ts which encourage thermal comfort in this type of house. Also, the human level response concerns what the occupants did in a T.C.H.T which helped them deal with the climate and weather change, according to each family's needs. It was achieved through the flexible movement of different activities in different places, spaces, and levels; the approaches which allowed better user control and customization of the environment. It is clear that the most interesting point in the lifestyle of the current users in the T.C.H.T in the Al-Kadhimiyah is environmental treatment, which created partial control of the environment (see Section 9.2.1).

(2) Environmental challenges means knowing what it is in the environment that needs to be controlled through: the inability to maintain comfort, or experiencing discomfort of environmental performance including thermal comfort, lighting, water and others; availability and adequacy of space by the balance between the number of people and place or space usage; the ease of making modifications by how easy or difficult it was for the residents to modify the T.C.H.T; transformation in space function concerns changes to the function of spaces, places, and levels in the T.C.H.T in the Al-Kadhimiyah, according to family needs; high cost of energy in terms of consumption; management of energy use of different sources of energy; device maintenance was found by breakdown of devices; eliminating safety risks as to be free from the risk issue; the role of government regulations concerning conservation; and modernization requirements of the courtyard house means adapting to modern ideas or methods according to modern needs (see section 9.2.2).

(3) Social struggles to ethics or behaviour and emotions, as they relate to the inhabitants' way of living. This is illustrated through the interaction of the occupants as changes in life rules have reduced people's interaction; the idea of place psychology represents the interrelationship between place and human effect; and crime prevention is related to security issues (see Section 9.2.3).

In turn, these issues lead to other new issues including:

(1) Architectural value— key features. The passive system is the key feature of the T.C.H.T in the Al-Kadhimiyah which 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 T.C.H.T.

(2) Limited space use, some spaces were not used, and the residents felt as if they were paralyzed at these times. Therefore, the space in use was affected by the house performance, caused by the unequal HP, so there is the limited space use is related to HP around the year.

(3) Requirements for new systems, this other significant new issue is found in the current study as the environmental challenges have had a negative effect on HP and caused great discomfort and an unhealthy indoor environmental situation for part of the time, or for specific places, because not all of the house had an equal environment all year round. It therefore needs new systems to refine the internal environmental performance and achieve equal performance of the whole house

around the year. Also, partial control of the environment through lifestyle is in turn related to passive systems. Accordingly, the occupants in T.C.H.T in the Al-Kadhimiya need new systems because they have difficulty controlling the whole house around the year or difficulty controlling specific spaces, places, and levels in specific time. Lastly new systems were needed because the occupants in the T.C.H.T. in the Al-kadhimiya had social struggles of living in this house type (see section 9.2.3). However, as stated the current level of environmental performance in the T.C.H.T was unequal in the whole house around the year. This represents the real need to improve HP for the current occupants by adding new systems to the T.C.H.T in Al-Kadhimiya. Therefore, the improvement of HP will probably improve the architectural value and enhance the space use. Therefore, the IS could represent the type of new systems required in the T.C.H.T. However, the current study will explore the role of enhancing T.C.H.T performance by using IS.

- **What do the data collections from three different resources mean for the current research?**

In order to understand the interaction between IS and the T.C.H.T to enhance their performance, a clear role of IS was determined related to this type of house, which has its own characteristics and specific features compared with other dwelling houses. These roles include how the nature of IS in the T.C.H.T in the Al-Kadhimiya for the lifestyle of the current users was explored through: Such systems can be complex or simple, but simple ones are more appropriate for the lifestyle of the current users in the T.C.H.T. Regarding wired and wireless, the relation between components for IS can be either, and the appropriate is wirelesses more than the wired for the lifestyle of the current users. With full systems and applications, the prospective use of IS in the T.C.H.T in the Al-Kadhimiya can enhance their environmental performance by appropriate types of ISs, either as applications nor a full system whether integrated or un-integrated, the prospective use of IS in the building must consider the relationship between different systems and whether these should be integrated to increase performance nor un integrated. Either sensors or actuators can be used to control the operation of ISs, but actuators may be appropriate for IS in T.C.H.Ts, in respect of the lifestyle of the current users and who will use these systems. From this, we understand the nature of ISs in the T.C.H.T should be wireless devices, applications, integrated, simple, and have actuators which are more appropriate for this house type to enhance its performance. For the

future users, the lifestyle could be different, and the nature of IS may change too. However, the priority of these systems needs to be clarified to complete the potential role of IS in enhancing the performance of the T.C.H.T. (see section 9.3.1).

This study nominates the categories of BRE global (cited in Holden, 2008) according to the potential applications, and associated technologies, that include: energy use, environmental control, communications, security and access control, life-safety systems, systems monitoring and maintenance, and lifts and escalators. This is the second stage in determining the role of ISs in enhancing the performance of T.C.H.T in the Al-Kadhimiyah and deciding which ISs are needed, as well as whether these systems need to be permanent or temporary. Therefore, ISs need to be permanently added according to the lifestyle of current occupants' needs in the T.C.H.T in the Al-Kadhimiyah. These are: energy use systems, and environmental control systems, but also there is a need for communications systems as a part of everyday life in the T.C.H.T. Security and access control was deemed necessary but there was no need for lifts or escalators. There is also a temporary need for other systems in order to change the situation in Iraq; these systems are: systems monitoring and maintenance, and a life-safety system. All these systems above would enhance T.C.H.T performance and then sustain the lifestyle of the current users by maximum space use in T.C.H.T in the Al-Kadhimiyah. However, the need for these systems may change in the future according to the lifestyle of the residents related to changing needs. These systems, therefore, are needed in terms of priority; however, we still need to know how these systems could be added to the T.C.H.T. in practice (see section 9.3.2).

To complete our understanding of the interaction between IS and the T.C.H.T, we can consider the role of ISs in the T.C.H.T in improving the performance by using the latter as "containers". The T.C.H.T in Al-Kadhimiyah were built before 1918, and the options for the T.C.H.T are for them to be retrofitted or to have a new design related to the architectural value/ key features in the Al-Kadhimiyah historical area. The possible application of IS in T.C.H.Ts. by retrofitting will achieve a strong value through improving house performance and then achieving maximum space usage. However, the possibility of using a new design in the T.C.H.T could be appropriate for those houses with no architectural value or a poor, deteriorating, slum structure (see section 9.3.3). Thus, the T.C.H.T could be transformed into an IB with containerized technology which had a level of intelligence through the nature or IS in

T.C.H.T. However, the current study classified the level of intelligence in a dwelling unit generally, and the T.C.H.T specifically which includes:

- A high level of intelligence giving optimum integration between ISs, including the multiple aspects of operation and communication management by APPS, such as a smart phone, which can be used in the future to monitor and control household appliances when the applications involve being able to connect and operate in this way.
- A mid-level of intelligence gives integration between the main ISs which is performed by different systems such as environmental control, energy use, communication, and others.
- A low level of intelligence by the integration of sub systems covering specific systems, for example, the security and access control systems, or energy use systems.

Therefore, according to the priority of IS in the T.C.H.T in Al-Kadhimiyah, it achieves a medium level of intelligence and this will have a great impact on the T.C.H.T in terms of the house performance, with respect to the families' needs according to the lifestyle of the current users. Future users are likely to have a different lifestyle and so the level of intelligence may change; thus, the potential need for ISs may also change too due to the type of IS and its operation (see section 9.3.4).

10.3 Completion of aim and objectives

This section presents how the research has satisfied the proposed objectives. Ragin (1989, p.54) stated that research has general aims that go further than the specific objectives of the study being done. The aim of this study was to explore the potential role of IS in improving the performance of courtyard house types in Baghdad, Iraq. This research was conducted between on IS and the T.C.H.T in Iraq, Baghdad, to provide information that directly answered the two main research questions see Table 10.1.

Table 10.1: Answering the research questions, (Author).

Search question	Findings and corresponding chapter
What are the key features of courtyard houses and to what extent do these support the lifestyles of current and future users?	The passive system is the key feature of the T.C.H.T in the Al-Kadhimiyah which definitely supports the lifestyle of the current users, and is likely to do so for future users by achieving thermal comfort (see Section 9.2.4).
What are the features and capabilities of intelligent systems and to what extents can these enhance or not the performance of courtyard houses with respect to the lifestyles of current and future users?	Adding simple ISs as applications which are integrated and wireless, with an actuator, will certainly help the residents enhance the house performance in Al-Kadhimiyah. This will be done by: developing the level of control over the environment, reducing the environmental challenges, decreasing the social struggles, and supporting the response to the environment (see Section 9.3.4).

To accomplish the current research objectives, the research used qualitative methods as shown in section 5.2.2/ 3, 5.3, and Table 5.1. These present an overview of how this research has fulfilled these objectives by describing the research methods. From these results, the aims of the study have been achieved via the findings of the literature review and case study from three different resources see Table 5.2, from which the key findings and their interrelationships have been explored. This has given the potential role of IS in improving the performance of courtyard house types in Baghdad, Iraq. The aim of this thesis is to “explore” whether or not IS can be enhance performance. However, it takes the form of exploration by attempting to uncover patterns in the data, and then to explain and understand them. Table 10.1 shows the competition of current research objectives.

Table 10.2: Summary of objectives, research methods, and findings, (Author) Continued...

Objectives	Source of evidence	Findings and corresponding chapter
1. To investigate the characteristics and features of the traditional courtyard house in Iraq	Literature review and case study	<p>The current available information about the T.C.H.T contributed to understanding this type of CH in Iraq, enclosed from three sides by other houses, using the criterion of the number of courtyards incorporated within each house, grouped into four categories: one, two, three, and four courtyard houses. Also, this house type had different sizes: larger, medium, and small (section 3.2.2). These houses there were more than two levels and roofs on around 4-6 levels (section 7.4). This information explained that the T.C.H.T responds to the environment by the passive systems related with TC.H.T components. Besides this it responds to culture and social aspects related to lifestyle (section 3.2.4). Additionally, this T.C.H.T in Iraq had partial control of the environment through the passive systems and lifestyle (section 9.2.1). Accordingly this neither house deserved to be conserved and it should nor demolished and rebuild. However, we must consider the difficulties in adapting to changing needs as concerned with different T.C.H.T categories, especially large and medium T.C.H.T, and those with three or four interior courtyards. Accordingly, this house needs to rehabilitated and developed.</p>
2. To investigate the meaning, nature and application of intelligent systems in buildings	Literature review	<p>The efficiency of information is crucial to clarify that the IS as a recognizable whole that has different applications linked in a systematic way. It can determine boundaries, the environment, and intent and has evolving capability. This system has the ability to communicate with other systems which could connect to the internet (section 4.4.2). The nature of IS in the building is clarified through: (1) The concept of systems intelligence and whether they are complex or simple systems. (2) The IS type is full of systems or applications. (3) The relation between IS as integrated or not. (4) The relation between IS components could be wired or wireless (5) IS operational comprise a control system through sensors and actuators (4.3.6) The application of IS in building for example (1) washing machines, boiler automation and chiller control, smart chimney hood, a Smart TV, and automatic transfer switch could all be part of energy use systems. (2) Applications such as washing machines, boiled automation and chillers control, pumps with a smart float switch, multi split units, smart chimney hoods, and automatic emergency lighting could be part of the control of the environment systems. (3) With wireless routers, a smart phone, smart TV, digital satellite, DVD player, and portable Bluetooth speakers these applications can comprise communication systems. (4) The possible application of security and access control systems in a building includes a smart camera and smart TV. (5) Smart fire alarms, automatic transfer switches, smart refrigerators, smart ovens, and others could be part of life-safety systems in a building. (6) The application of monitoring and maintenance</p>

<p>3.To investigate the lifestyle of current users of traditional courtyard houses and how these buildings support their needs</p>	<p>Case study</p>	<p>systems, such as boiler automation and chiller control, multi split unit, digital camera, fire alarm, smart Fridge, and smart cooker (7) A smart lift and smart escalator could be applied in buildings as the last system of lift and escalator (section 4.4.1). However, the nature of this IS depends on the systems needed for the current lifestyle and possible change for the future users.</p> <p>The current lifestyle in T.C.H.T could be explained through: (1) The lifestyle arising from the current space occupation is outlined in the following: For partial occupation of house around the year as the current users use some spaces, place and level only part of the time around the year. For full occupation of house as the current users use all the spaces, places, and levels around the year. (2) The current lifestyle in T.C.H.T can be clarified according to extended families as there are different age include children and adults, and older people at home; at the same time there are varied of education and knowledge. (3) Occupation times, this type of house was occupied 24/7 around the year. The key features of the T.C.H.T are passive systems which support the lifestyle by enhancing thermal comfort related to the level of natural lighting, cooling, heating and ventilation (section 9.2.1). However, there are very different kinds of lifestyle and there is a mix of activities for people to do in T.C.H.T.</p>
<p>4.To examine the potential role of IS in improving the performance of courtyard houses</p>	<p>Case study</p>	<p>These roles include three major steps: (1) The nature of intelligent systems in the courtyard house (2) Intelligent system priorities (3) The courtyard house as a container for intelligent systems (see section 9.3.1-9.3.4). However, the use of IS should address the specific features and characteristic which based on their roles in the T.C.H.T for the current and future user.</p>
<p>5. Make recommendations on the possible applications of IS to courtyard houses</p>	<p>Case study</p>	<p>The research recommended the application of IS in T.C.H.T. there was the possibility of applying ISs in the T.C.H.T. by using the latter as a container by retrofitting those T.C.H.T which had a high architectural value, and creating a new design for those with limited architectural value and poor structure (see section 9.3.3).</p>

10.4 Contribution to knowledge

This section explores how the research has contributed to knowledge. This is achieved by reviewing the available literature. The significant difference between the research findings of this study and those of previous studies needs to be clarified in order to determine the contribution of the current study.

