Welsh School of Architecture

Cardiff University

TOWARDS OPTIMAL DESIGN STRATEGIES IN HOT-ARID CLIMATE

A comparative study of environmental and socio-cultural performance of the traditional and modern housing in Baghdad, IRAQ

Thesis for the degree of Doctor of Philosophy

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Abstract

The main aim of the research is to identify and evaluate the environmental and socio-cultural performance of traditional and modern houses in Iraq in order to establish optimal design strategies that enable occupant comfort in a context of reduced energy use and socio-cultural responsiveness.

Through literature review and primary investigation this research has identified and evaluated important factors relating to traditional and modern houses in Baghdad. These are socio-cultural, economic, neighbourhood, architectural, services and environmental factors and the research has compared these characteristics in existing traditional and modern houses. The study has included a physical survey of fourteen case study houses in Baghdad, seven traditional and seven modern, to establish their current architectural characteristics, as well as occupant observation and a questionnaire survey of the occupants of these houses in order to establish their perspective on the socio-cultural and environmental responsiveness of their current houses.

Further, occupants' comfort diaries were analysed and thermal monitoring undertaken of two selected traditional houses and two selected modern houses during representative summer and winter periods. The thesis presents analysis of these findings together with analytical comparison of the thermal performance of the two traditional houses and of all four monitored houses for the summer and winter in order to establish the current occupant comfort, satisfaction and thermal performance of these houses.

Finally, the research has sought to combine the findings of these investigations to inform a set of design considerations responding to the socio-cultural, economic, neighbourhood, architectural, services and environmental factors found to be relevant in the current context. These proposals respond to the negative performance found in both traditional and modern houses, as well as draw on positive performance identified in each, in order to propose future design strategies that are intended to inform a modern vernacular style for housing in Baghdad.

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GLOSSARY OF TRADITIONAL ARCHITECTURAL TERMS

Arabic terms with an asterisk are Iraqi colloquial

Badgir:	Air-scoop, wind catcher
Kabishkan:	Small, mezzanine level in the upper storey of the traditional courtyard house
Mejaz:	Entrance hall or lobby at the traditional house.
Juss:	Plaster
Talar:	A colonnaded space opened into the courtyard.
Tarma:	A colonnaded gallery in the upper storey of the traditional house.
Ursi:	Room with large sash windows onto the courtyard.
Shanashils:	Oriel windows.
Sirdab:	Basement level room in traditional courtyard house.
Neem:	Semi-basements level room in traditional courtyard house.

CHAPTER I

INTRODUCTION

1.1. TRADITIONAL AND MODERN ARCHITECTURE

This research is inspired by a conviction that a new modern domestic architecture is needed in Iraq, one that sees modern architecture blended with the traditional vernacular for great value.

According to the Traditional Architecture Group of the Royal Institute of British Architects, traditional architecture is committed to developing the values established by long tradition and adapting them to the modern world. Traditionalism looks to the past only to see the future more clearly. Traditionalists believe that however much the times we live in might change, there are basic human values which do not change, such as our values in respect of the built environment. **Colquhoun (2004)** states that traditionalism is the solid, viable, long-term future for architecture. Traditional architects believe that buildings of the past are uniquely capable of satisfying people's needs. In the past, architects were schooled in a tradition that had evolved over several years, which integrated the practical and aesthetic requirements of buildings.

However, in the latter part of the twentieth century, the majority of architects held utopian dreams of reforming society and the individual. These architects aimed at a rupture with the past, holding that history was irrelevant to the modern world (**Royal Institute of British Architects 2005**). It is from this latter position that the domestic architecture of Baghdad has developed in recent years. The birth of Modern Architecture is said to have occurred in the nineteenth and early twentieth century (**Collins 2000**). While modern architecture hinges on how modernity is defined, it can also be seen to be dependent on the characteristics that have been associated with modern architecture; however, in its most inclusive definition, 'modern' architecture originates in the Renaissance and is still being defined today.

Conservation and redevelopment work in Baghdad started in the 1980s and as a result a large number of traditional old houses were removed and replaced by new houses, new roads, and new zones of redevelopment. It is argued here that the traditional houses not only represent a historic value, but also a potential model for an appropriate built form for the future too. Further, it is maintained that a true understanding of the performance of these buildings is needed in order to help optimise domestic design to provide modern comfort standards using minimal building services (air conditioning) and therefore active energy input. It is argued here that the concept of evolution in modern architecture should continue and be capable, and indeed be defined by the capacity to embrace strategies and learning from the past and present.

There are many problems with the modern houses in Iraq relating to design, building materials and technologies used. These problems have been aggravated as a result of recent climate and environmental changes, as well as the post-war situation in Iraq where shortages in electricity and other fuels have affected occupants in both modern and traditional houses. However, resulting occupant comfort has, anecdotally, been found to be more significantly affected in modern houses where thermal mass is substantially less (330 mm uninsulated concrete) than that found in traditional houses (700 mm thickness of stone and rubble). On the other hand, the traditional neighbourhood, designed and constructed many years ago, is also likely to have disadvantages, in particular in relation to services that have vastly changed and developed in terms of consumer expectations over the last century.

This study will focus on a study of both traditional and modern houses in the Al-Kadhimiyeh area in Baghdad, a township which is located in the north of Baghdad where the majority of the remaining, occupied traditional courtyard houses are situated.

1.2. RESEARCH GAP

A number of researchers have produced relevant work on various aspects of traditional and modern architecture in Iraq, including work by **Al-azzawi (1984)**, **Warren (1984)**, **Fethi (1982)**, **Al-Kaisi (1979)**, **Al-Douri (1984)**, and **Edward (2006)**.

The most relevant work in the field is that of **Al-Azzawi (1984)** who produced a descriptive analysis of the traditional courtyard houses and modern houses in Baghdad at this time. Further, he carried out building monitoring of three traditional courtyard houses and three modern houses in Baghdad in summer and winter. The case studies were identified and building monitoring carried out during the 1970s but since then the economic and social situation in Baghdad has changed significantly and the climate has also changed. The other relevant work in this field is that of **Warren (1984)** and **Fethi (1982)** who have investigated the traditional houses in Baghdad and how to use traditional courtyard houses as a ‘home’. While **Warren (1984)** has also produced an intensive study about the conservation of traditional courtyard houses in Baghdad, Edward's work – comparison of courtyard houses in different countries – has presented the characteristics of traditional houses in different regions.

It can be seen that, to date, such studies have discussed how traditional courtyard houses, their forms, concepts, types, and structure have been developed and adapted to the environmental changes and answered the climate problem and socio-cultural demands whereas modern houses have not. However, these studies are now 30–40 years old and there have been significant changes in both the climate with hotter summers and also, potentially, the socio-cultural context.

However, no work published to date has investigated the occupant perspective through questionnaires, occupant observation and also occupants' comfort diaries for both the traditional and modern houses. This research intends to apply this method alongside monitoring and a survey in order to help provide an informed solution to existing housing problems.

1.3. BACKGROUND & CONTEXT

> *Indigenous courtyard houses in Baghdad make up the bulk of its vernacular domestic architecture. These have been in existence for centuries, and the prototypes of their plans date back to the antiquities of Mesopotamia. By the middle of the nineteenth century, they appear to have reached a high level of sophistication in concepts, designs and details within the limitations in existence at the time.*
>
> *The present stock of these houses appears to have been developed over the years by a process of trial and error where the accumulated experience of one generation was passed on to the succeeding one for use, emulation and improvement* **(Warren 1984)**.

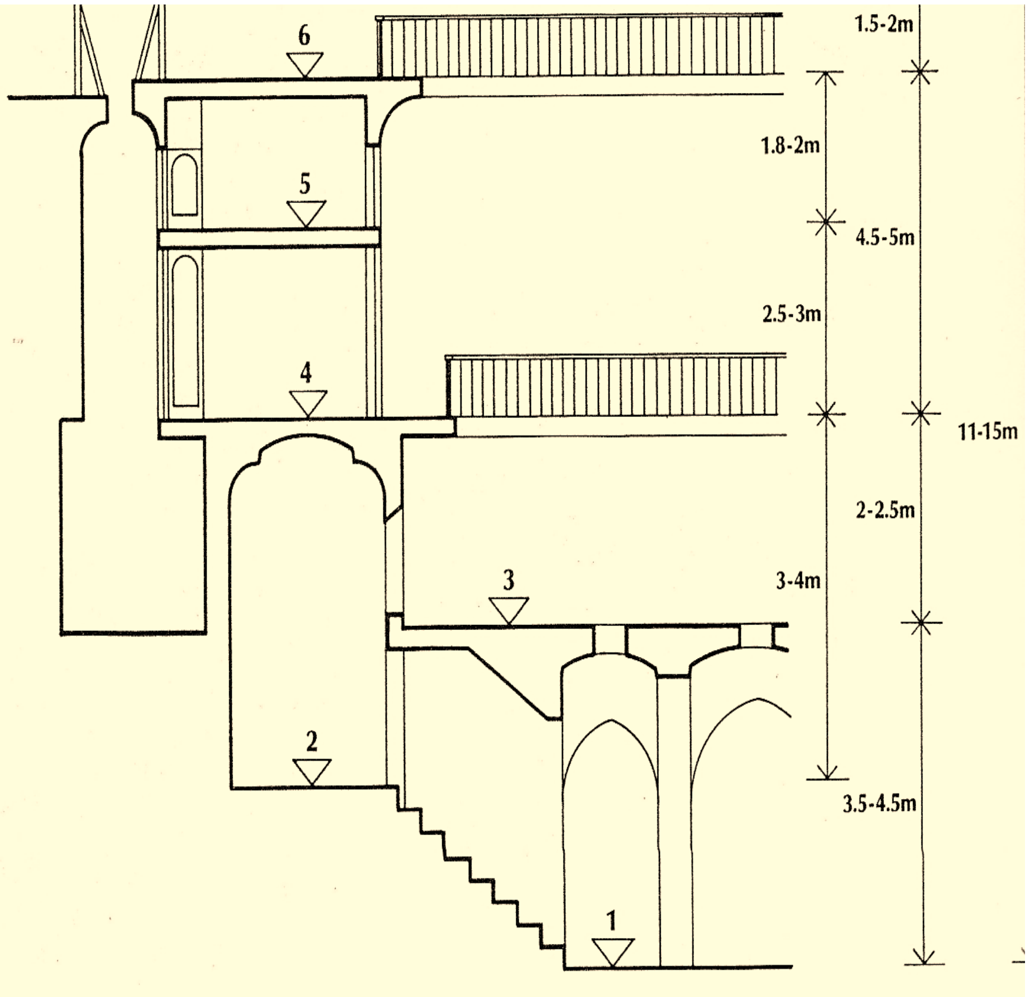
For the uninitiated, the traditional courtyard house in Baghdad could easily be dismissed as nothing more than a provincial building type, yet it is a house of architectural distinction and great stylistic merit. Its characteristics represent no particular phase of development but rather the accumulated stylistic expression of many centuries – perhaps millennia **(Chadirji 1982)**.

The traditional courtyard house has been renovated over centuries to satisfy the inhabitants' needs and typically consists of two storeys incorporating a courtyard which is an open space to the sky where most inhabitants' daily activities take place, as well as social activities such as receiving visitors like neighbours and friends.

Fig. 1.1. The internal courtyard of one of the selected traditional houses in Baghdad (Researcher)

The traditional courtyard houses have been designed to:

- Satisfy the functional needs of the inhabitants such as social and environmental demands to provide the inhabitants with complete privacy when they use their house
- Ameliorate the severe microclimate and internal thermal environmental conditions prevailing in summer, and
- Produce a comfortable microclimate and internal thermal environmental conditions.



The six basic levels of the traditional house.

1. Basement – *sirdab* – 3.5-4.5m below ground floor level.
2. Semi-basement – *neem* – 3-4m high (1.5-2m below ground floor level).
3. Ground floor – entrance, *talar, neem,* and courtyard – 2-2.5m high.
4. First floor – *tarma, shanashil, ursi* – 4.5-5m high including mezzanine.
5. Mezzanine – *kabishkans* – 1.8-2m high.
6. Roof – 1.5-2m parapet.

Fig. 1.2. The six basic levels of the traditional house (Warren & Fethi 1982)

On the other hand, the modern homes have been built as detached or semi-detached and may consist of one or two storeys, or be partially single or two storeys. Typically the building only partially covers the plot area and does not incorporate a courtyard in the center of the home but has garden(s) that could be located to the front, rear or side of the house. As a result the habitable rooms and spaces look outwards – towards the garden and the street.

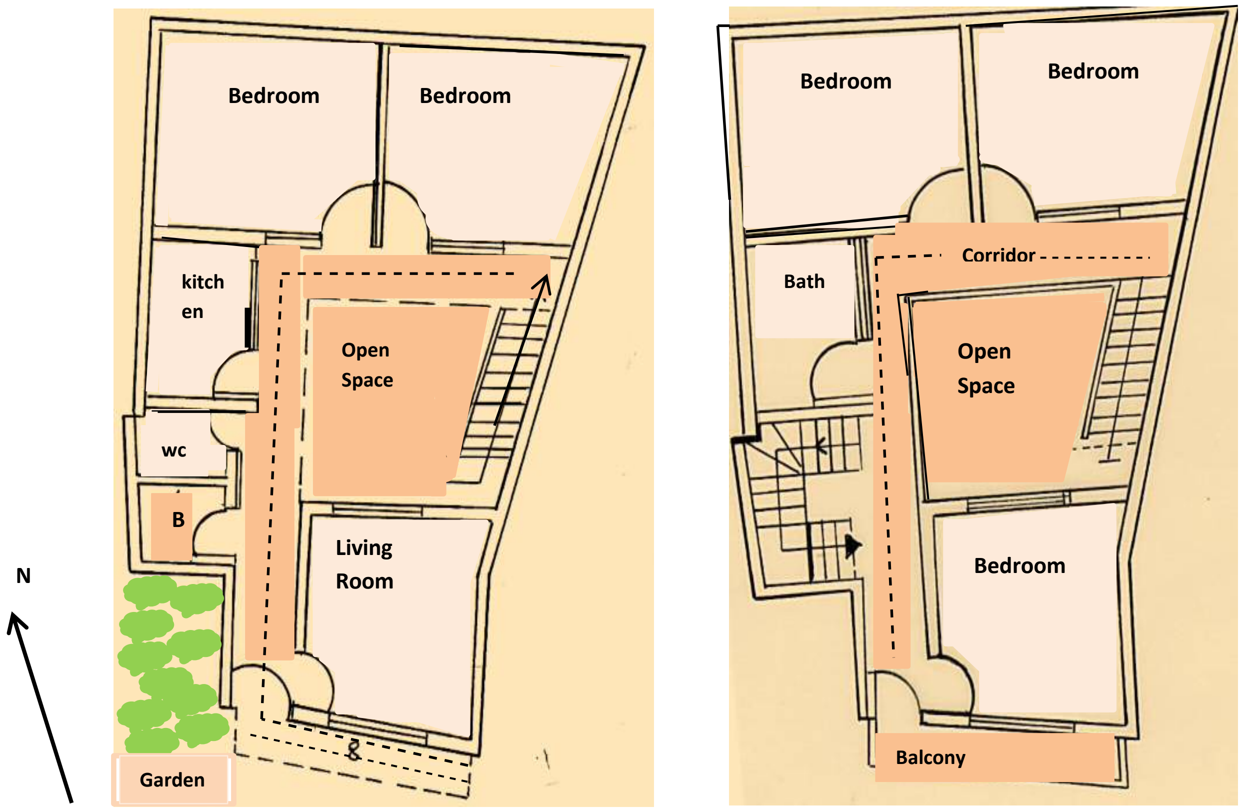


Fig. 1.3. Ground floor level plan and first floor level plan of the selected modern house Scale: 1:100 (Researcher)

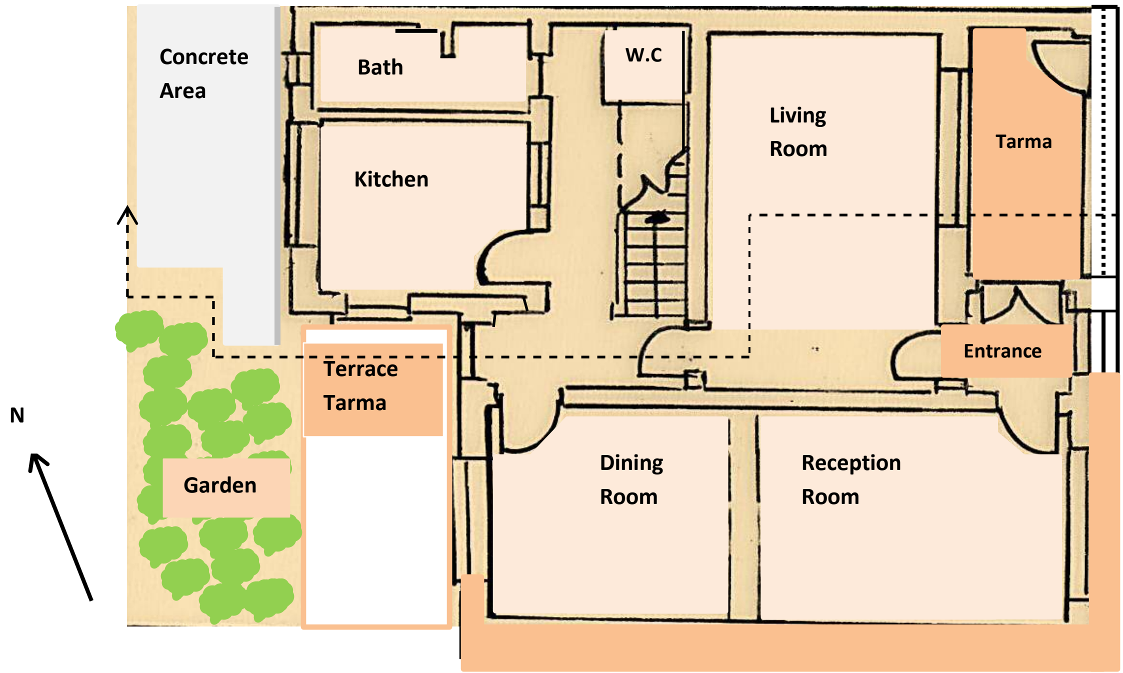


Fig. 1.4. Ground floor level of the selected modern house. Scale: 1:100 (Researcher)

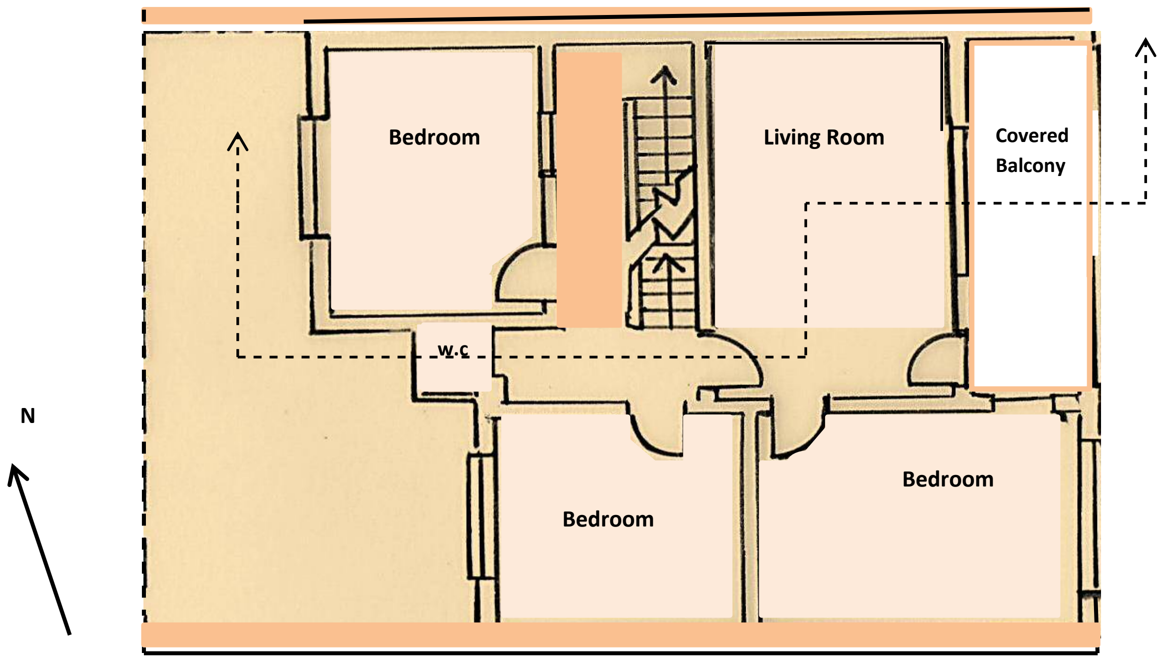


Fig. 1.5. First floor level plan of the selected modern house. Scale: 1:100 (Researcher)

Fig. 1.6. One of the modern houses in Baghdad (Researcher)

The following themes will be reviewed within the course of the research:

- **Socio-cultural factors**
- **Economic factor**
- **Neighbourhood factors**
- **Architectural factors**
- **Services factors**
- **Environmental factors**

These factors are reviewed in Chapter II and also have been considered in the two questionnaires for the traditional houses and modern houses as most important issues for the inhabitants of the two house types. (Full details are presented in Chapter IV in the section on the questionnaire analysis.)

1.4. RESEARCH AIMS

The main aim of this research is therefore to identify and evaluate the environmental and cultural performance of traditional houses and modern houses in Iraq, in order to establish optimal design strategies that enable occupant comfort in a context of reduced energy use and cultural responsiveness. This research will therefore require the comparison of the characteristics of traditional courtyard houses in Baghdad with the relevant characteristics of modern houses. Further it will be necessary to establish a comparative study of the environmental performance of traditional houses and modern houses.

1.5. RESEARCH OBJECTIVES

The aims of this research will be achieved through the following specific research objectives:

1. Identify the current understanding of socio-cultural, economic, environmental, neighbourhood and services factors of the traditional courtyard houses and modern houses in Baghdad.
2. Establish the architectural characteristics of selected case study houses to be studied.
3. Establish the current socio-cultural, economic, neighbourhood and services performance and responsiveness of traditional and modern houses throughout the year.
4. Establish the occupant comfort, satisfaction and thermal performance of traditional and modern houses throughout the year.
5. Establish appropriate design strategies that are responsive to the socio-cultural and environmental context, to inform a 'modern vernacular style' for housing in Baghdad.

1.6. CONTRIBUTION TO KNOWLEDGE

The research will contribute new knowledge in architecture by investigating how the architectural advantages of traditional courtyard houses might be beneficial when applied appropriately in modern buildings. Also it will be helpful to identify the advantageous characteristics of both traditional and modern housing types and how these might best be synthesised to produce optimal design strategies for the ideal future house.

From experience it can be seen that these problems have been aggravated by recent climate and environmental changes and with the post-war situation in Iraq, which has caused frequent shortages in electricity and fuel that have affected the occupants in both modern and traditional houses.

The results of the research will generate strategies to improve the effectiveness of future modern houses using concepts borrowed from traditional courtyard dwellings. This research will develop a new methodology in modern buildings to the benefit of architects, building industry and ultimately, building occupants.

Further, this will provide academia, policymakers and the local authority of Baghdad with new concepts which may be useful in the reconstruction of Iraq and hopefully may be applicable to other areas in Iraq and other countries.

1.7. RESEARCH METHODOLOGY

Objective 1 – To identify the current understanding of socio-cultural, economic, environmental, neighbourhood and services factors of traditional courtyard houses and modern houses in Baghdad.

This will be achieved through a literature review.

Objective 2 – Establish the architectural characteristics of the case study houses to be studied.

This will be achieved through an intensive physical survey of traditional and modern case study buildings to gather data on design, structure, building materials, insulation, climate and comfort zones, including openings/windows, privacy and passive technologies for heating and cooling including natural ventilation.

Objective 3 – Establish the socio-cultural, economic, neighbourhood and services performance and responsiveness of traditional houses and modern case study houses throughout the year.

Data on these factors will be collected through a combination of questionnaires designed and administrated to the occupants of the case study homes as well as occupant observation.

Objective 4 – Establish the occupant comfort, satisfaction and thermal performance of traditional and modern houses throughout the year.

This objective will be achieved through thermal monitoring as well as analysing responses from occupants' diaries during the representative periods in summer and winter.

Objective 5 – Establish appropriate design strategies that are responsive to the socio-cultural and environmental context to inform 'modern vernacular' style for housing in Baghdad.

This will be achieved through a synthesis of findings from the field work together with findings from relevant literature and an understanding of appropriate passive design strategies for the context.

1.8. A BRIEF DESCRIPTION OF THE THESIS CHAPTERS

Chapter I: Introduction

This chapter presents the introduction, providing a summary of both traditional courtyard houses and modern houses as well as the research aims and objectives; it establishes how this work will achieve the research aims and objectives, providing links to the proposed research methodologies.

Chapter II: Research Context – Housing in Baghdad

This chapter responds to objective 1 of this research and will present the historical background of both types of housing in Baghdad and their response to the economic, environmental and neighbourhood factors and services required in the Baghdad context as understood in current literature.

Chapter III: Phase 1 Methodology

This chapter aims to both justify the development of the proposed mixed methodology and goes on to describe the approaches to be applied within the three phases of this proposed method:

- Phase 1: Buildings and Occupants – Measurement, Questionnaire and Observation
- Phase 2: Performance, Comfort & Analysis
- Phase 3: Discussion – Optimal Design Strategies

These methods are directly linked to the relevant objectives of this research.

Further, this chapter aims to present the reasoning for the chosen case study method together with a brief description of each case study house provided in a table. The methods which have been used and presented in this chapter are the physical survey and survey questionnaire for the Phase1 Results: Buildings/Occupants.

Chapter IV: Phase 1 Results: Buildings/Occupants

This chapter has achieved objectives 2 & 3 of this research and presents the following:

Case studies: Survey measurements of the fourteen case studies, seven selected traditional courtyard houses and seven selected modern houses in Baghdad have been measured and analysed architecturally. Occupant observation in the case studies has been undertaken, establishing how the inhabitants of the houses use their houses during the summer/winter/transition seasons and the way in which the habitable rooms and spaces have been used during the four seasons of the year. This chapter also presents the questionnaire responses of the occupants of the case study houses. The respondents were from two groups, the older generation and younger generation, and the analysis of the two questionnaires was in terms of the inhabitant's age group in order to present the different opinions of different generations in relation to: Architectural/Environmental/Socio-cultural/Services/Economic factors.

Chapter V: Phase 2 Methodology

This chapter will present the methods which have been used by the researcher to achieve objective 4. This chapter aims to justify the development of the proposed methodology. It presents and describes the chosen case study houses which have been used for the monitoring and also presents the spaces which have been monitored for the summer and winter periods for the two traditional houses and modern houses in a table.

The chapter aims to present the method for the use of the equipment (loggers), the building monitoring method and occupants' comfort diaries method for Chapter VI Phase 2 Results.

Chapter VI: Phase 2 Results: Performance, Comfort & Analysis

This chapter has achieved objective 4 of this research. It identifies and evaluates the environmental performance of the traditional and modern houses and establishes the occupant comfort and satisfaction and thermal performance of the two types of houses.

This analysis is also informed by the occupants' diaries which have been completed by the selected occupants of the traditional houses and modern houses during the summer and winter period; diary responses are presented and analysed.

The chapter will then present a comparison between the traditional and modern house performance during the summer and winter measurement, and also a comparison between houses of the same type during the same periods. Finally, this chapter will present concluding remarks on the results and findings on the performance of the traditional houses and modern houses.

Chapter VII: Phase 3 Discussion – Optimal Design Strategies

This chapter will present the evaluation of the findings of Phase 1 Results and Phase 2 Results in order to achieve objective 5 of this research, to establish the optimal design strategies.

Chapter VIII: Conclusion & Recommendation

This chapter presents the conclusion in response to the research objectives and main aims which have been achieved by this research. Further recommendations are made by the researcher for future work in this field.

CHAPTER II

RESEARCH CONTEXT: HOUSING IN BAGHDAD

2.1. INTRODUCTION

The following literature review has been undertaken in order to achieve objective 1 of this research.

> ***Objective 1*: identify the current understanding of the architectural, environmental and socio-cultural characteristics of traditional courtyard and modern houses in Baghdad.**

This chapter will present the historical background of Baghdad city and of the traditional courtyard houses and modern houses and their architectural response to the socio-cultural and environmental needs of the Baghdad context as identified through the literature.

As a result, this chapter aims to establish the extent to which traditional houses and modern houses have been designed to satisfy occupants' needs in terms of socio-cultural and environmental requirements, as well as to consider architectural factors.

2.1.1. Historical Background of Baghdad

> *Baghdad was built in AD 762 and it is situated in eastern Iraq straddling the Tigris River. Downstream lay the commercial suburb of Kharkh, into which the Caliph soon banished the noisy nuisance of the markets of the Round City. To the north was the ceremony of the Quaraysh where in 799 Imam Musa ibn Jafar was buried. His tomb, near the gate known as Al-Tibn, became eventually the centre of religious devotion, and around his shrine, coupled with that of his grandson, Imam Jawad, grew up the town of Al-Kadhimiteh* (**Warren & Fethi 1982, p. 26**).

As the Round City died the core of medieval Baghdad expanded further downstream across the river and on the bank opposite from the Al-Karkh area. Here the suburb of Al-Rusafa grew to become the walled medieval city. Here the Caliph returned after his rule of around eighty years in Samarra city. Subsequently the Al-Russafa area was sacked by the Mongols in AD 1258, but has been re-built and walled again; it survived throughout the Ottoman period to become the core of the modern Baghdad city (**Warren & Fethi 1982**).

Baghdad has been described as the city of the Caliphs, of fabulous imagery and exotic splendours. There is no evident history prior to its establishment as the capital of the second great ruling house of Islam, the house of Abbas. For his seat, the Caliph Abu Jaffar Al-Mansur, second ruler of the dynasty, selected a river bank site thirty miles or so upstream of Ctesiphon, the imperial capital of the defeated Sassanian Empire. It was strategically placed where the Tigris and the Euphrates curve mightily towards each other and where the canals of antiquity linked the rivers by trade routes irrigating the great fertile band across the centre of the country (**Warren & Fethi 1982**).

One particular canal, walled to act as a northern defence of the Sumerians, reached the Tigris River at the spot where Caliph Al-Mansur chose to establish his city (see Figure 2.1). Near the site of Al-Mansur's capital there are still remains projecting from the Tigris (**Warren & Fethi 1982**).

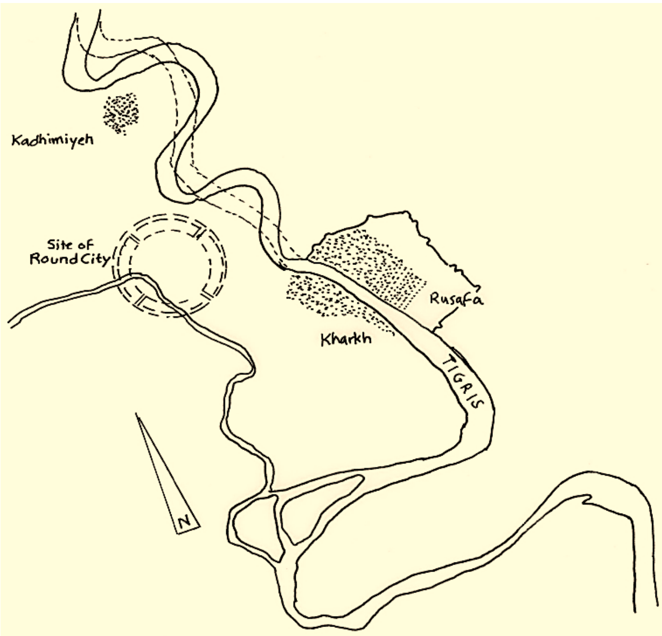


Fig. 2.1. The location of the Round City (Warren & Fethi 1982)

On a slightly raised area to the right of the western bank, Abbasid workers built the famous centripetal Round City, which had a diameter of about 3,000 metres, and focused on the central zone containing the Caliph palace. This central zone was a royal precinct. It was built as a green-domed palace with golden gates, equidistant from residential quarters which lay in a circular, peripheral band that were literally quarters, the residential ring being divided equally by four great gates on the principle's axes (**Warren & Feth 1982**).

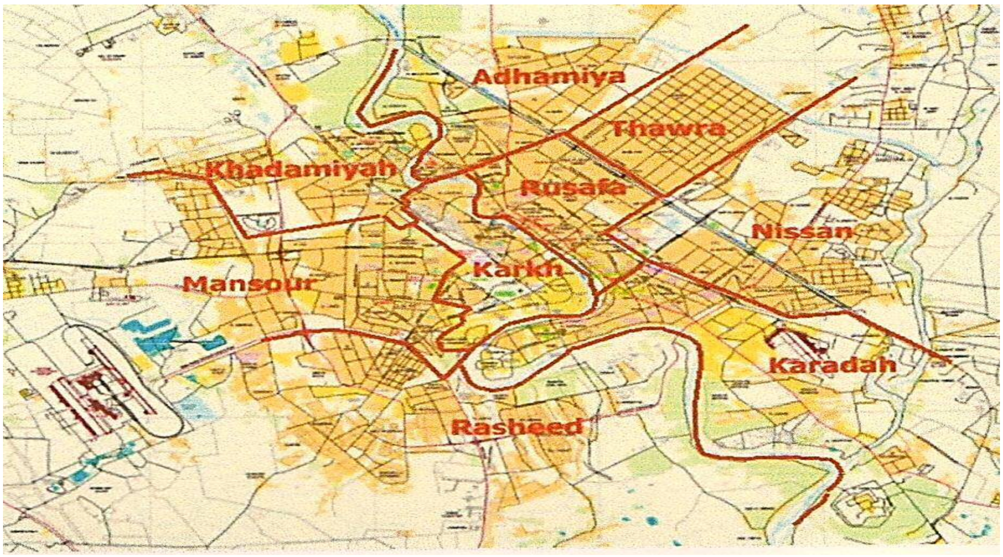


Fig. 2.2. The oldest areas in Baghdad (Municipality of Baghdad)

Fig. 2.3. Al-Mustansiriya school, the oldest school in Baghdad (Municipality of Baghdad)

2.1.2. Climatic Description of Baghdad

The region can be described as an arid desert, and in general, experiences a very hot and dry climate. Average maximum temperatures can reach 50ºC during the summer months, and even in the winter, the weather can be generally mild and very rarely reaches freezing temperatures. There is very little rainfall throughout the year except during November through to March when the average rainfall is around 1 inch per month. The average relative humidity during daytime hours of 27% annually is quite dry, as can be expected of a desert climate. The intense daytime heat in the summer months, however, can be mitigated to an extent in terms of thermal comfort by this low relative humidity (**Weather Station, Baghdad 2013**).

According to the Koppen Climatic Classification, Baghdad is described as having a subtropical desert climate and is classified as one of the hottest cities in the world. The air temperature during the summer between June and August reaches to a maximum between 44°C to 50°C in the shade and even at night, temperatures in the summer are rarely below 24°C (**Koppen Climatic Classification**). Baghdad's record highest temperature of 51°C was recorded in July 2015 (**Koppen Climatic Classification**).

Relative humidity in Baghdad is very low during the summer, typically under 10% which is due to the location of Baghdad city far from the southern marshes of Iraq and the coasts of the Arabian Gulf (**Koppen Climatic Classification**).

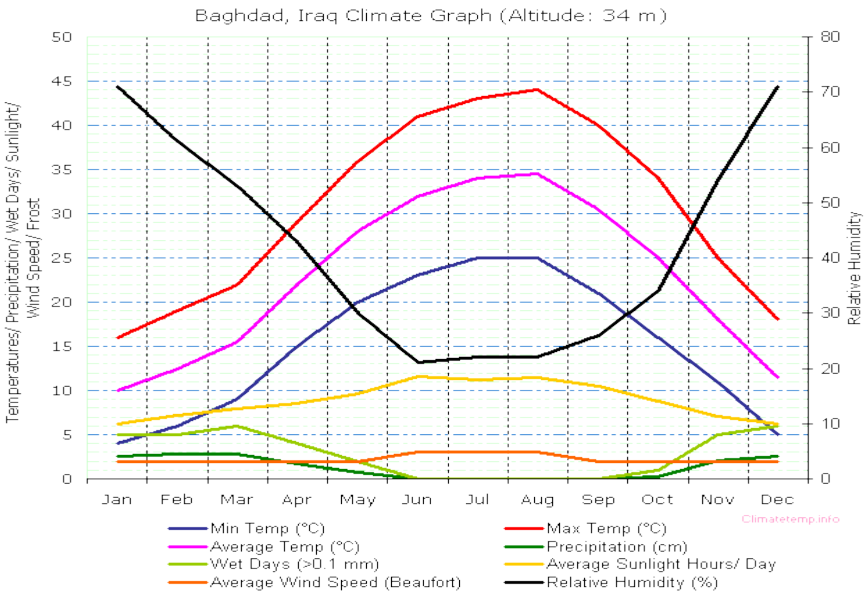


Fig. 2.4. Baghdad annual climate (Weather Station, Baghdad Airport 2013)

The winter in Baghdad is mild but has chilly nights, especially between December and February. The maximum air temperatures during the day in winter are between 15.5°C and 18.5°C and while the morning temperatures are chilly, the average temperature in January can reach to 3.8°C **(Koppen Climatic Classification)**. The average temperature in Iraq ranges from higher than 44°C in the shade in July and August to below 5°C in January. The summer months are marked by two kinds of wind phenomena:

1. From the **southern and southeast** regions are dry, dusty winds with occasional gusts to 80 km an hour, occurring from April to early June and again from late September through November.