The varied contributions and qualities of this research are now described in different aspects:

10.4.1 **Partial control of the environment and passive systems**

In reviewing the control of the environment across disciplines, and the use of this theme, much more information has become available in journals, books, website, and others. There is the concept of the control of the internal environment through ISs, which can provide an enhanced building performance. For example, Wang, et al. (2012), Alwaer and Croome (2010) highlighted that an IS makes use of computer technology to control and adjust the building environment. Wong et al. (2008) added that ISs provide better operational and energy efficiency which is more exact observation and control of the internal environmental quality. Holden (2008), and Intille (2006) confirmed that the intelligent building systems achieved full control of the environment and operational control, which all had a positive impact on building performance. Another concept is control of environmental measures by using IS as dynamic response and control to different environmental conditions in dwellings, especially those for older people who live alone (Chan et al. 2009) and (Ding et al. 2011).

The literature has not presented the links that are required between each knowledge base to partial control the environment and passive systems. On the other side, these studies cover the relationship between controlling the environment and active systems. Nevertheless, much of the existing literature has not presented a description of partial controlling the environment and passive systems process as being a way to provide thermal comfort. Partial control of the environment via passive systems is a virtual concept with a possible of new perspective in the T.C.H.T linked to enhancement of the house performance through thermal comfort.

Therefore, this research has clearly identified that controlling the environment can be achieved by supporting passive systems relevant to the T.C.H.T., as it contributes to the above understanding of the important key features which is essential to the current level of house performance that presents different ways of thinking about the T.C.H.T at the building fabric response through traditional dwelling units linked to house design, structural and materials, architectural elements, and details and through the site /compactness. This idea converges around passive systems: the level of thermal behaviour, level of natural cooling, level of natural lighting, and level of natural ventilation. Thus, the building fabric response created passive systems in T.C.H.Ts. which enhance thermal comfort in this type of house. Therefore, the passive systems contribute to the achievement of partial control of the environment.

Thus, this house has its own high personality and interaction with the local environment to achieve an excellent natural environment for the dwellers of the T.C.H.T.

10.4.2 Partial control of the environment and lifestyle

This study has explored many journals on topics related to lifestyle such as landscape and urban planning, energy policy, ecological economics, presidia, social and behavioural sciences, and others. Lifestyle can be used to develop our knowledge of the multifaceted basis of residences related to the sustainable environment (Axsen et al., 2012; Sanquist et al., 2012). The effect of lifestyle as an explanatory variable in residences is important for the planning of homes (Shahril et al., 2012). The concept of lifestyle as a key specific behaviour or phenomena was found to be rather extensively used in other disciplines. For example, in the context of sustainable development, lifestyle is often used as a domain that needs to be adjusted (Jensen, 2009). Wei et al. (2007) described how lifestyles adapt according to climatic factors, in addition to the more common socio-demographic variables of family pattern and life schedules. These then form what they refer to as "*regional basis lifestyle*". In their second study, lifestyle is described indirectly from a pattern of family life. This has mainly been used in the form of explanatory variables in order to understand how lifestyle is a gauge of a person's behaviour. These issues have been underexplored, as evidenced by the amount of literature.

The previous literature has revealed the depth of the notion of lifestyle as it links to the concept of evaluating the space-related environment, behaviour or phenomena within a specific domain, and sustainability of the environment. However, this study has progressed beyond traditional research on partial controlling to the environment; linked to lifestyle in the T.C.H.T. A review of the current study with lifestyle as a factor concerns space occupation, social aspects, and occupation time. Nevertheless, not one of these studies concerns the link between the current lifestyle and the achievement of a partial controlled environment by using intelligent way for environmental treatments, supported by passive systems to enhance the house performance. This represents other different ways of thinking about the T.C.H.T. The current study adds the theme of partial controlling the environment, and thus gives importance to the lifestyle generated at the human level response linked to activities movement due to people gathering, practising hobbies, sleeping, eating, and cooking

and washing. Modification and adaptation of the places and users is linked to alteration modern equipment, mobility of family, and appropriate clothing.

The lifestyle exists because of the need to achieve thermal comfort, avoid rain water, smoke, and dust filling the house, keep the house warm or cool, retain the coolness of the interior attained at night, and reduce thermal gain from the exterior. This, in turn, encouraged cross-ventilation and air-movement, which helped to cool the interior and avoid humidity and odours. All acted as specific environmental treatments that give partial control of the harsh weather, which was dynamic in different places and levels at different times. Therefore, another important finding in the current study is that the lifestyle of the current user in T.C.H.T had partial control of the environment.

10.4.3 Environmental challenges and house performance

The World Wide Web has shown great potential as a media for distributing current information in real time. However a few of the ideas presented by the previous literature were linked to the environmental challenges. Ongoing environmental change will constitute a factor that may influence future management. The effects of the predicted climate change over the next century may be extensive, along with growing human activity with consequent increases in impacts on ecosystems (Sánchez and Njaastad, 2014, p. 292). Characteristic trends in land use and climate highlight critical challenges in future resource management (Williamson et al, 2014). Environmental challenges have been affected by non-centralized government control and policies through the creation of community capitals in response to environmental issues (Thompson, 2016, p.71).

In reviewing the literature on this subject matter, there is some confusion as to the concept of environmental challenges across disciplines, and the use of this concept presented in the literature above is as challenging issues due to environmental management, and community adoptions which not in the same fields. This is significant for the identification of different issues that could contribute to a unified whole because no data were found on the association between the main theme and the issues under investigation.

The present study was designed to determine the environmental challenges, formulated with different issues which require major revisions in order to meet the occupants' needs. As discussed above, many of the ideas presented were linked to

the environmental challenges which affect the house performance. This research, therefore, attempts to develop an understanding of the relationship between the environmental challenges and these issues, to provide an integrated view of this theme and thus contribute to a deeper understanding of the T.C.H.T in Iraq. Therefore, the study reveals that the new issues of this research have been derived from this theme. This theme converges on a core of ten main issues, and these are:

- To maintain/ enhance comfort due to difference in levels of comfort had caused great discomfort environmental situation, however, this affected the house performance.
- The availability and adequacy of space due to the residents had had difficulty caused by lack of control of the indoor environment quality of current service rooms in the face of frequent and intense use of service rooms, which contributed to the difficulty in controlling the environmental performance of this house type. Therefore, such difficulty is a part of the environmental challenges of living in the T.C.H.T.
- The ease of making modifications due to the rigidity of this type of house presents limitations in terms of the type of change possible, such as reshaping of space. Therefore, inflexibility is a manifestation of the environmental challenges. However, this inflexibility might have affected house performance.
- The transformation of space function due to the less management of the indoor environment is linked to indoor activity quality in the T.C.H.T., which could have an important effect on house performance. Therefore, the inability to manage the indoor environment shows the environmental challenges in the T.C.H.T.
- Cost of energy, this indicates that energy consumption in their use of service systems showed economic limitation, which probably affected house performance. Therefore, unclear strategies of energy consumption are part of the environmental challenges in the T.C.H.T.
- Management of energy resources, the mismanagement of different sources shows how unclear strategies between different recourses of electricity supply in the T.C.H.T in the Al-Kadhimiyah could impact house performance. Thus, management of energy sources have led to environmental challenges.
- Devices maintenance, the breakdown of devices gives an indication of the lack of maintenance of these devices, which might have created difficulty in house performance. Therefore, in this study, one of the more significant findings to

emerge is that not maintaining devices was one of the frustrating aspects of living in a T.C.H.T in the Al-Kadhimiyah, and a part of the environmental challenge.

- Elimination of safety risks: it can be seen that poor safety features had led to accidents by fire hazard in the house, and so safety was another environmental challenge in living in the T.C.H.T.
- The role of government regulation: 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.
- Modernization requirements for CH: 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. All of these issues have had a negative effect on house performance linked to the environmental challenges.

10.4.4 *Social struggles of living in traditional courtyard house*

A few of the ideas presented by the literature were linked to the social struggles. Social and struggles follow from social bonds and in the relationship various environments become established with the individual differences of the feeling and behaviour of space and place through participation, adaptation, and the promotion of individual freedom (Stefanicka, 2010). The transformations in social life of the post-modern individual have led to such phenomena as social alienation and a hindered ability to relate to, or even to tolerate, the other (Scannell, 2013)

The literature has mainly focused on other current issues to provide social struggles. It should be noted how the study revealed that the social struggles involved different issues which can directly or indirectly influence the living in T.C.H.T. In other words, this theme seeks to address the different issues found in the T.C.H.T. through:

- Interaction of the occupants, the lack of communication for family members or with others represented a reduction of pleasure or enjoying time together. Therefore, miscommunication refers to the fact that there are social struggles of living in the T.C.H.T. Also, loss of privacy was created by the simultaneous use of different devices, and therefore privacy led to social struggles when living in the T.C.H.T.
- The idea of place psychology refers to the fact that belonging and nostalgia of occupants had been created by the collective memories of living in to the T.C.H.T.

Therefore, the belonging and nostalgia represented the social struggles of living in the T.C.H.T.

- Crime prevention, there were obstacles to monitoring which made crime easier. Therefore, the lack of observation monitoring led to this further social struggle.

10.4.5 The role of intelligent systems in traditional courtyard house

This study can be demonstrated in the fact that the research area identified new knowledge in IB. The current study seeks to address the potential role of IS in T.C.H.T reasons for its ambivalence towards exploring the topic in more depth or extending it beyond the appropriate application of this house type. The findings have contributed to understanding the roles of intelligent systems in improving the performance of courtyard house types in Baghdad, Iraq, by using the latter as "containers." This is done through what the T.C.H.T has and needs, and this procedure was demonstrated in three major steps: First, the nature of ISs in the T.C.H.T. Second, the priority of IS in the T.C.H.T. Third, there was the possibility of applying ISs in the T.C.H.T. by using the latter as a container.

Thus, the capability of additional IS to the T.C.H.T as a container will certainly help the occupants fulfil the varied T.C.H.T performance, by:

- Enhancing the level of control over the environment by providing full control of the environment though supporting the passive systems and environmental treatment.
- Reducing the environmental challenges by maintaining/ enhancing comfort; reducing the effect of the unavailability and inadequacy of space, reducing the difficulty of making modifications. Also, reducing the effect of the transformation of function; management of energy use; reducing total energy consumption then reducing the bill, enhancing the maintenance of devices; achieving freedom from risk. Lastly, reducing the effect of the role government regulation; and providing modernization.
- Supporting the response to the environment through enhancing the building fabric response and promoting the human level response.
- Decreasing the social struggle by enhancing the occupant interaction; providing strong place psychology; also, reducing the major disquiet of protection.

The role of IS in the T.C.H.T has contributed many useful experiences in improving the house performance and helping the occupants to maximize the use of space. It is bringing forward new thinking on the courtyard house, and providing various

perspectives. In this way, it is hoped that the current study contributes to the growing body of literature in different fields.

10.5 Research limitations

The value of the study outcomes is reliant upon the selection of the research methodology, and the consistency of the accumulated data. Constraints and limitations on the reliability of results include the validity of the research instrument, the validity of data gathered, and finally the validity of the conclusion drawn (Walker, 1997). According to this research, the recognised limitations and constraints include the following aspects:

The limitation of not being able to make a selection for the case study from a wider area may have been overcome somewhat by these findings. From these, a balanced representation of opinions was obtained from a relatively specific number of individuals. However, this was in the context of travel to Iraq being very limited.