2. A steady wind from the **north and northwest** prevails from mid-June and mid-September. This dry air from the north permits an intensive sun heating of the land surface but also provides some cooling effects. Dust storms accompany these winds (**Weather Station, Baghdad Airport 2013**).

Extremes of temperature and humidity coupled with the scarcity of water will affect both people and equipment. During the dry season clouds of dust caused by vehicle movement will increase detection capabilities within desert regions. Flash flooding across roads will hinder traffic and re-supply efforts during the rainy season (**Weather station, Baghdad Airport 2013**). Table 2.1 provides details of average weather conditions over the year within Baghdad.

Table 2.1. Baghdad annual climate

Temperature	Average (annual)	22ºC
	Range of average monthly	24.5ºC
	Average max (August)	50ºC
	Average min (January)	4ºC
Rainfall	Average annual	156 mm
	Average monthly	13 mm
	Days with >0.1 mm rainfall	34 days annually 3 days per month
	Driest months – Avg 0.0 mm	June, July, August, and September
	Wettest months – Avg 28 mm	February and March
Relative Humidity	Average	42.3%
	Average range – daily	21% to 71%
Sunshine	Annual sunshine hours	3,244 hours
	Average daily hours	8.9 hours
	Min daily hours – January	6.2 hours
	Max daily hours – June	11.6 hours

2.1.3. Traditional Courtyard and Modern Houses in Baghdad

In terms of housing in Iraq this section aims to present the background and context of both traditional courtyard houses and modern houses in Baghdad and critically review previous research studies. In particular it will present what has been established to date from existing literature of how traditional courtyard houses in Baghdad have shared characteristics with traditional courtyard houses in other countries with similar regional characteristics. In particular, the literature has identified important factors that have influenced traditional courtyard housing design regarding socio-cultural design responses such as 'privacy', while architectural/environmental factors still need to be considered in the modern-day context.

This work is considered in the context of a broader debate in architecture. According to the Traditional Architecture Group of the Royal Institute of British Architects, traditional architecture is committed to developing the values established by long tradition and adapting them to the modern world. Traditionalism looks to the past only to see the future more clearly where Traditionalists believe that however much the times we live in might be subject to change, there are basic human values which do not change, such as our values in respect of the built environment. **Colquhoun (2004)** states that traditionalism is the solid, viable, long-term future for architecture. Traditional architects believe that buildings of the past are uniquely capable of satisfying people's needs. In the past, architects were schooled in a tradition that had evolved over several years that totally integrated the practical and aesthetic requirements of buildings. However, in the latter part of the twentieth century it might be argued that the majority of architects moved away from this tradition and became beholden to utopian dreams of reforming society and the individual.

These architects aimed at a rupture with the past, holding that history was irrelevant to the modern world (**Royal Institute of British Architects 2005**). Modern architecture is usually considered to be the kind of architecture peculiar to the twentieth century, but all recent writers on the subject have recognised that its origins go back much further, even though they may not agree as to where exactly they begin (**Collins 2000**). Modern architecture can refer to a canonical body of work, or be more generally applied to the architecture created in the modern period (**Collins 2000**).

On the one hand, what modern architecture includes hinges on how modernity is defined; on the other hand, it is dependent on the characteristics that have been associated with modern architecture within these different conceptions of modernity. In its most inclusive definition, 'modern' architecture originates in the Renaissance and is still being defined today. The birth of modern architecture is said to have occurred in the nineteenth and early twentieth century (**Collins 2000**).

It should be noted that much of this literature is itself relatively old, largely 30–40 years, and the societal structure in Baghdad has changed significantly over this same period. In addition the climate has changed over this same time period. It is therefore relevant to explore the extent to which this driving design concept of privacy is still the same and to what extent the socio-cultural and environmental factors may have varied over time, and should be considered in this and future work.

2.1.3.1. *Traditional houses – background and context*

> *For the un-initiated the traditional courtyard house in Baghdad could easily be dismissed as nothing more than a provincial building type. Yet it is a house of architectural distinction and great stylistic merit. Its characteristics represent no particular phase of development but rather the accumulated stylistic expression of many centuries – perhaps millennia* (**Chadirji 1982, preface**).

The earliest traditional courtyard houses identified in Baghdad were built in the mid-eighteenth century. The oldest houses were found in the Al-Kadhimiyeh area and the latest houses built entirely in the traditional style date back about 170 years. In a survey of the Al-Kadhimiyeh area less than 9% of these houses listed as being of historical worth were built prior to 1869 (**Reuther 2005**).

A typology for these houses was established by **Oscar Reuther** in his PhD thesis published in Berlin in 1910. Reuther established that much of the fundamental character of the traditional courtyard houses comes from features shared with housing in cities throughout the Muslim world. In this sense neither the courtyard itself nor the narrow streets overhung by latticed balconies are unique. In varying forms they are found in the other countries such as Morocco, Egypt, in the cities of the Gulf states, in central Asia and in the Indian sub-continent (**Reuther 2005**).

According to **Al-Azzawi (1984)**, the traditional courtyard houses in Baghdad are indigenous types of houses. They have been developed through the years and their development can be traced back to antiquity. They appear to have developed in order to satisfy the functional needs of their inhabitants from the point of view of functional requirements, socio-cultural demands, micro-climatic and internal thermal environmental factors, energy saving, and economic factors. The houses incorporate desirable architectural qualities of their own, both internally and externally, within a wider coherent concept of socially and environmentally responsive urban design. All of these objectives were achieved within the limitation of the building technology existing at the time and within the economic means of the owner-occupier (**Al-Azzawi 1984**). What is necessary now is to establish to what extent these needs and therefore these architectural forms are still relevant today.

The traditional courtyard house has been renovated and conserved over the years. The courtyard is the core of the house where the main social and daily activities of the inhabitants are performed. The courtyard is an open space where life is played out in many facets by friends, relatives and neighbours (**Al-Azzawi 1984**).

> *While much of the work in traditional courtyard dwellings in Baghdad reflects the high flown architecture of the palatial buildings and shrines it ranges across the scale of building reflecting the affectation and elegance in lesser degrees. Equally simple and basic requirements of humble building types are reflected throughout the whole range though in the grander houses this is sometimes disguised by an overlay of more elegant decoration* (**Warren & Fethi 1982, p. 138**).

A comparative study between the traditional courtyard houses in Iran and in Baghdad can be undertaken from many different points of view, socio-cultural, and environmental, which provide useful insights. We will consider the most important factors: the climatic and socio-cultural factors (**Shooshtari 1969**).

> *As a starting point it is instructive to note the similarities in architectural terminology throughout the Arabic countries. Persian words such as* ***talar (large veranda), sirdab (full basement) and badgir (wind-catcher)*** *have been adapted by Arabic language. Conversely, Arabic terms such as* ***shanashil (latticed supported balconies), tarma (veranda)*** *have become absorbed into Persian usage, particularly in the south and south-west of Iran where a strong cultural relationship existed between Iran and its Arabic neighbours over the centuries* (**Ghodar 1978, p. 21**).

From literature there is evidence that the traditional courtyard houses existed in Iran around 8,000 years ago. These have been found in the north-west of Tehran. Here the rooms were positioned on one side of the courtyard and included living spaces and stores. The courtyard was also an important feature in the later Mesopotamian civilisation (**Shahmirzadi 1986**).

There are a number of surviving traditional courtyard houses from both the pre-Islamic and the Islamic period. The courtyard, however, does not perform the same function in domestic architecture. Its role differs from one region to another in both Iran and in its neighbouring Arabic countries. By reference to variation of types, it is possible to identify the following functions of the courtyard as drawn from **Memarian (1993)**.

- *The demarcation of limits of the property*
- *The definition of a place of privacy for the family*
- *The unification of spaces and elements in a house*
- *The provision of a circulation element*
- *The creation of a garden or cool place*
- *The promotion of ventilation* (**Memarian 1993**).

These functions are either treated separately or work in combination. In the traditional courtyard houses, both in Iran and Baghdad, the courtyard performed a number of these functions in itself and for the habitable rooms and spaces surrounding the courtyard. In the compact urban texture of historical towns such as **Shiraz, Yazd and Isfahan**, the house is bounded either by neighbouring dwellings or by narrow alleyways (**Memarian 1993**):

> *The house was therefore entirely inward-looking and the courtyard became a small garden, which with its pool provided a cool space in summer* (**Memarian 1993, p. 22**).

2.1.3.2. ***Modern houses – background & context***

> *By the beginning of the twentieth century the pattern had begun to change under the impact of new materials and Western technology. Iron from European mills arrived on the quay sides and in the railway sidings of the city and with its arrival rapid and irreversible change set in* (**Warren & Fethi 1982, p. 116**).

The modern architecture in Iraq was first found during the 1930s but its evaluation started in earnest during the 1950s, in particular after 1955 (**Municipality of Baghdad 2014**).

What has been found from the literature is that new suburbs of modern housing have started to be built in Baghdad during this period of time and all the houses which have built since this time in Baghdad were of this more modern typology.

The characteristics of these houses have been borrowed from the characteristics of Western European modern architecture:

> *Such houses seem to contradict the needs of their inhabitants from the points of view of functional requirements, socio-religious demands, micro-climatic and internal thermal environment performance, energy saving, and economics means. Their architectural qualities are not necessarily coherent with rational*

design, and their concept of urban planning and urban design is only that of two dimensional road layout (**Al-Azzawi 1984, p. 33**).

What has been found from the literature is that architects in Iraq were not involved in architectural design and development in the country until the 1930s when a group of young Iraqi architects returned from their training overseas, which had been mostly in England. At this time they played an important role in increasing the influence of modern Western architecture in Iraq (**Nooraddin 2004**).

However, by the 1950s the national movements were increased in Iraq and that encouraged the architects to search for a modern national architectural identity. By the 1960s Iraqi architecture had developed an indigenous style and local movements concerned with different aspects of modern Iraqi design had been established.

During the 1970s and 1980s, Baghdad city experienced major construction and re-development activity as a direct consequence of the economic boom resulting from increasing oil revenues. These projects have changed the city's local housing stock and international architects belonging to different architectural movements participated in this process (**Nooraddin 2004**).

2.1.3.3. *Comparison of traditional courtyard and modern houses in Baghdad*

This research requires a comparison between the characteristics of the traditional courtyard houses in Baghdad with the relevant characteristics of modern houses in order to identify the architectural, environmental and socio-cultural characteristics of both traditional and modern houses.

After reading a wide range of relevant work in the field, the researcher has found a number of research studies have produced relevant work investigating the advantages and disadvantages of traditional courtyard houses and modern houses in Baghdad, such as: **Al-Azzawi (1984), Warren (1982, 1984), Fethi (1982), Al-Kaisi (1979), Al-Douri (1984) and Edward (2006)**.

The most relevant work in the field is that of **Al-Azzawi (1984)**. Al-Azzawi has produced a descriptive analysis of the traditional courtyard houses and modern houses at this time in Baghdad. He carried out a building monitoring of three traditional courtyard houses and three modern houses in Baghdad for the summer and winter period. The case studies were identified and building monitoring carried out during the

1970s. Although this research is highly relevant to the work to be undertaken here, it is important to note that since the 1970s the economic and social situation in Baghdad has changed significantly and also the climate has changed. It is necessary therefore to consider to what extent the review of architectural, environmental and socio-cultural characteristics of both traditional and modern houses produced nearly 40 years ago remains valid in the twentieth century.

The other relevant work in this field is that of **Warren (1984)** and **Fethi (1982)** who have investigated traditional houses in Baghdad and how to use the traditional courtyard houses as a 'home'. Warren (1984) also produced an intensive study of the conservation of traditional courtyard houses in Baghdad and he led a large-scale project of renovation and re-development work in Baghdad during the 1980s. While **Edward's (2006)** work has presented the characteristics of the traditional courtyard houses for the countries of the region of hot-dry climate, studies by **Al-Kaisi (1979)** and **Al-Douri (1984)** presented the thermal monitoring of the traditional houses in Baghdad.

2.2.1. Building Materials

In order to understand the performance of the housing typologies being considered here it is important to understand their materiality. The following factors will be presented and discussed in relation to the building construction for each house type (see Table 2.2).

Table 2.2. Building construction of the traditional and modern house

		Traditional	Modern
Foundations		x	x
Walls	Retaining	x	N/A
	External	x	x
	Party	x	x
	Internal	x	x
Roofs	Parapet walls	x	x

2.2.1.1. *Building materials of traditional houses*

Foundations: In terms of their construction traditional houses are typically built on a foundation of step down strip foundations built of hard-burnt brick and the mortar used is either lime (Noora) and ash (Ramad) or lime and sand. The thickness of the foundation depends on the wall above and the depth they have to go down to; therefore they vary around 700–1200 mm (**Al-Azzawi 1984**).

Retaining Walls: The retaining walls are among the most important walls of the traditional courtyard house. They can be identified here as the walls found at the basement level room (Sirdab) and semi-basement level room (Neem) and also these walls could be part of the external walls, party walls, the walls overlooking the courtyard and also even the internal walls.

The retaining wall which is part of the external wall and the party wall is always thick, typically 700–900 mm and consists of two skins of brickwork with broken bricks between these two skins. The external skin consists of multi-brick or Brak brick and the internal skin consists of different types of broken bricks (**Al-Azzawi 1984**).

While the retaining wall which is part of the wall overlooking the courtyard is not as thick, 450–700 mm, it also consists of two skins of brickwork with broken brick between. The external and internal skin of this wall consists of Brak brick.

The retaining wall which is part of the internal wall consists of the same construction and same materials as the retaining wall which is part of the wall overlooking the courtyard and the thickness of this wall is about 450 mm.

It can be seen that these walls provide significant thermal mass to the buildings and as such may influence the internal thermal environment significantly, in particular lowering the internal temperature peaks during the summer.

External Walls: The external walls of the traditional courtyard house are very thick; they are 500–700 mm thickness and consist of skins of brickwork. These walls are built of heavy-weight construction.

> *Parapet walls overlooking the alleyway are built of light-weight construction consisting of full-height corrugated iron sheets (cheenkoo) fixed to vertical wooden studs (4 in diameter) at about 3.0 centres and horizontal wooden battens (a sole plate, a top batten and an intermediate batten)* (**Al-Azzawi 1984, p. 131**).
>
> *The parapet wall overlooking the alleyway is constructed as a timber balustrade about 1000 mm high consisting of top rail and bottom rail with vertical cast iron bars between them and wooden balusters at 1500–2000 mm intervals. Sometimes, a full-height privacy screen of timber lattice-work is fixed to the*

balustrade to prevent overlooking between neighbours across the alleyway (**Warren and Fethi 1982**).

Party Walls: Party walls at ground floor level are very thick; they are 500–700 mm thickness, built of skins of brickwork and the insulation is broken bricks. These walls are built of heavy-weight construction.

At first floor level the party walls still are very thick, but they are 400–500 mm thickness. They are also built of skins of brickwork and the insulation is broken bricks. The party walls of the roof terrace are built of brickwork and sometimes are built of light-weight construction. The party walls of the roof terrace incorporate natural ventilation (Badgir) inlets.

Internal Walls: The internal walls of the basement level room (Sirdab) and semi-basement level room (Neem) are very thick, 500–700 mm in thickness of the brickwork. The construction materials used for the internal walls are similar to the materials of the retaining walls. The internal walls between the habitable rooms are about 500 mm in thickness; they are built of brickwork (**Al-Azzawi 1984**).

Roofs: The roof of the traditional house is always flat in the form of a terrace and it is located along two, three or four sides of the upper part of the courtyard. In the case of small or medium traditional houses, the roof terrace is finished with two layers of a mixture of clay and chopped straw. This mixture of red earth and chopped straw is mixed with water and left for at least two days. This material provides some insulation to the penetration of heat from the day into the internal spaces as a result of air trapped in this construction material. In the case of large traditional houses the roof terrace is finished with paving bricks (**Warren 1984**).

Parapet Walls: The roof terrace of the traditional house has parapet walls and they are always built in two thicknesses:

- The lower part is typically around 900 mm high and this part is very thick with about 250 mm brick or 225 mm brick with Gypsum (jus) as a mortar (**Warren & Fethi 1982**).
- The upper part is about 900 mm above the roof terrace and up to 19 mm high and this part is very thin and built of bricks (8 x 8 x 2) and again with Gypsum (jus) as a mortar (**Warren & Fethi 1982**).

2.2.1.2. ***Building materials of modern houses***

Foundations: The foundation of the modern house consists of a strip of concrete footing about 450–675 mm wide and about 300 mm thick, at about 600–750 mm below natural ground floor (**Al-Azzawi 1984**). This concrete incorporates brick of 350–450 mm thickness and the rest consists of sand and cement.

External Walls: These walls are relatively thin when compared to those of the traditional courtyard house, with typical thicknesses of 220–320 mm of brickwork. The external walls are usually rendered on the outside and plastered on the inside and as a result this increases the thickness of the wall slightly to a maximum of 350 mm in total. These walls do not provide the same protection from the very hot summer climate as their thermal mass is substantially lower than that provided by the construction of the traditional courtyard houses. It should be noted that for the larger sized houses the external walls, especially those overlooking the road, consist of two skins, the internal skin about 230 mm and the external skin about 120 mm of brickwork. The external walls at first floor level consist of 230 mm of brickwork and it has the same materials as the external walls at ground floor level. They are rendered from outside and plastered from inside (**Al-Azzawi 1984**).

Party Walls: The party walls of the modern houses are similar to the external walls and have the same building materials. The party walls are not thick in comparison with the party walls of the traditional houses; they are 230–340 mm of brickwork (**Al-Azzawi 1984**).

Internal Walls: The internal walls of the modern houses are relatively thin, 200–225 mm in thickness, and are built of brickwork. At first floor level the internal walls are of a similar construction.

Roofs: As is the case for the traditional courtyard houses, the roof terrace of the modern house is always flat. The roof is typically built of brickwork bedded in Gypsum (jus) mortar. This type of construction is called ‘Igada’, where the lower part of ‘Igada’ is plastered over while the Gypsum (jus) and water is applied to the upper part of ‘Igada’ to give a water-proof layer. The roof terrace is then finished with terrazzo tiles (kashi) about 24 mm thick bedded in Gypsum (jus) mortar (**Warren 1984**).

Parapet Walls: The roof terrace of the modern house has parapet walls which are not high enough for privacy, about 1200 mm in total and have been built in one thickness of about 150 mm or 180 mm bricks or concrete, using Gypsum (jus) as a mortar (**Warren 1984**).

2.2.1.3. *Comparison of building materials of traditional and modern houses*

Table 2.3 below provides a comparison of building materials used in traditional houses built at the end of the eighteenth century/beginning of the nineteenth century and modern houses built at the end of the twentieth century in Baghdad.

Table 2.3. Building materials of traditional and modern houses

	Traditional	**Modern**
Foundations:	***Materials/ Thickness***	
	Hard-burnt bricks	Strip of concrete footing
	700–1200 mm thickness	350–450 mm thickness
Walls:	***Thickness***	
Retaining:	700–900 mm thickness	N/A
External:	500–700 mm thickness	220–320 mm thickness
Party:	500–700 mm thickness	230–340 mm thickness
Internal: Sirdab/Neem	500–700 mm thickness	220–225 mm thickness
Roofs:	***Thickness***	
Parapet walls:	250–225 mm thickness	150–180 mm thickness

2.3. SOCIO-CULTURAL FACTORS

This section will present findings from the literature regarding socio-cultural factors relating to traditional and modern houses; ‘privacy’ has been considered an important aspect for society in Baghdad in previous studies, but the extent to which this is still relevant in the modern-day context despite changes in the fabric of society is subject to query.

2.3.1. Socio-Cultural Factors in Traditional Courtyard Houses

The design of the traditional courtyard house evolved to respond to sets of objectives; this type of housing has been built to satisfy the functional needs of the occupants, such as socio-cultural and environmental demands. In this section we will focus on the social cultural factors that have driven the design, in particular the strategy to provide occupants with complete privacy (**Al-Azzawi 1984**). The following design strategies will be discussed and illustrated below:

- Entrance lobby – Mejaz
- Internal courtyard

- Rooms openings onto courtyard
- Isolation for male visitors/maintenance
- Family privacy
- Roof terrace – sleeping.

Floor plans and images of the traditional courtyard house are provided in the following Figures 2.5 to 2.9 and Table 2.4 provides details of design strategies.

Table 2.4. Traditional courtyard house design strategies

Design Strategies	Description	Source
Entrance Lobby - Mejaz	The house is entered through the entrance lobby (Mejaz) which ensures that the interior of the house retains privacy from the outside world. The entrance lobby (Mejaz) makes the link between the interior and exterior of the house and achieves privacy by preventing overlooking by passers-by while the inhabitants are using the courtyard and the habitable rooms and spaces.	**Al-Azzawi 1984** **Warren & Fethi 1982**
Internal Courtyard	The incorporation of the internal courtyard in which most of the inhabitants' activities take place	**Al-Azzawi 1984**
Rooms Opening onto Courtyard	The courtyard of the traditional house is considered to be the core of the house and all the habitable rooms and spaces face inwards onto the courtyard. As a result this provides the occupants with privacy when they use the habitable rooms and spaces.	**Al-Azzawi 1984**
Isolation for Male Visitors/ Maintenance of Family Privacy	What has been found from the literature is that to achieve complete privacy for the inhabitants the traditional house consists of the habitable rooms and spaces which have been designed especially to receive adult male visitors; these rooms could be a living room or reception rooms used by adult male visitors without affecting the inhabitants' privacy. To maintain complete privacy for the family, the access to this space is typically through a separate door from the public alleyway to the private interior and entrance to the reception room could be directly through the entrance lobby (Mejaz).	**Al-Azzawi 1984**
Roof Terrace – Sleeping	Also the roof terrace provides the inhabitants with privacy by preventing overlooking by neighbours when used as a sleeping area during the summer	**Al-Azzawi 1984**

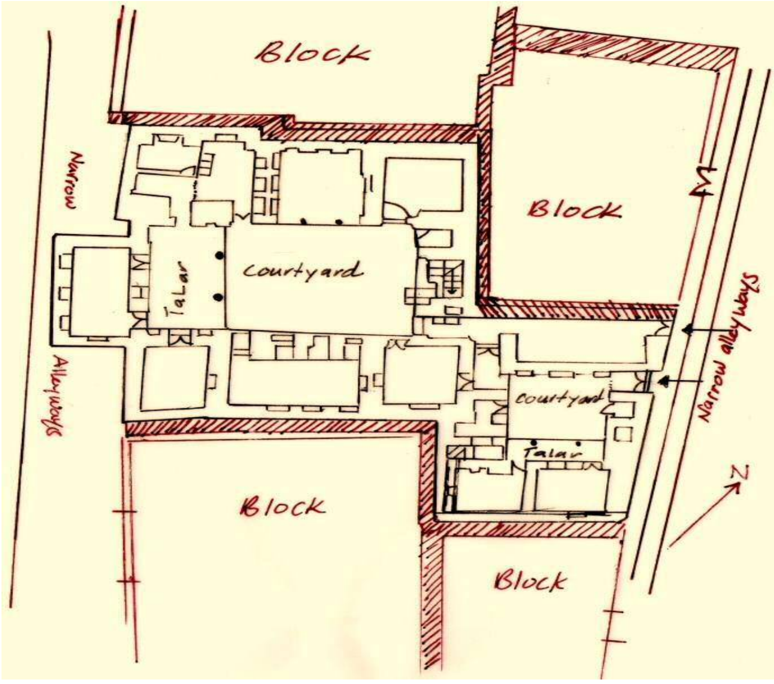


Fig. 2.5. Site plan of the selected traditional house (Researcher)

Fig. 2.6. Bay window (Shanashil) (Researcher)

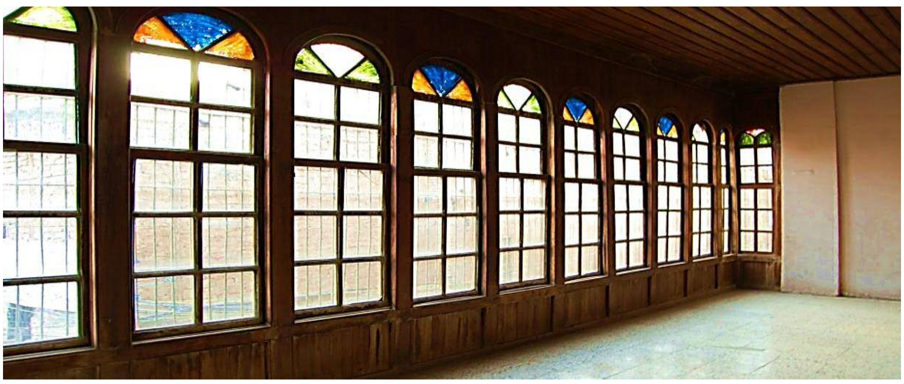


Fig. 2.7. The interior of the Ursi room (Researcher)

Fig. 2.8. The entrance of the Ursi room (Researcher)

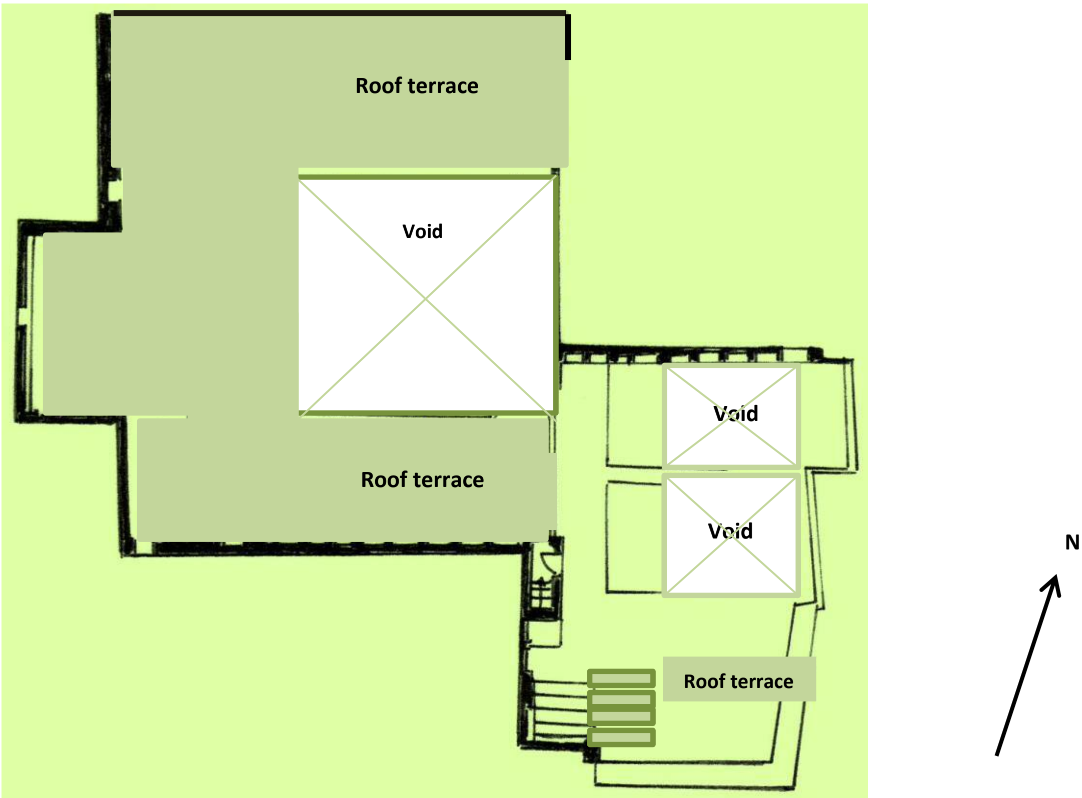


Fig. 2.9. Roof terrace level plan of the traditional courtyard house No. 4. Scale: 1:50 (Researcher)

Such factors relating to 'privacy' have also been found to be an important aspect in the socio-cultural responsive design strategies identified in the Iranian traditional courtyard house to protect the female inhabitants from the eye of the adult male visitors. The house might be divided into two areas:

1. The ‘*outside*’ which refers to the quarters close to the main entrance; this was traditionally the male area where male visitors were taken by the men of the household.
2. The ‘*inside*’ or the family quarters would be for the female inhabitants and while female visitors might on occasion enter into the reception rooms within the ‘*outside*’ they were more likely to be taken inside (**Ghazali 1979**).

In the traditional courtyard house in both Iran and Iraq the entrance arrangements were also important. Although the Iranian traditional houses were rarely more than single-storey houses, the walls were high, thick and blank. Where there were openings, these were small and located above eye level to prevent overlooking by passers-by. The presence of a single heavy door was the only indication of the habitation within. But, importantly and in common with the Baghdad homes discussed in the literature, this entrance did not allow a direct view of the private areas of the house (**Kaizer 1984**). Other authors have also drawn attention to the use of the ‘bent’ entrance in traditional courtyard housing in Arabic countries, such as the traditional courtyard house in Baghdad. Indeed, this type of entrance was one of the architectural features that appeared in the main gates of the ‘Round City’ of Al-Mansour in Baghdad built in AD 762 (**Al-Azzawi 1969**). At this time it was likely that the function of the bent entrance was ‘wholly defensive’. However, later, such as in Iran, it has been adopted in order to achieve complete privacy of the courtyard and internal spaces. Also privacy was further developed by the use of double doors (**Brown 1996**).

The literature review indicates that the traditional courtyard house has been designed to satisfy the occupants’ historic socio-cultural requirements with regard to privacy both in terms of preventing overlooking by neighbours and passers-by while the inhabitants are using the habitable rooms and spaces, as well as with regard to gender separation. However, there is no recent literature exploring the validity of this socio-cultural requirement in current times; this remains a gap in knowledge that this thesis aims to address.

2.3.2. Socio-Cultural Factors in Modern Houses

In contrast to the socio-culturally responsive driven design of the traditional courtyard housing, the design of modern houses has been largely influenced by a desire to copy stylistically from Western housing typologies. As such it can be found from the literature that the buildings are less clearly designed to respond to these historical valid social norms. Table 2.5 below provides details of the design strategies associated with modern housing in Baghdad – see also Figures 2.10 and 2.11.

Table 2.5. Modern house design strategies

Design Strategies	Description	Source
Entrance – Mejaz	There is no discussion of these strategies in modern housing.	**N/A**
Rooms Opening onto Garden	The absence of the courtyard leads to the habitable rooms and spaces looking outward towards the garden which is the only open space of the modern house. This does not necessarily provide privacy nor does it prevent overlooking by neighbours or passers-by.	**Al-Azzawi 1984**
Isolation for Male Visitors/Maintenance of Family Privacy	Both the visitors and the occupants typically enter the house to the reception/dining rooms directly from outside through the open space (Tarma). As such there is no architecturally defined gender isolation provided within modern houses.	**Al-Azzawi 1984**
Roof Terrace/ Sleeping	Although modern houses do provide a roof terrace for sleeping during the summer, this space does not incorporate adequate detailed design in order that occupants maintain their privacy, with overlooking by neighbours.	**Al-Azzawi 1984**

The literature review indicates that the modern house does not satisfy the inhabitants' needs for complete privacy by preventing overlooking from neighbours and passers-by. However, given the age of the literature available, it is now necessary to establish the extent to which the social constructs that required such privacy remain valid.

Fig. 2.10. The living room (Hall) of the modern house (Researcher)

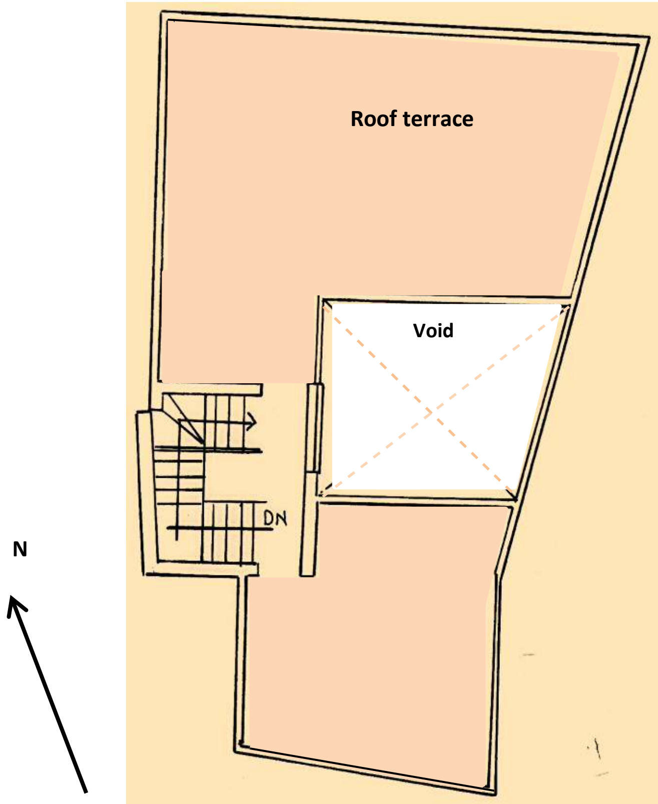


Fig. 2.11. Roof terrace level plan of modern house No. 3. Scale: 1:100 (Researcher)

2.3.2.1. *Comparison of socio-cultural factors in traditional and modern houses*

Socio-cultural factors have historically been found to be important to the people of Baghdad, where the inherent design of the traditional courtyard house with its inward facing spaces leading from the internal courtyard provides the occupants with privacy.

Furthermore the entrance lobby (Mejaz) also reinforces this privacy by separating the interior from the exterior. This detailed socio-culturally responsive design is also identified in the provision of habitable rooms and spaces including those that have been designed to receive visitors, particularly the adult male visitors. Finally, the roof terrace of the traditional house is designed in detail to ensure occupant privacy when used overnight as a sleeping area during the summer.

This is in contrast with the modern house that incorporates a garden which is not necessarily private and does not inherently provide the occupants with privacy. The modern house does not incorporate an entrance lobby (Mejaz) and as a result the visitors and the inhabitants enter the house from the same place, the open space (Tarma) in front of the house. The modern house does not incorporate dedicated habitable rooms and spaces which have been designed for receiving visitors, particularly adult male visitors.

Finally, due to detailed design factors, the roof terrace of the modern house has been found not to provide occupants with privacy when used overnight as a sleeping area during the summer.

The following Table 2.6 is intended to compare the socio-cultural responsiveness of housing as described in the literature to date. It must be noted however, that the literature available in this context is dated, being 30–40 years old and as such there remains the question as to what extent the socio-cultural requirements might have changed or evolved. As such, an evaluation of current socio-cultural requirements is required to understand the current state of play and therefore inform an emerging modern vernacular housing design strategy.

Table 2.6. **Comparison of traditional and modern house for socio-cultural factors**

Socio-Cultural Factors Privacy	Traditional House	Modern House
Entrance	Satisfied	Not satisfied
Outside Spaces	Satisfied	Not necessarily satisfied
Internal Privacy between Genders	Satisfied	Not necessarily satisfied
Privacy for Outside Sleeping Spaces	Satisfied	Not satisfied due to detailed design concerns
Socio-Cultural Factors	**Completely achieved**	**Not achieved**

2.4. ARCHITECTURAL FACTORS

The architectural factors relate to an evaluation of the extent to which the architecture of the traditional and modern house satisfies occupants' needs, such as the type and function of habitable rooms and spaces. Such architectural factors have been identified as important by researchers in this field to date.

2.4.1. Architectural Factors in Traditional Houses

A key factor in the architecture of traditional houses is summarised in the following:

> *A sample of 45 houses in Shiraz in Iran revealed various patterns of occupation and movement within the house. The main winter rooms might be on the north-east or north-west sides, and the summer rooms could be on the south-east sides. As in many other places in hot-arid regions a general shift took place around the end of May from the winter rooms to the summer rooms on the south of the courtyard. In some cases, however, the house was without distinct winter accommodation; in others there were no summer rooms on the south side* (**Memarian 1998, p. 25**).

The following Table 2.7 summarises the architectural factors relevant to this thesis.

Table 2.7. Traditional courtyard house design strategies

Design Strategies	Description	Source
Planning	In plan the traditional courtyard house consists of the courtyard which is located in the centre of the house with the habitable rooms and spaces looking inwards – towards it. The house consists of two floor levels (ground floor level and first floor level).	**Al-Azzawi 1984**
	The orientation of the traditional houses in Iran is north-east/south-east axis. Habitable rooms might be grouped on two, three or even four sides of the courtyard but the main family habitation is divided between the north and south sides.	**Ghodar 1978**
Basement Spaces	At the ground floor level the house incorporates the basement level room (Sirdab) which is located underneath the floor of the courtyard and the semi-basement level room (Neem); these habitable rooms are used by the inhabitants during the summer.	**Al-Azzawi 1984**
Seasonal Use of Spaces	Findings from the literature indicate that one of the important features of vernacular architecture in Iran is the seasonal movements between the rooms. During the ***winter*** occupants spend most of their time during the daytime in the rooms with openings located in the corners of the courtyard houses as well as use the larger open rooms which face south. These rooms might take the form of the winter room (Ursi) or some type of colonnaded gallery such as (Tarma) or (Talar).The Ursi also incorporates bay windows – Shanashil – at the first floor level overlooking the alleyway. This space is also used during the transition seasons. In the ***summer*** the occupants spend most of their time at the south-eastern end of the house as well as in the basement level room (Sirdab) where they take their afternoon siesta. Occupants typically sleep on the roof terrace during the summer and in bedrooms on the first floor in the winter and transition seasons.	**Ghodar 1978** **Al-Azzawi 1984**
	In the case of the large-sized houses, the traditional house incorporates a mezzanine level room (Kabishkan) which is located either in the two sides of the house or in the four sides of the house. This room is used by the inhabitants during the winter as a living room or for receiving visitors, or sometimes could be used as a bedroom.	**Warren & Fethi 1982**

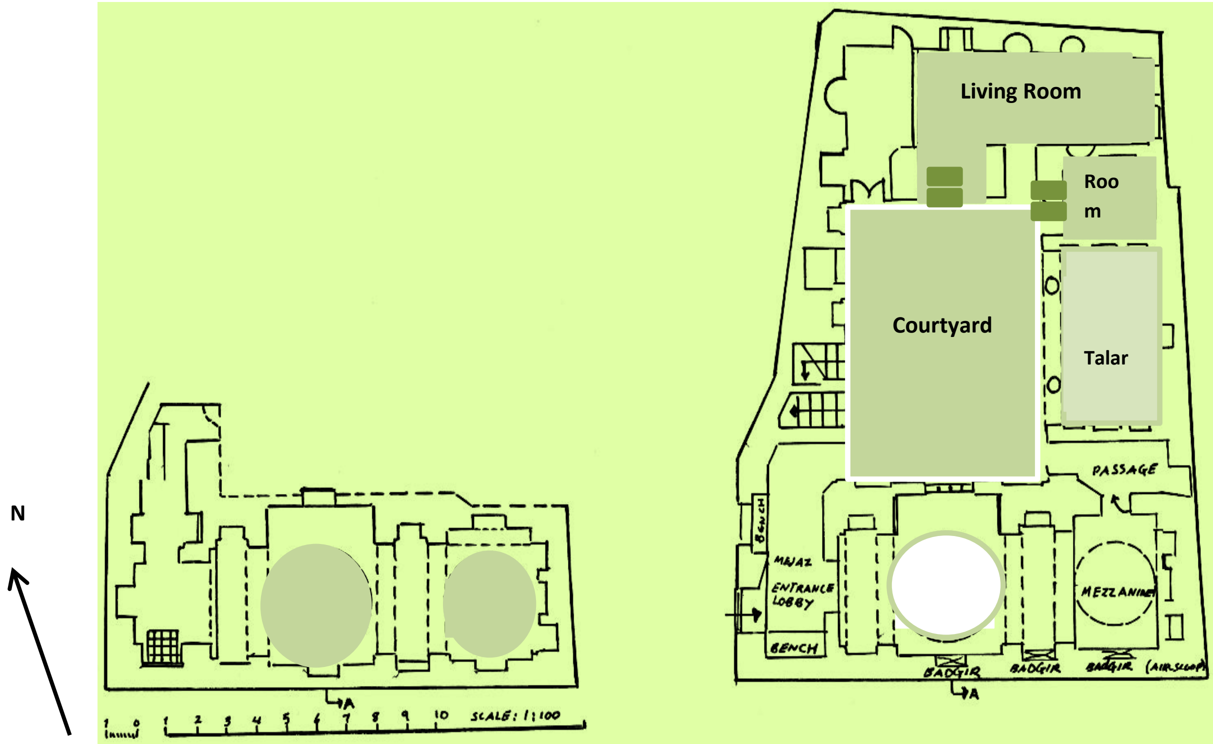


Fig. 2.12. **Basement level & ground floor level plans of traditional courtyard house No. 2. Scale: 1:50 (Researcher)**

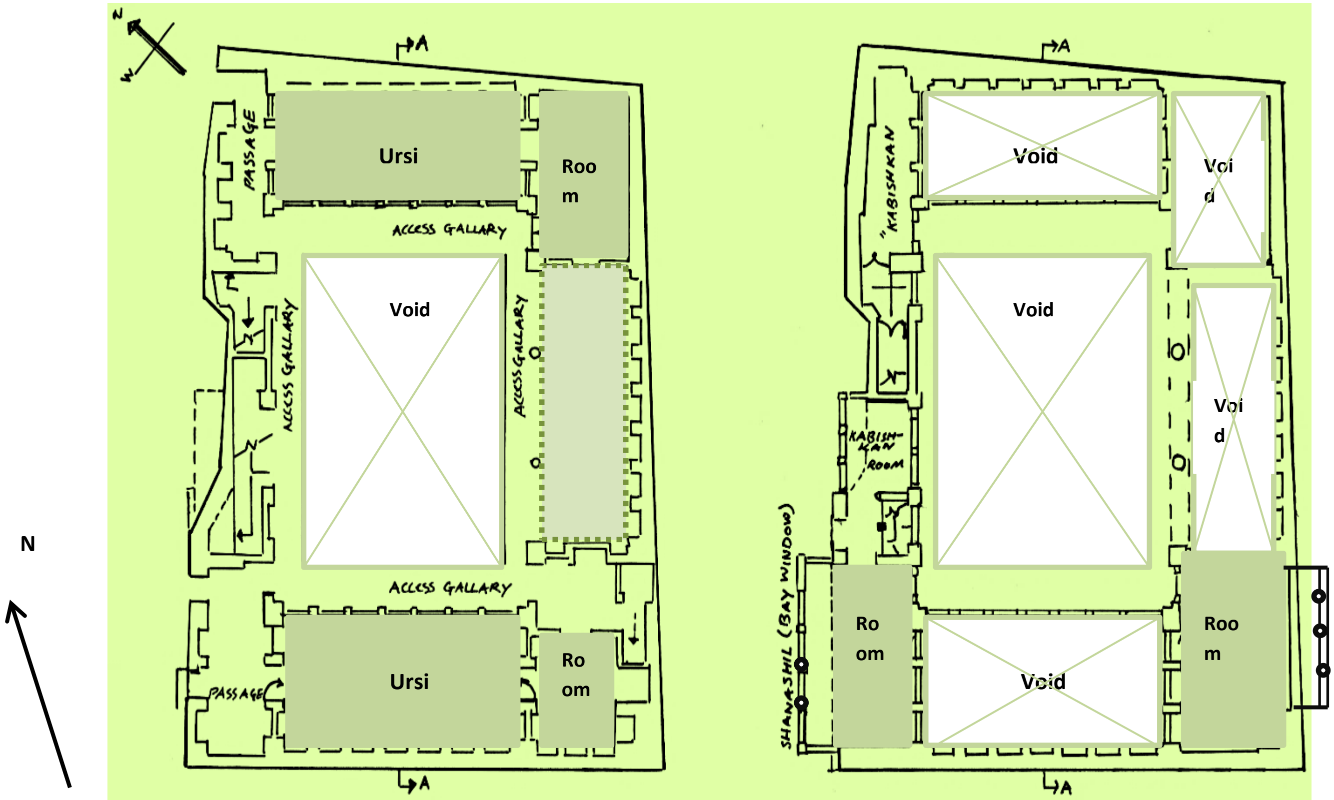


Fig. 2.13. **First floor level & second floor level plans of traditional house No. 2. Scale: 1:50 (Researcher)**

It can be seen that this description and understanding of the occupation of traditional houses is dependent on an inherent understanding of the passive functioning of the houses (Figures 2.12 & 2.13); indeed it requires an understanding of the climate and seasonally responsive living strategies. In the modern context of air conditioning and active servicing of buildings, this might be questioned as a strategy that continues to remain acceptable in the current time.

2.4.2. Architectural Factors in Modern Houses

In terms of architectural factors the modern house can be seen to retain the roof terrace as a functional design strategy in common with traditional courtyard houses; however, the houses are typically of two storeys. Moreover, the strategy for seasonal variation in the use of spaces is no longer found in the occupation pattern of modern homes, beyond the use of the roof terrace for sleeping in the summer. Table 2.8 below provides further details of the design strategies adopted in modern housing in Baghdad.

Table 2.8. Modern house design strategies

Design Strategies	Description	Source
Planning	The modern house consists of two floor levels (ground floor level and first floor level and the roof terrace). The first floor level is built partially and does not cover the whole area of the ground floor level. At the ground floor the modern house incorporates a living room (Hall) which is used by the inhabitants during the four seasons and also incorporates a reception/dining room to receive visitors.	**Al-Azzawi 1984**
Basement Spaces	This strategy is not applied.	
Seasonal Use of Spaces	In common with the traditional courtyard houses, occupants typically sleep on the roof terrace during the summer and in bedrooms on the first floor in the winter and transition seasons. None of the other seasonal uses of spaces are employed as strategies.	**Warren & Fethi 1982**

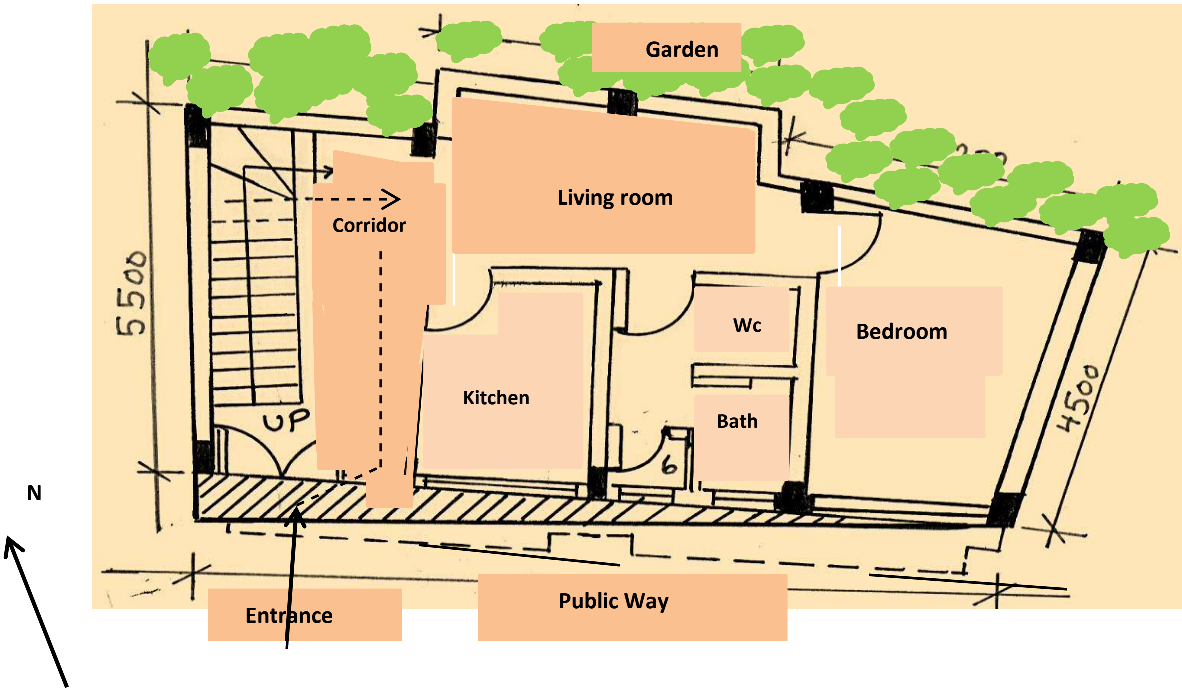


Fig. 2.14. **Ground floor level plan of modern house No. 5. Scale: 1:100 (Researcher)**

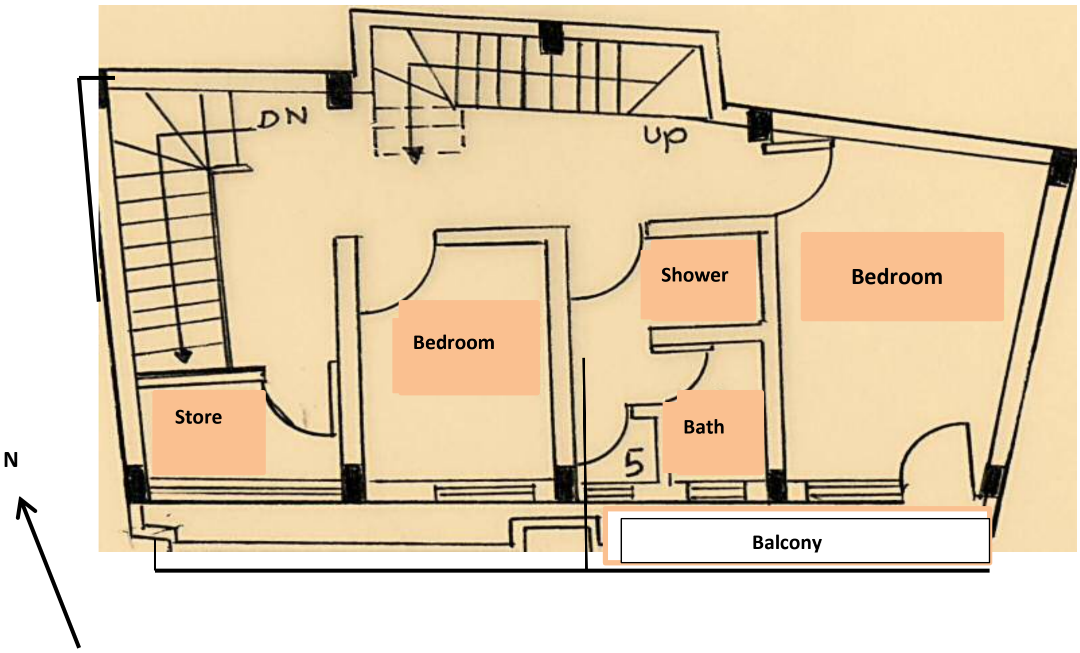


Fig. 2.15. **First floor level plan of modern house No. 5. Scale: 1:100 (Researcher)**

It can be seen from Figures 2.14 and 2.15 that the plan of the modern house is more simple and compact in comparison to the traditional house, while the relationship to the climate is less explicit.

2.4.2.1. *Comparison of architectural factors in traditional and modern houses*

In terms of functional planning, although the scale (two storeys) and the presence of the roof terrace is common in both, the relationship with the site is very different, with the traditional house facing inwards and the modern house being placed as a compact form in a garden. Despite these differences, both housing typologies are able to meet the functional programme of use for their occupants. What is meant here is that the architectural form and style is not a barrier to delivering functional space for the occupant's needs. However, the seasonal variation in use of the spaces is not currently considered in the modern houses, beyond the use of the roof terrace for sleeping in the summer. Again the building form is not a barrier in itself to this, but any attempts to facilitate seasonal use of spaces could be considered in the detailed design – including orientation and design of openings (see Table 2.9 below for a comparison of differing design elements).

Table 2.9. Comparison of architectural factors of traditional and modern house

Factor		Traditional House	Modern House
Planning		Both housing typologies are capable of providing a response to the requirements in terms of scale and number and type of spaces required.	
Basement Spaces		Provided	Not provided
Seasonal Use of Spaces		Enabled	Not Enabled
Architectural Factors	**Functional Programme of Use**	**Achieved**	**Achieved**
	Seasonal Programme of Use	**Enabled**	**Not achieved**

2.5. ENVIRONMENTAL FACTORS

The final group of factors that affect the occupancy of both traditional and modern houses are the environmental factors, which influence the thermal comfort of the occupants during the summer and winter. This section examines the results of the literature review on the extent to which traditional and modern houses satisfy their occupants' needs environmentally.

This section will be considered in two parts. Firstly those strategies which are intended to impact on thermal comfort in the summer will be considered and then those that are designed for winter.

2.5.1. Summer Environmental Factors

This section will compare those design strategies incorporated into traditional and modern houses to respond to the thermal comfort of occupants in the summer.

2.5.1.1. *Summer environmental factors in traditional houses*

An architectural environmental factor denotes the shared architectural characteristics that have been developed to give a local response to the prevailing conditions (**Olgyay 1963**).

As has been already been established from the literature the traditional house is occupied in a manner that is responsive to the altering climate with spaces specifically designed and used at the extremes of the climate, the cold and hot times of year. In line with this can be established in the literature that the climate has had a strong influence on vernacular architecture in Iran and Iraq for at least 8,000 years (**Olgyay 1963**).

As was established earlier in this chapter, countries including Iran, Iraq and Saudi Arabia all lie in the hot-dry zone, where the relative humidity is very low in summer and the winter is cold or mild and where daytime summer temperatures may in some places be in the region of 50°C, as is experienced in Iraq. A key factor that can influence architectural environmental response to such climates is where the difference between day and night temperatures is very large. Under these extreme thermal conditions a number of methods can be employed to maintain thermal comfort. These include the application of building materials of high thermal insulation, high thermal mass, the construction of basement rooms, the provision of verandas and other semi-open spaces as well as the use of natural ventilation systems (Badgir) (**Olgyay 1963**).

One design strategy in terms of urban planning noted by **Al-Azzawi** (**1984**) is that due to the compact urban layout of the traditional houses, the proximity of the houses provides shading that gives protection from the sun in summer (see Figure 2.16). The internal walls of the house are also very thick and they are always in the shade and as a result they provide the interior with comfortable internal thermal environmental conditions. Table 2.10 below provides further details of design elements associated with environmental comfort and traditional housing, noted in the literature.

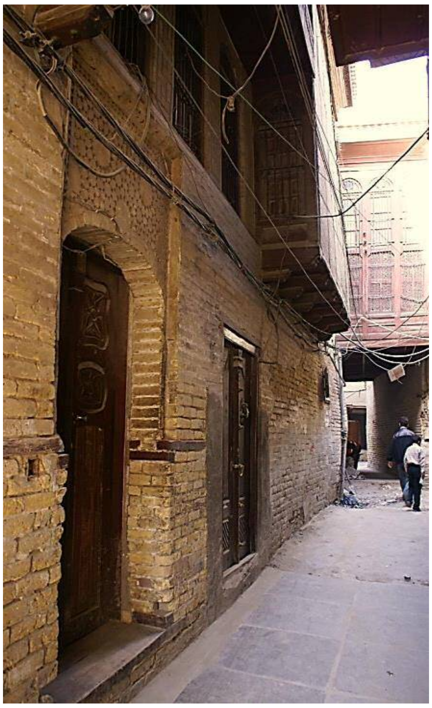



Fig. 2.16. **The close proximity of houses (Researcher)**

Table 2.10. Traditional house design strategies

Design Strategies	Description	Source
External Spaces	The courtyard has a good proportion of dimensions in length and width to height and as a result the courtyard floor is in shade during the summer.	**Warren & Fethi 1982**
Dust Storms	As the traditional courtyard house is exposed to the spring/summer dust storms the courtyard is not protected from dust when used by the inhabitants during the day for their daily activities.	**Warren & Fethi 1982**
	But sometimes the courtyard is covered during the dust storm to provide the inhabitants with some protection from dust.	**Al-Azzawi 1984**
Seasonal Usage of Space	The first floor is largely unused in the summer; this enables the entire floor to act as a barrier against solar gain to the habitable spaces on the ground floor. This is in addition to the seasonal utilisation of space as described in architectural factors.	**Al-Azzawi 1984**
Thermal Mass	Construction is of thermal mass.	**Olgyay 1963**
Basement Rooms	At the traditional courtyard house there are habitable rooms and spaces which have been designed to be used by the inhabitants during the summer. These habitable rooms are the basement level room (Sirdab) and the semi-basement level room (Neem).	**Warren & Fethi 1982** **Al-Azzawi 1984**

According to Al-Musaed work regarding cooling by shading in Iraqi traditional concept, the traditional house in Iraq reflects the necessity to achieve thermal comfort. The external spaces such as the roofs and courtyards and the compact layout of the house explain the concept of bioclimatic house. The traditional house in Iraq is influenced of the historical house in the city of UR southern Iraq which was displays with heavy facades with limited openings on the external elevation. The existing houses are well shaded (**Al-Musaed 2207**).

Basement Level Room – Sirdab

The basement level room (Sirdab) is located underneath the floor of the courtyard about 5000–6000 mm below the courtyard (**Al-Azzawi 1984**). This space receives daylight and natural ventilation through the roof light which is located on one side of the courtyard. The roof light does not prevent anyone moving in the courtyard.

The Sirdab is used by the inhabitants during the summer particularly in the afternoon for siesta. This room is kept cool most of the day due to the thermal inertia of the ground that surrounds it (**Warren & Fethi 1982**).

> *As the basement level (Sirdab) is a subterranean cellar, it presents no problem of orientation except the need to protect the roof lights in the courtyard floor against direct solar radiation; therefore the roof lights are often located in the shaded area of the courtyard or they are covered over* (**Al-Azzawi 1984, p.75**).

Fig. 2.17. The entrance of the basement level room (Sirdab) (Researcher)

The Sirdab typically has a direct or indirect connection to the Neem. This may be via a staircase or in addition an archway, doorway, vestibule or corridor (**Al-Azzawi 1984**).

Semi-Basement Level Room – Neem

In larger sized traditional courtyard houses the house may also incorporate a semi-basement level room (Neem) with some incorporating more than one Neem without a Sirdab. The majority of traditional courtyard houses however do have a Sirdab (**Al-Azzawi 1984**).

Fig. 2.18. **Inside the semi-basement level (Neem) (Researcher)**

The Neem is located either at semi-subterranean level alongside the courtyard or at the back of the colonnaded gallery (Tarma) and is located about 1200–3000 mm below the courtyard (**Warren & Fethi 1982**).

The Neem typically incorporates large windows which receive daylight and natural ventilation, however, due to its location behind the colonnaded gallery (Tarma), its windows are protected and are intended to receive very little if any direct sunlight. It is important to mention here that the semi-basement level room (Neem) is cooled and ventilated by the natural ventilation system (Badgir) (**Al-Azzawi 1984**). The majority of the traditional courtyard houses in Baghdad have a natural ventilation system (Badgir – meaning air-scoop or air-catcher) (**Warren & Fethi 1982**).

The Badgir is located in an air-cavity between two skins of the party wall which is divided into sections so that each Badgir is about 900–1200 mm wide x 600 mm deep and extends up to the top of the party wall of the roof terrace. The external opening of the Badgir is about 900–1200 mm above the roof terrace level (**Warren & Fethi 1982**).

The incoming air is forced into the Badgir first by the action of the prevailing wind and secondly by deflection and is cooled by conduction from the cold surfaces of the party walls of the house (**Warren & Fethi 1982**) (see Figures 2.19 & 2.20).

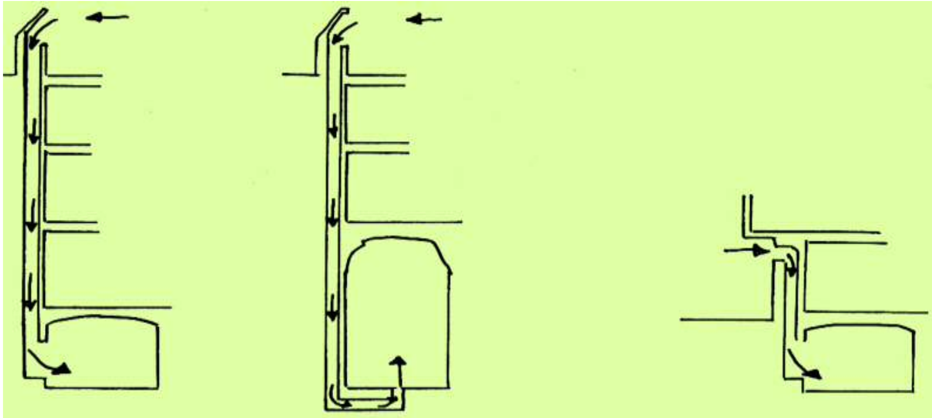


Fig. 2.19. The function of the air-scoop (Badgir) (Warren & Fethi 1982)

Fig. 2.20. Air-scoop (Badgir) openings (Researcher)

According to **Al-Azzawi (1984)** the U-shape plan of the inlet is usually broad and shallow and faces the roof terrace of the same house. However, where this is not possible for reasons of orientation and plan arrangement, the opening of the inlet is made in the narrow side of the Badgir within the thickness of the parapet wall; in this case the inlet is narrow and deep. It ought to be mentioned here that the opening of the inlet never opens onto or faces the roof terrace of an adjoining house. Where the axis of the courtyard (and those of the habitable rooms and spaces) point in the direction of the secondary cardinals, the wind-catcher and the inlet opening of the Badgir are oriented towards the north-western prevailing wind (**Al-Azzawi 1984**).

The literature review has revealed that the traditional courtyard house has been designed to respond to the occupants' thermal comfort through a series of passive design strategies that have been integrated into the design of the houses. In particular these include:

- The use of thermal mass
- Urban design strategies that promote self-shading of buildings from solar gain
- Simple strategies to shelter from dust storms
- Seasonal usage of space strategies that enable function response to climate
- Integration of basements rooms to enable benefit from earth sheltering
- Natural ventilation system/wind-catcher – Badgir to promote cooling through ventilation.

However, as has been the case in previous sections, there is no recent literature exploring the effectiveness of these design strategies as experienced by occupants in current times; this remains a gap in knowledge that this thesis aims to address.

2.5.1.2. *Summer environmental factors in modern houses*

It has been found from the literature that the modern house has no habitable rooms and spaces which have been designed specifically for summer habitation and all the habitable rooms and spaces are designed to be used by the occupants during the four seasons (**Al-Azzawi 1984**).

However, the most significant strategy applied to provide thermal comfort to these houses is the installation and operation of air conditioning systems.

The findings from the literature indicate that the modern house is less successful in responding to the environmental/climatic demands of the location (see Table 2.11 below). The age of the literature available is less of a concern as the limitations discussed relate to passive strategies, in particular solar shading and the use of thermal mass, that would serve to reduce energy demand for air conditioning were they to be integrated into modern housing design. It is, however, necessary to establish the extent to which passive strategies would be effective in this context.

Table 2.11. Modern house design strategies

Design Strategies	Description	Source
Urban Planning	As a result of the site planning of modern housing development in Baghdad, where the houses are built in detached or semi-detached forms, the houses do not offer beneficial shading to each other.	**Al-Azzawi 1984**
External Spaces	At the modern house the garden is the only open space and it is not protected from the sun in summer. The habitable rooms and spaces do not open directly to the outside and as a result there is less heat loss and the cold gain is reduced during the winter.	**Warren & Fethi 1982**
Dust Storms	As for the traditional courtyard houses, the modern house is exposed to the spring/summer dust storms. However, it is not possible to shelter the garden to provide protection for the occupants. During the dust storms the windows and the doors are kept shut.	**Warren & Fethi 1982**
Seasonal Usage of Spaces	The first floor is largely left unused in the summer; this enables the entire floor to act as a barrier against solar gain to the habitable spaces on the ground floor. Other aspects of this strategy are not applied.	**Al-Azzawi 1969**
Thermal Mass	Construction is of relatively low thermal mass.	**Olgyay 1963**
Basement Rooms	Strategy not applied	
Natural Ventilation System Badgir		

2.5.1.3. *Comparison of environmental factors in traditional and modern houses*

Environmental factors have historically been found to be important to the people of Baghdad, where the design evolution of the traditional courtyard house was integrated with vernacular passive design strategies including self-shading urban planning, shaded external spaces, strategies to provide shelter from dust storms, seasonal usage of spaces, and the architectural integration of thermal mass, basement rooms and natural ventilation systems.

This is in contrast with the modern house, which from its planning does not integrate self-shading strategies and whose provision of a garden rather than a courtyard does not provide for dust storm protection. The provision of a garden rather than a courtyard does not in itself preclude shaded external spaces – but it is not made clear in the literature the extent to which this has been a strategy applied to date. The seasonal use of the roof terrace as a sleeping area does provide for the bedrooms on the first floor to provide shading and a buffer zone, as is the case for the traditional courtyard houses, to prevent transfer of solar gain on the roof to the inhabited spaces on the ground floor. Finally the clear passive design strategies explicit in the courtyard houses are all absent in modern housing design.

The following Table 2.12 is intended to compare the environmental responsiveness of housing as described in the literature to date. It must be noted however, that the literature available in this context is dated, 30–40 years old and as such there remains the question to what extent the environmental strategies remain effective/valid in the current context.

As such, an evaluation of current environmental performance and occupant thermal comfort is required to understand the current state of play and therefore inform an emerging modern vernacular housing design strategy.

Table 2.12. Comparison of summer environmental factors of traditional and modern houses

Factors	Traditional House	Modern House
Urban Planning	**Satisfied**	**Not satisfied**
External Space	**Satisfied**	**Not satisfied (*Although possible*)**
Dust Storms	**Partially satisfied**	**Not satisfied**
Seasonal Usage of Spaces	**Satisfied**	**Partially satisfied**
Thermal Mass	**Satisfied**	**Not satisfied**
Basement Rooms	**Satisfied**	**N/A**
Natural Ventilation System Badgir	**Satisfied**	**N/A**
Summer Environmental Factors	**Achieved**	**Not achieved**

2.5.2. Winter Environmental Factors

This section will compare those design strategies incorporated into traditional and modern houses in order to respond to the thermal comfort of occupants in the winter.

2.5.2.1. *Winter environmental factors in traditional houses*

As the case for summer factors, it is necessary to refer to the occupation of the traditional courtyard house. As has already been established from the literature the traditional courtyard house is occupied in a manner that is responsive to the altering climate with spaces specifically designed and used at the extremes of the climate, the cold and hot times of the year (see Table 2.13).

Table 2.13. Traditional house design strategies

Design Strategies	Description	Source
Urban Planning	Because of the compact urban layout of the traditional houses the close proximity of the houses protect each other from the rain and wind in winter.	**Al-Azzawi 1984**
Built Form	A negative aspect of the design for the winter context is that all habitable rooms and spaces look inwards towards the courtyard, with opening windows and doors to this external space. They are cold during the winter because of the heat loss through these external walls, windows and doors and through ventilation losses through the windows and doors.	**Al-Azzawi 1984**
Seasonal Usage of Space	In the past the main winter rooms were located on the north-western end of the courtyard, enabling solar gain. This illustrates the important role climatic conditions and passive design played in the planning of the courtyard house. The inhabitants also played a key part by their own seasonal movement.	**Olgyay 1963**

From the literature it can be established that the traditional courtyard house has been designed to respond to the occupants' thermal comfort through a series of passive design strategies that have been integrated into the design of the houses. In particular these include:

- Urban design strategies that promote protection from rain and wind.
- Seasonal usage of space strategies that enable functional response to climate.

However, in the case of the winter scenario, the form of the building is less effective, with every room having at least one external wall, with associated heat loss through conduction and ventilation losses. Further, as has been the case in previous sections, there is no recent literature exploring the effectiveness of these design strategies as experienced by occupants in current times; this remains a gap in knowledge that this thesis aims to address.

2.5.2.2. *Winter environmental factors in modern houses*

It has been found from the literature that the modern house has no habitable rooms and spaces which have been designed specifically for winter habitation and all the habitable rooms and spaces are designed to be used by the occupants during the four seasons (**Al-Azzawi 1984**).

However, the most significant strategy applied to provide thermal comfort to those houses is the installation and operation of the air conditioning system.

Table 2.14. Modern house design strategies

Design Strategies	Description	Source
Urban Planning	Because of the urban layout of the modern houses they are exposed to the negative effects of rain and wind in winter.	**Al-Azzawi 1984**
Built Form	The compact form of the modern house has the potential to be more efficient to heat with less external surfaces for volume of internal space.	**Olgyay 1963**
Seasonal Usage of Space	There is no application of this strategy.	**N/A**

From the literature it can be seen that the modern house is less successful in responding to the environmental/climatic demands of the location in terms of negative exposure to wind and rain and positive solar gain. It is relevant to note here that it would be possible to integrate passive strategies into modern house design in the future such as benefiting from solar gain during the winter. However, the built form is a positive aspect of this design typology in terms of delivering efficient heating to deliver thermal comfort in the winter.

The age of the literature available is less of a concern as the discussion again relates to passive strategies, in particular solar gain, that would serve to reduce energy demand for heating were they to be integrated into modern housing design. It is, however, necessary to establish the extent to which passive strategies would be effective in this context.

2.5.2.3. *Comparison of the environmental factors in traditional and modern houses*

The design evolution of the traditional courtyard house in response to the winter cold is less clear, and despite effective protection from wind and rain as well as orientation and space usage to maximize solar gain, the building form and exposure to heat loss and ventilation loss is less successful.

For the modern house, the opposite is true, with its exposure to wind and rain and lack of consideration of orientation and therefore potentially haphazard exposure to solar gain, while the compact form potentially optimizes its thermal efficiency for heating provision.

The following table is intended to compare the environmental responsiveness of housing as described in literature to date. It must be noted however, that the literature available in this context is again dated, 30-40 years old and as such there remains the question to what extent the environmental strategies remain effective/valid in the current context. As such an evaluation of current environmental performance and occupant thermal comfort is required to understand the current state of play and therefore inform an emerging modern vernacular housing design strategy.

Table 2.15. Comparison of winter environmental factors of traditional and modern houses

Factors	Traditional House	Modern House
Urban Planning	Achieved	Not achieved
Built Form	Not achieved	Achieved
Seasonal Usage of Space	Achieved	Not achieved
Winter Environmental Factors	Achieved	Partially achieved

2.6. CONCLUSION

In summary, from the literature it can be seen that the two housing typologies have achieved or might "enable" achievement of socio-cultural, architectural and environmental factors to a differing level.

Table 2.16. Comparison of the three factors in traditional and modern houses

Factors	Traditional House	Modern House
Socio-Cultural Factors	**Completely achieved**	**Not achieved**
Architectural Factors	**Enabled**	**Not enabled**
Summer Environmental Factors	**Completely achieved**	**Not achieved**
Winter Environmental Factors	**Mostly achieved**	**Partially achieved**

As has been found, the traditional courtyard house has satisfied the occupants' needs regarding the socio-cultural factors by providing them with the complete privacy they have historically sought when they use the courtyard and the habitable rooms and spaces. On the other hand, the modern house does not satisfy these historic needs, although it is now necessary to establish to what extent these needs might have changed over the last 30–40 years, since the publication of literature in this context.

The traditional courtyard house has also been found to enable the achievement of the occupants' needs in terms of the architectural factors associated with the traditional house. This is in terms of incorporating adequate spaces as well as in terms of provision of seasonally appropriate spaces and basements. While the modern house shared the capacity to provide adequate functional space it did not currently address the other aspects of this factor.

Environmentally, the traditional courtyard house theoretically satisfies the occupants' needs to provide them with thermal comfort through the integration of a range of passive strategies, while the covered courtyard gives the inhabitants some protection during the spring/summer dust storms. In contrast, the modern house theoretically does not satisfy the occupants' thermal comfort in relation to passive strategies, but through this compact built form provides for lower levels of heat loss through conduction and ventilation. Moreover, the garden of the modern house does not give the inhabitants any protection during the spring/summer dust storms.

The most significant conclusion, however, relates to the age of the literature available in the context of Baghdad, which is dated, being 30–40 years old and as such a noteworthy question remains as to what extent these findings remain valid in the current context. As such an evaluation of current usage, performance and occupant thermal comfort is required to understand the current state of play and therefore inform an emerging modern vernacular housing design strategy for Baghdad, Iraq.

CHAPTER III

PHASE 1: METHODOLOGY

3.1. INTRODUCTION

As already stated, this research aims to compare the characteristics of traditional courtyard houses in Baghdad with those of modern houses. The first task being to identify both the advantageous and disadvantageous characteristics of both house types and following a thorough evaluation of both house types in the modern-day context, it is intended that those positive characteristics be combined to inform guidelines for a modern vernacular housing for Baghdad.

To this point, this study has focused on traditional courtyard houses and modern houses commencing with desk based research where key secondary data, sources included books, journals and building industry publications as well as relevant academic and architectural journals in both print and electronic forms. To this end, Chapter II has already achieved objective 1 of this research and has identified and evaluated the social and environmental issues as well as architectural and neighbourhood characteristics of both the traditional and modern houses and how these houses have or indeed have not satisfied the inhabitants' needs, as described in the literature.

Further Chapter II has explained that the traditional courtyard houses were designed to satisfy the historical functional needs of their inhabitants as well as the social factors and the cultural/religious demands of the inhabitants. In particular, this was manifest in the provision of both indoor and outdoor privacy regarding use of habitable rooms and spaces and the courtyard for their daily activities, social gatherings and religious occasions; and finally in terms of privacy and comfort when householders use the roof terrace as a sleeping area during the summer. However, given the age of much of these studies it remains necessary to explore to what extent these original requirements are still valid for current occupants and the society of the twenty-first century.

Also Chapter II has explained that modern houses in Baghdad have not been designed to satisfy these social, cultural and environmental requirements for their inhabitants. Indeed, the built form of modern homes has largely been imported from other climates and cultures. The question as to the relevance of the historic socio-cultural norms to current society remains, if we are to provide responsive built environment. For both contexts this responsive environment must also be appropriate to the climate, which has changed since the design and construction of the traditional courtyard homes.

Chapter II has therefore established the necessary findings to achieve objective 1:

> ***Identify the current understanding of the architectural, environmental and socio-cultural characteristics of traditional courtyard houses and modern homes in Baghdad.***

This chapter aims to both explain the development of the proposed mixed methodology and will then go on to describe the approaches to be applied within phase 1 of this proposed method. Phase 2 method and phase 3 method are found in Chapter V.

It can be seen in Figure 3.1 that a case study based methodology has been selected for this research as this will provide a framework to develop a detailed description and analysis of a group of buildings and as such will enable the delivery of a well structured analysis of the housing types and their occupants that are the focus of this study (**Zainal 2007**).