The major limitation inherent in the nature of this research and its findings was the situation in Iraq which is deteriorating and becoming less stable, particularly in Baghdad at the time of writing. Another limitation was the issue of travelling, and the restrictions on visiting Iraq, which occurred only once during the study. Permission had to be granted to visit governmental office buildings such as the Municipality, to obtain permission to visit traditional courtyard houses without official security permission from the Iraqi government. The researcher waited six months to receive an official letter and security permission to get information and collect data for traditional courtyard houses in Baghdad.

The other limitation of this study was the issue of travelling, and the restrictions on visiting Iraq, which occurred only once during the study. There was also a restricted amount of time for the case study to be undertaken because I had permission for 12 months and when I stayed 14 weeks my sponsor informed me that I needed to return as soon as possible. The review, test and evaluation of the application of IS in real courtyard houses was a limitation. Because IS were not widely adopted and practically applied by most courtyard house types, it was especially difficult to find appropriate house projects during the period of the research. Also, because of the high risk in Iraq and the strict schedule of travel, it was extremely difficult to obtain permission to test IS in real courtyard houses more than once.

This research deals with the T.C.H.T. in Baghdad. The lack of existing data on the CH in Iraq is a major obstacle to understanding the intelligence requirements of buildings in different sectors. There is a great deal of literature on Iraq by both Iraqis and others, mainly on its economy, social change, and the political problems. This can be found in publications by the United Nations and in government documents, reflecting one type of resource. Furthermore, most of the literature on the T.C.H.T is represented by old studies describing the situation of the T.C.H.Ts as they have developed, and regenerated architecture in Iraq is rarely found. However, official data available on the courtyard house type in Iraq is limited. Few of the assessed courtyard architecture requirements were found in governmental publications and the only source available for information was found in the Municipality/ Mayoralty of Baghdad; the majority of the documents, for example architectural drawings, especially of the T.C.H.T s., are unavailable, or some were very old hard copies.

This research is exploratory, and IS are understood to be subjective evidence from participants, in that reality is a social interaction between both the researcher and the researched. It is affected by their personal experience, open to various interpretations by participants, and intended to understand the role of IS in T.C.H.T from various perspectives. In short, all knowledge is local, provisional and context-dependent, and in Iraq.

Furthermore there are other limitations of current research findings related to the T.C.H.T in Iraq as a specific area in an arid zone which might not be generalized to other T.C.H.T in different regions or with other types of CH.

10.6 Recommendations and further research

The purpose of the current study was to explore the potential role of IS upon the courtyard house type in Iraq. This was based on understanding the T.C.H.T in Iraq and to explore the appropriate IS for this house type by using the latter as “containers” to fill the gaps in performance created by adopting intelligent technology and leads to the specification of the need for IS to be added to T.C.H.T. There are two types of IB as containers of IS: through retrofitting or new design. The focus on adding IS in our existing T.C.H.T is a question of suitability, rather than creativity. The T.C.H.T in Al-Kadhimiyah were built before 1918, and the options for the T.C.H.T are for them to be retrofitted or to have a new design. According to this research finding, a number of recommendations are suggested.

- The research has recommended that the T.C.H.T in Al-Kadhimiyah deserves to be conserved and not demolished but should be rehabilitated extensively and professionally according to their features and characteristics; besides, the advantages of the T.C.H.T were the significant aspects in this type. Also, there were disadvantages and problems of T.C.H.T which represent the best possibility for the refurbishment and development of this type, to improve its performance.
- The IS is one significant component of an IB. All structures have devices that permit some type of automated response to exterior variations, but they might not be seen as IB. To distinguish IB from non-intelligent buildings with IS we need to explore further.
- To understand the nature of IS in buildings, the lifestyle of current users and possible changes for future users should be explored. This helps explore the potential role of ISs in improving the performance of the T.C.H.T in Baghdad, Iraq.
- To explore appropriate applications of IS, which may be suitable for houses according to changing requirements, we need to explore which systems are needed for the lifestyle of the current and future users in the T.C.H.T.
- The possibility of T.C.H.T being a container of IS by retrofitting existing houses will achieve a strong architectural value through improving house performance and then achieving maximum space usage. This could be a significant part of a development and refurbishing project. However, there is limited use of ISs with the current lifestyle, which could be interpreted with caution because adding these systems will clash with environmental treatment as a part of the current lifestyle.
- The research study also recommends the possibility of using a new design in the T.C.H.T as a container for ISs, which could be appropriate for those houses with no architectural value or a poor, deteriorating, slum structure; the benefit of such a change will be linked to house performance.

In order to generalize the findings and the procedure of the role of IS in enhancing the performance of the T.C.H.T in Iraq, further investigation should be conducted on:

- CH types that currently implement applications of IS. This may provide an understanding of house performance, and enable a possible comparison of the real situation, so that it can revise to suit both current and future users.
- Finding similar houses with IS in them and comparing these with those in my study.

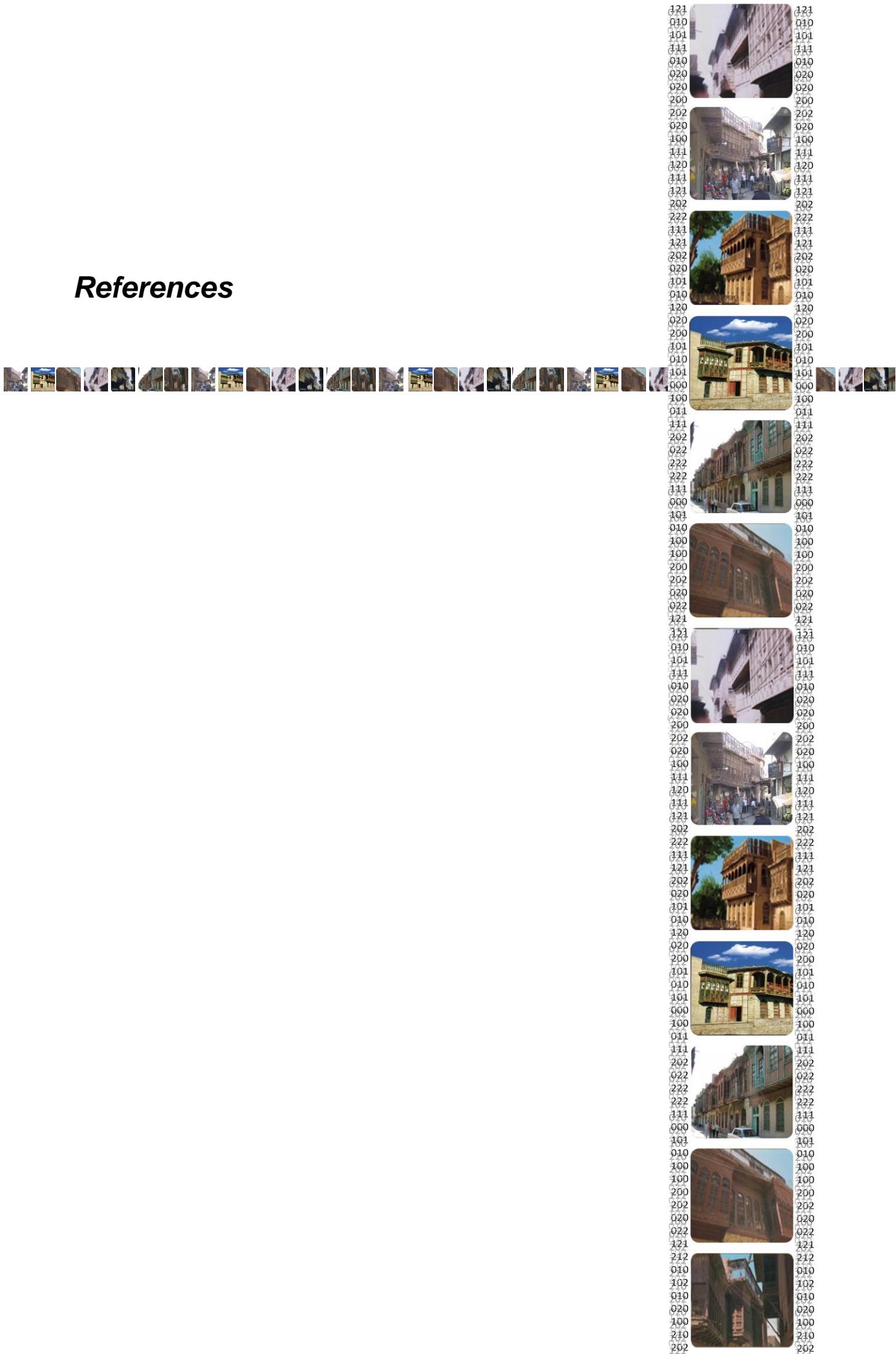
- Testing and evaluation of IS in the T.C.H.T can be conducted to assess their performance for both current and future users, to demonstrate the potential and a benefit of using IS and encourages the adoption of such system in the house.
- The identification of new factors, such as economy issues, may affect the application of IS may include cost.
- The selection procedure of appropriate ISs for the T.C.H.T should be clarified.
- The level of intelligence in current T.C.H.T compared with other CH types or different dwellings.
- The development could be undertaken of other potential applications for ISs through the development of a knowledge base for rule-based expert systems to select applications and guide the requirements in an intelligent house.
- This research has studied T.C.H.T in Iraq/ Baghdad. Further studies could examine the potential role of IS other CH. type, as well as other dwellings.

10.7 Concluding statement

The current research is concluded that the key features of the traditional courtyard house type are passive systems which support the lifestyle by achieving thermal comfort. Adding simple ISs as applications which are integrated and wireless, with an actuator, will certainly help the residents enhance the house performance in Al-Kadhimiyah. This will be done by: developing the level of control over the environment, reducing the environmental challenges, decreasing the social struggles, and supporting the response to the environment.

This study contributes to the role of ISs in enhancing the performance of the traditional courtyard house. For the current users, these roles are achieved through three major steps: (1) the nature of IS in traditional courtyard house, (2) The priority of systems; (3) Using the courtyard house as a container for intelligent systems. Future users are likely to have a different lifestyle and so the level of intelligence may change; thus, the potential need for ISs might change too due to the type of IS and its operation. A clean air recirculation module is one application to be used in the traditional courtyard house type in Al-Kadhimiyah, which can be selected to enhance house performance.

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Appendix



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A.1 Example of interview with architects

A.1.1 Individual/ professional

Data of interview: April 2012

Time and period of the interview: 119 minutes

Interview with: Arch.21 (individual)

Arch.21:

- What skills/profession do you have?

I graduated from the University of Baghdad 1982-1983 and worked in the mayoralty of Baghdad with Professor Rifat Chadirji. Baghdad was at the time in the process of urban renaissance and many projects were executed. I continue working and became the director of basic design institute. I contribute too many projects either as a supervisor or a planner, and I also participate in many architecture competitions. In 1996, I studied for my MSc in the University of Technology and PhD in the University of Baghdad. In 1996, I opened my own consultant bureau in 1996. In 2009-202, I worked with Professor Taglib al-Waili, a consultant engineer who has worked in the UAE and Canada (he worked with Professor Hisham Al-Madfa'i on planning) and we worked together in the rehabilitation of Al-Rashid Street (one of the oldest streets in Baghdad).

I am still working with the mayoralty of Baghdad in the development or maintenance of historical and cultural projects, especially those with distinctive urban features and I was nominated to work with Professor Taglib al-Waili due to his vast experience.

General information.

- Did you ever design a house with an interior courtyard during your professional life? How do you improve and modify a design like that? Or what are your views about an inner courtyard within a modern house?

Description of the present situation including the style of life through daily activities/space/time. In 1992, I participated (with Professor Ma'ad Al-Alusi and German Architect Rani Khali) in a competition to develop the Tikarta sector in Karkh, Baghdad. Baghdad is bisected by the River Tigris into the eastern half being called 'Risafa' and the Western half known as 'Karkh'. This competition was part of the

largest project to develop and rehabilitate the whole Karkh area. We looked at every part of Karkh in terms of standards and specifications for building in that part.

At that time, I asked to work with Professor Ma'ad Al-Alusi voluntarily due to my love of these historical traditional places and to learn more. The competition was concerned with urban design and every department designed one or more models for traditional houses with an interior courtyard, taking into consideration all the criteria present in the traditional houses and emphasizing the number of levels in each house and the sizes of the spaces etc.

I designed two models and one of them won the competition and was executed. I took into consideration all aspects, even the social aspect and the environmental aspect.

We met Dr. Mikdad Al-Jawadi who is a specialist in that field (and he built his own house inspired by the traditions) and we discussed with him a lot of aspects and how one can employ many of the design principles and architectural excellence elements in the traditional units with the interior courtyard, for example the stricter facades, the opening inward, the levels differentiations, the use of badgeer (windcatchers), the shanasheels, and the directed spaces, etc.

I worked with Professor John Warren after my graduation in developing and executing the traditional Al-Khadmia city (surrounding the holy shrine) and Bab-alSheik sector.

It is very difficult to obtain a clear picture in the working drawings of the traditional buildings without surveying the site first, for example: after removing part of the wall, one can find a partition of wood inside it or special details, so one cannot draw without investigating the site to discover these details.

We have no actual architectural research to show every detail in the traditional units with the interior courtyard, but when studied in practice, we discover a lot of new details, even in the relations between the residential units, and always there is a new discovery. I participated in many surveys of many of the residential units with the interior courtyard, some with the Department of Antiquities and Heritage, but the maintenance of all these units was done by local workers and there is no architectural specialist in maintenance of traditional units (within the work force). So we depended on the local workers who have practical experience in the maintenance and for that reason, and according to the circumstances, the building may be renewed completely and worked as before, or become worse, or a new problem may emerge unexpectedly.

My project to develop the Tikarta sector in Karkh, Baghdad was executed completely. We executed the project on the level of general planning and on the level of the design of one residential unit and tried to add some modern processors compatible with the development of modern times such as using modern processes for services such as central heating and cooling system or splits. We also studied the width of the alleys and arranged them to have enough space so ambulances or fire-fighting vehicles can reach each unit easily. All this was done while we maintained the traditional fabric that united all units with each other. We used the same old methods such as badgeers and shanasheels (with a few modifications) to fit the social, environmental and technological changes.

I believe it was a very successful experiment when compared with rehabilitation or renewal of a single unit with an interior courtyard from an environmental or social point of view. I must say that in order to establish such a fabric and its units depending on traditional design principles (with new overlook), the final result will be a study of the traditional principles by mixing the demands of modern life socially, economically and environmentally with them. Before we demolished the area and built it again, I found while surveying it that a simple family living in a small unit with an interior courtyard (no more than 50 square metres) has all the modern equipment within it.

The most influential point for us was the political decision that all the units built must be given (owned by) to the residents that used to live in them. If a family hired an old unit for 25 years, then this family would own the new unit and the original owner would be compensated. This decision took the social and economic criteria into account.

The results were residential units that mixed between traditional and modern, creating a modern residential unit with an interior courtyard that not forced in the house, but built after studying all factors and aspects on environmental, social, economic and technological aspects, and taking in mind the principle of privacy. The spaces were oriented according to the traditions. The whole modern fabric system was not a copy of the old but a simulation.

- Can you tell me what will happen when buildings such as a house are completed? I, with Professor John Warren, supervised and designed and studied the traditional residential unit with an interior courtyard specifically and its whole fabric in general in Al-Khadmia city and the Bab-alSheik sector. Our suggested project was accepted

because it was a compatible project since it permitted the modern requirements and kept the old and most important of all is the ability to allow cars to enter the Old City through the creation of an underground garage to maintain the fabric of the old narrow alleys and shanasheels and other details. In this way, each traditional unit worked correctly within its fabric socially, environmentally and economically.

I imagine that new modern ideas in architecture reject the use or entry of the car during the development of historic traditional areas, particularly those located in the centres of modern cities.

When my project to develop the Tikarta sector was discussed, there were two opinions contradicting each other; the first opinion was to reject the entry of cars and keep the traditional fabric with its unit with an interior courtyard as it was before, while the other opinion (which dominated luckily) was to simulate the old fabric by using a new style. It was suggested that the alleys must be widened to permit, at least, ambulances and fire-fighting vehicles in case of emergency. The widening of the alleys affected the movement of the air, so new modifications had to be done. In all, our project studied all these concerns and the new fabric we designed and executed worked compatibly with its units of interior courtyard perfectly. We preserved all the social, environmental, economic and architectural categories.

Specific information

1. How would you describe the urban and design planning of the inner courtyard house that enriches the traditional environmental performance?

The urban and design planning of the traditional unit with an interior courtyard is compatible due to: the fabric being connected with air currents, winding and narrowness of the alleys, the relationships between the multiple levels in the traditional unit, the badgeer, the direction of the sun and the relationship between the space and vacuum. All this created thermal comfort. All the units are connected together and there is a relationship between the mass, the vacuum and the stricter interfaces with the opening towards the inside, the location of the slots and their relationship to the level of interfaces, which give environmental protection and thermal comfort. The following strengthened and enriched the environmental performance: the dimensions of the interior courtyard, their relationships with sunrays, the presence of the fountain, the presence of the tree (the buckthorn), the building materials and the thickness of the walls. The use of some details and architectural elements enriched the environmental performance, such as the

badgeer. Gradient spaces were used on the level of the traditional unit and on the level of the fabric. The use of multiple levels created a temperature difference between the sardab and the roof of about 15°C. There was a sardab and a neem-sardab.

2. How would you describe the heat gain and the heat loss in the design of a traditional courtyard house?

The study of the thickness of the walls, directions of spaces, the materials used on horizontal and vertical levels, the shape of these materials, the relationship between the dimensions of the courtyard and all these will give advantage and features for the traditional unit with an interior courtyard. This will lead to the gain and loss of heat through all the year and during the day. This gain and loss of heat was studied perfectly and lead to clear thermal comfort suitable for residents and on all levels and all spaces.

This is why no one objects if someone says “the traditional unit reflects the environmental performance”.

3. What are the types of architectural elements that are responsive (reflect) to the environmental performance?

Frankly, all the design of the traditional unit and its fabric reflects the environmental performance, but especially: the badgeer is an important and active element in the environmental performance, which consists of a vertical duct and shaped slots in the direction of the wind; the shape, size and type of finishing materials; the arabesque found in all the slots that open to the outer space; the thickness of the walls especially those on the ground floor; the strictness of the outer side interfaces and the use of the interior courtyard; the slots on the level of the outside interfaces especially those in the shanasheels on the first floor and on the level of the interior interfaces and their relationship with the space; the multiple levels on the section level; and the use of decorations and arabesque in the windows. All the above reflect the environmental performance. The single unit contains reactions and compatibilities on a single level and an overall level.

4. What are the strengths and weaknesses in a traditional courtyard house?

I believe the traditional unit with an interior courtyard has no weak points, but it has strong points and many of them, and this is why all the experts from the east and west praised the traditional unit on planning or design levels. This unit has deep secrets and many architectural experts are trying to transfer the idea to the west as

one can see in Copenhagen, where the climate is completely different, but those experts are trying to transfer the idea with reasonable modifications.

Our problem came from having an "Incomplete picture on the level of design of the traditional unit with an interior courtyard in the minds of people, and have no idea about his plan and design, so they will consider it with many points of weakness". Some needed services are points of weakness if not treated properly. The change in social relationships during the years many be a point of weakness, since the unit is designed to develop strong social relationships.

5. How would you describe the current level of environmental comfort in a traditional courtyard house? Do you think that the traditional courtyard house is comfortable or not? Why?

I lived in a traditional house with an interior courtyard in the alSheik sector. That house was used as the Department of Islamic Studies of Baghdad city. I remember these days as the best days of my life. The house stands alone since all its fabric was demolished, but we lived in this house during summers and winters and we had thermal comfort and never used modern coolers or heaters except for a few days during the year. The house was provided with cooling and heating systems but the employers never used them (except rarely). We adapted nicely to the life in that house.

6. If you were asked to assess the environmental performance of a traditional courtyard house, what would you say? Why?

The environmental performance in traditional units with an interior courtyard is very good since every element was well studied from different aspects especially environmental categories as well as aesthetic, functional, technological, architectural and structural categories.

Even on the level of details, for example, the treatment and the design of the woods that formed the frame for the interior windows are completely different from its design in the outside windows. Even the small details take into account the effects of sun, heat, winds, pressure differences, and the direction of the winds etc. The environmental treatment and thermal comfort are compatible and played an important role in the direction of spaces, the use of multiple levels and the use of architectural elements such as the badgeers and shanasheels.

Examples of this are the thickness of the walls, the orientation of spaces, the use of different levels, the presence of the sardab and the roof, the use of gradual

transition spaces, the use of other architectural elements such as the badgeers and shanasheels and the shapes and positions of the slots. All these enrich the environmental performance and increase its efficiency.

The traditional house consists of several levels: The ground floor, the first floor, the sardab, the kafish kan, the neem-sardab. In Najaf city, there is more than one level of sardab. There are 2-3 sardabs going twenty metres deep interspersed with air channels that move the air between the units, and all these levels strengthen the environmental performance and increase the effectiveness of the traditional unit with an interior courtyard.

I visited hundreds of traditional units with an interior courtyard in Rusafa and Karkh (in Alchriat, Al-Rashid, Al-Betawen, al-Kadhimiya, al-Fadhil, Adamyhia, and alSheik sectors) and from my point of view the real reasons behind neglecting or changing the activities of these traditional units are not environmental but economic or social. The families who live in these units want to adapt to the climate changes and modify the unit to achieve thermal comfort, so I am against closing or semi-closing the interior courtyard to avoid dust storms (or heavy rain or extreme cold or heat), but I will suggest a fabric curtain (the materials that make tents) of the same size as the courtyard and fixed in a way. In case of extreme heat, I suggest spraying palm fronds with water and putting these in the outer and inner openings of the badgeer (windcatcher) to cool the hot incoming air.

Reed mats can be used to reduce heat or cold, but I believe truly that by closing the courtyard or the badgeers we will lose the mechanism of the whole unit. The important thing is not to cancel an element but modify it or add to it some natural and not artificial supplements. I personally refuse to add mechanical supplements to the system.

7. What possible improvements to the services in a traditional courtyard house can help improve its performance? Try to introduce further improvements that would help the residents.

There are many improvements that can be added to the traditional unit with an interior courtyard especially “service spaces”, and every improvement will depend on the size of the unit. It is possible to add toilets, kitchens and bathrooms and other systems that give humans more comfort.

The “service spaces” were almost non-existent or primitive in nature before the 1930s, and in that time electricity lines were established, while hot water pipes were

added in the 1950s or 1960s, and the sewage was connected with public sewage. Phone lines were added in the 1970-1980s.

The old toilets were built as a small place under the stairs which is impractical these days, and the traditional unit must be linked to the public sewage, electricity and telecommunications, since the whole city system has been changed and the health services must be improved. No harm will occur from the use of heating and cooling units that provide good ventilation in certain periods of the year if these will not affect the unit in terms of environmental, functional and aesthetic aspects.

8. What are the possible solutions to improve the living standards in the traditional courtyard house, and how? Can some artificial systems be used?

First of all, the whole fabric of the sector or the city must be preserved since its absence directly affects the traditional unit with an interior courtyard (because the services systems are compatible between them such as air currents, the space graduation, the direction of the sun, the effects of sunrays etc). This also includes: the continuous maintenance and sustainability to all residential units and its fabric; the adaption of some modern systems, so the units will be adapted to the advancement in the world and not a reflection of an old thing; awareness of the importance of these traditional units and the importance of our heritage, ancient monuments and our civilization; the development of laws and legislation to protect these traditional units from potential changes; and the continuous monitoring of the residents and their needs. With the use of any modern systems that keep pace with the times, one needs to be aware of how to use them without affecting the unit and the fabric.

Certainly, the use of some artificial systems will increase thermal comfort for the residents, but no traditional element must be removed or neglected and emphasis must be put on the architectural elements that enrich the environmental performance or embody it. The traditional unit cannot work alone, but must work compatibly with the whole fabric at first, and with other functional, security, services, environment, social aspects, and economical systems, and all these must be compatible with each other on the level of a single unit first and on the level of the whole fabric second.

When an artificial system must be added, the effect of this system must be studied to be certain whether its addition will affect the single unit or the whole fabric. The efficiency of any additional system depends mostly on the users (the residents). The

social, cultural and education background of the residents will affect the use of the additional system, which affects the unit and the fabric together.

The use of highly technological systems will increase the sustainability of the traditional units for a long time, and increase the thermal comfort of the residents. The residents who are aware of the importance of these systems will maintain them and at the same time maintain the traditional unit and its fabric. Many highly technological systems can be added to the traditional units with an interior courtyard, for example: ventilation and air conditioning (heating and cooling) systems that are needed at a certain period of the year must be limited to a certain period in the day, and take into account on which floor; communications systems are necessary; sewage and health systems – to recycle the water for reuse. These must be used by the whole fabric and not a single unit. There is natural light in most spaces of the traditional unit. The angle of sun entry has been well studied. In summer, the courtyard has light but is cold, while the first floor is so warm. In order to get stronger light, the ratios are calculated using the courtyard, the inner space and the relationship with slots as well as the use of mirrors that help to reflect the light in the space, so we do not need home lighting during the day but at night it is used to minimize energy consumption. We do not need a security system because security is guaranteed in terms of the location of the unit (through a relationship with slots, rigid interface, the inward opening, the narrow winding alleys and the gradient space, but if the unit changes from a residential unit into an administrative, industrial or commercial one, then security systems are needed. The health services are present but need development and sustainability. The electrical systems are found and need maintenance and more development to keep pace with the times first and the country second. Air conditioning (heating and cooling) systems are present. Some additions are needed for them to work in certain periods during the year. Ventilation is excellent if the courtyard stays open. The natural light is excellent during the day and the units need electricity at night.