As such, it is considered that the case study method will enable the researcher to closely examine the data within a specific context, where the design of the detailed methodology applied to the case studies is very important. This must follow a set of clearly defined procedures with proper application and produce a chain of evidence, either qualitatively or quantitatively, that is systematically recorded or achieved. This is particularly necessary when direct investigation or observation by the researcher is the main source of the data. Therefor the subjects to be evaluated through this research phase were informed directly by the literature review, while the questions were developed in line and guidance from questionnaire writing literature, most importantly Oppenheim (1992).

It is asserted that establishing the case study approach will enable the researcher to carry out the following:

- ***Method 1 – Physical Survey*** of the case study houses to understand their architecture, structure and materials.
- ***Method 2 – Occupant Survey*** in order to understand the occupants' perspectives about their house, in particular, attitudes to thermal comfort and

socio-cultural responsiveness throughout the four seasons of the year.

- ***Method 3 – Occupant Observation*** in order to understand the occupants' behavior in the case study houses; this will inform the emerging understanding of the occupants' comfort and satisfaction (**Schell 2012**).

In order to achieve objectives 2 & 3–4 Primary Data Collection will be required.

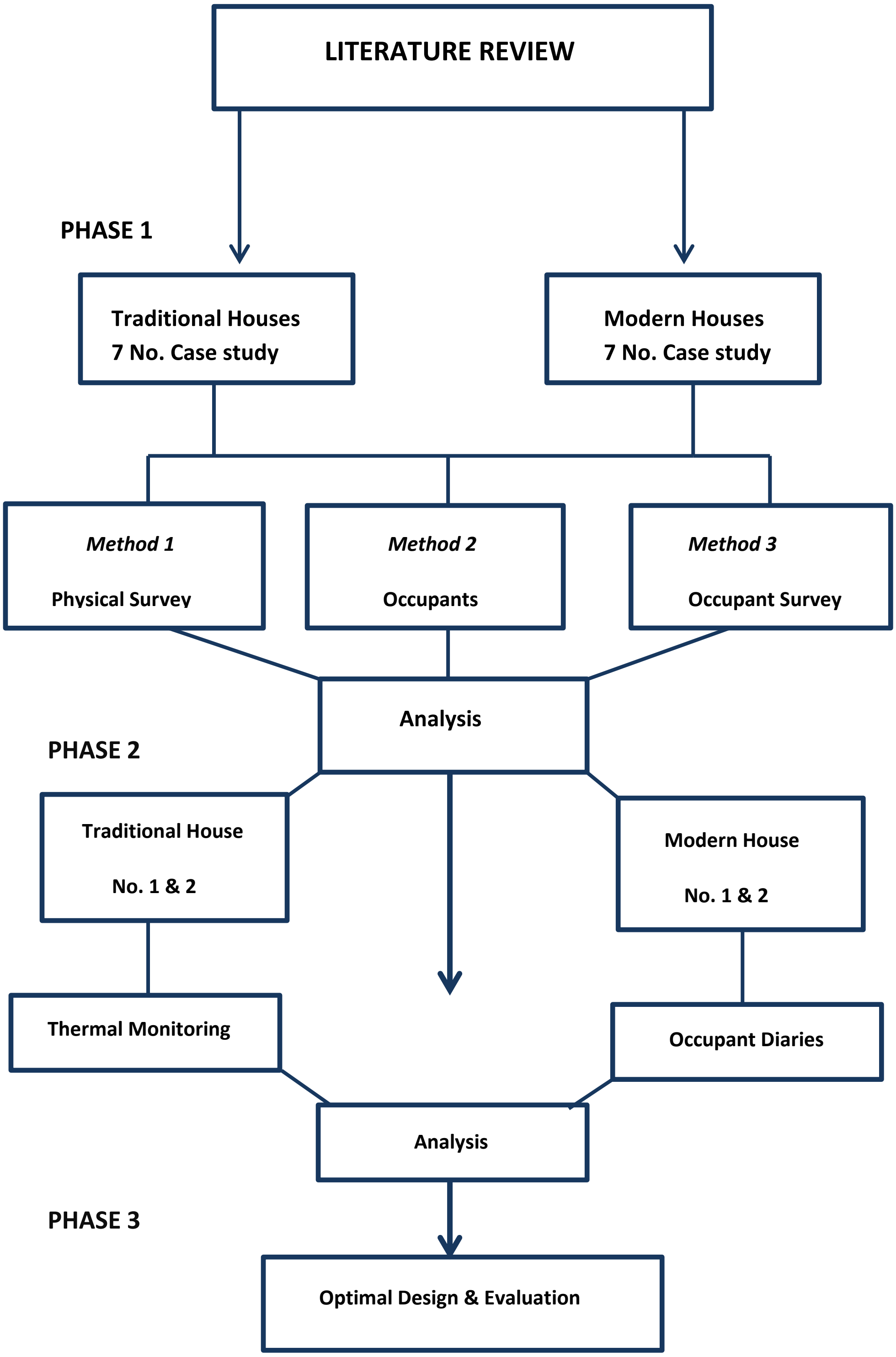


Fig. 3.1. The research methodology process

The types of data to be collected by this phase of the research are therefore both quantitative (housing survey and occupant survey) and qualitative (occupant survey and occupant observation). **Burrel and Morgan (1979)** argue that quantitative and qualitative research methods are mutually exclusive because their underlying assumptions are seen as contradictory. Taking an opposing viewpoint, writers such as **Gable (1994)**, and **Remenyi and Williams (1996)** disagree, insisting that these alternate research methods should be seen as the ends of a continuum. Consistent with the writing of **Gable (1994)** and **Remenyi and Williams (1996)**, as well as with the view of **Easterly–Smith et al. (2000)** who draw a thin line between qualitative and quantitative techniques, this research will adopt a mixed methods approach. In particular:

> ***Method 1 – Physical Survey*** in order to achieve objective 2 to establish the architectural characteristics of case study houses.

The researcher has conducted in depth physical survey of all the selected traditional houses and modern houses in Baghdad. The researcher considered this to be necessary in order to understand and analyse the architecture of both types of houses and in particular to enable for like comparison of the architectural characteristics of the two types of case study to be studied. It was not possible to find published literature on modern housing typologies, with very little available about the design, construction and planning of these houses types published in recent times. Further, there is also limited information about traditional houses typologies, with a particular gap in knowledge about those that are still occupied and used in Baghdad. These are not placed in the context of wider building typologies and information presented in incomplete and inconsistent for example is not systematically documented. In summery in order to enable complete comparison of the characteristics of traditional courtyard houses with the relevant characteristics of modern houses. It was necessary to conduct physical survey in this research.

The 14 no. case study buildings in Baghdad (7 no. traditional courtyard houses and 7 no. modern houses) were selected in order to be representative of each typology. The selection criteria are described later in this chapter. The physical surveys were undertaken in February 2014 and were intended to gather data on design, structure, building materials (including thermal performance of materials – insulation), opening/windows, privacy and passive technologies for heating and cooling, including natural ventilation.

Method 2 – Occupant Survey & Method 3 – Occupant Observation to achieve objective 3 in order to establish the socio-cultural performance and responsiveness of traditional and modern houses throughout the year.

The ***Occupant Survey*** was designed and administrated to a sample of the occupants of the case study homes. The respondents were from both the older and younger generations. This questionnaire was designed to address occupant experience in the four seasons of the year, although the transition seasons, spring and autumn, are very cool in Iraq and can provide thermal comfort.

The questionnaire was completed and the data was analysed using the statistical software package, SPSS for quantitative data analysis, where descriptive statistics of mean and standard deviations have been applied to the resulting data, and further, where appropriate comparison between findings from occupants of the two types of buildings has been undertaken.

The ***Occupant Observation Method*** approach has been used and applied with the occupants of the case study homes during the summer and winter. This period provided the opportunity for the researcher to observe the occupants' activities within the case study houses during the day as well as having informal periods to talk with the occupants.

3.2. CASE STUDIES

Fourteen case studies have been chosen for this research. While two example case studies from each typology were selected from this set for the environmental monitoring method applied in phase 2 of the research as described in Figure 3.1, details of all case studies are presented in Phase1 Results Chapter IV. In order to select the traditional courtyard houses and modern houses for study it was necessary to define the relevant criteria.

3.2.1. Traditional Courtyard House Case Studies

Although there are a breadth of criteria relevant for the selection of a representative sample of traditional courtyard houses, including floor area, numbers of courtyards, numbers of floors, and age to name a few, the key criteria that were applicable to this study were their condition and accessibility. This is due to the state of repair of many examples of traditional courtyard houses, where there are groups of this typology found in various neighbourhoods in Baghdad, but unfortunately many of them are in poor condition. The group of traditional courtyard houses found in the Al-Kadimiyeh area north of Baghdad have been renovated over recent years and are therefore in a good condition; further it was possible to gain support from the local authorities to study these buildings. Moreover, there was no objection from the inhabitants to do the survey measurements of their houses, nor to take part in the occupant survey and observation work. All of the selected traditional courtyard houses are the same design, where the courtyard is the core of the house and the habitable rooms and spaces are located around and are accessed from the courtyard. The great majority of these houses are of two storeys and all of them incorporate a basement level room (Sirdab) and semi-basement level room (Neem).

A further factor for case study selection was that all of the houses should be located in the same neighbourhood in order to enable ease of access during each of the phases of the study. This was of particular relevance and importance given the security limitations currently in existence in Baghdad that limit freedom of movement around the city. The researcher faced difficulties in movement during the period of the field study due to the security situation of the city which caused delays in reaching the sites during the day. The Al-Kadhimyeh area has been considered one of the most important areas in Baghdad due to the many religious ceremonies that take place in this area; as a result it is subject to security provisions and there was no easy access during this period of time.

Table 3.1 below provides details of the seven traditional houses in Baghdad that were selected as case study subjects.

Table 3.1. Traditional house case studies

Code	Floors	Living/Reception Rooms	Bedrooms	External Space
TH1	2 floors	*Ground*:1 living room *First:* 2 Ursi	3	1 courtyard 1 roof terrace
TH2	3 floors	*Ground*: 1 living room *First:* 2 Ursi	5	1 courtyard 1 roof terrace
TH3	2 floors	*Ground*: 1 living room *First:* 2 Ursi	2	1 courtyard 1 roof terrace
TH4	2 floors	*Ground*: 1 living room *First:* 4 Ursi	6	2 courtyard 1 roof terrace
TH5	2 floors	*Ground*: 1 living room *First*: 2 Ursi	3	1 courtyard 1 roof terrace
TH6	2 floors	*Ground*: 1 living room *First*: 2 Ursi	3	1 courtyard 1 roof terrace
TH7	2 floors	*Ground*: 1 living room *First*: 2 Ursi	2	1 courtyard 1 roof terrace

3.2.2. Modern House Case Studies

In addition to being co-located with the selected group of traditional courtyard houses, in the Al-Kadimiyeh area north of Baghdad, the potential criteria for the selection of modern house case studies also varied, including building size (floors, number of rooms), location, plot size, external space and also whether they are detached, semi-detached, or terraced.

It was decided that houses should be located on a main road because one of the modern neighbourhood characteristics is house location on main roads; also this was more secure for the researcher. In addition, it was necessary that the modern house should have a similar design. Further, it was specified that the housing selected should have access to the external space with a garden in the front or in the back of the house. It was further specified that the houses might be either one storey or two storeys.

As mentioned previously in the beginning of this chapter, unlike the traditional courtyard house, the modern house does not incorporate a basement level room (Sirdab) and semi-basement level room (Neem).

Table 3.2 below describes the seven modern houses in Baghdad selected as case study subjects.

Table 3.2. Modern house case studies

Code	Floors	Living/Reception Rooms	Bedrooms	External Space
MH1	2 floors	*Ground*: 1 reception/1 living room *First* : none	4	1 garden 1 roof terrace
MH2	2 floors	*Ground*: 1 reception/1 living room *First*: none	5	1 garden 2 roof terrace
MH3	2 floors	*Ground*: 1 reception/1 living room *First*: none	5	1 garden 1 roof terrace
MH4	2 floors	*Ground*: 1 living room *First*: none	3	1 garden 1 roof terrace
MH5	2 floors	*Ground*: 1 living room *First*: none	3	1 garden 1 roof terrace
MH6	2 floors	*Ground*: 1 reception/1 living room *First*:1 living room	3	1 garden 1 roof terrace
MH7	2 floors	*Ground*: 1 living room *First:* 1 living room	3	1 garden 1 roof terrace

3.3. PHASE 1 METHOD 1: SURVEY MEASUREMENT

The first fieldwork was started by the researcher in February 2014, when survey measurements were taken of the 14 case study houses in Baghdad (seven selected courtyard houses and seven selected modern houses). The ethics approval was obtained from the Board of Research and also the consent letter was approved and signed off by Cardiff University to start the research.

The researcher chose to carry out a physical survey of these houses in order to understand the traditional and modern houses in terms of design, structure, building materials (including thermal performance of materials – insulation), opening/windows, privacy and passive technologies for heating and cooling, including natural ventilation. This method directly corresponds to the research aims in comparing the characteristics of traditional courtyard houses in Baghdad with the relevant characteristics of modern houses; it is necessary to understand and analyse these characteristics of both types of houses and identify to what extent the characteristics of traditional courtyard houses can be relevant in modern houses.

The researcher received permission from Amanat Al-assima (Municipality of Baghdad) for the physical survey to be carried out. The Amanat Al-assima provided measuring tapes and two members of staff who assisted the researcher with the survey measurements of all 14 case study houses. All survey measurements were completed within the one month that was the duration of the fieldwork.

Surveys were conducted by the researcher and team from 9:00 am until 4:00 pm every day for a period of 14 days. The researcher has drawn sketches of each of the case study houses with the exact dimensions noted and using these, detailed plans have been drawn.

This approach to physical measurement follows previous work undertaken in the 1980s that used the same survey method (survey measurements) of traditional and modern houses in Baghdad (**Al-Azzawi 1984**). Al-Azzawi's work in the 1980s studied three traditional houses and three modern houses which in the researcher's opinion did not provide adequate understanding of the variation in characteristics of these housing typologies. Therefore, this study is based on a larger sample – where seven case studies of each typology were studied.

Further, **Al-Azzawi (1984)** does not collect information regarding occupant behaviour, while as has been argued, here it is considered vital to the research to gain understanding from the occupants' perspective through the use of Occupant Surveys and Occupant Observation for the summer and winter period.

The analysis of the 1980s work has been presented according to the researcher's knowledge, as his father was one of the traditional courtyard house builders and the researcher was an occupant of a traditional courtyard house during his childhood.

The study by Al-Azzawi was completed during the 1980s but the thermal buildings monitoring work was done during the 1970s and at that time traditional houses were serviced naturally and they had not yet been equipped with cooling systems as they are nowadays. But the modern houses were monitored with air conditioning systems in operation.

3.4. PHASE 1 METHOD 2: OCCUPANT SURVEY

As has been mentioned earlier in this chapter, the researcher selected the survey questionnaire method in order to investigate the occupants' perspective about their homes in terms of thermal comfort throughout the four seasons of the year; socio-cultural responsiveness and relevance; as well as to help to identify and inform the development of solutions to existing housing problems.

Two complementary questionnaires incorporating both quantitative and qualitative data collection were designed and administrated to selected occupants of each of the case study typologies: traditional courtyard houses and modern houses in Baghdad. The research aimed to establish the following:

- Socio-cultural factors
- Economic factors
- Neighbourhood factors
- Architectural factors
- Services factors
- Environmental factors.

The survey was designed to consider the occupants' experience in all four seasons in Baghdad. In particular the questionnaire was designed to build upon the findings of the literature informing a more up-to-date understanding of the experience of occupation of these two housing typologies in the current climate and socio-cultural context that remains unreported in existing literature.

The following sections are intended to describe in more detail the questions that were posed associated with each of the above groups of factors which were considered in the questionnaires.

3.4.1. Socio-Cultural Factors

This set of questions are intended to establish the occupants' perspectives on a range of socio-cultural factors including those related to privacy, social activities and habitation patterns (see Table 3.3).

This research study, in considering this set of factors, intends is to establish a current contextualised understanding of the following:

Table 3.3. Purpose of questions on socio-cultural factors

Question Intention	Traditional House	Modern House
As was established in literature, privacy was historically an important issue for the inhabitants of the traditional house, having a significant influence on the design of this housing typology. This question was included in order to establish whether both housing types provide occupants with privacy in their	*Does your courtyard provide you with privacy?* *Does the courtyard prevent overlooking by passers-by?*	*Does your garden provide you with privacy?* *Does the garden prevent overlooking by passers-by?*

external spaces.		
Both garden (in the modern house) and courtyard (in the traditional house) are used for social gatherings by the occupants. In the context of privacy, it is important to know whether these spaces feel comfortable when occupiers use these spaces for social gatherings.	*Do you feel comfortable when you use the courtyard for social gatherings?*	*Do you feel comfortable when you use the garden for social gatherings?*
In this context of social connectivity within the local neighbourhood, it is relevant to establish to what extent the occupants socialise with their neighbours.	*Do you know your neighbours?*	*Do you know your neighbours?*

3.4.2. Economic Factors

Economic factors were investigated through the questionnaires directed to the occupiers of both traditional houses and modern houses (see Table 3.4).

Table 3.4. Purpose of questions on economic factors

Question Intention	Traditional House	Modern House
The plot size and therefore building density is different in the traditional and modern housing developments. This question intends to establish whether the larger plot sizes of modern housing are used effectively by occupants, or whether there might be better use made of this land.	*Because the use of the small plots results in comparatively less demand on land for houses and alleyways, this could potentially leave more land available for economic development. What would you use this land for?*	*The modern house is usually designed to cover only part of the site: the rest is left as a garden at the front, rear or along one or two sides. What do you use this external space for?*
It is relevant to understand why occupants of both traditional and modern houses have been attracted to the house they currently own/occupy/rent. Is it the house itself or the neighbourhood or the cost of the house/rent?	*Why were you attracted to this house when you decided to buy/occupy/rent?*	*Why were you attracted to this house when you decided to buy/occupy/rent?*
For both traditional and modern houses it is relevant to establish the respective energy costs for each house type.	*How much energy do you use in your house?*	*How much energy do you use in your house?*

It is relevant for the researcher to know the energy cost to provide inhabitants with a comfortable environment.	*What does it cost to provide you with comfort? (a little or a lot?)*	*What does it cost to provide you with comfort? (a little or a lot?)*
It is relevant for the researcher to know how the inhabitants of both traditional and modern houses pay for their energy; is it every month, every six months?	*How do you pay your bills?*	*How do you pay your bills?*
It is culturally difficult to ask people about money and therefore this question was designed to establish whether it was affordable to heat and cool these properties, without asking for actual costs. It is very important to know whether the cost of the energy bills for both types of housing are affordable for occupiers.	*Is it affordable for you?*	*Is it affordable for you?*

3.4.3. Neighbourhood Factors

The neighbourhood factors have also been investigated in the questionnaires for occupiers of both traditional and modern houses (see Table 3.5 below).

Table 3.5. Purpose of questions on neighbourhood factors

Question Intention	Traditional House	Modern House
The researcher needed to know whether the occupants of both traditional and modern houses know their neighbours and do they socialise with them, as this aspect is important for social connections.	*Do you know your neighbours?* *Do you socialise with them?*	*Do you know your neighbours?* *Do you socialise with them?*
Most of the occupants of both traditional and modern houses have been living in their houses for a long time. The researcher wishes to know whether they happy with their neighbourhood.	*Are you happy with your neighbourhood?*	*Are you happy with your neighbourhood?*
This question is related to both neighbourhood and services factors to know whether the occupants of both traditional and modern houses have any problems associated with the alleyways or pavements during the summer and winter.	*Do you have problems associated with the surface of the alleyways?*	*Do you have problems associated with the surface of the pavements?*

3.4.4. Architectural Factors

Architectural factors have been considered as important factors that require investigation in the questionnaires for occupiers of the traditional and modern houses (see Table 3.6).

Table 3.6. Purpose of questions on architectural factors

Question Intention	Traditional House	Modern House
The traditional courtyard houses are under the local authority's responsibility, it is relevant to establish the level and frequency of support that the owners/occupants of these houses receive.	*Have you had any conservation work to upgrade your house in the last four years?*	*N/A*
In the context of the above it is necessary to establish the occupants' perspective on the work that has been undertaken in their house, including the scale of the work and the impact that this has had on their living conditions.	*To what extent do you consider that the building work which has been undertaken has improved your living conditions?*	*N/A*
Both housing typologies have access to outside spaces, where the courtyard is an important, core space in the traditional house and all modern houses have provision of outside gardens. In this context it is necessary to establish to what extent these spaces are used by the occupants for their daily activities.	*Do you use the outdoor space in your house for your daily activities?*	*Do you use the outdoor space in your home for your daily activities?*
In the same context as above, from literature it can be seen that the courtyard was designed and utilised historically as a hub for social gatherings. In this context it is necessary to establish to what extent this role is maintained and to what extent the gardens in the modern houses have a corresponding role.	*How often do you use the outdoor space (courtyard) for social gatherings?*	*How often do you use the outdoor space (garden) for social gatherings?*
Anecdotally the researcher has experienced that one of the concerns expressed by occupants of modern buildings are problems of noise transfer and therefore inadequate acoustic insulation or detailing.	*N/A*	*Is it uncomfortably noisy in the main living space in your house?*
Modern houses intended to provide occupants with a secure, private and thermally comfortable sleeping area. This is indicated as both traditional and functional by the existing literature;	*Do you feel secure when sleeping on your roof terrace?*	*Do you feel secure when sleeping on your roof terrace?*

however, in the modern day it is important for this research to establish whether the occupants of traditional houses and modern houses continue to feel secure when sleeping here.		
In the same context as above, privacy is also an important issue for occupants of both traditional houses and modern houses, when using the roof terrace as a sleeping area in summer.	*Does the roof terrace provide you with adequate privacy when you use it as a sleeping area during the summer?*	*Does the roof terrace provide you with adequate privacy when you use it as a sleeping area during the summer?*
In the same context as above, as well as in the context of a changing climate, it is also important to ascertain whether the roof terrace continues to provide the inhabitants of both the traditional houses and modern houses with thermal comfort.	*Does the roof terrace provide you with thermal comfort when you use it as a sleeping area in the summer?*	*Does the roof terrace provide you with thermal comfort when you use it as a sleeping area in the summer?*
The summer in Baghdad is long and hot-dry and some of the traditional courtyard houses continue to be occupied without air conditioning systems, while many have partial A/C systems installed. The inhabitants of the traditional houses have been asked whether it is important for their house to be equipped with air conditioning to provide them with thermal comfort. For the occupants of modern houses that have been built with A/C systems, this question is intended to ascertain whether it is important for them to keep the air conditioning system on at all times in order to provide them with thermal comfort	*In your opinion, is it important for traditional courtyard houses to be equipped with air conditioning to provide you with thermal comfort?*	*In your opinion, is it important in modern houses for the air conditioning to be used at all the times to provide you with thermal comfort?*
This question has been posed in order to establish whether the main living space in the two house typologies have a thermally comfortable response to the climate conditions.	*Do you feel thermally comfortable in your sitting area without air conditioning?*	*Do you feel thermally comfortable in your sitting area without air conditioning?*
This question is related to the previous factors about the neighbourhood, whereby the researcher wishes to establish about the connectivity of the neighbourhood to important locations for the occupants.	*How long does your journey take? To* • *work* • *school* • *market*	*How long does your journey take? To* • *work* • *school* • *market*

3.4.5. Services Factors

The other important set of factors considered by the researcher in the questionnaires for the occupants of both traditional houses and modern houses is that of services availability and functioning. These have been included in order to establish the extent to which modern services might influence housing acceptability (see Table 3.7).

Table 3.7. Purpose of questions on services factors

Question Intention	Traditional House	Modern House
The traditional courtyard houses and modern houses have different sanitation systems. This question is intended to establish occupant satisfaction with these systems.	*Are you satisfied with your sanitation system?*	*Are you satisfied with your sanitation system?*
Rubbish storage can cause a health and safety risk for occupants. These questions intended to establish to what extent this represents a concern in these two housing typologies.	*Where do you keep your rubbish?* *Do you consider this to present a risk to health?*	*Where do you keep your rubbish?* *Do you consider this to present a risk to health?*
During both hot and dusty days in summer and cold and rainy days in winter, it is important to establish whether occupants of both house types have any problems associated with the surface of the alleyways or with the unpaved pavements for the modern house.	*When there is heavy rain, do you have any problems associated with the surface of the alleyways?*	*When there is heavy rain do you have any problems associated with the surface of the pavements?*
As in many traditional cultures the kitchen is an important space in Iraqi houses. This question has been posed in order to establish whether the kitchen with or without full fittings provides the occupants of both types of houses with comfort.	*A kitchen in an average-sized traditional house is usually a medium- or small-sized room that overlooks the courtyard but without any fittings.* *Do you think that such a kitchen is comfortable or adequate?*	*A kitchen in an average-sized modern house is a medium-sized room incorporated in the plan of the house, with full fittings and overlooking the garden.* *Do you think that such a kitchen is comfortable or adequate?*
Generally, the traditional courtyard house incorporates only one cold water tap which is located in the courtyard, and one in each kitchen and bathroom at ground floor and another at first floor. There is typically no hot water system.	*Does this water system satisfy your needs?*	*N/A*

It is relevant to identify the location of the cold water tank to establish whether it is subject to passive heating from the sun.	*Where is the cold water tank located?*	*Where is the cold water tank located?*

3.4.6. Environmental Factors

These questions are intended to establish the thermal comfort levels of the occupants of both types of houses. The questions listed in Table 3.8 provide details of the factors on which the researcher wished to elicit responses from survey participants.

Table 3.8. Purpose of questions on environmental factors

Question Intention	Traditional House	Modern House
In response to climate variations, it is important to know the occupants' opinion as to the adaptation of their house to current climate conditions.	*Do you think that your traditional courtyard house is well adapted to the climate?*	*Do you think that your modern house is well adapted to the climate?*
This question is related to the climate response question above and is intended to establish more detail – relating to thermal comfort with minimal services in the living room.	*In your main living room, do you feel comfortable with minimal services, such as ceiling fans?*	*In your main living room, do you feel comfortable with minimal services, such as ceiling fans?*
This question intends to establish a general level of occupant internal thermal comfort conditions in the houses.	*In terms of your thermal comfort, are you generally happy with the house you live in?*	*In terms of your thermal comfort, are you generally happy with the house you live in?*
This question aims to establish current occupant thermal comfort levels with the natural ventilation system in their basement level room (Sirdab).	*How comfortable do you feel in the basement level room (Sirdab) during the summer?*	*N/A*
This question was only asked of those homes that do not have air condition systems installed and was intended to establish the general level of thermal comfort in these homes.	*For the family living in Baghdad through the summer months without air conditioning system: Do you generally feel thermally comfortable around the house?*	*N/A*
As above, this question was only asked of those homes where there was no central heating system in operation for the winter months.	*For the family living in Baghdad through the winter months without heating system: Do you generally feel thermally comfortable around the house?*	*N/A*

Some of the traditional courtyard houses have natural ventilation systems integrated into their fabric and this system is intended to provide comfortable ventilation during the summer. For these traditional houses this question aims to establish whether the occupants consider this to contribute to their thermal comfort during the summer. For modern houses, none of which have natural ventilation systems designed to benefit thermal comfort during the summer, the question was whether their comfort is affected by the absence of such systems.	*To what extent, do you think that the natural ventilation system (Badgir) contributes to thermal comfort within your house through the year?*	*To what extent do you think your thermal comfort is affected by the lack of natural ventilation system (Badgir)?*
Twice a year (spring and summer) dust storms significantly affect air quality in the Baghdad environment.	*Is your house exposed to spring/summer dust storms?*	*Is your house exposed to spring /summer dust storms?*
It was established from the literature that it is important for traditional courtyard houses to have fountains in the courtyard to increase humidity and thus reduce the intense heat (temperature) in the summer.	*Do you have fountains in the courtyard of your house?*	*N/A*
In the context of the above question: it is relevant to establish the extent to which the occupants perceive fountains as contributing to the provision of occupant thermal comfort during the summer.	*How important do you think the fountains in the open courtyard are in providing thermal comfort during the summer?*	*N/A*

3.5. SAMPLE

This questionnaire was administered to the occupants in each housing type, who were categorised according to age as either older generation (age range 19–59 years) or younger generation (age range 0–18 years). This was with the intention of enabling the analysis of the occupants' viewpoint in relation to their age group as it was considered important to ascertain whether different age groups have differing points of view. English versions of each questionnaire for traditional houses and modern houses are provided in Appendix 1. The inhabitants of the traditional courtyard and modern houses were very helpful in answering all the questions. It is relevant to note here that in some cases translation into Arabic was difficult, for example, ensuring that concepts of comfort were appropriately recorded was important. The questionnaire was administrated to a total 56 occupants of the seven traditional courtyard houses and seven modern houses in Baghdad.

Table 3.9 below summarises the questionnaire respondents from the seven selected traditional houses in Baghdad: total 28 respondents.

Table 3.9. Characteristics of respondents from traditional houses

Code	Tenure	Older Generation	Younger Generation
TH1	Owner	1 no. head of the family	3 no. oldest son/younger son/daughter
TH2	Tenants	1 no. head of the family	3 no. oldest son/youngest son /daughter
TH3	Tenants	1 no. head of the family	3 no. oldest son/youngest son/ daughter
TH4	Owner	1 no. head of the family	3 no. oldest daughter/youngest daughter/ son
TH5	Owner	1 no. head of the family	3 no. oldest son/ youngest son/daughter
TH6	Owner	1 no. head of the family	3 no. oldest son/youngest son/daughter
TH7	Owner	1 no. head of the family	3 no. oldest daughter/youngest daughter/ son

Table 3.10 summarises the questionnaire respondents from the seven selected modern houses in Baghdad: total 28 respondents.

Table 3.10. Characteristics of respondents from modern houses

Code	Tenure	Older Generation	Younger Generation
MH1	Owner	2 no. head of the family/wife	2 no. oldest son/youngest daughter
MH2	Tenants	2 no. head of the family/wife	2 no. oldest daughter/youngest son
MH3	Owner	2 no. head of the family/wife	2 no. oldest daughter/youngest son
MH4	Tenants	2 no. head of the family/wife	2 no. oldest son/youngest daughter
MH5	Tenants	2 no. head of the family/wife	2 no. oldest daughter/youngest son
MH6	Owner	2 no. head of the family/wife	2 no. oldest daughter/youngest son
MH7	Owner	2 no. head of the Family/wife	2 no. oldest son/youngest daughter

3.6. PHASE 1 METHOD 3: OCCUPANT OBSERVATION

The aim of the research in using the occupant observation method is to observe how the occupants make use of the habitable rooms and spaces in their house during the four seasons of the year.

The data was collected during arranged visits to the selected traditional courtyard houses and selected modern houses, when measuring the houses and when administering the questionnaires.

While the researcher was taking the survey measurements the data on occupant observation was collected directly from observation of how the occupants of the traditional and modern houses used their homes during summer, winter and the transition seasons spring and autumn. The occupants of both types of houses were very helpful in providing the researcher with information about their daily activities.

The researcher observed the occupants at different times of the day during these seasons, during the day, afternoon and evening. For night-time and late evening the occupants were asked about the use of the spaces as observation was considered to be unacceptably intrusive at this time.

Information regarding occupant usage of these housing typologies is supplemented by personal experience as the researcher lived in one of the modern homes in Baghdad.

About five visits a week were arranged for observation of the occupants from 9:00 am to 4:00 pm for the period of two weeks. These visits were also used for the survey measurement and to administer the survey questionnaire.

The observation periods were as follows:

- Winter: February 2014
- Summer: September 2014
- Winter: February 2015.

The researcher gathered data about the spring and autumn directly from the occupants and from the researcher's knowledge.

The research aimed to establish answers to the following questions for each of the seasons, summer, winter and during the relatively short transition seasons of spring and autumn:

- Where do the occupants undertake domestic activities including cooking, washing and cleaning?
- Where do the occupants eat their meals?

- Where do the occupants relax? Which is the most private space in the building?
- Where do the occupants receive guests?
- Where do the occupants sleep?

And to consider these questions throughout the day:

- Morning 7:00–12:00
- Lunch time 12:00–14:00
- Afternoon 14:00–18:00
- Evening 18:00–22:00
- Night-time 22:00–7:00

In short the observation methodology was utilised in order to establish how the occupants of both types of buildings use or live in their house. The findings will help to establish whether social and cultural assumptions made in the literature review and that have informed design of the traditional houses still hold true in the twenty-first century.

3.7. SUMMARY

This research aims to consider this set of methodologies in order to understand the occupants' perspectives about their house and socio-cultural responsiveness. Also it is necessary to understand the occupants' behaviour in order to inform emerging understanding of their comfort and satisfaction which all leads to establish the architectural and socio-cultural performance of the traditional and modern house.

CHAPTER IV

PHASE 1 RESULTS: BUILDINGS/OCCUPANTS

4.1. INTRODUCTION

In order to achieve objectives 2 & 3 of the research the following procedures were followed:

> ***Objective 2**: Establish architectural characteristics of case study houses to be studied.*

An extensive physical survey of traditional courtyard houses and modern houses in Baghdad was undertaken to address the research questions. The survey gathered data on design, building materials, climate and comfort zones, and natural ventilation. There was a measured survey of seven selected traditional courtyard houses and seven selected modern houses in Baghdad which were representative of each typology.

> ***Objective 3**: Establish the socio-cultural, economic, neighbourhood and services performance and responsiveness of traditional and modern case study houses throughout the year.*

A questionnaire was designed and administrated to the occupants of seven selected traditional courtyard houses and seven selected modern houses in Baghdad. The respondents were selected using the simple random technique. Data analysis was completed by using SPSS software. Also a process of occupant observation was undertaken in the traditional and modern houses in February 2014.

This chapter will present the following **case studies** in which survey measurements were taken of the fourteen selected house and analysed architecturally; it will also present the data collected from **occupant observation**. Details will be provided of how the inhabitants of the traditional courtyard houses and modern houses are using their house during the summer/winter/transition seasons. The chapter will present details of how these buildings are serviced. Is it by an air conditioning system or by a natural ventilation (Badgir) system? Are these houses connected to other buildings?

This chapter will present the questionnaire responses of the occupants of each traditional courtyard house and modern house. The respondents were from two groups, the older generation and younger generation, and the analysis of the two questionnaires was in terms of the inhabitants' age group in order to present the different opinions of different generations. The questionnaire has identified the most important factors for the inhabitants of both traditional houses and modern houses. These are: **architectural factors, environmental factors, socio-cultural factors, services factors and economic factors.**

4.2. CASE STUDIES

Case studies have been chosen in the neighbourhood of Al-Kadhimiyeh which is located in the north of Baghdad and where most traditional courtyard houses are situated (see Figure 4.1). The group of traditional courtyard houses which have been chosen for this research are in good condition and have been renovated and conserved. Some are large-sized houses of 150 m^2–250 m^2 and others are medium-sized houses of 80 m^2–100 m^2. There are no criteria for choosing the traditional courtyard houses because all the traditional houses are in the same design; they consist of two storeys and most of them incorporate a basement level room and semi-basement level room and all the traditional courtyard houses are located in alleyways.

Fig. 4.1. Al-Kadhimyeh, neighbourhood of traditional and modern houses (Google Earth 2014)

The criteria for choosing the modern houses are that the selected modern houses should be of the same floor levels and located on main roads. They should have almost the same number of habitable rooms and spaces and also should be equipped with an air conditioning system. They should be built with the same building materials, like concrete, glass and metal because some of the early-stage modern houses have been built with old building materials which are not in use nowadays.

4.2.1. Traditional Courtyard Houses

All plans of the traditional courtyard houses and modern homes presented in this chapter have been drawn manually by the researcher.