As an engineer, one can easily use any system, but I always think about the difficulty of using any system from the cultural, social and knowledgeable aspects. I encouraged the developing of modern systems that help to maintain the unit, but these systems must be compatible with the natural systems that cool, warm, reflect the sun and move the air inside the unit. These systems can bring a great thermal comfort to the residents at all times of day and night and can be environmental friendly and increase social interactions. They can create new spaces with new

activities and give more importance to the unit. I believe modern technological systems will increase the aesthetic, functional, social and economic values of the unit and reduce the use of energy.

During my work with these units, I found that the economic level of all the residents was good or very good, but their educational level was below average, although there were a few very well educated people. From my point of view, the use of technology in general is affecting the health of the human beings especially in the absence of awareness and knowledge of them, and instead of complete dependency on them, one must find a more natural system that is compatible with them.

9. What is the exact choice to increase the performance efficiency of the unit and the fabric?

That depends completely on the social, cultural and economic aspects of the individual. If I was the decision-maker, I would choose the best technological systems in this world and apply them reasonably and after a long study of the traditional unit. The traditional unit with an interior courtyard is adaptable and changeable and has a lot of flexibility and can achieve anything new.

10. What are the key strategies that enhance comfort in a traditional courtyard house?

The most important strategies that are supposed to be used and we used it as an executed designer group is to do an analytical study of the traditional sectors with a complete field survey in Kadimyha. There were two projects.

The first project was to preserve certain units (or houses) with the fabric chosen due to its once housing a large family, having residents of a distinct personality, from a certain historical period (or a particular event) or due to distinct architectural features. The group selected 45 units and restored, repaired and rehabilitated them. After the restoring of these 45 units, unfortunately, the project stopped due to a budget problem and a loss of interest (because of the Iraq-Iran war in 1980 and other wars that followed). The second project was the developing and enlargement of the area around the holy shrine in Kadimyha and the addition of different services to suit the increase in religious tourism and visitors to the holy shrine. The rehabilitation idea depends on preserving the historical district in proportion with the new changes that have occurred at the same time, i.e. maintaining the old fabric while absorbing and adapting to the new changes in order to maintain the effectiveness of basic holy

shrine and the development of other related criteria (social, architectural, urban, environmental, economic) without forgetting the fabric as a whole. Maintaining these principles and strategies means preserving the historical city.

I attended the "Islamic Cities and Capitals conference" in 2010 in Baghdad and we discussed the development and designs of the historic area, but devastating ideas and projects came from people who know nothing of preservation. They claimed the surrounding area around the holy shrine must be removed and demolished to open more passages and garages and other service facilities for the visitors. These schemes were adopted and are going to be executed by removing part of the fabric, and no protests will stop such devastating ideas.

From my point of view, the work that leads to a complete destruction of the historical fabric and the destruction of the entire region will have a bad environmental impact on the holy shrine in particular and the Kadmiyha city in general. The market of Al-Strabadii (suk alstrabadii) is one of the oldest traditional markets in Kadmiyha city and I know its planning very well and I have surveyed it several times (all these studies have disappeared), so anyone who wants to redesign it must research all the old studies before developing and rehabilitating it, or destroying and demolishing this ancient market.

The idea of the interior courtyard is an ancient idea that appeared in Ur, 3000BC and continues today. The idea of the courtyard emerged for social and environmental reasons. The direction towards the inside will provide privacy and protection and at the same time it is an environmental necessity. The largest unit has more than one courtyard. There are 2, 3 and 4 courtyards in some houses. The bigger house has four courtyards, one for the family, one for the guests, one for the services and the last for animals. The direction of the four courtyards takes into account the environmental factors, the sun, and the ventilation etc. I noticed this in all traditional units in Kadmiyha and Babalsheikh and even in the units found in our ancient cities. The traditional unit is linked with beauty for social or environmental reasons or both; for example, the slots found in some parts of the house are decorated in a fashion that is beautiful and serves to provide thermal comfort. The different types of spaces inside the traditional unit served the resident and provide comfort. Thermal comfort was given priority, and for this reason there were multiple spaces and multiple levels that formed the traditional unit. The traditional unit is used from one space to another in order to create a complex compound that serves the human beings living in it and gives them a comfortable life (sleep, social activities, entertainments, washing,

cooking etc.), and the inward direction, stricter facades, graduated spaces and transitional spaces helped this.

Demands of social, environmental and functional levels combined with the aesthetic side led to the creation of the traditional unit with an interior courtyard. The relationship of the units with their alleys differs according to the position, so the relationship of a unit with a single interface differs with the relationship of a unit with two interfaces (opening into two alleys) and all this creates the beauty of the whole fabric. The alley and its units is an organic fabric which encourages air currents. The creation of the kafish kan is for the oldest woman and the head of the family, so she can control the whole unit from above, and at the same time this hanging room creates an aesthetic side and solves the problem of the neglected external corners, whilst also being a smart way to manipulate the levels.

I believe the courtyard was created as a complex environment depending and based on functional, social, environmental, economic, security, architectural and technological needs.

11. What do you think of appropriate services for the traditional courtyard house? or
What characteristics do you think are important for appropriate services in traditional courtyard house?

The most important aspects for additional services systems for the traditional unit with an interior courtyard are:

- The addition must not affect the beauty or distort or pollute the environment
- The addition must not affect the protection of the building
- The maintenance of the added system must be known
- The users must be aware of how to use the added system

The economic and social aspects and the awareness of the type of used system was added. The resident, as well, will set limitations, rules and specific attitudes about the use of the new system, such as the maintenance of the added system and its repair (in case of malfunction). In Iraq, maintenance is ignored by the state and people when buying new systems, which is a problem affecting the country as a whole.

Lastly, the state must be aware of the importance of the traditional units and must set a "control observer side" that observes and supervises these units and educates the residents of their importance. The state must connect these units with public electricity, water, and sewage etc. and provide social security for the residents.

Closing conversation

- Is there anything else you want to add?

No, I do not think so, you have covered everything.

- Give me one sentence that describes how you feel on the subject of debate?

You were marvellous and I was delighted with such discussion even though it took more than one meeting to be completed. I have wide experience and this subject, in particular, is a hurt and pain to discuss. We (me and my colleagues) spent months putting suggestions and ideas to preserve the historical fabric of our cities but nothing was achieved in practice and even though the problem is clear, no adequate and realistic solutions were found.

There are many who speak about this subject while they have no idea about it, so I have the pleasure to discuss this subject with one who has full knowledge and experience. I am glad to have had such an exchange of emotions when talking about the greater value of this distinct cultural field of science.

A.2.2 Group/ less experience

Data of interview: April 2012

Time and period of the interview: 142 minutes

Interview with: Arch.a—and Arch b--- (Group)

- What skills/profession do you have?

Arch a: Architect and town planner, teaching at Institute of Urban Planning for Higher Education and the University of Baghdad

Arch b: I'm an Architect and I have a Master's Degree in Architecture from the University of Baghdad (2009); after that I worked for several construction companies, and my duties there were various such as designing, supervising or evaluating the performance of the designed buildings and providing a patrol report on what it needs to work, according to what it's required for. Therefore, I need to find / invest new solutions to new conservation projects which sometimes concerns urban site problems to help me advise clients about the best architecture and engineering solutions. I always like to invest more time in planning than implementation, which will lead to a successful project.

General information

- Did you ever design a house with an interior courtyard during your professional life? How do you improve and modify a design like that? Or what are your views about an inner courtyard within a modern house?

Arch a: Yes, I designed a house with a courtyard, but not in the same way and specifications of the traditional inner courtyard. I put a roof over my courtyard and modified it into an interior space. The truth is that in our present time, no designer can take the decision to adopt the principle of the inner open courtyard without taking into consideration the design of the house within the fabric of the city. The traditional interior house was part of an integrated environmental system and therefore was environmentally successful unlike at the present time.

As for what I want to see in the inner courtyard of the new house?

I think the traditional courtyard was environmentally successful within the context of the traditions of its time. It was considered the meeting place of the whole family in their spare time as well as giving some sort of control to the parents over the members of the family.

There was a sort of intimacy that has faded in our present time when every member of the family has his/her own room and therefore does not help the interaction of the family. I believe in being inspired by the old principles and mixing them with contemporary ideas.

Arch b: Well, until now I haven't designed or implemented a house with a traditional courtyard. For me, I like the idea of using a courtyard as a starting point when designing houses as it was a useful design element in the past but now it's hard to convince clients to go with a traditional design theme because of the changeable needs of today.

What do I want to see in the new courtyard of today? Well, to provide me with all my needs such as social, environmental, sensational needs such as the degree of privacy I need and that beautiful spirit of the past, which can be transformed by using the past design elements and trying to rediscover them once more in a new social – ecological approach, which applies for the needs of today.

- Can you tell me what will happen when the building such a house is completed

Arch a: As I understand it, the question is about the implementation of a traditional courtyard house in the context of the contemporary city? I answered that before (it is

illogical to implant it in a modern city since the urban planning of our modern cities differs completely due to many factors: environmental, social and planning.

The cars have forced all the streets and alleys to be straight, so the traffic can move easily and freely, and put most of the Iraqi cities in a sharp predicament due to the inadequacy of the planning in relation to the Iraqi climate (hot and humid most days of the year). This change leads to the building of environmentally separated houses, where each house depends on itself and not upon other houses in the locality. If people build courtyard houses today, they will be forced to put a roof over the courtyard or use high technology devices for ventilation.

Arch b: Well, as you know the courtyard as a single element doesn't work properly by itself as it depends on other main elements and factors such as the urban fabric (carved alleys with closed ends, fabric edges..etc.), and according to the available space and resources like the building material. It's related to the fact that the characteristics of the social factor and the building methods which are used for local materials stems from the surrounding area of the place and it uses techniques inherited over time and transfers them as a legacy to subsequent generations with respect as it's what only we own. I can't say I have built or lived in one, but I wish one day I can be part of team to build a house with a traditional courtyard.

Specific information

1. How would you describe the urban and design planning of the inner courtyard house that enriches the traditional environmental performance?

Arch a: The planning of the traditional city used to be described as random (organic) or chaotic due to the lack of a clear system, but in truth the planning is unique and achieved a great comfort to the residents of the city. The ancient architects used the principle of right and wrong with the experiences of some other cities that had access to them to be able to reach and build the traditional city as we know it now, and this city had environmental, social, security and excellent health dimensions.

Arch b: Well, I'm one of many architects and urban planners in Iraq who believe that green and sustainable thinking is what we need to rebuild our societies once more after failing to keep up with the needs of today and the future. The courtyard house once was an urban unit in the traditional fabric, which enriches one and others and this will help improve the environment quality to a better living level. We should try to implement more courtyard house design methods, to enrich our land use, and the built environment and urban management. But it depends on the community to

embrace it as a successful starting point for all architects and urban planners to embrace it when preparing design concepts for urban development.

2. How would you describe the heat gain and the heat loss in the design of a traditional courtyard house?

Arch a: The use of building environmental friendly materials (brick clay) with certain dimensions in the presence of “positive and negative” spaces within the fabric of the traditional locality (with its winding narrow alleys) that makes the gain and loss of heat in the courtyard house compatible with the local environment so that it gives a sense of comfort throughout all days of the year and through the heat of the day.

Arch b: Well, as we know, it is based on simple design factors such as a wind tower, which works as a heating and cooling system in the following ways:

- The house basement: at night when the air is cooler the wind from the towers passes over the walls and roofs and ceiling, drawing the stored heat of the day from them, and so when the family enters in the morning they are cool to sit in.
- The house roof: this is made from cold materials so sometimes in the very hot summer nights the family climbs up to the roof and they sleep under stars.
- The whole form of the house: this is designed to maximize its passive cooling potential in summer and its power to warm in winter.
- The building materials: these not only absorb and store heat or coolness but also act as insulation so once the heat or coolness are in, they stay there.

3. What are the types of architectural elements that are responsive (reflect) to the environmental performance?

Arch a: The following elements, shanasheel, the badgeer and the interior yard, at the level of the housing unit, and the winding narrow alleys and the urban spaces -that graduate slowly from the wide public spaces such as mosques or holy shrines until they reach the interior courtyard, at the level of city planning.

Arch b: Iraq especially has a very large day-night temperature difference, ranging from very cold in winter to extremely hot in summer (reaching 60°C in shade), and the air tends to be very dry all day long. Most traditional buildings are constructed of very thick clay walls with extremely high natural insulation values. Furthermore, urban areas centered on desert tend to be packed very closely together with high walls and ceilings relative to western architecture, maximizing shade at ground level. The heat of direct sunlight is minimized with small windows that do not face the sun and the

most well-known traditional architectural elements which respond to the environmental performance are:

a. The courtyard: it's a square or rectangular open space, which is located in the heart of the house. It performs an important function for climate well as lighting purposes. A fountain was placed in the middle with living spaces opened onto it. During the past, the courtyards of the traditional houses had an important role of maintain the owner's privacy and being a source of light. In the 19th century, the courtyard lost its environmental role, due to the rise in the number of floors to four and by losing the urban fabric of the old city; this is an aspect that led to its complete disappearance shortly afterwards.

In traditional houses, the courtyard played a climatic role, as it allowed outdoor activities to occur while protecting from undesired wind and dust; it also served as a light source. One of the great functions of the courtyards is that it provides small areas with a cool breeze, using the ground heated by the sun as the heat source. This leads to a drop in air temperature of 10-20°C.

b. The wind tunnels (towers): the wind tower is a traditional architectural element and is mainly part of residential houses. The function of this tower is to catch the cooler breeze that prevails at a higher level above the ground and to direct it into the interior of the building. This feature is used in many Arab countries.

One of the most common uses of the badgeer is as an architectural feature to cool the inside of the dwelling, and is often used in combination with courtyards and domes as an overall ventilation/ heat management strategy. The malqaf is essentially a tall, capped tower with one face open at the top. This open side faces the prevailing wind, thus 'catching' it, and bringing it down the tower into the heart of the building to maintain air flow, thus cooling the interior of the building. This is the most direct way of drawing air into the building, but importantly it does not necessarily cool the air, but relies on a rate of air flow to provide a cooling effect. This successful use of the malqaf or windcatcher has been employed in this manner for thousands of years.

c. The shanasheel (mashrabiya): is an element of traditional Arabic architecture used from the middle ages up to the mid-20th century. It is mostly used on the street side of the building; however, it may also be used internally on the courtyard (sahn) side. They are mostly found in urban settings and rarely in rural areas. Basra is often called "the city of the shanasheel". The wooden screen with openable windows gives shade and protection from the hot summer sun while allowing the cool air from the street to flow through. The designs of the latticework

are usually with a smaller opening in the bottom part and larger openings in the higher parts, hence causing the draft to be fast above the head and slow in lower parts. This provides a significant amount of air moving in the room without causing it to be uncomfortable. The wood itself absorbs the humidity from the air.

The projection of the shanasheel achieves several purposes: on one hand, it allows air from three sides to enter, even if the draught outside was parallel to the house façade; on the other hand, it serves the street and in turn the neighbourhood. A row of projected shanasheels provides shelter for those in the streets from rain or sun. The shade in normally narrow streets will cool the air in the street and increase the pressure as opposed to the air in the sahn, which is open to the sun, making it more likely that it would flow towards the sahn through the rooms of the house. The shanasheel also provides protection and shade for the ground floor windows that are flat and usually unprotected.

4. What are the strengths and weaknesses in a traditional courtyard house?

Arch a: The most important strength is the environmental interactions of the courtyard with the environmental systems of other spaces in the city, the great outdoors space at the city level, which represents the space of the mosque or the holy shrine, the space at the level of the sector, a space at the level of the locality and space at the level of the neighbouring residential down to the courtyard as well as the small space of the winding alleys. These achieve levels of comfort.

The points of weakness are its poor handling of the heavy rain and thick dust, especially with the changes of the environment during the present day.

Arch b: The Strengths:

- It has more green and sustainable design schemes then today.
- It is energy efficient in its design & implementation process.
- It has efficient materials using just local materials such as wood, stone, clay, soil, and palm fronds for roofing etc.
- It provides the house occupants with high levels of healthy environments, with safety, efficiency and privacy.
- We can say it's more aligned with the culture and social environment of Iraq.

The weaknesses:

- It is not updated to the present or the future users' needs.
- It can't standalone; it needs an urban fabric to work according to its environmental purposes.

- It needs a lot of area for the courtyards and external facades.
- Its building materials need regular maintenance.
- The cost of building them is very high compared with modern houses.

5. How would you describe the current level of environmental comfort in a traditional courtyard house? Do you think that the traditional courtyard house is comfortable or not? Why?

Arch a: Our traditional cities have a unique ecosystem derived from the concentration of all its components and their interaction within a unique pattern that makes the levels of thermal comfort acceptable to a large population of the residents and without any need for modern cooling or warming systems.

No one can deny that the style of the planning of the city and the unique design of the interior courtyard houses have the greatest impact on achieving the levels of thermal comfort using the differences in pressure in spaces by using the negative and the positive (shaded and sunny, closed and open) in the creation of air currents within the alleys of the city and the housing unit, which helps in creating a level of thermal comfort.

Arch b: In Iraq, there are few examples of houses which contain in their design elements a courtyard in a good building condition, but, as I mentioned before, the environmental performance of the courtyard depends on the surrounding urban fabric of the city and we can say it was a successful solution to withdraw the heat of the house by suction and to change that hot air with wind tunnels (Malqaf) and shaded alleys without using the mechanical equipment of today. Thus, it had a high level of environmental comfort.

Yes, we can say they were comfortable at that time, because they had all the successful buildings elements, good craftsmen, building materials and a suitable house design for the owners' needs.

6. If you were asked to assess the environmental performance of a traditional courtyard house, what do you say? Why?

Arch a: My evaluation will depend on the theoretical side, which gives the perceptions of the scientific performance of the interior courtyard environmentally as well as the site visits for the remnants of the traditional fabric of the cities and my experience as a designer of such dwellings during my career. I think that the performance of such kind of courtyards are ideal, especially as we are passing through a stage of the scarcity of energy and the need to return to extraordinary

inspired plans to reduce the use of energy and at the same time create an environment with a level of thermal comfort. The thick walls, the wooden ceilings and the shanasheel create an effective system that smoothes the atmosphere within the ranges of accepted thermal degrees (in summer and winter). On the other hand, the environmental support for the interior courtyard house comes through the urban fabric of traditional winding and narrow alleys that create air currents air that decrease or increase the temperature of the traditional home.

Arch b: Well, now it's very difficult to evaluate the environmental performance of the traditional courtyard houses, because it isn't one module that can be used for all the urban fabric and, to be specific, every house with a courtyard is unique in design, space and size. Therefore, even if you evaluate one you will need to compare the data you have collected with other data from different courtyard houses in the same urban fabric to see what makes it unique when we compare it with others.

Well, that's very difficult now! The services of today are hard to implement in the traditional courtyard houses or old urban areas, without destroying some building facades or one or two design elements, so these services can fit in that traditional context. However, if I start to rediscover the traditional courtyard house and implement today's technologies step by step with a design process it will be in the end enhanced with its performance and efficiency.

7. What are the possible improvements to the services in a traditional courtyard house that can help to improve its performance? Try to introduce further improvements that would help the residents.

Arch a: The main problem that faces all Iraqi houses (traditional or modern) is the poor (or the lack of) infrastructure (road network, sewage network, a network of safe drinking water, an adequate electricity net and so on). Most areas, for example, lack the presence of service cars (rubbish collecting cars, ambulance cars, fire cars and so on). The government admits that 50% of total electrical energy is lost through the distribution network. If the government plans for adequate infrastructure services, all other problems can be solved. To increase the green areas inside the interior courtyard house with the building of a fountain will help to improve it. In many traditional houses, channels of water close to walls surrounded the house from the inside.

Arch b: Any home, new or old, needs to be updated and upgraded with the latest services which will be used by the occupant for his/her daily needs, and such

improvements might be social, sentimental, economic, and environmental for a better indoor comfort, such as indoor gardens on different floors (levels) or roofs, better use of natural light for energy management, rediscovering wind tunnels for better air ventilation etc. The services can help the house occupants to improve their living quality.

8. What are the possible solutions to improving the living standards in the traditional courtyard house, and how? Is it through some artificial systems? Can some artificial systems be used?

Arch a: It is difficult to find a solution to improve the living in the interior courtyard house without interfering or changing the urban planning of the whole city. If one can find that one would be able to meet the contemporary needs of the population and at the same time face the environmental challenges (such as the rising temperature in the last two decades to the steps of up to 55 degrees Celsius in the shade, to the effect of global warming, to the crisis of wars and the crisis in water and unsuccessful agricultural policies and less cultivated areas). We can only improve the living in this type of house.

In reality, the traditional houses were negatively affected by the modern urban developments of our cities. The rising temperature of 10-15 degrees Celsius during the last twenty years, the three successive wars (that affected the Iraqi green cultivated areas) and the split of old united localities into isles between modern buildings weakened their self-ability to face the harsh environment.

The shortage of water in the main Iraqi rivers (due to dams built by Turkey and Iran) led to the rising of underground water that affects the traditional houses. All the above are putting limitations on the ability of the present existing traditional houses to fight the harsh environment without the use of modern warming and cooling systems. The establishment of a moving roof that can close the interior courtyard during dust storms and rain will help in improving the atmosphere inside the house.

Arch b: How can we improve living conditions in tradition urban areas which contain courtyard houses? If we want to find possible solutions for that we need to understand urban development and the increasing population problem and their desires. These have brought with them a multitude of social and economic problems and we need to make the building environment suitable for living in, like providing economic security, green indoor and outdoor environments, and upgrading infrastructure services.

Studies show that people prefer the comforts and pleasures associated with most green facilities. Findings reveal higher levels of occupant satisfaction in buildings where green practices are used. That doesn't mean that we need to use just artificial systems; but we can associate green schemes with no artificial ones, to create more comfortable environments for occupants by increasing their satisfaction. This could deal with:

- a. Comfort, safety and accessibility to interact with whole the courtyard house.
- b. Building stronger social relationships with neighbours and the community by improving communication and organizing services like community events.
- c. Setting and attaining conservation and sustainability goals.

9. What is the exact choice to increase the performance efficiency of the unit and the fabric?

Arch a: All infrastructure services are needed for traditional or modern homes.

Arch b: As I mentioned before, we need better infrastructure services in traditional urban areas to reduce people desertion and increase living stability. We need to rethink or redesign the tradition house with all its architecture elements, materials and size once more but with the language of today, linked to upcoming needs and fixable techniques in its form, dimensions, building materials and services.

10. What are the key strategies that enhance the comfort in a traditional courtyard house?

Arch a: Good interaction between the house as a cell in the body of the city and the whole city. This will achieve great comfort to the dwellers and residents of the traditional house.

Arch b: A suitable strategy which will help to enhance the user's comfort is to use:

- An open dialogue with the user and developer.
- Mixing between traditional and innovative design by implementing methods concerning green living and sustainable development for better user comfort environment.
- Raising users' awareness about new development approaches which can be more economically sustainable (sustainable tourism, opening green business, creating new job opportunities), socially positive (urban connections, free and open communities, preserving legacy, etc.) or environmentally friendly (energy management, re-use and recycling) or all three together.

- Using early stage thinking in project planning and reflecting it into the implementation process, which will help us enhance the user's comfort economically, socially and environmentally.

11. What do you think of appropriate services for the traditional courtyard house?

Or, what characteristics do you think are important for appropriate services in the traditional courtyard house?

Arch a: The most important service characteristics for the interior courtyard house are its compatibility with the local environment (temperature, humidity, wind movement etc.).

Arch b: In the traditional courtyard house, the most important characteristic we need for better services is to use:

- A socio-eco theme when designing and implementing services in courtyard houses.
- The main core of the house needs better spatial orientation in its shape, height and size, so that it can be used for multiple different purposes. The courtyard is the heart of the whole house and all services pass through it, so it depends on the courtyard for survival.
- The traditional house can be really understand as a raw element and we just need to reform it and rediscover it by going back to our past way of life, legacy, local culture and identity, to use it in new urban area developments or planning themes.

Closing conversation

- Is there anything else we should have covered but didn't?

Arch a: The subject is interesting and the questions are fun, although tiring. Sometimes the researcher repeats questions for unknown reasons. Maybe multiple choice questions will be better.

Arch b: No, I think most of the questions covered the topic.

- Give me one sentence that best describes how you feel about the topic discussed today?