4.2.1.1. *Traditional house No. 1 – TH1*

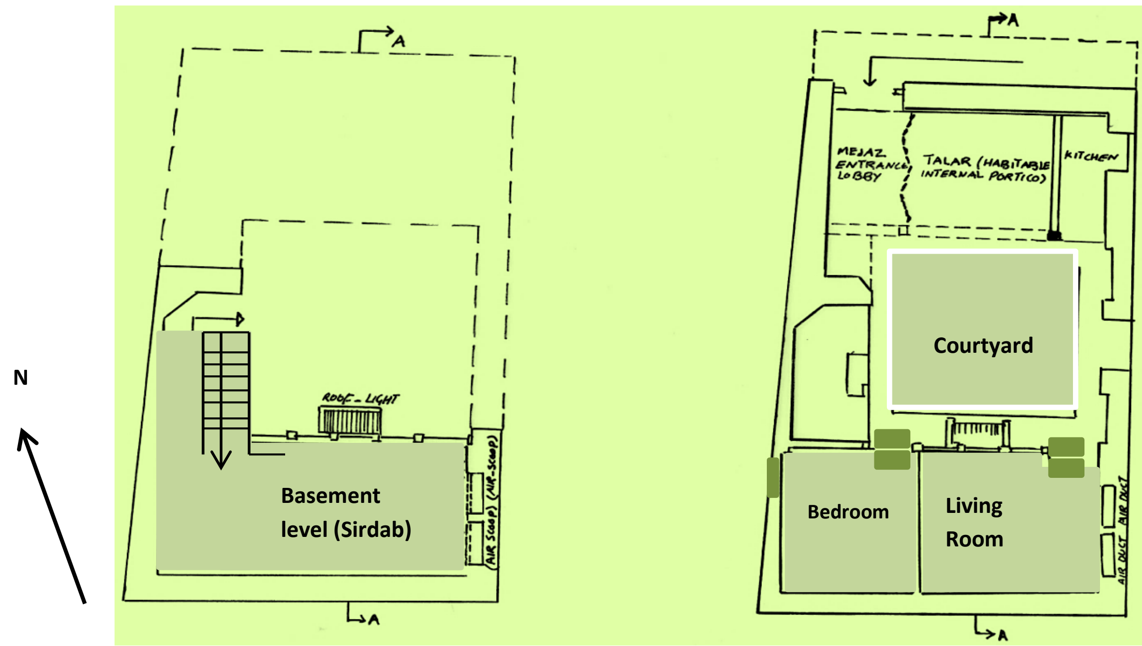


Fig. 4.2. Basement level (Sirdab) plan and ground floor level plan of traditional courtyard house No. 1. Scale: 1:50

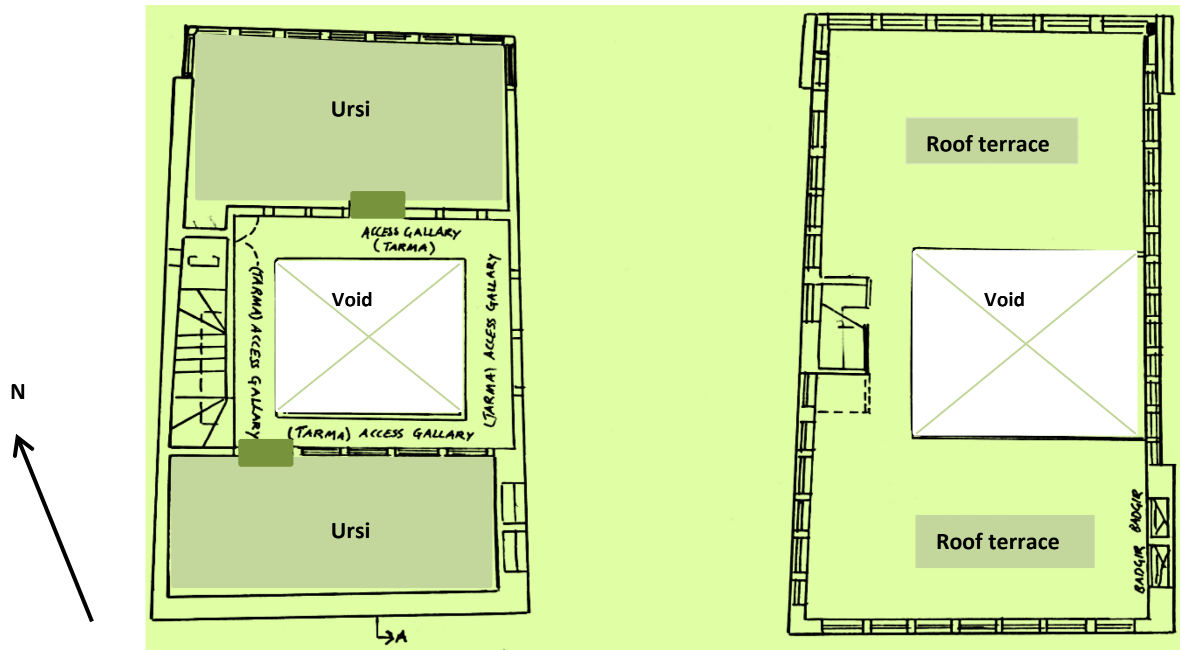


Fig. 4.3. First floor level plan showing the Ursi rooms and roof terrace plan of traditional courtyard house No. 1. Scale: 1:50

Table 4.1. Services for internal and external spaces in TH1

Internal Spaces	**Services: Cooling/Heating**
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Semi-basement level room (Neem)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Ceiling fans **Heating**: Paraffin heaters
Main bedroom (ground floor)	**Cooling**: Ceiling fans **Heating**: Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded gallery (Talar)	N/A
Roof terrace	N/A

In plan (see Figures 4.2 & 4.3 above) the traditional courtyard house No. 1 (TH1) is considered a medium-sized house (150 m^2). It consists of two storeys (ground floor level and first floor level) and the roof terrace level. At the ground floor level the house incorporates a courtyard which is located in the centre of the house and a living room and one bedroom which are located around the courtyard. It also incorporates the colonnaded gallery (Talar) which opens onto the courtyard. At the ground floor level the house incorporates an entrance lobby (Mejaz) which insulates the interior of the house from the exterior. The house has one kitchen and one bathroom.

At the first floor level the house incorporates two large winter rooms (Ursi) which are located at both sides of the house; their doors and front windows are overlooking the access gallery (Tarma), the front elevation of which is overlooking the courtyard. The roof terrace is always flat and it covers the whole area of the house.

The traditional courtyard house No. 1 is not equipped with a cooling system unlike most of the other traditional courtyard houses. It uses the ceiling fans which are operating in the living room and the bedroom at the ground floor level. The house has a natural ventilation system (Badgir) which mainly operates in the basement level room (Sirdab) (see Table 4.1).

Although the traditional courtyard houses are built in groups with each house connected to the other, each house does not overlook the other nearby house; this is due to the external walls of the houses which are high enough to prevent overlooking by neighbours and by passers-by.

In general, the inhabitants of all the traditional courtyard houses are using their house in the same way during the four seasons and almost all have the same activities during the day. The inhabitants of the traditional courtyard house No. 1 have used the habitable rooms and spaces within the house according to each season of the year.

Occupant Observation

Summer: The inhabitants of this house use the ground floor level more than the first floor level in the summer. The inhabitants used the courtyard sometimes during the summer for their daily activities, particularly in the early morning for having their breakfast, washing and sometimes for cooking. They have used it in the late afternoon for afternoon tea and receiving visitors, after the floor of the courtyard has been washed with water to reduce the high air temperature and increase the relative humidity. The courtyard was used in the evening by the inhabitants for sitting, watching TV and having dinner. Sometimes the inhabitants use the colonnaded gallery (Talar) at the ground floor for their breakfast and also receiving visitors.

The living room was used by the inhabitants most of the day in summer for sitting, having lunch and sometimes for the afternoon siesta. Sometimes they used the basement level room (Sirdab) for the afternoon siesta, particularly when the electricity has been cut off the inhabitants move to the basement room and depend on the natural ventilation system.

The roof terrace was used by the inhabitants as a sleeping area overnight during the summer. This roof terrace has provided the inhabitants with complete privacy by preventing overlooking by neighbours.

Winter: The inhabitants use different habitable rooms and spaces during the winter. The inhabitants occupied the first floor level more than the ground level during the winter. As in the summer season, the inhabitants use the courtyard sometimes for their daily activities, in particular during the sunny days for having their breakfast and sometime having their lunch; these activities also sometimes take place on the roof terrace during sunny days. The roof terrace was not used as a sleeping area during the winter. The main bedroom at ground floor level sometimes has been used in the afternoon for the afternoon siesta and for sleeping in the night. The inhabitants use the space of the colonnade gallery (Talar) for breakfast, lunch and receiving visitors during the sunny days in winter.

At the first floor level, the inhabitants used a different living room which is considered as a winter room (Ursi). The inhabitants used the Ursi room most of the time during the day for sitting, having lunch and also receiving visitors. The Ursi room is the multi-purpose room that could be converted and has been used by the inhabitants as a bedroom during the winter.

Transition seasons, spring/autumn: The occupants can use all areas – there are no specific habitable rooms and spaces for seasonal use – as the spring and autumn are cool seasons during which occupants can live in comfortable temperatures.

The traditional courtyard house is exposed to the spring/summer dust storms and the house is not protected from the dust during this period as the courtyard is an open space. The habitable rooms and spaces around the courtyard and the inhabitants have no protection from the dust during the dust storms. But sometimes the courtyard may be covered to provide the inhabitants with some protection during this period of the year and there will be temporary installations of fans to provide the inhabitants with comfort (see Figure 4.4).

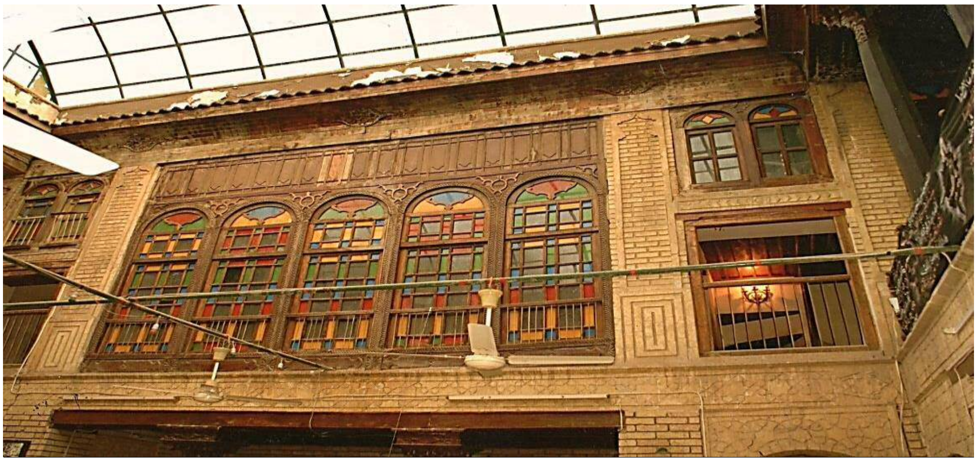


Fig. 4.4. The covered courtyard during dust storms (Researcher)

Table 4.2. Summer occupation of internal and external spaces in TH1

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Sleep	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyard	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	Eat	N/U	Socialise	N/U
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.3. Winter occupation of internal and external spaces in TH1

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi rooms (first floor)	Eat	Socialise	Socialise	Socialise/ Sleep
External Spaces				
Courtyard	Eat	Socialise	N/U	N/U
Colonnaded gallery (Talar)	Eat	Socialise	N/U	N/U
Roof terrace	N/U	N/U	N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.1.2. *Traditional house No. 2 – TH2*

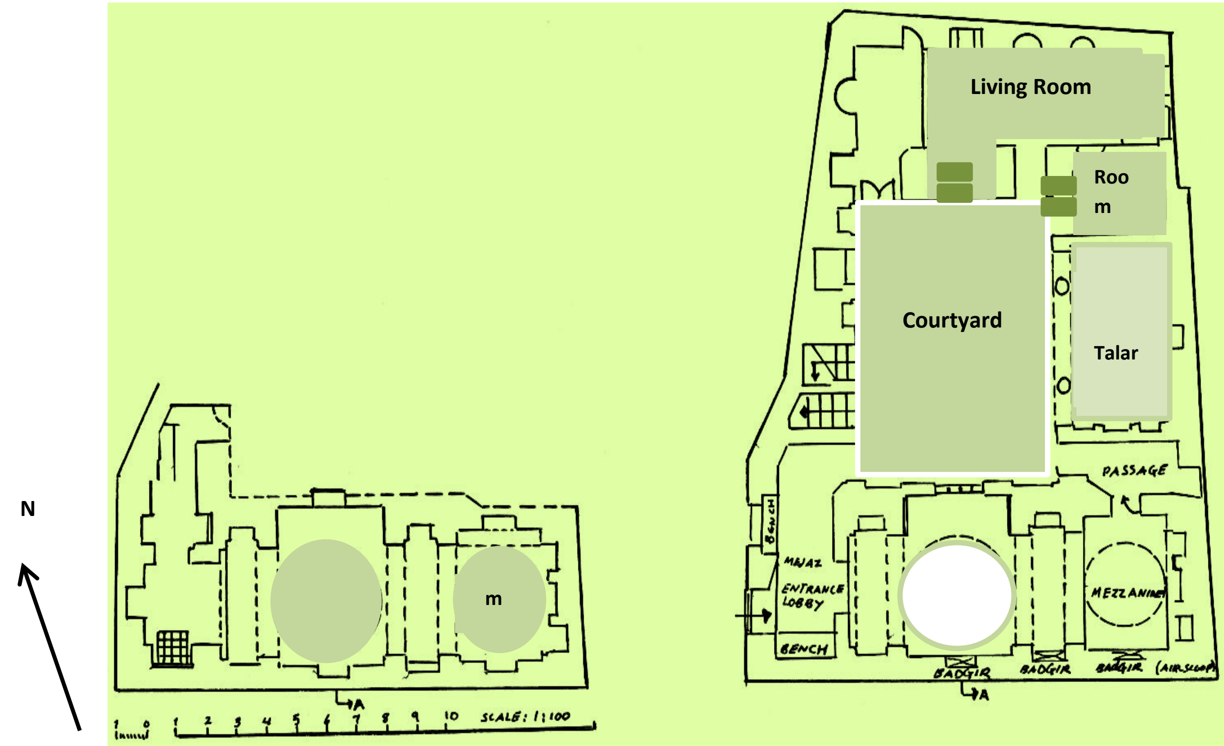


Fig. 4.5. **Basement level and ground floor level plans of traditional courtyard house No. 2. Scale: 1:50**

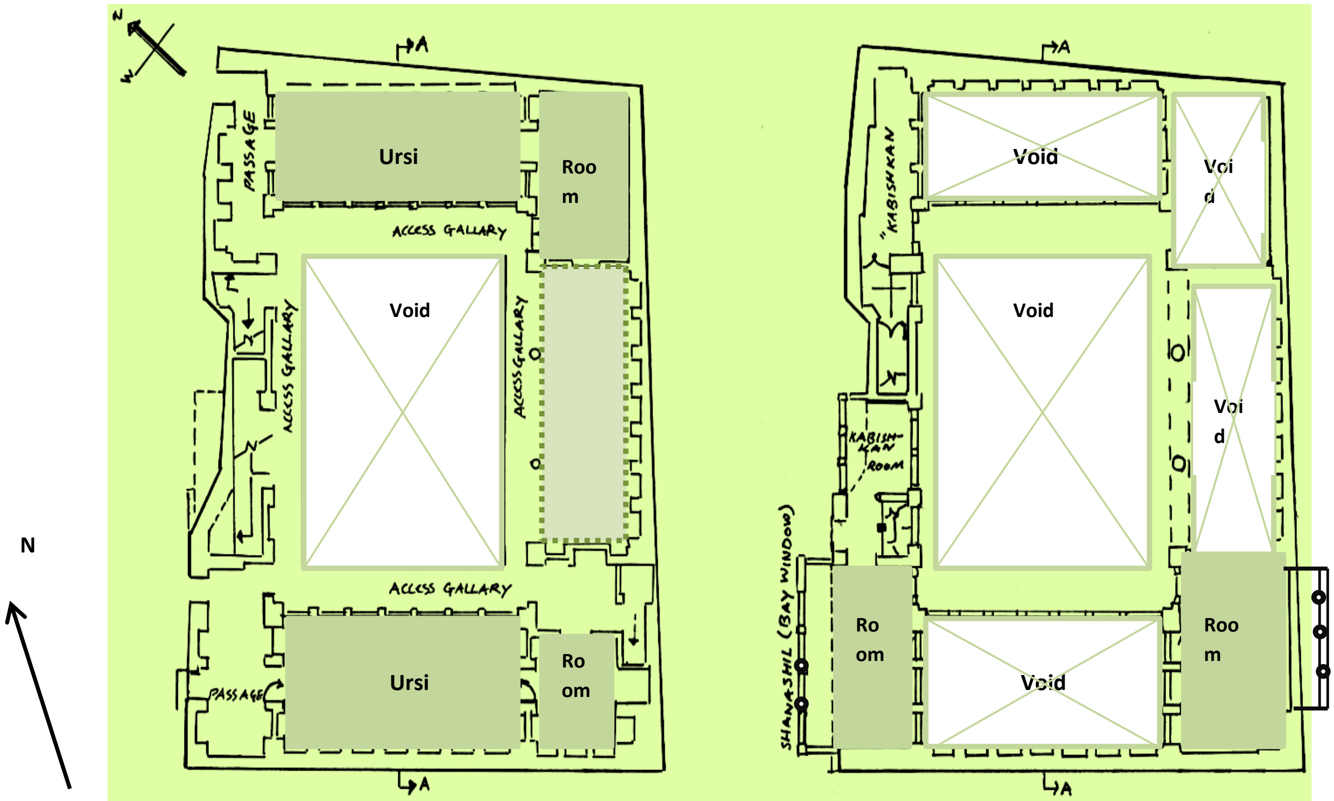


Fig. 4.6. **First floor level plan and second floor level plan of traditional courtyard house No. 2. Scale: 1:50**

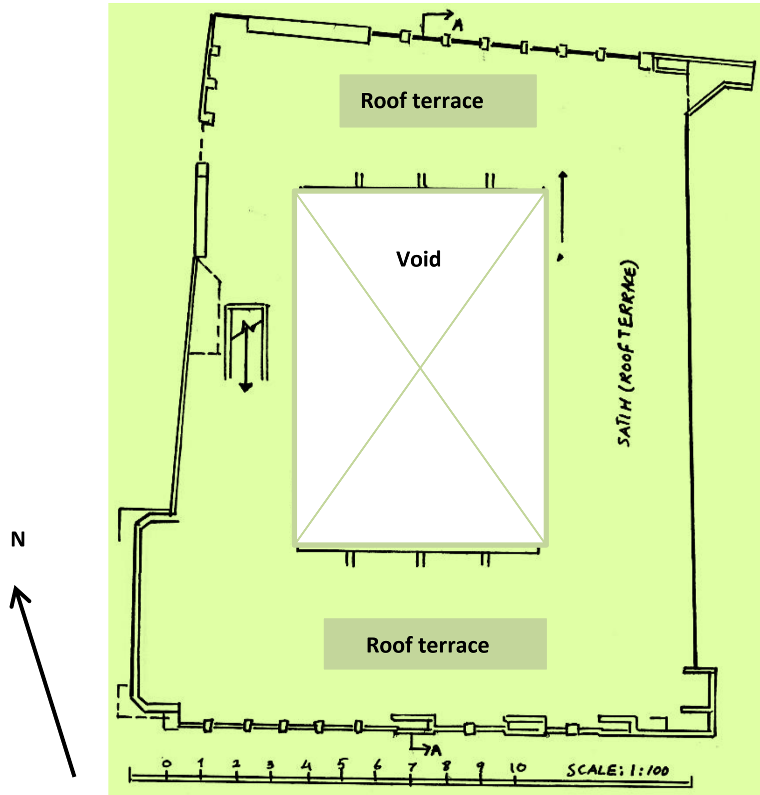


Fig. 4.7. Roof terrace level plan of traditional courtyard house No. 2. Scale: 1:50

Table 4.4. Services for internal and external spaces in TH2

Internal Spaces	**Services: Cooling/Heating**
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Semi-basement level room (Neem)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Main bedroom (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
Bedrooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
Kabishkan room - Mezzanine level	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded gallery (Talar)	N/A
Roof terrace	N/A

In plan the traditional courtyard house No. 2 (TH2) is considered a large-sized house (see Figures 4.5–4.7). This house (220 m^2) consists of ground floor level, first floor level, mezzanine level and roof terrace. At the ground floor level the house incorporates a large courtyard which is located at the centre of the house with all the habitable rooms and spaces around it. The ground floor incorporates an entrance lobby (Mejaz) and the colonnaded gallery (Talar) which is facing NE of the house and also has a living room which is facing N and the one bedroom. The traditional courtyard house No. 2 has a basement level room (Sirdab) and semi-basement level room (Neem). The house has one kitchen and one bathroom.

At the first floor level the house has two winter rooms (Ursi) which are located at both sides of the house, one of them is facing N and the other one is facing S. The first floor level incorporates two bedrooms, one of them is facing N and the other is facing S. The house also consists of the mezzanine level which incorporates two mezzanine level rooms (Kabishkan) with bay windows (Shanashil) which have been indicated in the plan as a room, one of them is facing NW and the other one is facing SE. The bay windows are overlooking the alleyways. The roof terrace is always flat and it covers the whole area of the house.

The TH2 is equipped with a cooling system which has been installed in the living room and the bedroom at ground floor level, and in the bedroom facing S at the first floor level. The house has also a natural ventilation system (Badgir) particularly in the basement level room (Sirdab) (see Table 4.4).

The inhabitants of TH2 are using their house according to the season of the year, using different habitable rooms and spaces in their house in different seasons and at different times of the day.

Occupant Observation

Summer: Sometimes in the early morning during the summer the inhabitants used the courtyard for their daily activities, such as having breakfast and washing clothes and sometimes cooking; when the kitchen became very hot their cooking activity took place in the courtyard.

During lunch and early afternoon the courtyard became very hot; when the floor of the courtyard received direct sunlight the inhabitants' activities took place inside the house. The colonnaded gallery (Talar) was used by the inhabitants during the early morning as well for having breakfast and during the late afternoon for afternoon tea and also during the evening for receiving visitors and for the family social gatherings.

The inhabitants of this house use the living room most of the day for sitting, and having lunch. They used the basement level room (Sirdab) and the semi-basement level room (Neem) for afternoon siesta and enjoy the natural ventilation and natural daylight; sometimes they used the bedroom at the ground floor for the afternoon siesta. The bedroom at the ground floor level sometimes is converted to be a reception room for receiving adult male visitors. The roof terrace was used by the inhabitants as a sleeping area overnight in summer and also they may have their dinner there sometimes when it is cool and enjoy the cool air temperature in the clear sky.

Winter: The inhabitants use the first floor level more than the ground floor level during the winter. The inhabitants used the winter room (Ursi) most of the time during the day for sitting, having lunch and even having dinner and receiving visitors and sometimes it has been used for the afternoon siesta.

The bedrooms at the first floor level are used for sleeping during the night in winter and sometimes for the afternoon siesta.

The mezzanine level rooms (Kabishkan) which are located at the mezzanine level incorporating bay windows (Shanashil) overlook the alleyways (see Figure 4.8). The Kabishkan rooms have been designed for winter habitation and particularly for receiving adult male visitors, and sometimes, at this house, they have been used by the female inhabitants for social gatherings.

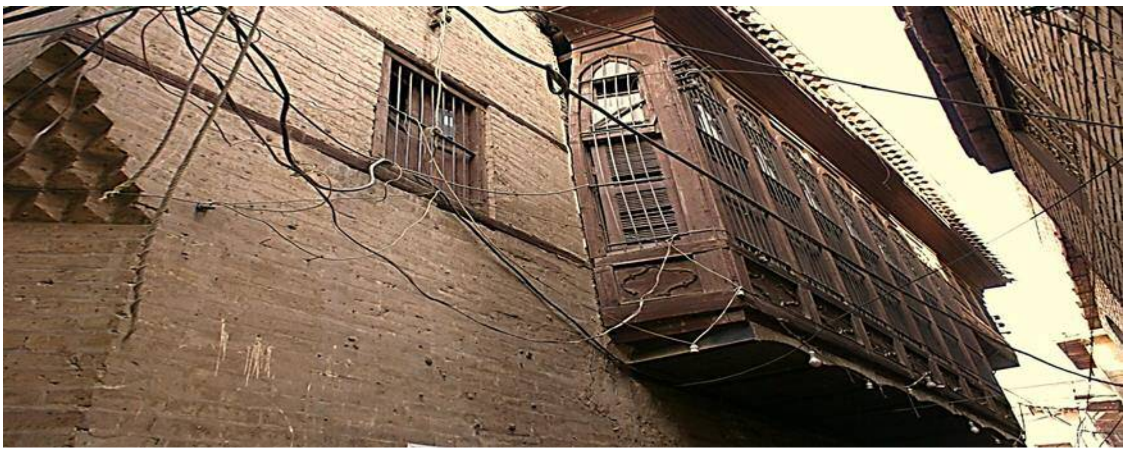


Fig. 4.8. Bay windows room at mezzanine level TH2 (Researcher)

Transition seasons, spring/autumn: There are no specific habitable rooms and spaces used by the inhabitants during spring/autumn. In spring the inhabitants are using the same habitable rooms and spaces which they used during the summer and in autumn the inhabitants are using the same habitable rooms and spaces which they used in winter. The transition seasons are cool and do not provide uncomfortable conditions.

The TH2 is exposed to the spring/summer dust storms and during this period of time the house does not protect people from dust; the courtyard does not provide shelter to the inhabitants from the dust unless it has been covered. The habitable rooms open onto the courtyard and they are not protected from the dust as well.

Table 4.5. Summer occupation of internal and external spaces for TH2

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	N/U	N/U	N/U	N/U
Kabishkan room (mezzanine level)	N/U	N/U	N/U	N/U
External Spaces				
Courtyard	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	Eat	N/U	Socialise	N/U
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.6. Winter occupation of internal and external spaces for TH2

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi room (first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
Kabishkan room (mezzanine level)	Socialise	Socialise	Socialise	Socialise
External Spaces				
Courtyard	Eat/cook	Socialise	N/U	N/U
Colonnade gallery (Talar)	Eat	Socialise	N/U	N/U
Roof terrace	N/U	N/U	N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time Green: Frequently used at this time

4.2.1.3. *Traditional house No. 3 – TH3*

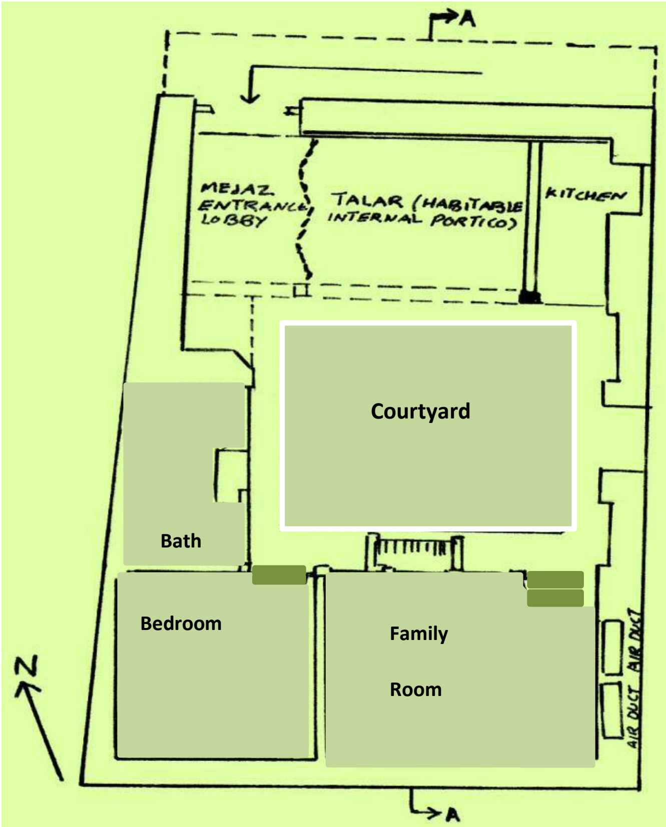


Fig. 4.9. **Ground floor level plan of traditional courtyard house No. 3. Scale: 1:50**

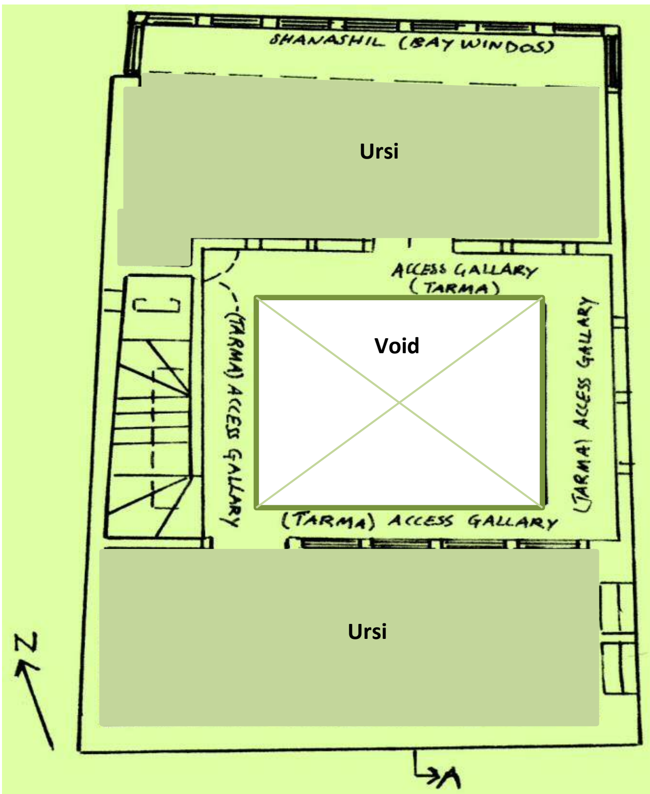


Fig. 4.10. **First floor level plan of traditional courtyard house No. 3. Scale: 1:50**

Table 4.7. Services for internal and external spaces for TH3

Internal Spaces	**Services: Cooling/Heating**
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Main bedroom (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded gallery (Talar)	N/A
Roof terrace	N/A

In plan the traditional courtyard house No. 3 (TH3) is considered a medium-sized house (150 m^2). This house consists of two storeys (ground floor level and first floor level with a roof terrace) (see Figures 4.9 & 4.10 above).

At the ground floor level the house incorporates a courtyard which is located in the centre of the house and the habitable rooms and spaces are looking inwards towards the courtyard. The house incorporates an entrance lobby (Mejaz) which insulates the interior of the house from the exterior. At the ground floor level there is the habitable colonnaded gallery (Talar) which is facing N. The house incorporates a large living room which is facing S and also a bedroom at the ground floor level facing SW.

TH3 has a small basement level room (Sirdab) which is underneath the floor of the courtyard and the house does not incorporate a semi-basement level room (Neem). The living room has inlets for the natural ventilation system (Badgir). The house has one kitchen and one bathroom. This house is fitted with a cooling system which operates in the living room and the bedroom at ground floor level; when the cooling system has been shut due to power cuts the inhabitants depend on the natural ventilation system.

At the first floor level the house incorporates two large winter rooms (Ursi); one of them is facing N and the other one is facing S. The Ursi room which is facing N incorporates bay windows (Shanashil) overlooking the alleyway. The house has a roof terrace which is flat.

The inhabitants of the TH3 have different activities during the summer, winter and during the transition seasons, spring and autumn.

Occupant Observation

Summer: The inhabitants of this house sometimes use the courtyard for their daily activities during the summer; the courtyard was used in the morning for having breakfast and sometimes breakfast takes place in the habitable colonnaded gallery (Talar) which opens onto the courtyard. The courtyard was used in the late afternoon after it has been washed by water to increase the relative humidity and reduce the high air temperature; also the house incorporates a fountain and trees for the same purpose.

The living room was used by the inhabitants most of the time during the day for having lunch and for family social gatherings and also receiving visitors. The bedroom at the ground floor level has been used by the inhabitants sometimes for the afternoon siesta and sometime their afternoon siesta takes place in the basement level room (Sirdab). The inhabitants have dinner either in the courtyard or in the habitable colonnaded gallery (Talar) in the evening while they are sitting and watching TV.

The roof terrace was used by the inhabitants as a sleeping area overnight during the summer.

Winter: The inhabitants of TH3 use the courtyard for their daily activities sometimes in winter during the sunny days. The first floor level incorporates two large winter rooms (Ursi) with an access gallery (Tarma) on four sides. The inhabitants used the winter room (Ursi) most of the day during the winter for sitting and having lunch and also receiving visitors. The female inhabitants used the Ursi room which is facing S, and the other one which is facing N was used by the adult male visitors; this Ursi incorporates bay windows (Shanashil) overlooking the alleyways (see Figure 4.11).

The winter rooms (Ursi) are used also during the transition seasons spring and autumn and they have been used as a bedroom by the inhabitants during the winter.

At the TH3 some of the inhabitants’ activities take place on the roof terrace during the day. The inhabitants sometimes have their lunch on the roof terrace during the sunny days as the roof terrace is not used as a sleeping area during the winter.

Transition seasons, spring and autumn: The inhabitants are using the same habitable rooms and spaces during spring and autumn which they have used during the summer and winter. Most of the daily activities of the inhabitants take place in the courtyard during spring and autumn.

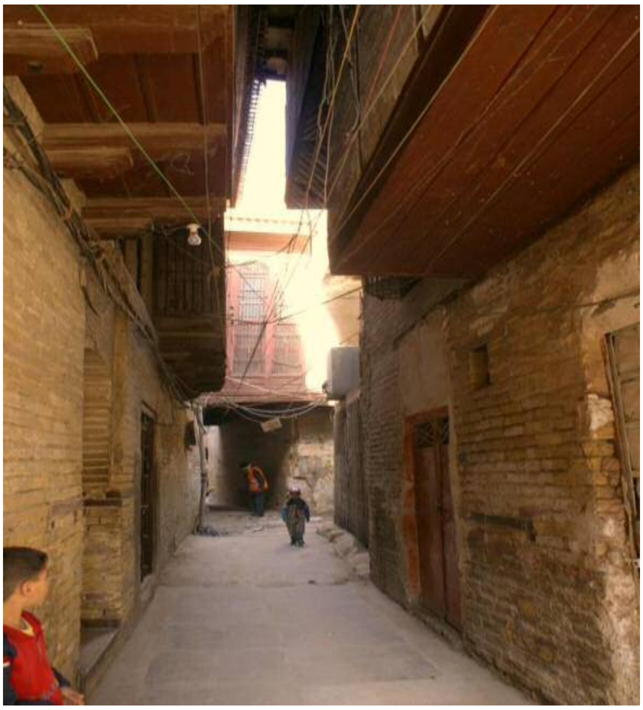


Fig. 4.11. The Ursi room overlooking the alleyway TH3 (Researcher)

Table 4.8. Summer occupation of internal and external spaces of TH3

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Sleep	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyard	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	Eat	N/U	Socialise	N/U
Roof terrace	N/U	N/U	N/U	Sleep

Key: Red: Never used N/U at this time Amber: Sometimes used at this time Green: Frequently used at this time

Table 4.9. **Winter occupation of internal and external spaces of TH3**

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi rooms (first floor)	Eat	Socialise	Socialise	Socialise/sleep
External Spaces				
Courtyard	Eat	Socialise	N/U	N/U
Colonnaded gallery (Talar)	Eat	Socialise	N/U	N/U
Roof terrace	N/U	N/U	N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.1.4. *Traditional house No. 4 – TH4*

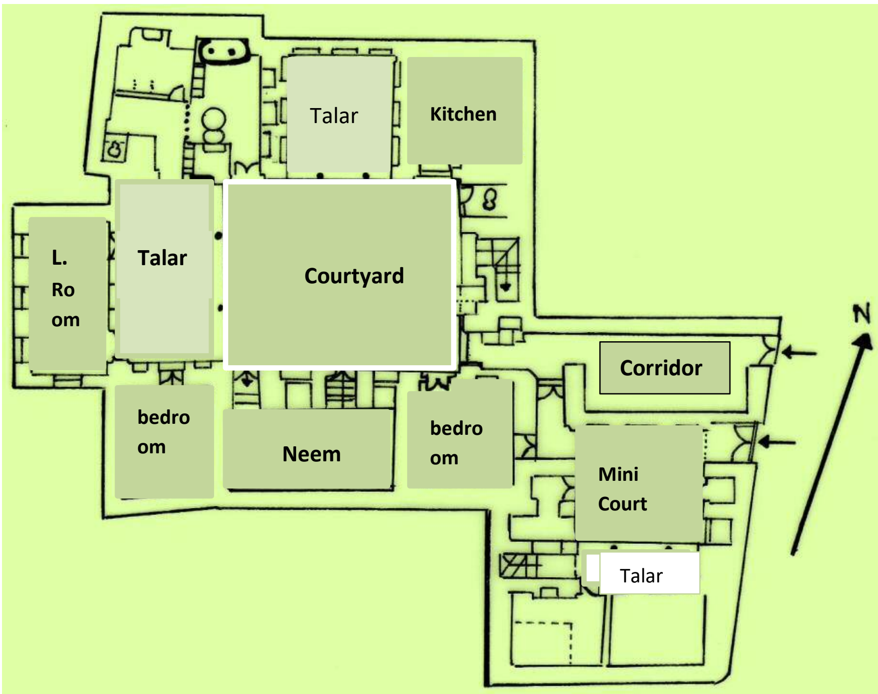


Fig. 4.12. **Ground floor level plan of traditional courtyard house No. 4. Scale: 1:50**

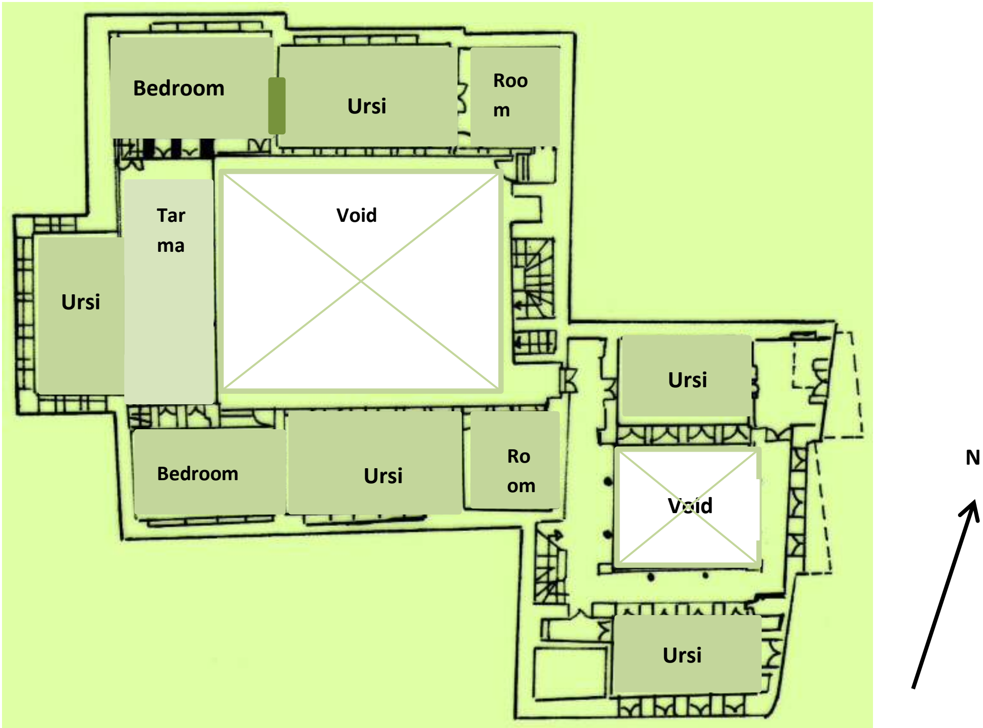


Fig. 4.13. **First floor level plan of traditional courtyard house No. 4. Scale: 1:50**

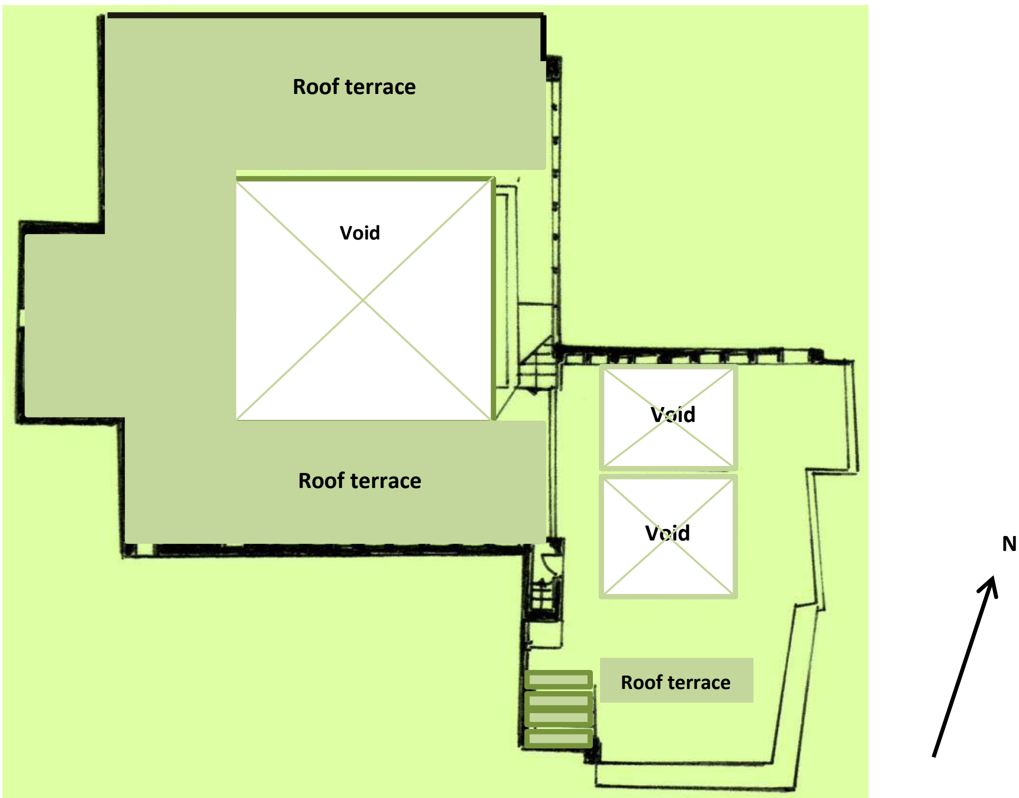


Fig. 4.14. **Roof terrace level plan of the traditional courtyard house No. 4. Scale: 1:50**

Table 4.10. Services for internal and external spaces in TH4

Internal Spaces	Services: Cooling/Heating
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Semi-basement level room (Neem)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Bedrooms (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
Bedrooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
External Spaces	
Main courtyard	N/A
Smaller courtyard	N/A
Colonnaded galleries (Talar)	N/A
Colonnaded gallery (Tarma)	N/A
Roof terrace	N/A

In plan the traditional courtyard house No. 4 (TH4) is considered a large-sized house. This house (230 m^2) consists of two storeys (ground floor level, first floor level and roof terrace level) (see Figures 4.12–4.14).