Arch a: My feeling is contradictory. There is a sense of joy and a sense of frustration at the same time. My joy is because there are still a few people who are trying to re-understand the system of traditional housing within the context of the city and therefore there is hope in the re-employment of our ancestors' ideas in a contemporary fashion, while the frustration and sadness are caused by the state of

our miserable cities (especially the traditional ones), which carries the heritage for generations. This heritage has tried to adapt to the extreme local environment through architectural configurations and construction that created a successful social, environmental, health and security environment. Today, all our cities (especially old localities) are neglected in a grotesque and deliberately manner that makes the remains of our traditional cities a real burden on the present generation and subsequent generations.

Arch b: It was a return voyage to our beautiful legacy.

A.2 Example of interview with occupants

A.2.1 Individual

Date of interview: May 2012

Time and period of the interview: 62 minutes

Interview with: Occ --- Male (Individual)

Address: (PH. CH8)

General information

- What skills/profession do you have?

Owner of a food / owner of a textile factory producing towels, out of the area

- How long have you been living in this house and how long are you planning to spend living in your home?

I have lived in this house since birth 60 years ago and I plan to stay to the last day of my life. My grandfather was born in this house in 1890 and it was built in 1840; now, I do some repairs and everything is okay except when the basement is submerged by groundwater.

- Who goes to work or study outside the house and who is staying in the house?

I live in this house with my family and with my wife and four children (3 boys and one girl). I go to work from morning to evening and my daughter and son will graduate from university, and I have two married sons and who live outside the house separately with their families.

Specific information

1. Describe the best times you ever had in the courtyard house during different days/seasons, and the worst. What qualities did each of them have? Where?

The best time I spent is still the afternoon in the summer in the region close to the basement or cellar. He was very comfortable as the air was cold and moving. He could make marshmallow without the need for anything like fans. Any ground floor and basement. Once on the ground floor, he opened one window or two windows of the space Al ursi and was very comfortable. But now, this area is submerged by groundwater and we cannot exploit it at all.

Despite the intense heat in the summer, the air was moving in the whole house, making the house very comfortable. I do not recall a bad time in this house, but the winter is cold and I need to heat it, especially the ground floor and the basement because of the presence of moisture and the high level of water in it.

- Could you elaborate on that point?

There is a problem of dust during continuous days of the year and especially during the summer because of a forecourt; we cannot control it because we have to close the top of the slot to keep the yard having an open aspect. The slot surface is 60m and a hole in the first floor is about 48m in a rectangle. On one side there is the wall of stone and on the other side we have added something like of a piece of iron work and we have a light cover to get rid of the problem of dust and the continuous cold winter. And do I remove it in the summer, knowing that the sides are always open for ventilation.

- What time of season is the most comfortable (or uncomfortable) and why?

The summer season is the most comfortable in the yard in Albadkir Central and they move the air all over the house as normal as well as the higher elevation of the roof on the first floor of up to 4.5m, which works as a protection for the ground floor height of 4.70m, in order to shield them from direct sun. It also does not allow the direct sun to enter in summer because of a yard outside the first floor and second. With the big thickness of the walls, which are up to 1.20m for the external walls, these affect the process of loss and heat gain?

- Which house level(s) is/are most comfortable (or uncomfortable) and why?

The ground floor is the most comfortable especially in the summer because it is cold and we only need to open the windows or in some cases we may use fans. The basement floor is uncomfortable due to high water levels and high humidity. The ground floor is also comfortable in the winter after making amendments such as processing humidity and the addition of heating systems such as space heaters and the use of carpet.

- Which room(s) is/are most comfortable (or uncomfortable) and why?

Ursi in connection with the rest of the parts of the house and this space is located on the ground floor. The ability to control all of the spaces is through the movement of the person on the inside and outside of the home.

- What time of day/night is the most comfortable and why?

The afternoon is the most comfortable, especially for summer air movement, which naturally leads to a breeze. I am comfortable anytime. The problem is in the seasons, as I mentioned before.

2. Where do you gather and interact with your family members? Could you be more specific?

I meet the family in summer in the yard and spend the majority of events either in the winter Vizma in a special room called the Holy House. Only the basement, named the chair dag, is unused. In the Living Room we have packed the room with wood sheeting to preserve it and keep the Albadkir a Abarhan slot found in the surface extensions, while maintaining the openings.

3. Would you describe your sleep pattern and possible changes?

Earlier in the summer we use the surface to sleep in the evening and use the basement to sleep at noon. We now do not use the surface lot due to the continuous presence of dust, especially after the events of 2003, and we cannot use the basement due to the presence of ground water. Therefore, we have tried to add some processors to it, in addition to the buried part of the alley near the sewage leak and the spread of odours. Now we sleep in the bedrooms located on the ground floor (house chair) in summer and in winter; we previously used the ursi and currently we are on the ground and first floors.

4. Describe your hobbies, interests and favorite activities and tell me where your interests happen in the house?

I am busy in my work all day and my wife uses the kitchen as well as the yard because she is a skilled cook and her passion is the work of the Eastern and Western cuisine, as well as excellent desserts.

As for my children, after they return from school or work and eat and then get some rest my daughter stays in her room to study or uses the ursi on the first floor and the ground when she works on the computer.

In depth

5. What to you is a healthy lifestyle? How do you describe the environment in which you are living?

A healthy lifestyle means to be comfortable in the place where you live throughout the day of the year. This house is considered it in the summer to be comfortable and healthy as the air moves continuously to the presence of the yard first, second and basement bad-geer secondly.

In the winter, it is very cold and heating the house is not easy. There is a problem of dust, which has continued since the events of 2003 during the year and in

particular the summer, making the air stifling in summer. Except for the problem of dust, I saw a healthy and comfortable environment. I am convinced that the house has a good environment, despite the difficulties.

6. How do you deal with the problem of hot and cold weather?

In the winter, we use the spaces of the first floor over the ground floor, but this does not mean that the ground floor is neglected as it has been carpeted and oil and gas space heaters have been added. These are electrical and have been packed into the open space because of the certainty of rain and humidity, and the problem of dust as well as extreme cold. In the summer, we focus on the ground floor and we have added a split and coolers to the first floor and fans and coolers to the ground floor; previously, we avoided the heat by using the basement as well as having the Albadkir, but unfortunately it is now submerged in water now, so we have added some industrial systems for more constant convenience in the home. Previously, we used the basement for many events in the summer, such as sleep and as a study for the children, and to talk and socialize, in addition to storage purposes. The basement is near the street or alley and has openings near the roof working on the introduction of air, as well as having the Albadkir that controls the movement of air. Cold air enters from the Albadkir and it moves the air in the afternoon and vice versa, In addition to this, the basement is buried under the ground and its walls are very thick and unfortunately we currently cannot use it due to the presence of groundwater. There is also sewage water, which leads to the spread of odors and unwanted insects. It has been buried and treated by adding some chemicals to it. I would like now to make some amendments to the basement the second using the same processors that have been used previously by the engineering company that dealt with traditional houses and they work networks above the wooden roof and set up iron pillars, but wood in my house is very good and probably better than the new wood currently used.

7. Describe the sort of problems that you may face during night? Could you be more specific?

There are no problems at night in summer, and in the absence of dust. We use the surface, but when there is dust we are forced to use the existing bedrooms on the first floor and ground. On the ground floor, we only need an open window for ventilation and run the fan on the first floor, and use the split coolers. In winter, there

is no problem at night on the first floor to a height of up to 4.5 meters, because the ventilation is good and cold, but otherwise we need to have heating systems.

8. With the particular environmental performance you have in your house, what do you find most frustrating in living in your house?

The problem of the high water table, which makes it frustrating for my children; I see a beautiful and comfortable house and I will live in it forever. The boys consider that the environmental performance of the house is not good, especially in the winter cold. At the same time and despite a transition some of the boys have moved to separate houses that do not contain an internal courtyard, but they come every day to visit me and visit the rest of the family and spend some time with their children. The containment features of this home are unique and special memories come back, but they do not wish to lose it, and carry between the walls sweet memories. The new generation does not reject living in such a house because it holds memories that cannot be obtained in the new home, or with a modern style.

Previously, a lot of activities occurred in the basement, such as sleeping, comfortable seating, storage, and work etc.

30 years ago it was used in the summer only but now the high water table is constantly in this house; there are two basements: the first area is 42m approximately and the second near the alley is 28m and was buried, as I said earlier, because of the sewage as well as high water levels. This leads to the emission of odours from it and the presence of many insects, which impact negatively on the walls of the basement.

9. Can you give us an example where you may have problems caused by inefficiency in your activities? Why?

The problem of moisture due to ground water in the basement complicates its use and therefore needs to be resolved, but we cannot resolve it. It needs the help of professional people to maintain its features without affecting the privacy, as it did when the Indian company handled the conventional and traditional homes where they worked Chelmanat. They used a secondary ceiling in the basement to protect the ground floor. There is also the problem of heating, especially when there is no electricity, as well as higher prices. The high ground water has become very problematic. Although previously it was used for many activities such as sleeping at noon in summer and family gatherings in the afternoon to evening and the

performance of many of the events due to the existence of the Albadkir that achieves comfortable ventilation.

10. How do you describe the services in the courtyard house?

There were no problems with the cold and hot water, especially after the addition of heaters. Sewage and sanitation were not bad and we made some changes with adding sinks and D streams related to a private home sewage but the general public sewage is not good and thus adversely affects the sewerage and sanitation in the house, such as the emission of odours. For heating, we use oil and gas space heaters in the absence of electricity, and carpets.

11. Which service rooms are the most common in your house?

The kitchen is the most common, which suffers from two problems. First is the increased humidity, and fumes from food and secondly there is the difficulty of ventilation and the spread of food odours and smoke. Sometimes it contains a lot of inscriptions in the ceiling and walls, which affect the process of cleaning. To avoid these problems, we changed the site around the old kitchen and the use of a room overlooking the alley which contained the appropriate openings for ventilation; we also added air catchers.

12. What sort of additional services do you use? Such as electronic and communication systems like the internet and how do these help you?

We use a computer but do not have an internet line, but aspire to in the future. We also use systems such as heating and cooling split units and chillers, ventilation fans, such as tractors and lighting at night.

13. What is the problem with your house services? Are there any limits or constraints that need to be replaced?

After the burial of the basement near the alley, there remained the problem of moisture, so now I work on the restoration and maintenance of a central basement depth from 3.70 to 3.80 meters high now.

14. The cost of utilities – electricity/ water and drainage. Do you think the cost is high?

The cost of electricity is very high, in addition to the use of private generators for the lack of electricity on an ongoing basis. The costs of the water and sanitation are reasonable and the company has worked to bring a sewer to the outside as well.

15. How would you describe your current level of environmental comfort in your house? Do you find your home comfortable or uncomfortable? What are some of your reasons for feeling as you do?

I would describe the current level in my house as very good and very comfortable, especially in the summer. There is light during the day which is direct and this is good as it the sun enters most of the spaces involved.

16. If I asked you to evaluate the environmental performance of your house, what would you say? Why?

The environmental performance is very good and it is a comfortable home and excellent in the summer, especially because of its natural air movement and the thickness of the walls and the ceiling height, and the use of natural materials in its construction such as wood, bricks, etc.

Because of the high water table, we buried part of the basement and the problem persists when it is cold in the winter so we shut down the yard. There can be dust every day of the year so we close the yard at the time of dust, especially the inner courtyard due to humidity and dust.

The kitchen was a problem because of the humidity rising from the fumes and smells of food because of the lack of ventilation. It was cold all over the house and especially the ground floor.

18. How do you enhance your comfort in the house, or how do you make yourself more comfortable? Is it through some artificial systems?

We use automated systems for particular environmental treatments, because the environment in Iraq too harsh, especially in the heat and cold or the recent frequent phenomenon of dust and moisture. The use of such systems helps to purify the air and makes the atmosphere of the house more suitable for comfort to humans and this in turn affects the absolute work.

I've added systems such as heating, cooling and ventilation to improve the performance, but I would like to add more sophisticated systems, so as not to affect the home and keep it and increase its sustainability, and to make us feel more comfortable. We would like to use all the courtyards, without exception. We also need to shed rain water in the courtyard patio and packaging and avoid the closure of part of it to avoid the intense heat and extreme cold, rain and dust.

Address the forecourt deviation does not affect it, or the ventilation or light and the lighting system fits any use of systems with natural ventilation and lighting used in the

home-Baghdadi so as to reduce the costs or limit the use of industrial systems and fit naturally with regimes.

The height was reduced to facilitate the process of cooling and warming by the use of artificial systems such as split units in summer and central heating in winter, if possible. Also, the sewage and sanitation were controlled to get rid of odours and blockages, use automatic machine which have control on the harsh weather especially in the winter and the dust this is my wishing.