At the ground floor level the house incorporates two entrance lobbies (Mejaz) (see Figure 4.15) which separate the interior of the house from the exterior alleyway. One of the entrance lobbies (Mejaz) leads to the mini courtyard and the other lobby leads to the large courtyard which is located in the centre of the house. The entrance lobbies incorporate an internal wall between them. The house has a small habitable colonnaded gallery (Talar) which opens onto the mini courtyard.

TH4 incorporates at the ground floor level two habitable colonnaded galleries (Talar) which open onto the courtyard, one is facing N and the other one is facing NW. The ground floor has a living room which is facing NW and also two bedrooms which are facing S. As a large-sized house the traditional house No. 3 incorporates a basement level room (Sirdab) which is located below the floor of the courtyard and a semi-basement level room (Neem) which is located above the basement level room (Sirdab). Also the house has one kitchen and one bathroom.

At the first floor level, there are five winter rooms (Ursi), two of them are facing N and the other two are facing S and the fifth one is facing NW. Two of the winter rooms (Ursi) overlook the colonnaded access galleries with their front elevation overlooking the mini courtyard. The other winter rooms (Ursi) overlook the colonnade access galleries with their front elevation overlooking the main courtyard of the house. There is also a bay window (Shanashil) overlooking the alleyway.

TH4 incorporates at the first floor level four bedrooms, two of them are facing N and the other two are facing S. There are two roof terraces; one is small which covers the whole area of the mini courtyard and the habitable rooms and spaces around it, and the large roof terrace covers the whole area of the main courtyard and the habitable rooms and spaces around it.

The inhabitants of TH4 have used the habitable rooms and spaces at different times of the day and at different seasons of the year.

Occupant Observation

Summer: The inhabitants of this house use the main courtyard sometimes for their daily activities during the summer, particularly in the early morning when it is still not too hot, they have breakfast, following which the courtyard is washed with water to produce a comfortable thermal environment. The main courtyard was used also during the late afternoon for afternoon tea and social gatherings and during the late evening when the inhabitants are having their dinner and watching TV. The habitable colonnaded galleries were used by the inhabitants sometimes for family social gatherings and receiving visitors, such as close friends and neighbours, during the late afternoon and in the evening.

The living room of this house was used by the inhabitants most of the day during the summer for sitting and having their lunch, and sometimes lunch took place in the kitchen; also the inhabitants used the living room for watching TV and for receiving their visiting relatives during the day.

The bedroom which is facing N was used by the inhabitants during the day for the afternoon siesta and sometimes their siesta took place in the basement level room (Sirdab) or in the semi-basement level room (Neem). The other bedroom which is facing S has been used for receiving adult male visitors during the summer. This bedroom acts as a reception room. The adult male visitors may have been received in the habitable colonnaded galleries which open onto the mini courtyard during the day.

The main roof terrace was used by the female inhabitants as a sleeping area overnight in the summer and the small roof terrace was used by the male inhabitants as a sleeping area overnight in the summer.

Winter: The first floor level at this house has been used by the inhabitants more than the ground floor level during the winter. They used the courtyard during the sunny days sometimes for having breakfast and sometimes just for sitting enjoying the sun. The main winter rooms (Ursi) were used by the female inhabitants most of the day for sitting, having lunch and dinner and also receiving visitors during the day and evening. The bedrooms were used by the inhabitants for sleeping during the night and also sometimes used in the afternoon for the afternoon siesta and sometimes their siesta took place in the winter rooms (Ursi).

The winter rooms (Ursi) at the TH4 have not been considered as multi-purpose rooms and were not used as bedrooms because the house has an adequate number of bedrooms. The small winter room (Ursi) which is located above the mini courtyard has been designed just for the male occupants' habitation and for receiving their adult male visitors during the day and in the evening during the winter. The inhabitants have been using the roof terrace sometimes during the winter, particularly during the sunny days for lunch and sometimes their lunch takes place in the courtyard.

Transition seasons, spring and autumn: The inhabitants use the same habitable rooms and spaces as during the summer and winter; there are no specific habitable rooms and spaces designed for spring and autumn habitation. They also have the same daily activities during the transition seasons. But the inhabitants use the courtyard for their daily activities during the spring and autumn more than during the summer and winter.

It is important to mention here that although this house has a natural ventilation system (Badgir) in operation, a cooling system has been installed in the house which operates in each habitable room at the ground floor level.

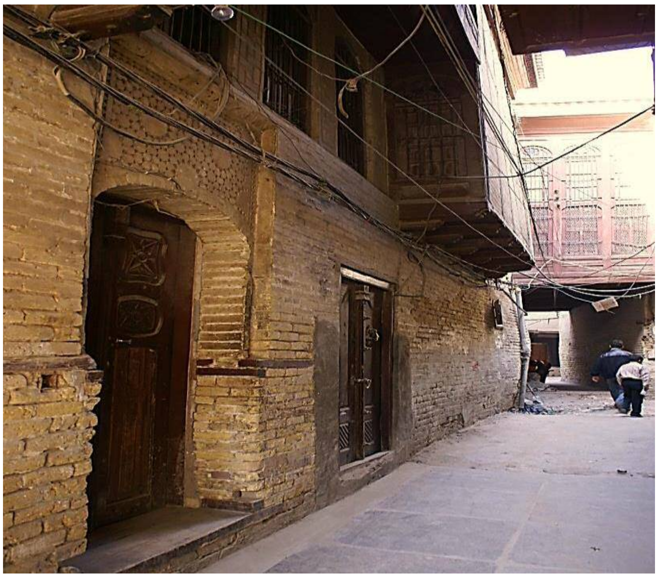


Fig. 4.15. The entrance lobbies of the TH4 (Researcher)

Table 4.11. Summer occupation of internal and external spaces in TH4

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Socialise	Socialise
Bedrooms (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyards	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	N/U	N/U	Socialise	Socialise
Colonnade gallery (Tarma)	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.12. Winter occupation of internal and external spaces in TH4

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Bedrooms (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi room (first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Courtyards	Eat/cook	Socialise	N/U	N/U
Colonnade gallery (Talar)	Eat	Socialise	N/U	N/U
Colonnade gallery (Tarma)	Eat	Socialise	N/U	N/U
Roof terrace		Eat		

Key: Red: Never used N/U at this time Amber: Sometimes used at this time. Green: Frequently used at this time

4.2.1.5. *Traditional house No. 5 – TH5*

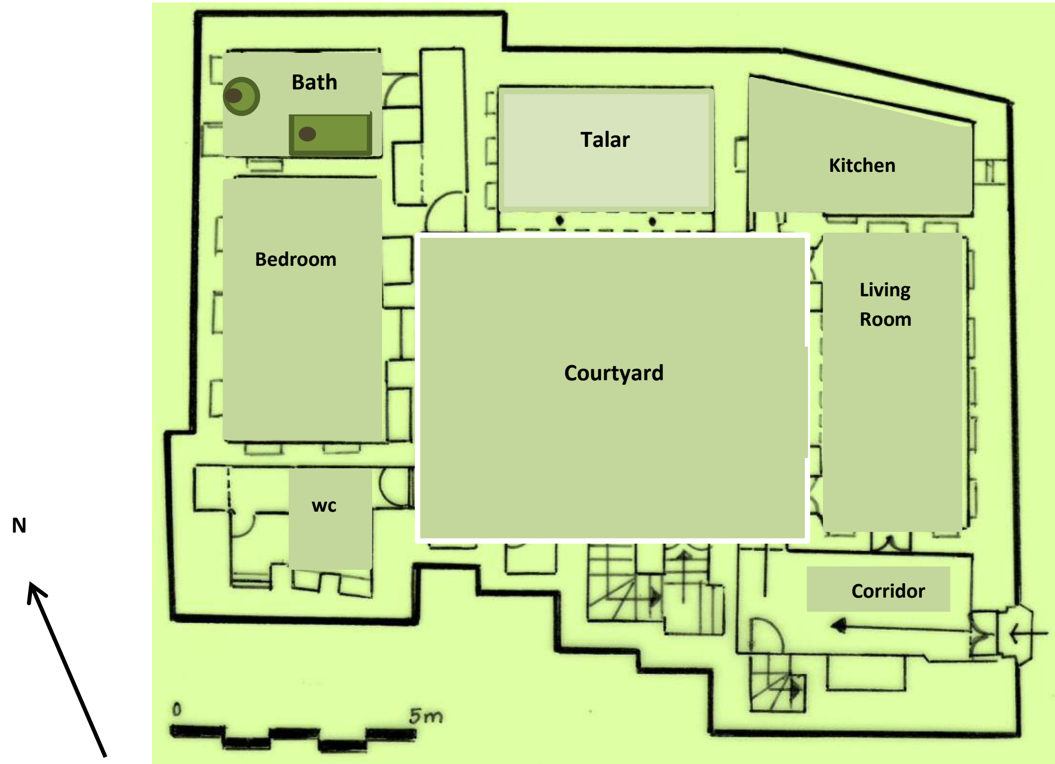


Fig. 4.16. Ground floor level plan of the traditional courtyard house No. 5. Scale: 1:50

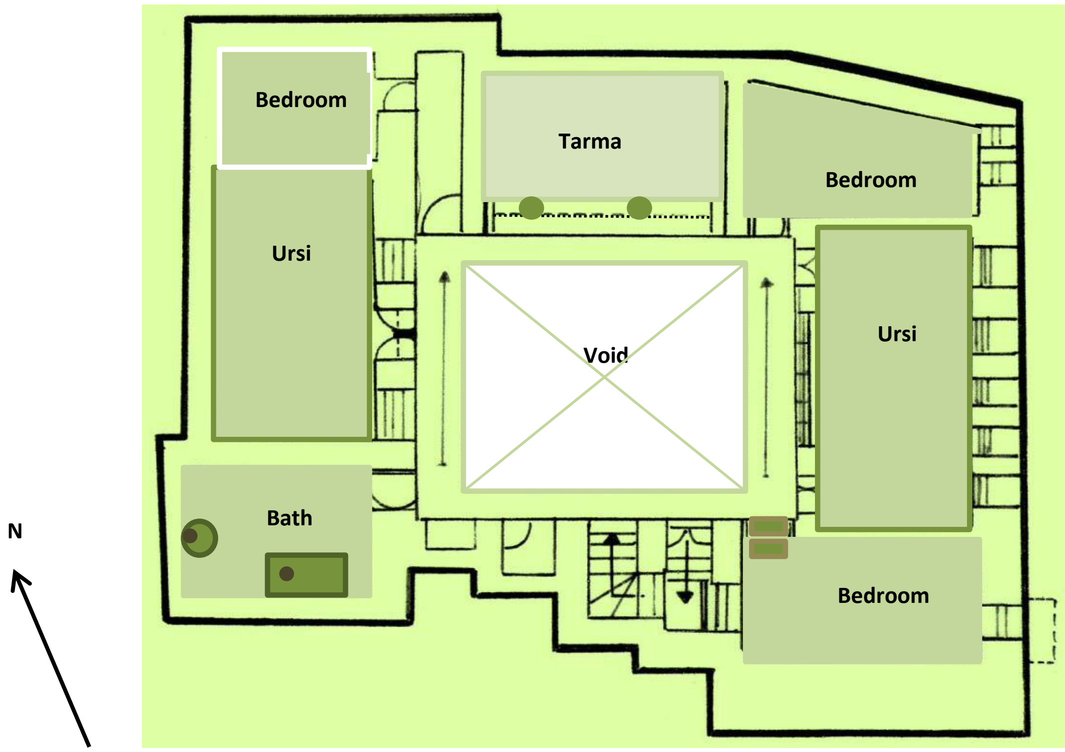


Fig. 4.17. First floor level plan of the traditional courtyard house No. 5. Scale: 1:50

Table 4.13. Services for internal and external spaces in TH5

Internal Spaces	Services: Cooling/Heating
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Main Bedroom (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
Bedrooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded galleries (Talar)	N/A
Colonnaded gallery (Tarma)	N/A
Roof terrace	N/A

In plan the traditional courtyard house No. 5 (TH5) is considered a large-sized house (240 m^2). The house consists of two storeys (ground floor level and first floor level with the roof terrace) (see Figures 4.16 & 4.17).

At the ground floor level the house incorporates an entrance lobby (Mejaz) which is facing SE of the house. This entrance lobby leads to the large courtyard which located in the centre of the house. The habitable rooms and spaces are looking inwards towards the courtyard.

The habitable colonnaded gallery (Talar) which is facing N opens onto the courtyard; there is a living room which opens onto the courtyard. Opposite the living room the house has a bedroom which is facing NW and opens onto the courtyard.

The house has a basement level room (Sirdab) which is underneath the floor of the courtyard and it does not have a semi-basement level room (Neem). The house has one kitchen and one bathroom at the ground floor level.

Although the TH5 has a natural ventilation system (Badgir) that covers the whole house with inlets of the Badgir in each habitable room, a cooling system has been installed in the house, which functions in the living room and the bedroom at the ground floor level.

At the first floor level, the house incorporates two large winter rooms (Ursi), one is facing NE and the other is facing NW. Also the first floor level incorporates a habitable colonnaded galley (Tarma) which is facing N, with the front elevation overlooking the courtyard. The first floor level has three bedrooms, two of them are facing N and the other one is facing S; it also has one bathroom at first floor level. The winter room (Ursi) which is facing NE has bay windows (Shanashil) overlooking the alleyway.

The inhabitants of TH5 have used different habitable spaces and rooms within their house in different seasons of the year.

Occupant Observation

Summer: In common with the majority of the inhabitants of traditional houses, the occupants have used the courtyard sometimes in summer because of the high air temperature and low relative humidity. In the very early morning they use the courtyard for having breakfast and for some daily activities such as washing kitchen appliances; however, in the late afternoon it is impossible to use the courtyard without using water to wash it to reduce the air temperature and increase the relative humidity. In addition, the courtyard was used sometimes in the late evening for family social gatherings.

The habitable colonnaded gallery (Talar) (see Figure 4.18) was used by the inhabitants just for receiving visitors during the day, such as in the late afternoon, because the Talar is located in the shaded area of the courtyard; it was also used during the evening.

The living room is the main room for the inhabitants during the summer, and it was used most of the time during the day for having lunch and dinner and for watching TV; sometimes lunch takes place in the kitchen. Also the inhabitants receive their visitors in the living room, in particular close friends and visiting relatives. The living room may be used by the inhabitants sometimes in the afternoon for the afternoon siesta.

The bedroom has been used as a reception room to receive adult male visitors, and sometimes used by the male inhabitants for the afternoon siesta. The basement level room (Sirdab) was used by the whole family in the afternoon for the afternoon siesta particularly when the cooling system is shut down.

Fig. 4.18. Colonnaded gallery (Talar) of the TH5 (Researcher)

The bedrooms at the first floor level are not be used during the summer; they are used just in the winter. The roof terrace has been used by the inhabitants as a sleeping area overnight in the summer.

Winter: The inhabitants of this house have been using the first floor level more than the ground floor level in winter. The winter rooms (Ursi) were used by the inhabitants most of the day in winter for having lunch and dinner and receiving visitors and also watching TV. The inhabitants of this house enjoy using the winter room (Ursi) during the winter, particularly the female inhabitants because this room provides them with privacy.

The winter room (Ursi), which is facing NW has been used by the male inhabitants and for their visitors during the day and early evening. The bedrooms at the first floor level are used by the inhabitants for sleeping in the night and also during the afternoon for the afternoon siesta.

The habitable colonnaded gallery (Tarma) has been used by the inhabitants for social gatherings and sometimes by the female inhabitants for receiving visitors such as neighbours.

Transition seasons, spring and autumn: No specific habitable rooms and spaces have been designed for spring and autumn habitation, as the transitional seasons are very short and cool and the inhabitants have no problems in using any habitable rooms and spaces during this period of the year. The inhabitants are using the courtyard almost every day for their daily activities during spring and autumn.

As with any traditional courtyard house, this house is exposed to the spring/summer dust storms. During this period, the house is not protected from the dust; the courtyard does not provide any protection to the inhabitants while they are using it for their daily activities. The windows and doors of the habitable rooms are shut during the dust storms.

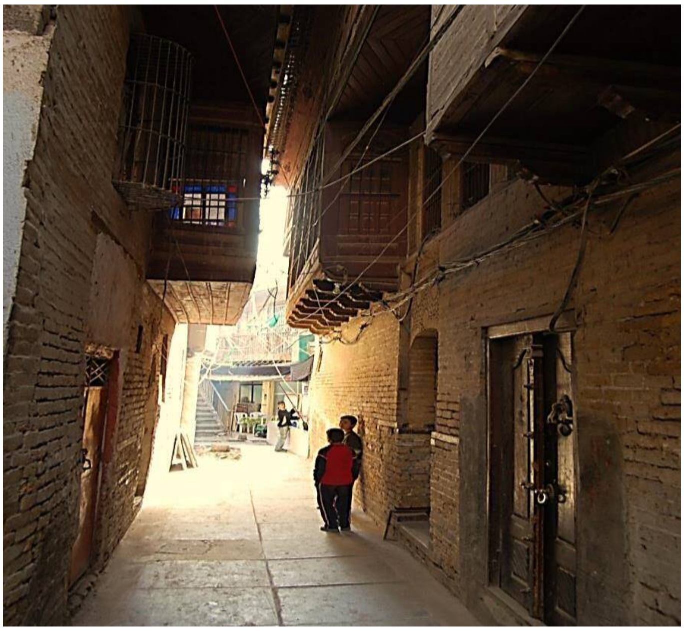


Fig. 4.19. The location of TH5 (Researcher)

Table 4.14. Summer occupation of internal and external spaces in TH5

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Socialise	Socialise
Bedrooms (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyards	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	N/U	N/U	Socialise	Socialise
Colonnade gallery (Tarma)	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Key: Red: Never used N/U at this time Amber: Sometimes used at this time. Green: Frequently used at this time

Table 4.15. Winter occupation of internal and external spaces in TH5

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Bedrooms (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi room first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Courtyards	Eat/cook	Socialise	N/U	N/U
Colonnade gallery (Talar)	Eat	Socialise	N/U	N/U
Colonnade gallery (Tarma)	Eat	Socialise	N/U	N/U
Roof terrace		Eat		

Key: Red: Never used N/U at this time Amber: Sometimes used at this time. Green: Frequently used at this time

4.2.1.6. *Traditional house No. 6 – TH6*

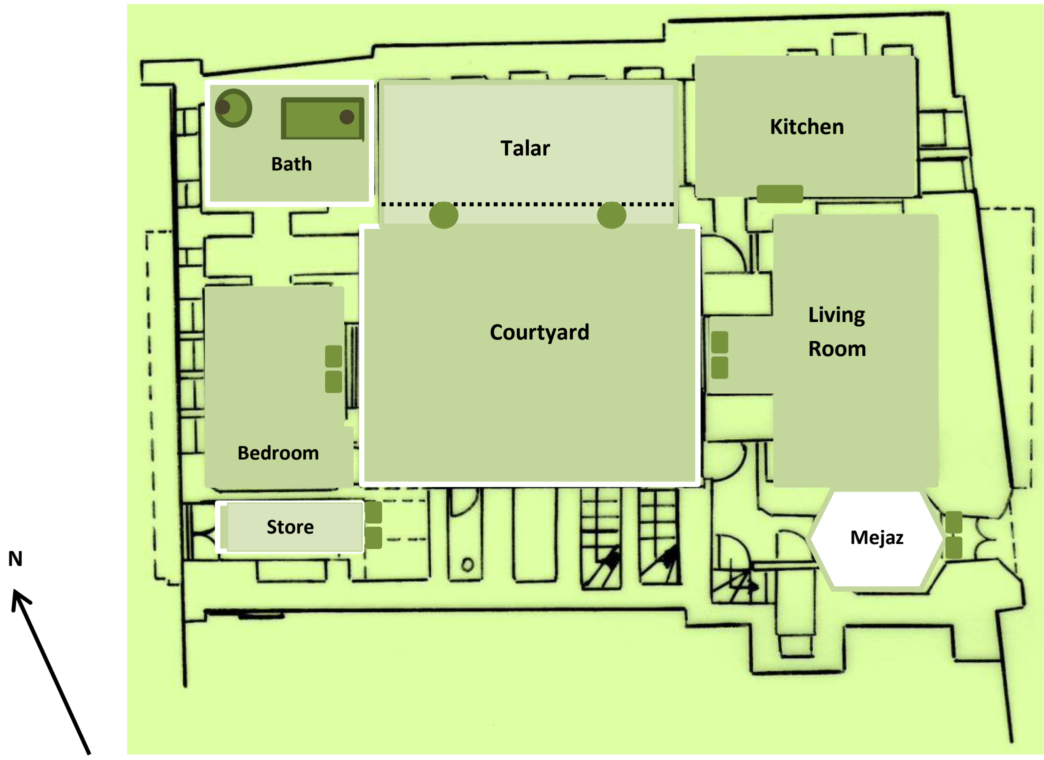


Fig. 4.20. Ground floor level plan of traditional courtyard house No. 6. Scale: 1:50

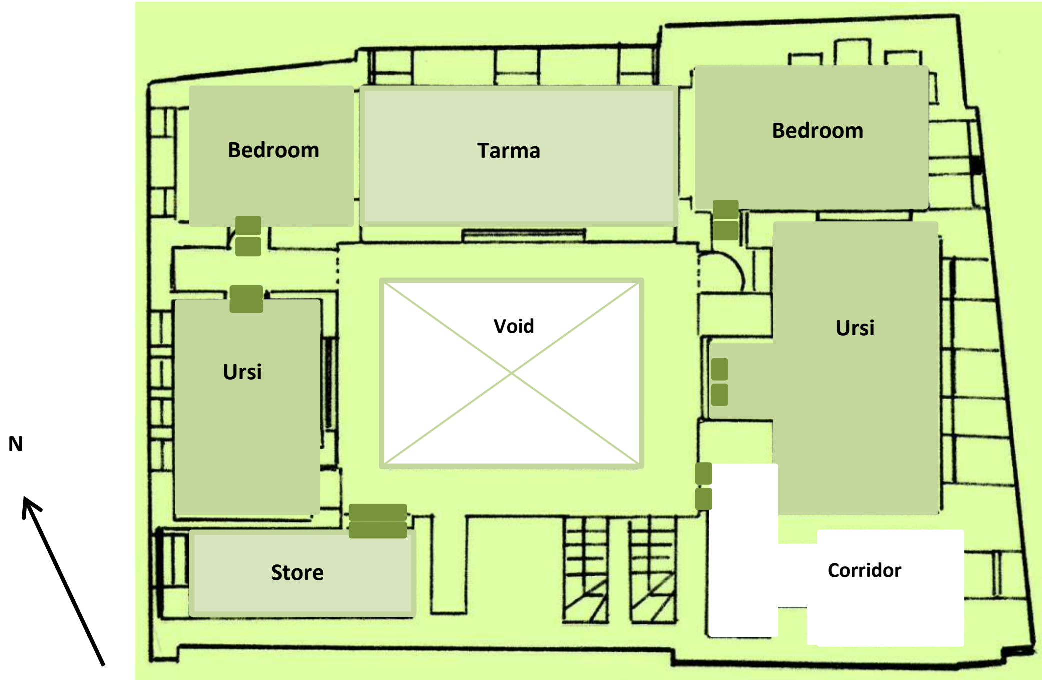


Fig. 4.21. **First floor level plan of traditional courtyard house No. 6. Scale: 1:50**

Table 4.16. Services for internal and external spaces in TH6

Internal Spaces	**Services: Cooling/Heating**
Basement level room (Sirdab)	**Cooling:** Natural ventilation - (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Main Bedroom (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation - (Badgir) **Heating:** Paraffin heaters
Bedrooms (first floor)	**Cooling:** Natural ventilation - (Badgir) **Heating:** Paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded galleries (Talar)	N/A
Colonnaded gallery (Tarma)	N/A
Roof terrace	N/A

In plan the traditional house No. 6 (TH6) is considered a large-sized house (240 m^2). The house consists of two storeys (ground floor level and first floor level with a roof terrace) (see Figures 4.20 & 4.21).

At the ground floor level the house incorporates an entrance lobby (Mejaz) at the front of the house and facing SE, and has a large courtyard in the centre of the house with the habitable rooms and spaces located around it.

The ground floor level incorporates a living room which is facing NE of the house and opposite is the bedroom which is facing NW of the house. Both the living room and the bedroom open onto the courtyard.

The ground floor level incorporates a habitable colonnaded gallery (Talar) which is facing N of the house and opens onto the courtyard. Also the house has a basement level room (Sirdab) which is located below the floor of the courtyard, and has no semi-basement level room (Neem).

At the first floor level the house has two winter rooms (Ursi), one is facing NE and the other one is facing NW of the house. There are two bedrooms, both of which are facing N of the house. The first floor level has a habitable colonnaded gallery (Tarma) which is facing N of the house; also there is another store at the first floor level.

The house has a roof terrace which is always flat and covers the whole area of the house.

The TH6 has been fitted with a cooling system which operates in the living room and the bedroom at the ground floor level, in addition to the natural ventilation system which has the inlets in each habitable room of the house (see Table 4.16).

Occupant Observation

Summer: The inhabitants use the ground floor level during the summer more than the first floor level. The courtyard is the main open space in the house and has been used by the inhabitants mainly in the very early morning to prepare and have their breakfast when some of the courtyard floor area is still in the shade. Also it was used in late afternoon for afternoon tea and for family social gatherings. The courtyard was also used during the evening for having dinner and watching TV until very late evening and also for receiving visitors such as neighbours, friends and visiting relatives.

The inhabitants also use the habitable colonnaded gallery (Talar) for the same activities, but sometimes the Talar has been used by the male inhabitants and their visitors.

The living room is the main habitable space for the inhabitants during the summer and they spend most of their time there during the day. It has been used for having lunch and sometimes having dinner; sometimes lunch takes place in the kitchen. The living room was also used for watching TV and receiving visitors who are related to the family.

The bedroom was used by the inhabitants just during the day for the afternoon siesta and sometimes the occupants used the basement level room (Sirdab) for the afternoon siesta. The inhabitants have used the roof terrace for sleeping in the night during the summer.

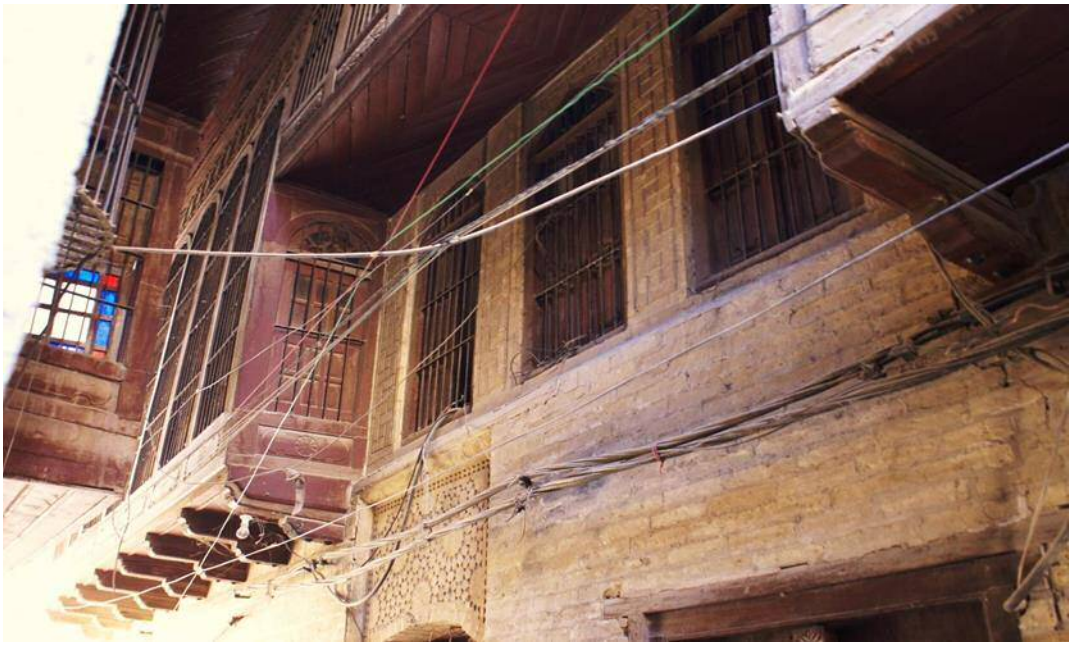


Fig. 4.22. The front elevation of the first floor level of TH6 (Researcher)

Winter: The first floor level was used by the inhabitants in winter more than the ground floor level. The inhabitants use the courtyard sometimes during the winter, particularly during the sunny days for having breakfast and sometimes for just sitting in the sun. The winter rooms (Ursi) act as a living room during the winter and have been used by the inhabitants most of the day (see Figure 4.23). The inhabitants of this house used the winter room (Ursi) for their lunch and receiving their visitors and also for their afternoon siesta. Also it was used by the inhabitants during the evening for watching TV and having dinner. And sometimes the Ursi room has been used by visitors for sleeping when the visitors stay overnight.

The bedrooms at the first floor level were used for sleeping during the night in winter. The habitable colonnaded gallery (Tarma) was used by the inhabitants during the morning for having breakfast and sometimes for lunch, particularly by the male inhabitants.

The roof terrace has been used by the inhabitants during the winter, for having their lunch during the sunny days and sometime for just sitting having a chat under the sun.

Transition seasons, spring and autumn: The inhabitants of this house feel comfortable using their habitable rooms and spaces during these transitional seasons. They have the same activities as during the summer and winter and they use the courtyard almost every day; this is due to the cool air temperature during spring and autumn.

The TH6 is exposed to the spring/summer dust storms and a result the house is not protected from the dust. Because the habitable rooms and spaces open onto the courtyard they have provided no protection from the dust. The inhabitants sometimes have to cover the courtyard when they have some occasions that need to take place in the courtyard.

Fig. 4.23. Inside the winter room (Ursi) of TH6 (Researcher)

Table 4.17. **Summer occupation of internal and external spaces in TH6**

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyards	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	N/U	N/U	Socialise	Socialise
Colonnade gallery (Tarma)	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Table.4.18. **Winter occupation of internal and external spaces in TH6**

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (Ground floor)	N/U	N/U	N/U	N/U
Main bedroom (Ground floor)	Sleep	N/U	Sleep	Sleep
Ursi room (First floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (First floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Courtyards	Eat/cook	Socialise	N/U	N/U
Colonnade gallery (Talar)	Eat	Socialise	N/U	N/U
Colonnade gallery (Tarma)	Eat	Socialise	N/U	N/U
Roof terrace		Eat		

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.1.7. *Traditional house No. 7 – TH7*

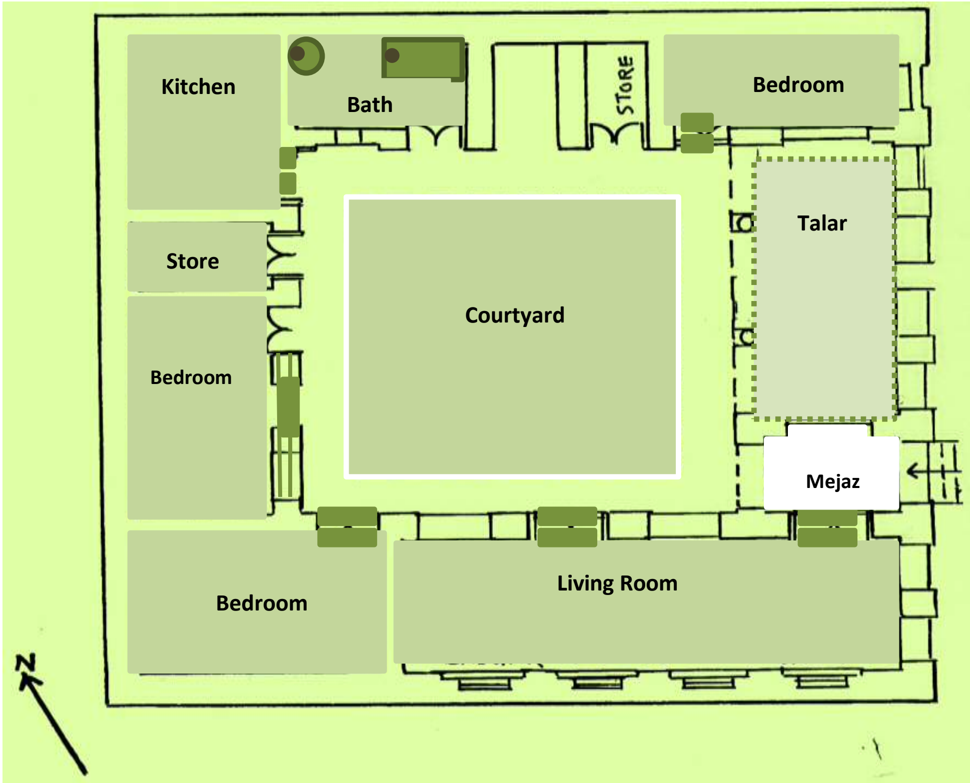


Fig. 4.24. **Ground floor level plan of traditional courtyard house No. 7. Scale: 1:50**

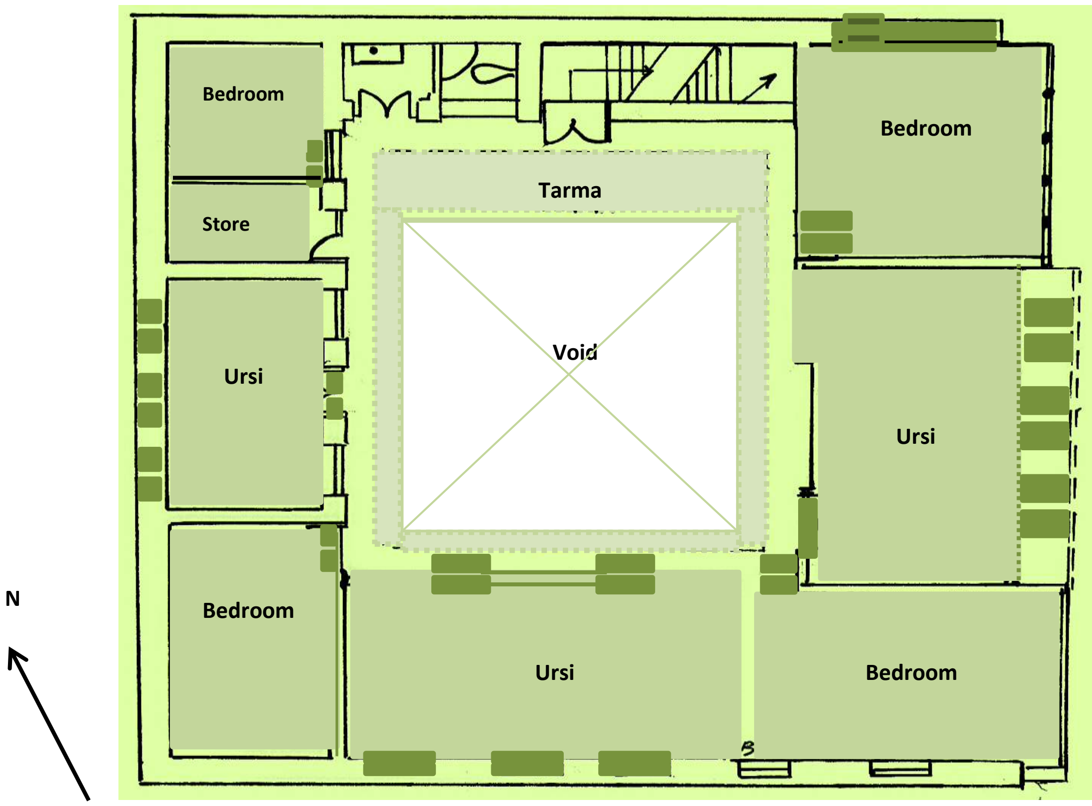


Fig. 4.25. **First floor level plan of traditional courtyard house No. 7. Scale: 1:50**

Table 4.19. Services for internal and external spaces in TH7

Internal Spaces	Services: Cooling/Heating
Basement level room (Sirdab)	**Cooling:** Natural ventilation (Badgir) **Heating:** N/A
Living room (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Main Bedroom (ground floor)	**Cooling:** Cooling system **Heating:** Paraffin heaters
Ursi rooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
Bedrooms (first floor)	**Cooling:** Natural ventilation (Badgir) **Heating:** Paraffin heaters
External Spaces	
Courtyard	N/A
Colonnaded galleries (Talar)	N/A
Colonnaded gallery (Tarma)	N/A
Roof terrace	N/A

In plan the traditional house No. 7 (TH7) is considered a large-sized house (250 m^2). The house consists of two storeys (ground floor level and first floor level with the roof terrace) (see Figures 4.24 & 4.25).

At the ground floor level, the house incorporates an entrance lobby (Mejaz) which is facing SE of the house and leads to the courtyard which is the main open and private space of the house. The habitable rooms and spaces look inwards towards the courtyard. The house has a habitable colonnaded gallery (Talar) which is facing NE of the house and opens onto the courtyard.

The house has three bedrooms on the ground floor, one is facing N and one is facing S and the other one is facing NW of the house; all of them open onto the courtyard. The ground floor level incorporates a living room which is facing S of the house and opens onto the courtyard.

Also the house has a basement level room (Sirdab) which is underneath the floor of the courtyard and depends on a natural ventilation system (Badgir) which has inlets in each habitable room and space. The house does not incorporate a semi-basement level room (Neem).

The house has one kitchen and one bathroom and one store on the ground floor level. Despite the existence of the natural ventilation system (Badgir), a cooling system has been installed in the house which functions in the living room and the bedrooms at the ground floor level. The house has two stores on the ground floor level.

At the first floor level, the house incorporates the three winter rooms (Ursi), one is facing NE, one is facing NW, and the other one is facing S of the house. There are four bedrooms at first floor level; two of them are facing N and the other two are facing S of the house. The first floor level has an access gallery (Tarma), with the front elevation overlooking the courtyard. The house has one store at the first floor level. The house incorporates a roof terrace which is always flat and covers the whole area of the house.

The inhabitants of the traditional house No. 7 are using different habitable rooms and spaces in the house throughout the day and night and during the different seasons of the year.

Occupant Observation

Summer: As in the other traditional houses, the inhabitants of this house are using the courtyard in the summer during the early morning for their daily activities, for having breakfast and for washing their clothes. In the late afternoon the courtyard was washed with water and used by the inhabitants for afternoon tea and receiving visitors, particularly neighbours.

In the evening, their dinner takes place in the courtyard and sometimes in the habitable colonnaded gallery (Talar), particularly for the male inhabitants. The habitable colonnaded gallery (Talar) has been used by the male inhabitants for receiving their visitors.

The living room was used by the inhabitants most of the day during the summer for sitting, having lunch and sometimes having dinner and receiving visitors, particularly by the female inhabitants; the living room was also used during the evening for sitting and watching TV.

One of the bedrooms at the ground floor level can be used as a reception room for the adult male visitors and the other bedrooms were used during the day for the afternoon siesta. And sometimes the afternoon siesta takes place in the basement level room (Sirdab), particularly when the electricity has been cut off.

Winter: The first floor level has been used by the inhabitants during the winter more than the ground floor level. The inhabitants used the courtyard sometimes during the winter because of the low air temperature and high relative humidity when they have been using it just during the sunny days.

The inhabitants used the winter rooms (Ursi) as living rooms which were occupied most of the time during the day and evening. The Ursi rooms were used by the inhabitants for sitting and talking, particularly by the female inhabitants. Sometimes they were used for having lunch and dinner and receiving visitors and sometimes for the afternoon siesta.

The bedrooms have been used by members of the whole family during the day for the afternoon siesta and during the night for sleeping. The roof terrace was used by the inhabitants during the sunny days just for sitting under the sun and conversing with each other.

Transition seasons, spring and autumn: The inhabitants use the courtyard every day during spring and autumn for their daily activities such as having breakfast, lunch and washing clothes and receiving visitors; also for the family social gatherings during the afternoon and early evening.

The inhabitants have used the habitable rooms and spaces of the house during the spring and autumn in the same way in which they have been used during the summer and winter.

The TH7 is exposed to the spring/summer dust storms and as in the other traditional houses, the house is not protected from the dust and provides no shelter to the inhabitants.

However, the inhabitants of this house have covered the courtyard during the dust storms and installed a ceiling fan for a temporary period, particularly when they have religious occasions which need to take place in the courtyard (see Figure 4.26).

Fig. 4.26. **The ceiling fans installed during the dust storms (Researcher)**

It is important point out here that all the traditional courtyard houses have a fountain which is located in the centre of the courtyard and have trees around these fountains which reduce the high air temperature and increase the relative humidity inside the house during the hot days in the summer.

Table 4.20. Summer occupation of internal and external spaces in TH7

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	Sleep	N/U
Living room (ground floor)	Eat	Socialise	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Ursi room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	N/U	N/U	N/U	N/U
External Spaces				
Courtyards	Eat/cook	N/U	N/U	Socialise
Colonnade gallery (Talar)	N/U	N/U	Socialise	Socialise
Colonnade gallery (Tarma)	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Key: Red: Never used N/U at this time Amber: Sometimes used at this time Green: Frequently used at this time

Table.4.21. Winter occupation of internal and external spaces in TH7

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Sirdab/Neem	N/U	N/U	N/U	N/U
Living room (ground floor)	N/U	N/U	N/U	N/U
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Ursi room (first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Courtyards	Eat/cook	Socialise	N/U	N/U
Colonnade gallery (Talar)	Eat	Socialise	N/U	N/U
Colonnade gallery (Tarma)	Eat	Socialise	N/U	N/U
Roof terrace		Eat		

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.1.8. *Discussion*

Physical survey: In general all the traditional courtyard houses have been built in groups and this is one of the advantages of the traditional characteristics as the closeness between the houses provides the inhabitants with direct social connections with their neighbours. Also it has been found that all the traditional houses are built of two storeys (ground floor level, first floor level and the roof terrace).

The researcher has found that although the traditional houses have different sizes, they incorporate the same habitable rooms and spaces. Moreover, there are specific habitable rooms designed particularly for summer and winter habitation, such as the basement level room (Sirdab) and semi-basement level room (Neem) at the ground floor level for summer, and the winter living room (Ursi) at the first floor level. As the researcher has found, these habitable rooms are essential in the traditional courtyard house.

Some of the selected traditional houses have not incorporated an adequate number of the bedrooms, so some of the habitable rooms have been converted for this purpose, such as the winter room (Ursi) and the mezzanine level room (Kabishkan) that could be used by the inhabitants as a bedroom.

At the traditional house the floor to ceiling height at the ground floor is lower than the floor to ceiling height at the first floor level; this is because when the first traditional houses were built they were designed to be serviced naturally by the natural ventilation system (Badgir) and as a result the rooms do not need to be installed with ceiling fans. Cooling systems have been installed in traditional houses due to the climate changes in the last 30 years, as they were necessary to provide the inhabitants with comfort. It has to be mentioned here that the cooling system is not an air conditioning system. The roof terrace of all the traditional houses incorporate a parapet wall which is high enough to prevent overlooking by neighbours; this roof terrace provides the inhabitants with privacy.

The building materials are mostly bricks and wood; there are many columns at the ground and first floors and the building techniques involved are no longer used in the building industry.

Occupant observation: The researcher has found that all the inhabitants of the selected traditional houses have used their house in the same way and have the same daily activities during the summer/winter and transition seasons, spring and autumn.

The ground floor level has been used by the inhabitants during the summer more than the first floor level. They used the summer rooms during the day and the main living room and main bedroom at the ground floor level during the summer. In winter the habitable rooms and spaces at the first floor level were used by the inhabitants during this season. The courtyard remains one of the most important spaces in the house and some of the daily activities take place in the courtyard during the summer and winter during the sunny days.

The inhabitants of the traditional houses have used the courtyard in different times of the day during the summer and winter and transition seasons, spring and autumn, for their daily activities.

In summer: The courtyard has been used by the inhabitants sometimes in the early morning for having breakfast, washing and sometimes cooking. It was used in the late afternoon for afternoon tea after it was washed with water to reduce the high temperature and increase the relative humidity; it was also used for social gatherings.

The courtyard was used in the late evening for watching TV and for social gatherings and receiving visitors such as neighbours, friends and relatives and sometimes for having the dinner.

In winter: The courtyard was used by the inhabitants sometimes in the morning when it was a sunny day for having breakfast, cooking or for family gatherings. During the lunch time the inhabitants used the courtyard when it was a sunny day for having lunch.

In spring/autumn: The courtyard was used by the inhabitants during the spring and autumn almost every day in the morning for having breakfast, washing clothes and in the afternoon and early evening for receiving visitors and family social gatherings.

Each house of the seven selected traditional houses has adequate space which has been designed to respond to the social requirements of males and females in the house. There are habitable rooms designed to be used by the adult male visitors and other habitable rooms designed to be used by the female inhabitants and their visitors.

During the investigation it was discovered that the habitable rooms and spaces designed for winter habitation, such as the Ursi room, has the best orientation in winter because its external windows are oriented towards the sun. And the habitable rooms and spaces designed for summer habitation, such as the basement level room (Sirdab) and semi-basement level room (Neem), have the best orientation in summer because these habitable rooms and spaces are underneath the courtyard floor and as a result they are shaded from the sun.

4.2.2. Modern Houses

4.2.2.1. *Modern house No. 1 – MH1*

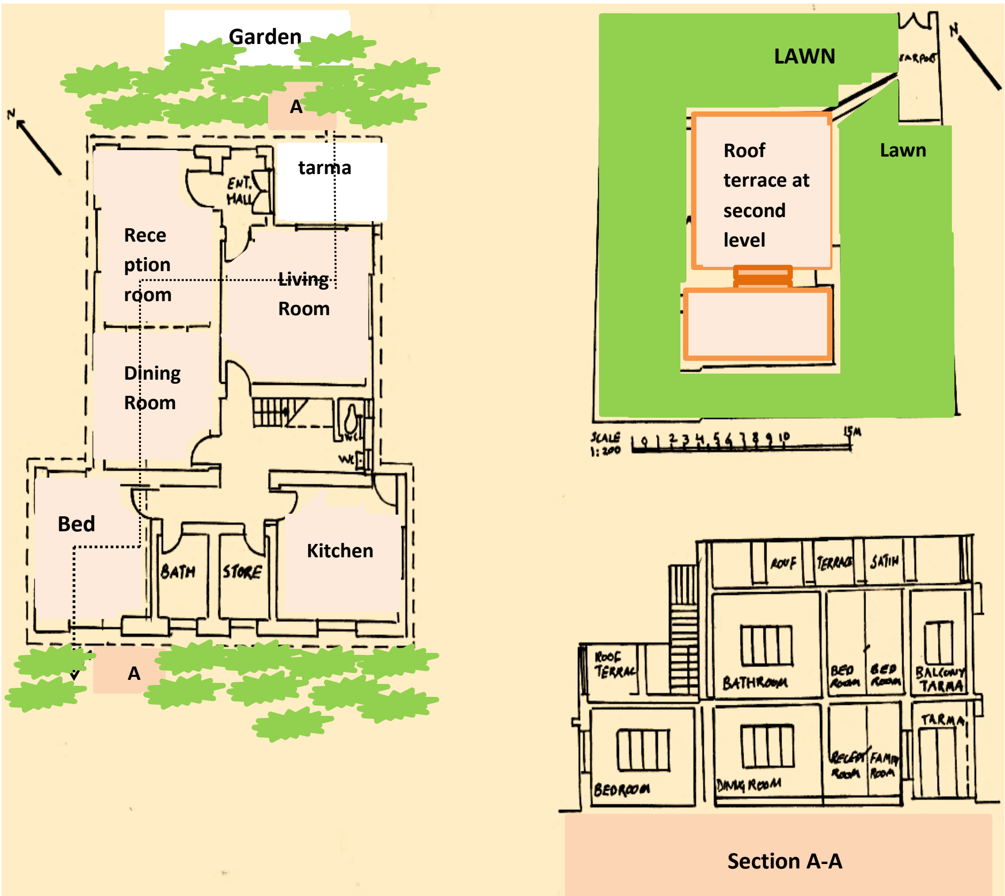


Fig. 4.27. Site plan and ground floor level plan with section A-A of modern house No. 1. Scale 1:100

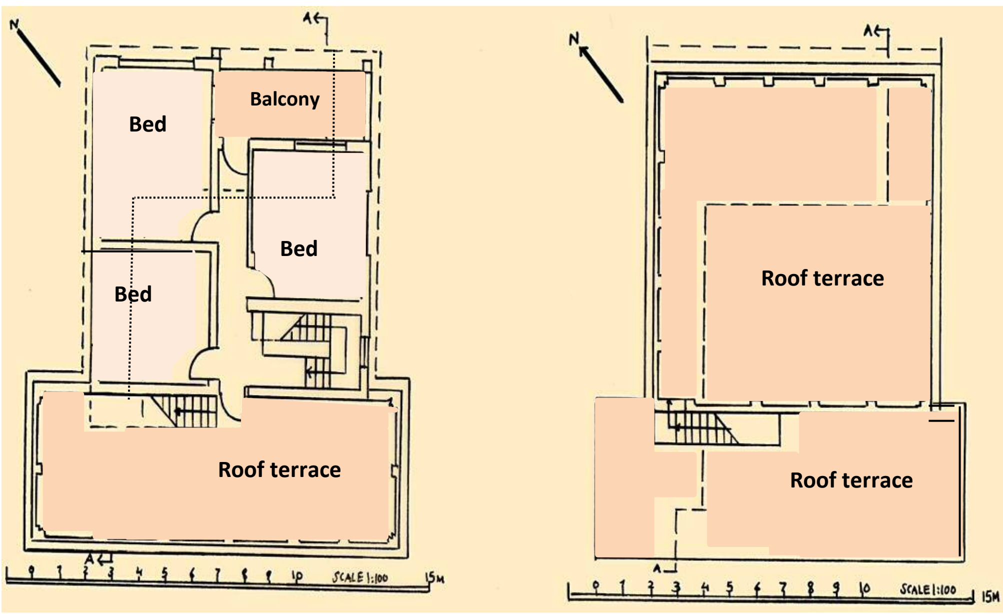


Fig 4.28. First floor level plan and roof terrace level plan of modern house No. 1. Scale: 1:100

Table 4.22. **Services for internal and external spaces in MH1**

Internal Spaces	Services: Cooling/Heating
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Reception room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Dining room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Main bedroom (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Open space (Tarma)	N/A
Roof terrace	N/A

In plan the modern house No. 1 (MH1) is considered a medium-sized house (250 m^2). The MH1 has been built as a detached house and is in part two storeys (ground floor level, first floor level and second floor level) (see Figures 4.27 & 4.28).

At the ground floor level the MH1 incorporates an entrance hall which is facing N of the home; this entrance leads to the interior of the house. Inside, the house incorporates a living room which is facing NE; this is the main habitable room of the house and has a large window overlooking the front open space (Tarma). The MH1 has a reception room and dining room which are both facing NW of the house. The ground floor level has one bedroom facing SW, one kitchen and one bathroom, and one store at the ground floor level.

The MH1 incorporates front and rear gardens; the garden is the only open space and it is not private.

At the first floor level the house has three bedrooms. There is a large bedroom facing N of the house that incorporates a balcony overlooking the front garden. Of the other two bedrooms, one is facing NW of the house and the other one is facing NE of the house.

The MH1 incorporates two roof terraces, one is located at the first floor level and the second roof terrace is located at the second floor level.

An air conditioning system has been installed in the MH1 which operates in all habitable rooms and spaces at the ground floor level and at first floor level. The MH1 is not connected to any other home in the neighbourhood.

The inhabitants of the MH1 have been using their home at different times of the day and at different seasons of the year.

Occupant Observation

Summer: The inhabitants of this modern house have used the ground floor level and first floor level during the summer. At the ground floor level the inhabitants used the living room, which is the main habitable room in the house, most of the time during the day. The living room was used in the morning by the inhabitants for having their breakfast, and sometimes for their lunch and dinner. Sometimes lunch and dinner take place in the dining room which is mainly used by visitors when invited for lunch or dinner. Also the living room has been used for receiving visitors, particularly close friends and visiting relatives and sometimes neighbours.

The reception room has been designed to receive visitors for both male and female inhabitants and it is not a private habitable room as the reception room at the traditional courtyard house.

Because of the absence of the basement level room (Sirdab) at the modern house, the inhabitants' afternoon siesta takes place in the bedrooms at the ground floor level and first floor level under the air conditioning system. In the evening the inhabitants occupy the living room for watching TV and having their dinner.

The garden is not used by the inhabitants of this house during the day for their daily activities during the summer because of the high air temperature and low relative humidity. It might be used during the late afternoon for afternoon tea or receiving visitors, after all the trees and the grass have been washed with water to increase the humidity.

The roof terrace of this home has been used by the inhabitants as a sleeping area overnight in summer.

Winter: At the modern house there are no specific habitable rooms and spaces designed for summer or winter habitation. The inhabitants of the modern house are using the same habitable rooms and spaces during the four seasons.

At the ground floor level the inhabitants have used the living room most of the day for the same activities during the summer. The inhabitants' lunch and dinner sometimes take place in the kitchen and sometimes in the living room. The reception room was used by visitors who are not related to the family and not close friends of both male and female inhabitants. The bedrooms at the ground floor level and first floor level were used by the inhabitants for the afternoon siesta and also for sleeping during the night in winter.

The front and rear gardens are not used by the inhabitants for their daily activities during the winter unless during the sunny days because of the low air temperature and high relative humidity. The roof terrace was not used by the inhabitants during the winter.

The MH1 is exposed to the spring/summer dust storms and the house is not protected from the dust. The garden is not protected from dust and provides no shelter to the inhabitants; the only protection they can get is to keep the doors and windows of the habitable rooms and spaces shut as they do not open directly to the garden.

Transition seasons, spring and autumn: The inhabitants are using the same habitable rooms and spaces in their house during the spring and autumn. The garden was used by the inhabitants almost every day for sitting in the afternoon for having tea and sometimes receiving visitors. The air conditioning system was used by the inhabitants during the spring/autumn less than during the summer. They might have used just the ceiling fans, particularly in the evening and during the early night.

Table 4.23. **Summer occupation of internal and external spaces in MH1**

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	**Eat**	**Eat**	**Socialise**	**Socialise**
Reception room (ground floor)	**N/U**	**N/U**	**Socialise**	**Socialise**
Dining room (ground floor)	**N/U**	**Eat**	**Eat**	**Eat**
Main bedroom (ground floor)	**Sleep**	**N/U**	**Sleep**	**N/U**
Bedrooms (first floor)	**Sleep**	**N/U**	**Sleep**	**N/U**
External Spaces				
Garden	**N/U**	**N/U**	**Socialise**	**Socialise**
Open space (Tarma)	**N/U**	**N/U**	**Socialise**	**Socialise**
Roof terrace	**N/U**	**N/U**	**N/U**	**Sleep**

Table 4.24. **Winter occupation of internal and external spaces in MH1**

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	**Eat**	**Eat**	**Socialise**	**Socialise**
Reception room (ground floor)	**N/U**	**N/U**	**Socialise**	**Socialise**
Dining room (ground floor)	**N/U**	**Eat**	**Eat**	**Eat**
Main bedroom (ground floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
Bedrooms (first floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
External Spaces				
Garden	**N/U**	**Eat/Socialise**	**N/U**	**N/U**
Open space (Tarma)	**N/U**	**Eat/Socialise**	**N/U**	**N/U**
Roof terrace	**N/U**		**N/U**	**N/U**

Key: Red: Never used N/U at this time **Amber: Sometimes used at this time**
Green: Frequently used at this time

4.2.2.2. *Modern house No. 2 – MH2*

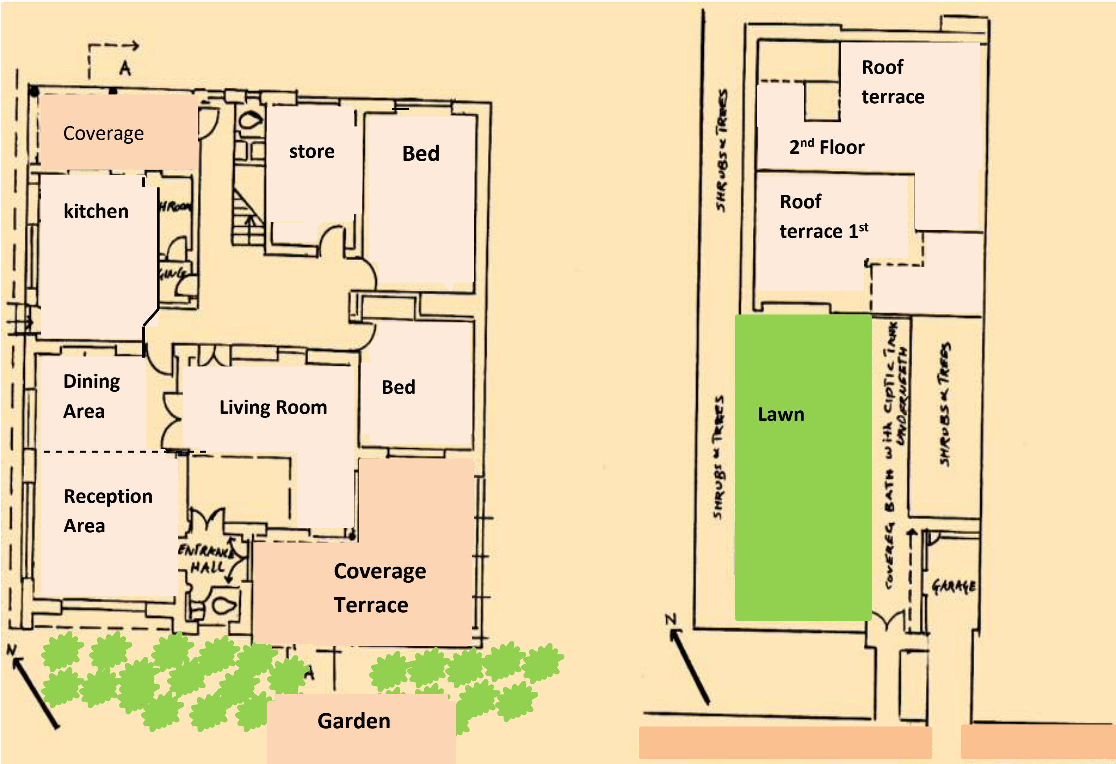


Fig. 4.29. Site plan and ground floor level plan of the modern house No. 2. Scale: 1:100

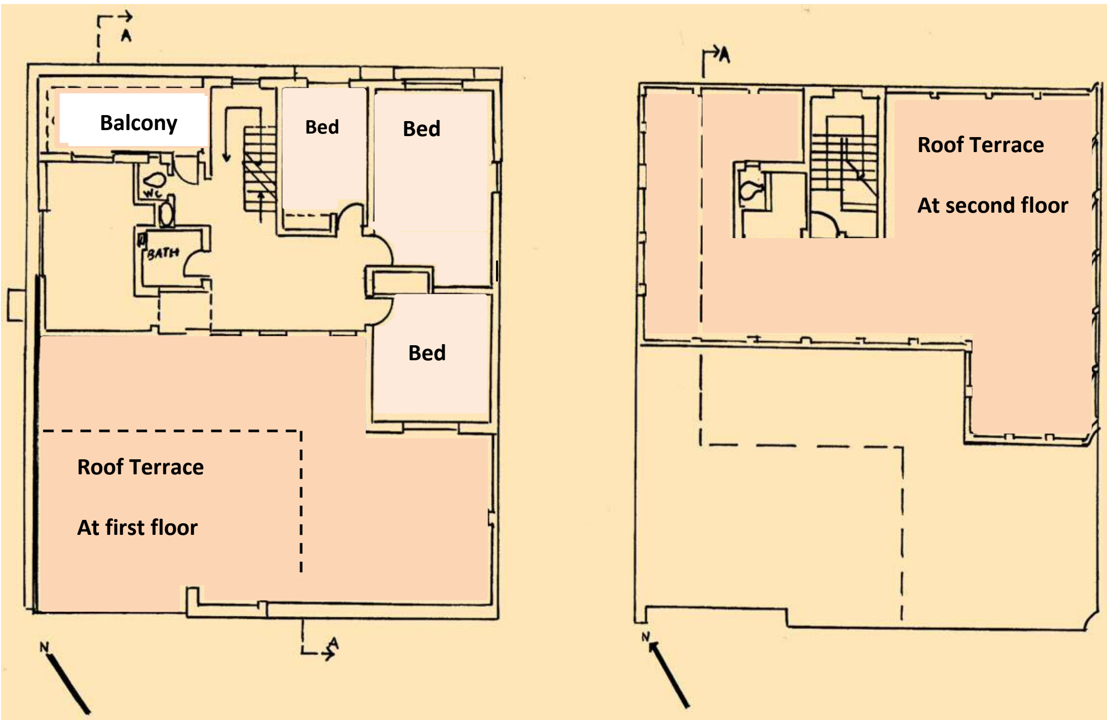


Fig. 4.30. First floor level plan and roof terrace at second floor level plan of the modern house No. 2. Scale: 1:100

Table 4.25. Services for internal and external spaces in MH2

Internal Spaces	Services: Cooling/Heating
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Reception room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Dining room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Main bedroom (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Covered terrace	N/A
Roof terrace	N/A

In plan the modern house No. 2 (MH2) is considered a large-sized house (360 m^2). The MH2 has been built as a detached house and it is in part two storeys (ground floor level, first floor level and second floor level) (see Figures 4.29 & 4.30).

At the ground floor level the house incorporates an entrance hall which is facing S of the house; this entrance leads to the living room and to the reception/dining room. In the front the house has a covered terrace which is overlooking the front garden. The living room incorporates a door which leads to the dining area.

The house has one kitchen and one bathroom. The kitchen is facing NW and incorporates a door which leads to the covered area at the back of the house.

The ground floor level incorporates two bedrooms, the small one is facing NE of the house and the large one is facing N of the house; also the ground floor level incorporates one store. The modern house No. 2 has a front garden.

At the first floor level, the house has three bedrooms; two bedrooms are facing N of the house and one bedroom is facing NE of the house. Also the first floor level incorporates one bathroom and toilet and a balcony which is overlooking the front garden. At the first floor level the roof terrace partially covers the ground floor level. The second floor level has a roof terrace which partially covers the first floor level.

An air conditioning system has been installed in MH2 which functions in all habitable rooms and spaces of the house.

The inhabitants of MH2 have used the same habitable rooms and spaces during the four seasons.

Occupant Observation

Summer: The inhabitants have not been using the garden during the day for their daily activities in summer due to the high air temperature and low relative humidity. The garden was used by the inhabitants during the very late afternoon for afternoon tea and for social gatherings and during the evening for receiving visitors and watching TV until late at night.

Inside the home, the living room has been used by the inhabitants of the modern house No. 2 almost all day, for sitting, receiving visitors during the day, such as neighbours or friends. The lunch and dinner take place in the kitchen.

The reception room was used by visitors during the day and during the evening and it was not used by the inhabitants of the home. Also the dining area was used just for the visitors of the family when they have been invited for lunch and dinner and was not used by the inhabitants.

The covered terrace which is located in the front of the home and overlooking the front garden was used by the inhabitants in the late afternoon for sitting, having afternoon tea and also during the evening for social gatherings.

The bedrooms at the ground floor level were used by the inhabitants during the day for the afternoon siesta and sometimes in the evening for watching TV. The bedrooms at the first floor level were used by the inhabitants just during the day for the afternoon siesta but have not been used for sleeping during the night in summer.

The roof terraces at the first floor level and at the second floor level were used as a sleeping area overnight in summer.

Winter: The inhabitants have not used the garden in winter during the day for their daily activities because of the low air temperature and high relative humidity but sometimes the garden was used just during the sunny days. The living room was used by the inhabitants during the winter most of the day and in the evening for sitting and watching TV and also for receiving visitors and for social gatherings. The reception room and dining room have been used by visitors of both male and female inhabitants but were not used by the inhabitants.

The bedrooms at the ground floor level were used during the day for the afternoon siesta and during the night for sleeping. The bedrooms at the first floor level were used by the inhabitants during the day and also for sleeping during the night in winter.

The roof terrace at first floor and second floor levels were not used by the inhabitants during the winter.

Transition seasons, spring and autumn: The inhabitants used the garden almost every day for sitting and for social gatherings during the spring and autumn. The inhabitants of this house have the same activities during the spring and autumn and they used the same habitable rooms and spaces as during the summer and winter, but just using the ceiling fans instead of the air conditioning system during the spring and autumn. The transitions seasons are very short and they can pass very comfortably.

The MH2 is exposed to the spring and summer dust storms and the house is not protected from dust during this period of the year. The inhabitants keep the doors and windows shut during the dust storms to have some protection.

As the MH2 has been built as a detached house it has no connection with other properties in the neighbourhood.

Table 4.26. Summer occupation of internal and external spaces in MH2

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Reception room (ground floor)	N/U	N/U	Socialise	Socialise
Dining room (ground floor)	N/U	Eat	Eat	Eat
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Covered terrace	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Key: Red: Never used N/U at this time Amber: Sometimes used at this time Green: Frequently used at this time

Table 4.27. **Winter occupation of internal and external spaces in MH2**

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	**Eat**	**Eat**	**Socialise**	**Socialise**
Reception room (ground floor)	**N/U**	**N/U**	**Socialise**	**Socialise**
Dining room (ground floor)	**N/U**	**Eat**	**Eat**	**Eat**
Main bedroom (ground floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
Bedrooms (first floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
External Spaces				
Garden	**N/U**	**Eat/ Socialise**	**N/U**	**N/U**
Covered terrace	**N/U**	**Eat/ Socialise**	**N/U**	**N/U**
Roof terrace	**N/U**		**N/U**	**N/U**

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.2.3. *Modern house No. 3 – MH3*

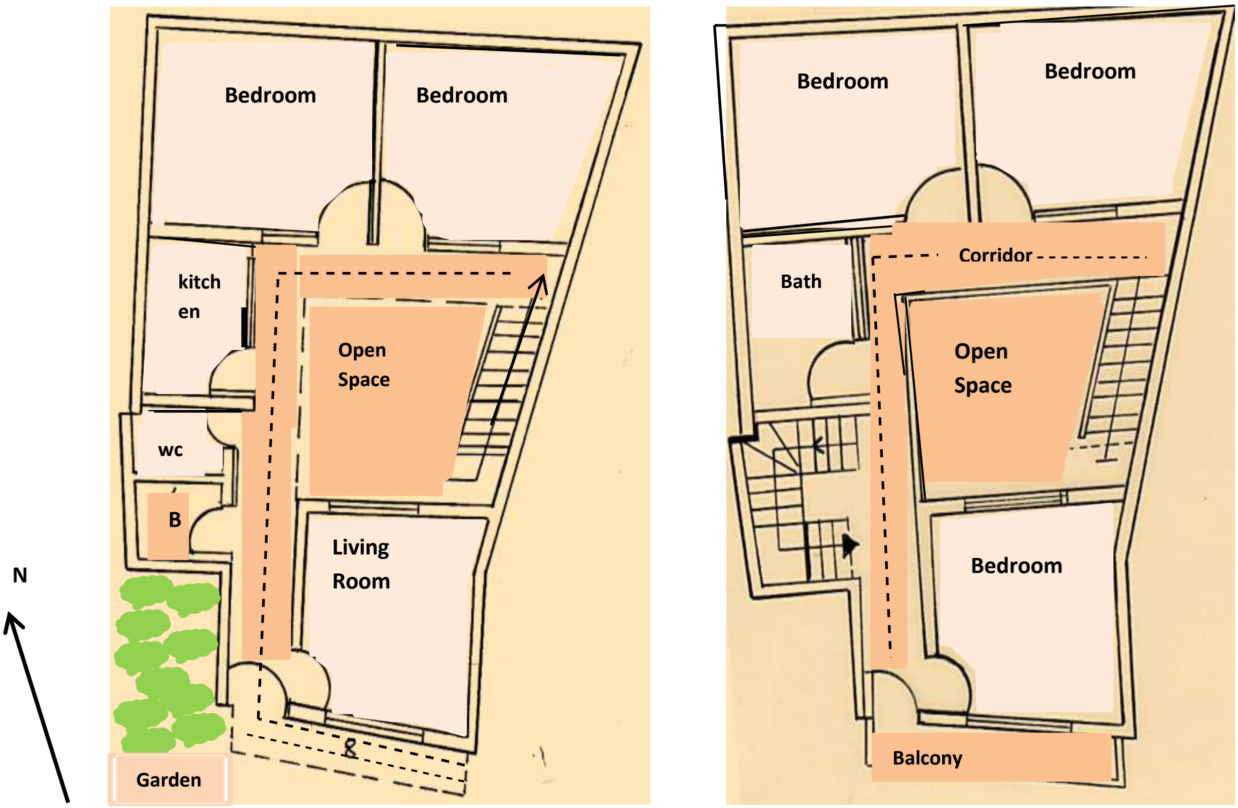


Fig. 4.31. Ground floor level plan and first floor level plan of the modern house No. 3. Scale: 1:100

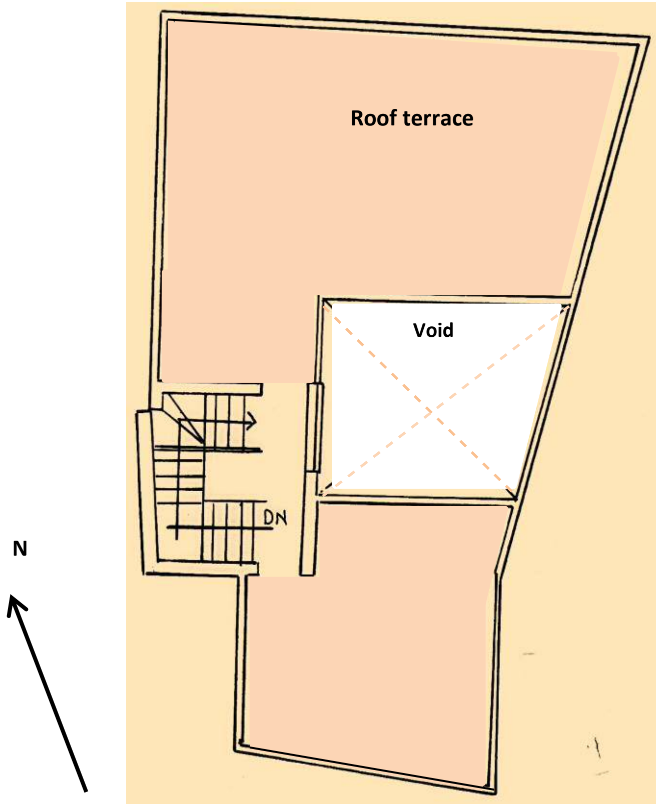


Fig. 4.32. **Roof terrace level plan of the modern house No. 3. Scale: 1:100**

Table 4.28. Services for internal and external spaces in MH3

Internal Spaces	**Services: Cooling/Heating**
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Roof terrace	N/A

In plan the modern house No. 3 (MH3) is considered a medium-sized house (220 m^2). This house has been built as a detached house and consists of two storeys (ground floor level, first floor level and roof terrace level) (see Figures 4.31 & 4.32).