Closing conversation

- Of all the needs we discussed, which is most important to you?

My wish is to use some kind of automated systems in the home that maintain the architectural features and keep it from external influences such as heat and extreme cold or humidity, as well as direct sunlight, dust, etc., using special heating systems, and cooling and ventilation.

It is important for me is to keep this house and its sustainability, and restore the basement; if I had the opportunity to use craftsmen or workers, professionals, such as workers from ancient Karkh, and restore the basement, this would be to our pride because of all the family memories and as a legacy of civilization for future generations and to encourage the use of such designs in future. We need to make some adjustments in proportion to the environmental changes and emphasise the use of the basement to save energy and reuse it for the Albadgir, which is distinct in these homes. It is also for the wonderful social relations that you find between the owners of these homes in times of crisis, such as death. I find it will carry me on its shoulders to my grave.

- Have I missed anything? Do you have anything to add?

There is no care or attention by those who built such buildings or homes, and this traditional heritage and civilization must be identified some time and I like to keep it.

A.2.2 Group

Data of interview: March 2012

Time and period of the interview: 61 minutes

Interview with: OCC 1+2 Male + Female (group)

Address: (PH. CH1)

General information

- What skills/profession do you have?

He is a retired civil servant who was a branch manager in Al-Jamhuria newspaper (owned by the state).

- How long have you been living in this house and how long are you planning to expand you're living in your home?

We moved to this house ten years ago (in 2003). My wife and my daughter disliked the house at first, and after a while they loved it and refused to move out. It is so near the holy shrine and seemed blessed like the whole area. It is state-owned and I will stay in it until the State orders me to leave.

- Who goes to work or study outside the house and who is staying in the house?

My wife, I, my daughter, my daughter in law and two young grandsons stay at home. My two sons go to work daily. One of them is a civil servant. My eldest grandson goes to primary school, and he is in the first level.

Specific information

1. Describe the best times you ever had in the courtyard house during different days/seasons, and the worst. What qualities did each of them have? Where?

The best time is when the sky is clear with a moderate temperature (during spring and autumn). The worst time is during winter when the day is cold and rainy. In winter, we suffer a lot due to the freezing cold, the rain, dust storms and winds since the courtyard is open. In summer, we stay in the courtyard or in the living room (the winter ursi) (all on the ground floor). We use both the ground and first floors and we store our things in the sardab. In the sardab, we have our computer and we work on it, and also I read in it. The summer ursi was modified into a kitchen. The courtyard has a big tree in the middle that used to cool the air, but it was very difficult to clean, so we cut the tree and covered it with concrete, and this affected the courtyard negatively in summer. It is hotter now.

- Could you elaborate on that point?

Sunrays do not enter the house in general and the ground floor in particular in winter, so the house is cold in winter, except for the summer ursi (modified into kitchen) and the rooms on the first floor. The smells from the kitchen spread all over the house in all seasons of the year, because we covered the courtyard with plastic in winter and a tent in the summer. Cooling and heating the house (especially the first floor) is very difficult (the roof is high as mentioned before).

- What time of season is the most comfortable (or uncomfortable) and why?

I prefer summer, as the house is cold compared to modern houses, but we freeze in winter and there is humidity. The builder does not use cement and only bricks and wood, and the badgeers are still working. I covered all the outside openings with steel networks to prevent rodents from entering the house.

- Which house level(s) is/are most comfortable (or uncomfortable) and why?

I prefer the ground floor since it is big and wide, especially when the courtyard is open. The first floor is so bad in summer and winter. Our main concern to make the children's room on the first floor as comfortable as we can; they are the future generation.

- Which room(s) is/are most comfortable (or uncomfortable) and why?

The winter ursi (the living room) is the most comfortable room, and its roof is low, so it can be cooled or heated easily. The light is good and it is warm in winter. We rarely use heaters inside it. The winter ursi is used for all activities; we sleep, sit and eat in it.

- What time of day/night is the most comfortable and why? I am comfortable anytime. The problem is in the seasons as I mentioned before.

In summer, the noises at night from the use of local or personal electrical generators are disrupting. At night, movement is difficult due to the absence of light from many spaces in the house.

2. Where do you gather and interact with your family members? Could you be more specific?

The family gathered in the courtyard all the time in spring and autumn. In summer, we gather in the courtyard (in two periods): from morning until noon and from sunset to the late hours of night. We gather in the ursi from noon until sunset. We do not use the sardab in winter since it is so cold.

3. Would you describe your sleep pattern and possible changes?

My wife, myself and my daughter sleep in the winter ursi (living room) in summer and winter, while my son and his family sleep on the first floor. My other son sleeps in a nearby hotel, as he found the house so cold or so hot. Our daughter sleeps in the same room which affects the relationship between us as husband and wife. The

sardab is unpractical and the wall of the roof is so low and we can be observed by neighbours.

4. Describe your hobbies, interests and favourite activities and tell me where your interest takes place?

I use the sardab in summer to work on the computer or to read. My wife spends her time in the kitchen or in the winter ursi reading the holy Quran, embroidering and sewing.

In depth

5. What to you is a healthy lifestyle? How do you describe the environment in which you are living?

I consider the house healthy since we have fresh air and a clean house. I agree with my wife that the environment of our neighbourhood is unhealthy. We could control the rodents and the insects if there were cooperation between the neighbours. There is a gap between the original roof and the secondary wooden roof and this is where the rodents gather. There are openings in the roof that permit insects to enter.

Historical facts.

This house is the house of the Astrebady family, in which the prime Minister of Iraq Nori Al-Saeid sought shelter in 1958. In the 1970s, the Iraqi government wanted to turn it and its neighbouring houses into museums or "historical classical houses". They bought the houses and signed a contract with Indian companies to renew the area, so the Indian company repaired the houses and covered the inside walls. The thickness of each outside wall is 150cm. New water pipes and reservoirs were added to them. All the sardabs were repaired and new electrical lines were planted. The houses were connected with the main sewage system. The plans were abandoned suddenly for no reason, and the State put the houses up for rent. The tenants (since 1970 to present day) neglected the houses and let them decay. Our problems with the house are:

The roof of the first floor is so high, so it is very difficult to heat or cool this floor. It is difficult to control the rain water and dust storms and this increases humidity.

6. How do you deal with the problem of hot and cold weather?

The high roof of the first floor (six metres high) created the problem of cooling or heating that floor, and this is why most of the first floor is neglected except two rooms (my son and his wife and the children room). All our activities are on the ground floor.

We use kerosene and electrical heaters in winter and air conditioners and fans in summer, but the first floor is hot in summer and freezing in winter. I try to give my grandchildren the best comfort I can afford. The sardab is neglected in winter but we use it often in summer. The badgeer is still working and it makes life easier for us. We covered the courtyard with plastic during winter and we set up a tent in it in summer.

7. Describe the sort of problems that you may face during the night? Could you be more specific?

We have no exact problems except for the continuous cuts in electricity. We avoid using our small electrical generator since it is loud and we try not to disturb our neighbours. We use the local electrical generator which malfunctions sometimes. In general, we prefer to stay in a dark and hot atmosphere than disturb our neighbours.

8. With the particular environmental performance you have in your house, what do you find most frustrating at living in your house? In other words, what types of uncomfortable environmental situations put you under pressure in your house, and how do you deal with such situations?

Freezing cold and no direct sunrays directly to the ground floor, while in summer the sunrays reached every place in the house (even the sardab). Most parts of the first floor are neglected (for the reason mentioned). The sardab is abandoned in winter since it is freezing. We sterilize (with sterilizers) the house continuously to keep all (especially the children) from diseases. Rainwater forms small lakes that affect the walls and we have tried several solutions. Now, we use plastic to protect the walls. One room is used on the ground floor and one room on the first floor, and all the others are abandoned (for the reasons mentioned). This affects my life and my wife with the presence of an unmarried daughter (and unmarried son) in the sleeping room with us. I hope every one of us will use his own room, so we can have our privacy. In summer, all the family gather in the courtyard from dawn until noon and then we move to the winter ursi. Even my son and his family abandoned the first floor completely.

There are many things that affect our comfort such as when we enter the house, we move from the street (public open space) to the courtyard (special open space), but the cold, rain, and hot rays of sun still affect us, so we cover the courtyard with a tent in summer and plastic in winter. This means that all the smells (from the kitchen) stay in the house, so we tried to remove them (air vacuum), but I disliked changing

the style of this historical building. We are tenants and not owners. The government may be relaxed with us now, but no one knows the future.

9. Can you give us an example where you may have problems caused by inefficiency in your activities? Why?

The main problem is the absence of a special space for the kitchen, because the original house is so big and has two courtyards. Later, it was divided into two houses and the other house has the original kitchen, so the ursi (originally a living room) was modified into a kitchen and we established cold and hot water pipes in it with sewage, but the smell of the food remains a problem (especially when we cook fish), because it has one window facing the courtyard. The walls are so thick, that an air vacuum is out of the question. The walls are decorated with distinct inscriptions and architectural landmarks that are very difficult to clean and I hate to destroy them. I love to keep the house as a historical monument.

10. How do you describe your services in the courtyard house?

The sewage, electricity and water systems are very good, but cooling and heating the first floor is a problem. Dust storms are difficult. The smells from the kitchen go all over the house and we cannot control it. Lastly, there is no escape for the rainwater when it comes off the roof and this affects the walls. We tried to invent a system that lets the rain water go in one direction and we semi succeeded.

11. Which service room is the most common in your house?

The kitchen is used the most as a serviceable space (the summer ursi was modified into the kitchen and we added cold and hot water pipes and sewage pipes to it). The winter ursi is used as a living room and a sleeping room (as I mentioned before), but the courtyard is essential and we cannot do without it.

12. What sort of additional services do you use, such as electronic and communication systems like the internet, and how do these help you?

We have a computer. I encouraged my family to follow the latest inventions and scientific news of the world. The Indian company established a central cooling and heating system for the whole house, but the misuse of this system by past tenants made it useless to us and needs a large amount of money to fix it.

13. What is the problem of your house services? Are there any limits or constraints that need to be replaced?

Heating the house (especially the first floor) is a problem due to the high roof (6m), and also cooling it in summer, so we have abandoned many rooms and concentrate on the spaces on the ground floor. The rain water forms ponds that affect the walls and there are smells from the kitchen.

We have a lot of limitations, such as: the house is historical and I do not want to damage it. If I use my own electrical generator, I must set aside a certain amount of money for gasoline, and the loud noise of that generator affects our neighbours (social and ethical limits). The house belongs to the state (like most of the houses near me) and about one million dollars has been spent on each house to make it a historical monument, but these are now abandoned (for 40 years now) and most of the equipment has decayed.

14. The cost of utilities – electricity/ water and drainage. Do you think the cost is high?

The cost of electricity units (from local generators) is so high, because national electricity does not exist. The cost of water and sewage are reasonable, but we buy drinking water all the time. The water in the pipes is used for cooking and washing.

15. How would you describe your current level of environmental comfort in your house? Or, do you find your home comfortable or uncomfortable? What are some of your reasons for feeling as you do?

Whether the house is comfortable is not the issue. We have adapted ourselves. The winter is freezing and the rain causes humidity, but we like the summer. The sun enters the entire house and even the sardab in summer.

16. If I asked you to evaluate the environmental performance in your house, what would you say? Why?

In summer, we abandon the first floor completely and live on the ground floor day and night. The winter is good to all of us except my wife. Our house is better than any house in the neighbourhood because we take good care of it; we have tried to repair it as our budget permits us. The evaluation of this house is good. Most importantly, it has good natural lighting.

17. How do you improve the performance/ efficiency of your services? In other words, what improvements to services would help you in the courtyard house? Please suggest further improvements that would help you.

I hope one day to treat the sardab to make it warm in winter by treating its walls and providing a heater in winter. To solve the problems of the first floor, I hope (if I have enough money) to add a secondary roof. I want to cover the whole courtyard with solid plastics and put air vacuums in that. This cover will be removable and I will get rid of hot and cold weather and especially the dust from the storms. I have made rain sewerage and connected them with the main sewage system.

18. How do you enhance your comfort in the house, or how do you make yourself more comfortable? Is it through some artificial systems?

I can make the house comfortable by repairing the central heating and cooling system established in the 1970s. I can use a lot of artificial electronic systems to make life easier for us.

Closing conversation

- Of all the needs we have discussed, which is most important to you?

To improve the house to adapt to climate change, and update it with modern life.

- Have I missed anything? Do you have anything to add?

No, you covered everything. I only wish that the State would continuously repair and maintain these historical houses. They are part of our history, civilization and culture.