At the ground floor level the house incorporates an entrance hall which leads to the interior of the home along a long corridor. The home consists of a living room which is facing S of the house and has a large window overlooking the front open space

(Tarma). The ground floor level incorporates an internal open space with two bedrooms which are facing N of the house. Each bedroom has a window overlooking the internal corridor. The house has one kitchen with a window overlooking the internal corridor and one bathroom and WC at the ground floor level. In the internal open space there is a stairs area which leads to the first floor level.

At the first floor level the house incorporates an internal open space which is located in the centre of the first floor. It also incorporates an internal corridor and balcony overlooking the front of the house. The first floor level has three bedrooms which are facing N of the house and one of the bedrooms has a window overlooking the internal corridor and the other bedroom which is facing S of the house has a large window overlooking the balcony. At the open space there is a stairs area which leads to the roof terrace level. The roof terrace is a flat area and covers the whole area of the first floor level. An air conditioning system has been installed in the MH3 which operates in all habitable rooms and spaces of the house.

Occupant Observation

Summer: The inhabitants of the MH3 did not use the garden during the day during the summer, but just in the evening for sitting or receiving visitors and sometimes watching TV until late evening.

Inside the house the inhabitants used the living room during the day and evening for sitting, watching TV and also for receiving visitors of both male and female inhabitants; as the MH3 does not incorporate a reception room the living room can be used as a reception room. When the male inhabitants received their visitors in the living room, the female inhabitants moved to stay in the bedrooms or in the kitchen.

The bedrooms at the ground floor level have been used by the inhabitants during the day only, particularly in the afternoon for the afternoon siesta.

The internal open space was used by the inhabitants as a dining area as this space is located opposite the kitchen; this dining area can be used by the inhabitants for having their lunch and dinner and has been used by visitors when invited for lunch or dinner. The inhabitants' lunch and dinner sometimes take place in the kitchen (see Figure 4.33).

Fig. 4.33. The kitchen of the MH3 (Researcher)

At the first floor level the bedrooms were used by the inhabitants just during the day in the afternoon and the internal open space at the first floor level was used by the inhabitants as a sitting area for watching TV during the day and evening. Sometimes this area was used for receiving visitors such as close friends or visiting relatives, particularly by the female inhabitants. The roof terrace has been used by the inhabitants as a sleeping area overnight during the summer.

Winter: The inhabitants used the outdoor space of the garden sometimes during the winter when it was a sunny day. It is impossible to use the garden during cold days and heavy rain. Inside the home, the inhabitants have used the living room for the same activities during summer and winter and also the internal open space was used in the same way by the inhabitants and by visitors. The bedrooms at the ground floor level were used by the inhabitants during the day for the afternoon siesta and for sleeping during the night. The family social gatherings sometimes took place in the kitchen during the day and evening in winter.

At the first floor level the inhabitants have used the internal open space as a sitting area for the family and for receiving visitors during the winter. The bedrooms were used by the inhabitants of the house during the day and night, during the day for the afternoon siesta and for sleeping overnight; they were also sometimes used during the evening for watching TV. The roof terrace was used by the inhabitants due to the low air temperature and high relative humidity during the winter.

Transition seasons, spring and autumn: The inhabitants used the outdoor garden almost every day during the spring and autumn, and particularly during the spring when the weather became cool and the thermal environmental conditions are comfortable.

Inside the house, the inhabitants used the habitable rooms and spaces during the spring the same way as during the summer, except they did not use the roof terrace as a sleeping area as they did in summer. The inhabitants have been using the habitable rooms and spaces during the autumn the same way as in winter.

During the spring and autumn the air conditioning system does not operate in the habitable rooms and spaces; the inhabitants use the ceiling fans instead. The MH3 is exposed to the spring/summer dust storms and the house is not protected from the dust during this period of time. The inhabitants need to keep all the doors and windows of the habitable rooms and spaces shut during the dust storm to have some protection inside the house. After the dust storms the inhabitants need to wash inside the house and the garden with water to remove the dust from the house.

Table 4.29. Summer occupation of internal and external spaces in MH3

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Bedrooms (ground floor)	Sleep	N/U	Sleep	N/U
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.30. Winter occupation of internal and external spaces in MH3

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (Ground floor)	Eat	Eat	Socialise	Socialise
Bedrooms (Ground floor)	Sleep	N/U	Sleep	Sleep
Bedrooms (First floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Garden	N/U	Eat/ Socialise	N/U	N/U
Roof terrace	N/U		N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.2.4. *Modern house No. 4 – MH4*

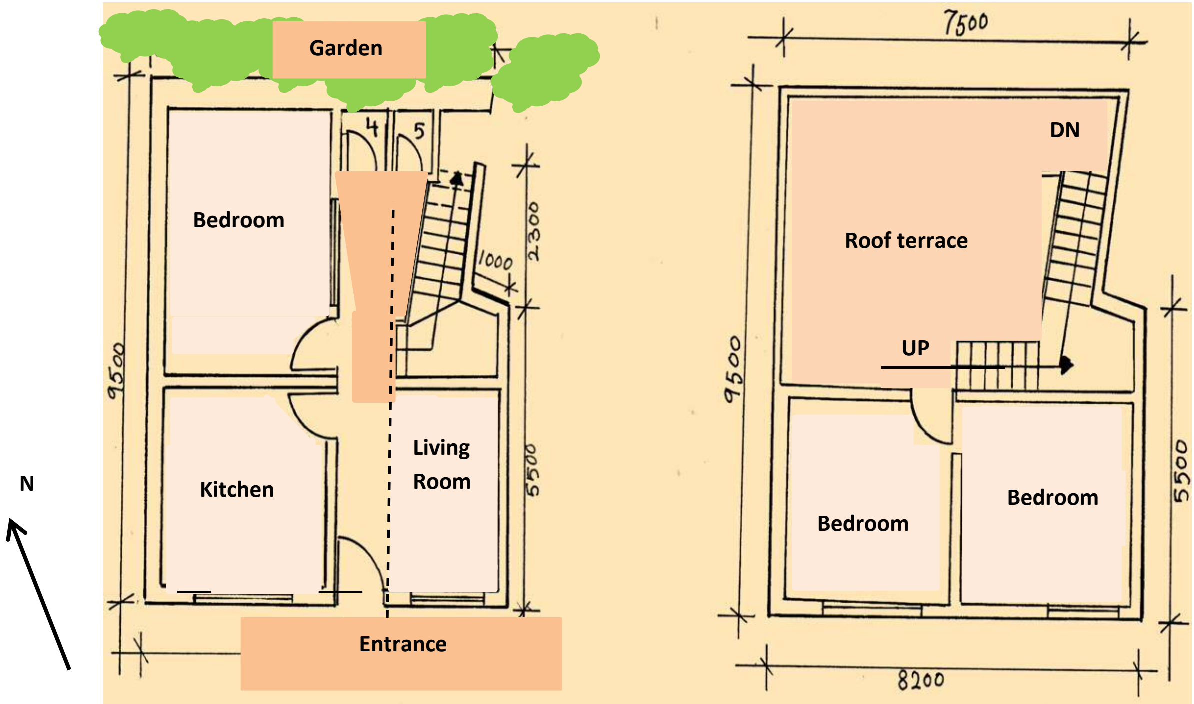


Fig. 4.34. **Ground floor level and first floor level plans of modern house No. 4. Scale: 1:100**

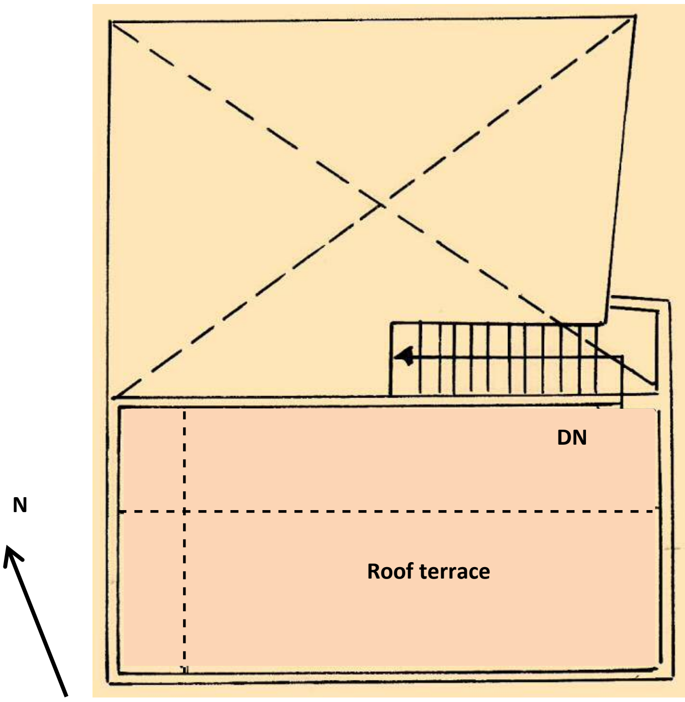


Fig. 4.35. **Roof terrace level plan of the modern house No. 4. Scale: 1:100**

Table 4.31. Services for internal and external spaces in MH4

Internal Spaces	**Services: Cooling/Heating**
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Main Bedroom (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Roof terrace	N/A

In plan the modern house No. 4 (MH4) is considered a small-sized house (170 m^2). This house was built as a semi-detached house and is two storeys in part (ground floor level, first floor level and the roof terrace level which is located at the second floor level) (see Figures 4.34 & 4.35).

The MH4 has a rear garden which is facing N of the house. At the ground floor level the house incorporates a front entrance which leads to the interior of the house. Inside the house there is a living room which is the main habitable room in the house and it faces S of the house; the living room has a window overlooking the front open space.

Opposite the living room there is a kitchen which is facing S of the house with a window overlooking the front open space of the house. The ground floor level has a shower and toilet. Beside the internal corridor there is a stairs area which leads to the first floor level.

At the first floor level the house incorporates two bedrooms which are facing S of the house and each bedroom has a window overlooking the main road. The first floor level has a roof terrace which partially covers the ground floor level. The roof terrace has a stairs area which leads to the roof terrace at the second floor level which partially covers the first floor level.

The MH4 has been equipped with an air conditioning system which functions in all the habitable rooms of the house.

The inhabitants of the MH4 have been using habitable rooms and spaces in their house at different times of the day during the four seasons.

Occupant Observation

Summer: As in the other modern houses, the inhabitants of this house do not use the outdoor space of the garden during the day in summer, particularly during the late morning and afternoon. They wash it with water in the very late afternoon just to reduce the air temperature and increase the relative humidity to prepare this area for use in the evening for sitting, having dinner and for family social gatherings, and also for receiving visitors such as neighbours, friends and visiting relatives for the male and female inhabitants.

The living room has been used by the inhabitants of the house most of the day in summer. As the living room is the main habitable room of the house the inhabitants spend most of their time in the living room during the day and evening (see Figure 4.36). It was also used for receiving visitors by both male and female inhabitants due to the absence of a reception/dining room.

The inhabitants' breakfast, lunch and dinner took place in the kitchen which was also used for sitting, particularly by the female inhabitants. The bedroom at the ground floor level has been used by the inhabitants during the day for sitting and receiving very close friends by the female inhabitants and also for the afternoon siesta. In the evening the bedroom was used for sleeping overnight by the old inhabitants who are not been able to sleep on the roof terrace.

Fig. 4.36. The living room of the MH4 (Researcher)

At the first floor level the bedrooms have been used during the day sometimes for sitting and for the afternoon siesta and sometimes during the evening for watching TV. The bedrooms at the first floor level were not used for sleeping during the night in summer.

The roof terrace at the first floor level was used by the female inhabitants as a sleeping area overnight in summer and the roof terrace at the second floor level was used by the male inhabitants as a sleeping area overnight in summer.

Winter: The inhabitants of the MH4 do not use the outdoor space in the garden during the day in winter, just during the sunny days.

Inside the house the inhabitants have used the habitable rooms and spaces in the same way as they have in summer. The living room was used by the inhabitants most of the day and the kitchen was used by the female inhabitants as a sitting area and for having breakfast, lunch and dinner. The bedroom at the ground floor level was used during the day and also during the night for sleeping.

At the first floor level the bedrooms were used by the inhabitants during the day for sitting, the afternoon siesta and sometimes during the evening for watching TV and for sleeping overnight. The roof terraces at the first and second floor level were not used by the inhabitants of this house during the winter.

Transition seasons, spring and autumn: The inhabitants have been using the same habitable rooms and spaces during the spring and autumn as during the summer and winter and have the same activities.

The inhabitants of this house have used the outdoor garden frequently, particularly in spring when the weather became very cool the inhabitants used the garden during the late afternoon and during the evening.

The MH4 is exposed to the spring/summer dust storms and during this period of time the home is not protected from the dust. The garden provided no shelter to the inhabitants during the dust storms. The inhabitants need to stay indoors and keep the doors and the windows of the habitable rooms and spaces shut during this period of time.

Table 4.32. Summer occupation of internal and external spaces in MH4

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.33. Winter occupation of internal and external spaces in MH4

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Garden	N/U	Eat/ Socialise	N/U	N/U
Roof terrace	N/U		N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.2.5. *Modern house No. 5*

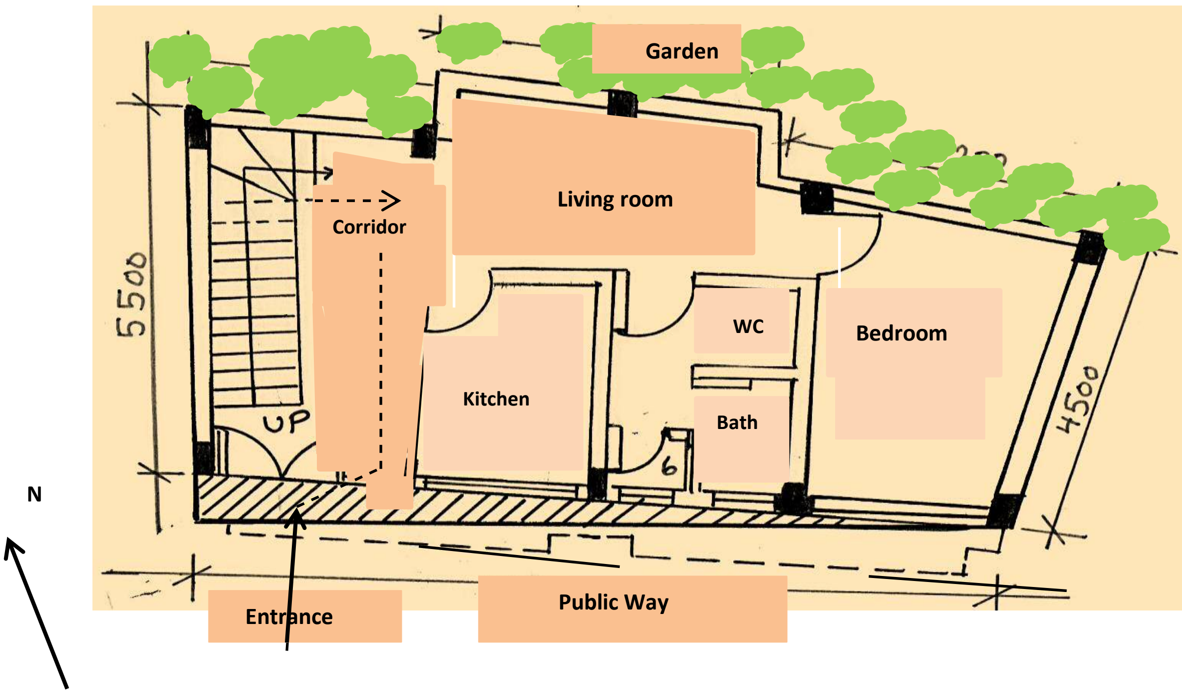


Fig. 4.37. Ground floor level plan of the modern house No. 5. Scale: 1:100

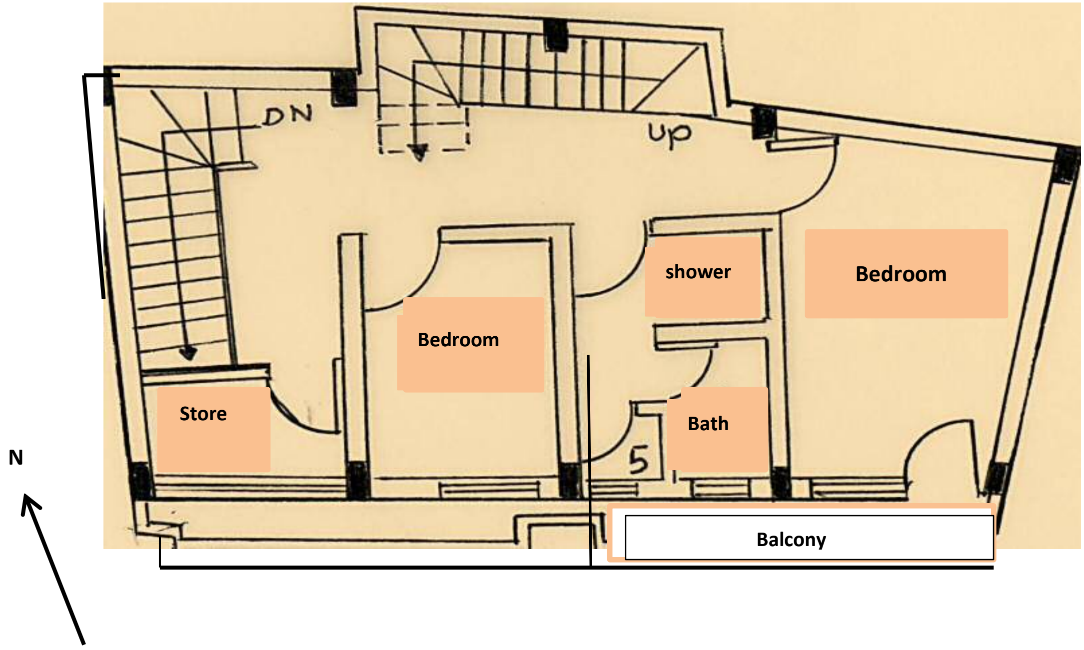


Fig. 4.38. **First floor level plan of modern house No. 5. Scale: 1:100**

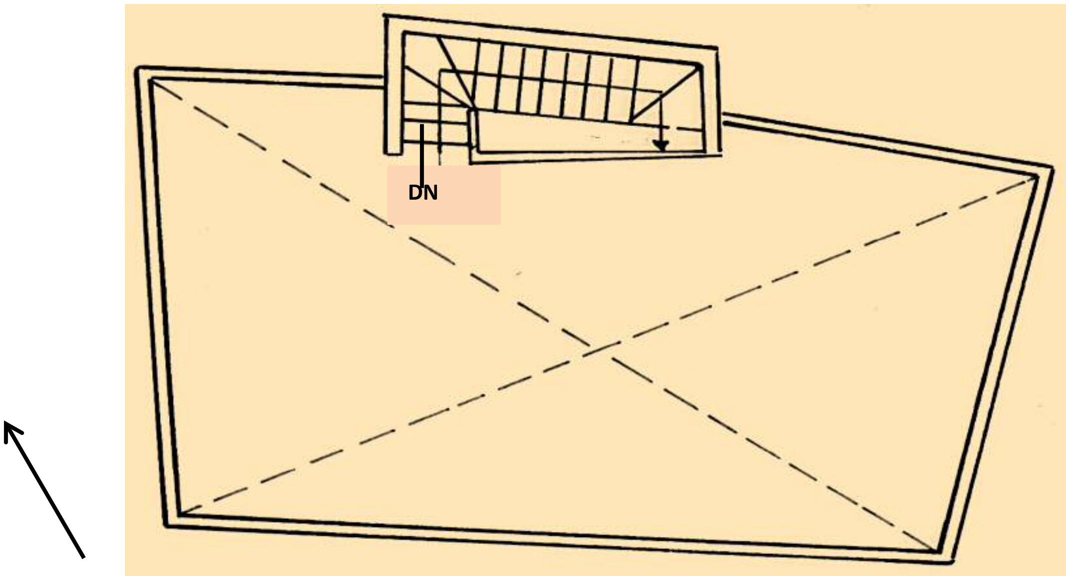


Fig. 4.39. **Roof terrace level plan of modern house No. 5. Scale: 1:100**

Table 4.34. Services for internal and external spaces in MH5

Internal Spaces	**Services: Cooling/Heating**
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Main Bedroom (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Roof terrace	N/A

In plan the modern house No. 5 (MH5) is considered a medium-sized house (280 m^2). This house was built as a detached house and consists of two storeys (ground floor level, first floor level and the roof terrace level) (see Figures 4.37–4.39).

At the ground floor level the modern house incorporates an entrance hall which leads to the interior of the house. Inside the house is a kitchen which faces S of the house with a large window, its front elevation overlooking the main road. The house has a living room which is facing N of the house and has been designed as an open space living room and it does not incorporate a door. The ground floor level has a bedroom which is facing S of the house with a large window with its front elevation overlooking the main road. The house has one bathroom and a WC at ground floor level. The MH5 has a rear garden which is facing N of the house.

At the first floor level the house has two bedrooms which are facing S. The large bedroom has a door which leads to the balcony and incorporates a window overlooking the balcony. The small bedroom has a window overlooking the main road. The first floor level incorporates a bath and shower and one store. Also there are stairs opposite the habitable rooms and spaces which lead to the roof terrace level. The roof terrace is flat and covers the whole area of the first floor level. The MH5 has an air conditioning system which operates in all the habitable rooms and spaces of the house.

The inhabitants of the MH5 have been using the habitable rooms and spaces at different times of the day during the four seasons.

Occupant Observation

Summer: The inhabitants have not been using the outdoor space of the garden in summer during the day, but just during the evening and sometimes in the very late afternoon after the garden has been washed with water a few times during the day to increase the relative humidity and reduce the high air temperature. The inhabitants prefer to keep themselves indoors under the air conditioning system during the day in summer.

As in the other modern houses, the inhabitants use the living room most of the time during the day and also during the evening for family social gatherings and for receiving visitors. The living room was used by the male and female inhabitants and by their visitors as the house does not incorporate a reception/dining area. The kitchen was used by the female inhabitants during the day and evening for sitting, or talking; also breakfast, lunch and dinner for the whole family take place in the kitchen.

The bedroom at the ground floor level has been used by the male inhabitants during the day, particularly in the afternoon for the afternoon siesta. In the night it was used for sleeping under the air conditioning system by the old inhabitants who are not been able to sleep on the roof terrace.

The bedrooms at the first floor level were used during the day by the female inhabitants, particularly in the afternoon, for the afternoon siesta and sometimes in the evening for watching TV. They were not used for sleeping during the night in summer. The store at the first floor level was used by the inhabitants to keep their goods. The inhabitants have used the roof terrace as a sleeping area overnight during the summer.

Winter: The inhabitants of this house have not used the outdoor space of the garden during cold and rainy days in the winter; the garden has been used sometimes by the inhabitants in winter, particularly during the sunny days for have lunch sometimes, or just sitting enjoying the sun. Inside the house at the ground floor level, as during the summer the inhabitants have been using the living room most of the time during the day and in the evening for sitting, watching TV and receiving visitors. The living room was used by both male and female inhabitants. Breakfast, lunch and dinner for the family take place in the kitchen. The bedroom has been used by the old inhabitants during the day and also for sleeping overnight. At the first floor level the inhabitants have used the bedrooms for their winter habitation and for sleeping overnight.

The roof terrace has not been used by the inhabitants as a sleeping area during the winter.

Transition seasons, spring and autumn: The inhabitants have used the outdoor space of the garden almost every day during the spring and autumn, particularly during the late afternoon when it becomes very cool and the thermal environmental conditions are very comfortable.

The inhabitants of this house have used the habitable rooms and spaces comfortably during the spring and autumn because these transitional seasons are very short and cool and provide comfortable conditions.

As in the other modern houses, the MH5 is exposed to the spring/summer dust storms and the house is not protected from dust during this period of the year. The inhabitants have to keep themselves indoors to have some protection from the dust. The garden is not protected during the dust storms as the garden is an open space and does not provide shelter to the inhabitants.

Table 4.35. Summer occupation of internal and external spaces in MH5

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Table 4.36. Winter occupation of internal and external spaces in MH5

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	Sleep
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Garden	N/U	Eat/ Socialise	N/U	N/U
Roof terrace	N/U		N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time Green: Frequently used at this time

4.2.2.6. *Modern house No. 6 – MH6*

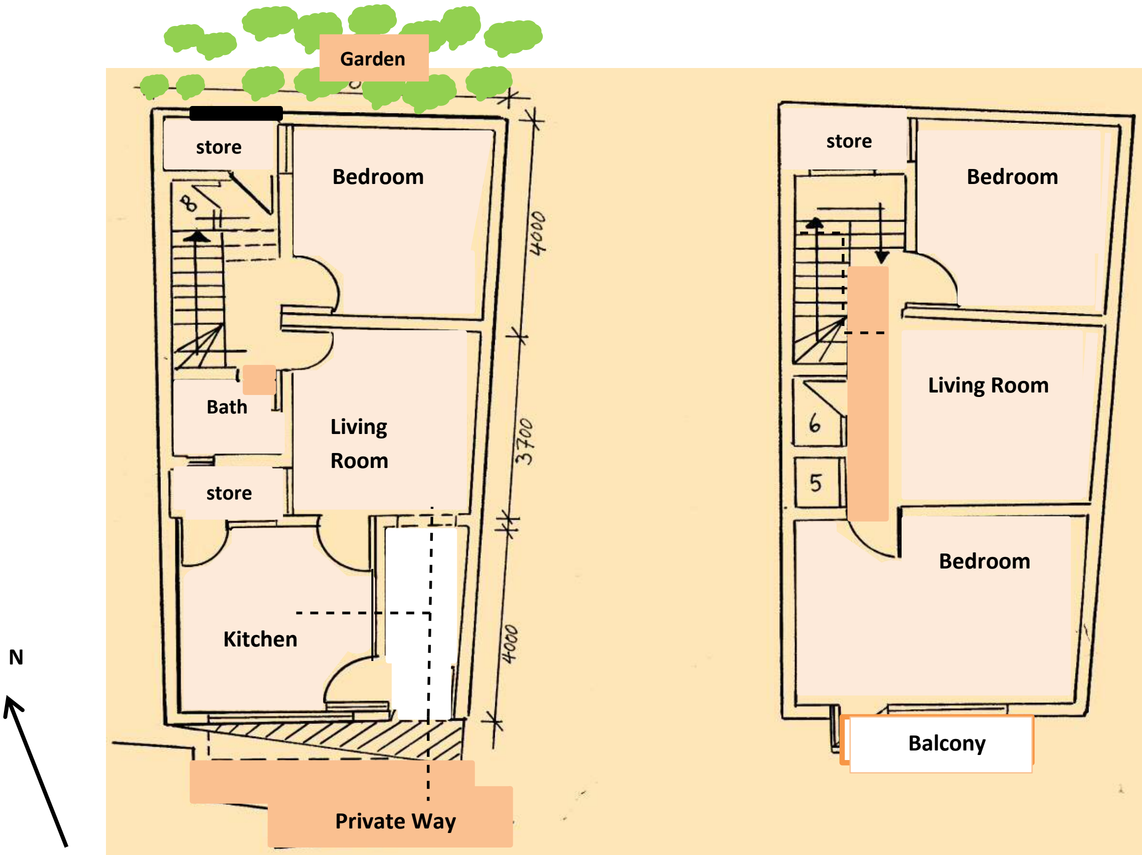


Fig. 4.40. **Ground floor level plan and first floor level plan of modern house No. 6. Scale: 1:100**

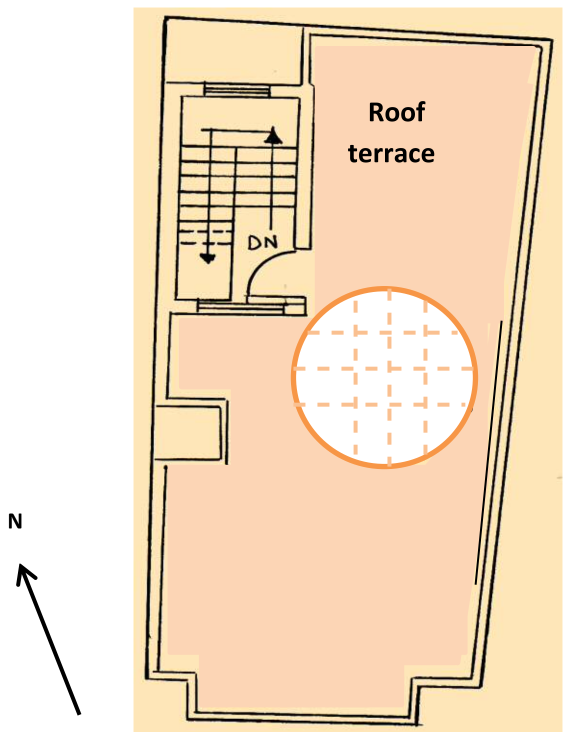


Fig. 4.41. **Roof terrace level plan of the modern house No. 6. Scale: 1:100**

Table 4.37. Services for internal and external spaces in MH6

Internal Spaces	Services: Cooling/Heating
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Main Bedroom (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Living room (first floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Roof terrace	N/A

In the plan the modern house No. 6 (MH6) is considered a medium-sized house (200 m^2). This house has been built as a detached house and consists of two storeys (ground floor level, first floor level and the roof terrace level) (see Figures 4.40 & 4.41).

At the ground floor level the house has a private way located at the front of the house used by the inhabitants as a parking space for cars and an entrance hall which leads to the interior of the house, to the kitchen and the living room. The ground floor level incorporates a kitchen which is facing S of the house. The kitchen has a window overlooking the front of the house and also a door which leads to the living room.

The living room is located in the centre of the house and has a door leading to the stairs area which leads to the first floor level. The ground floor level has one bedroom facing N of the house and a bathroom and one store.

At the first floor level there is a living room located in the centre of the floor; this living room has been designed as an open space living room. At the first floor level there are two bedrooms, the large one is facing S of the home and incorporates a balcony overlooking the private way of the house, and the small bedroom is facing N. The first floor has a shower room which has been indicated number (6) in the plan and a toilet which has been indicated number (5) in the plan.

The first floor level has a stairs area which leads to the roof terrace level. The roof terrace is a flat area and covers the whole area of the first floor level.

As any modern house, the MH6 has been fitted with an air conditioning system which operates in the living rooms and bedrooms of the ground floor and first floor levels.

The inhabitants of the MH6 have been using the habitable rooms and spaces in their home during the four seasons at the different times of the day.

Occupant Observation

Summer: The inhabitants have not been using the outdoor garden during the day in summer; they have sometimes used it in the very late afternoon and sometimes in the evening for family social gatherings or receiving visitors.

Inside the house the living room is the main habitable room and is considered as a reception room as well, as the house does not incorporate a separate reception room. The living room has been used by the inhabitants for their daily habitation and during the evening for watching TV and also for receiving visitors for both male and female inhabitants.

The inhabitants of the house have their breakfast, lunch and dinner in the kitchen and sometimes the kitchen has been used by the female inhabitants and their close friends and visiting relatives for social gatherings.

The bedroom at the ground floor level has been used by the inhabitants during the day only, particularly in the afternoon for the afternoon siesta. The store at the ground floor was used to keep kitchen equipment and goods.

The bedrooms at the first floor level have not been used by the inhabitants during the night in summer, but just during the day, particularly in the afternoon. The living room at the first floor level was rarely used during the summer as this living room has not been installed with an air conditioning system. The store was used by the inhabitants to keep the bedroom equipment such as blankets, pillows and the folded beds to be used by the visitors when they stay overnight.

The roof terrace was used by the inhabitants as a sleeping area during the summer.

Winter: The inhabitants used the outdoor garden sometimes during the winter, particularly during the sunny days. It is important to mention here that the inhabitants' daily activities are taking place indoors more than outdoors during the summer and winter and also during the transitions seasons.

As during the summer, the living room has been used by the inhabitants most of the time during the day and evening in winter. And also it was used to receive visitors during the day. The female inhabitants are spending more time in the kitchen for their gatherings during the winter, as the kitchen is considered a warm space and has provided them with comfortable conditions during the winter. The bedroom at the ground floor level was used by the inhabitants during the day and evening and also for sleeping overnight.

At the first floor level, the living room was used by the inhabitants during the day and evening, particularly by the female inhabitants for their social gatherings and receiving their visitors. The bedrooms were used during the day for the afternoon siesta and during the evening for watching TV and for sleeping during the night.

The roof terrace has not been used by the inhabitants for sleeping during the winter.

Transitions seasons, spring and autumn: During the spring and autumn the inhabitants used the outdoor space of the garden frequently during the day and evening for family gatherings or receiving visitors. They also worked in the garden, in activities such as cutting the grass or washing the garden with water. As the spring and autumn are very short and cool seasons the inhabitants use the house in comfort and have no specific activities inside the home during the spring and autumn.

The MH6 is exposed to the spring/autumn dust storms and this house is not protected from the dust. The inhabitants feel uncomfortable during this period of the year as the house provides no protection to them.

Table 4.38. Summer occupation of internal and external spaces in MH6

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Main bedroom (ground floor)	Sleep	N/U	Sleep	N/U
Living room (first floor)	N/U	N/U	N/U	N/U
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	Sleep

Key: Red: Never used N/U at this time   Amber: Sometimes used at this time
Green: Frequently used at this time

Table 4.39. Winter occupation of internal and external spaces in MH6

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	**Eat**	**Eat**	**Socialise**	**Socialise**
Main bedroom (ground floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
Living room (first floor)	**Socialise**	**Socialise**	**Socialise**	**Socialise**
Bedrooms (first floor)	**Sleep**	**N/U**	**Sleep**	**Sleep**
External Spaces				
Garden	**N/U**	**Socialise**	**N/U**	**N/U**
Roof terrace	**N/U**	**N/U**	**N/U**	**N/U**

Key: Red: Never used N/U at this time   Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.2.7. *Modern house No. 7 – MH7*

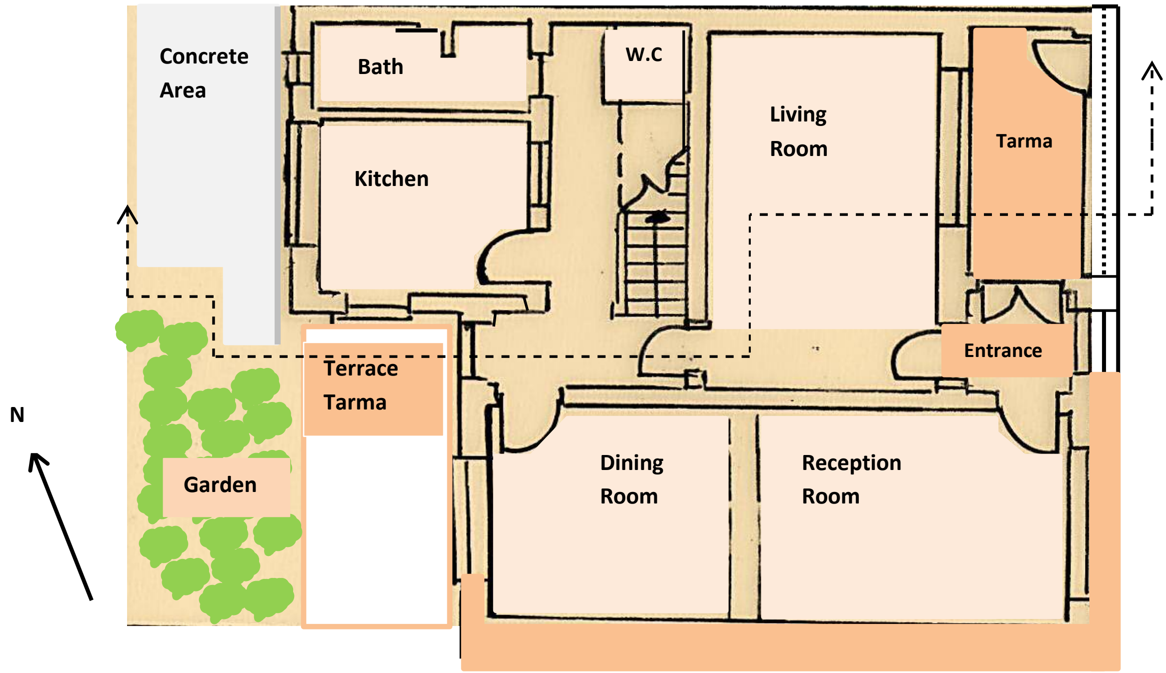


Fig. 4.42. Ground floor level of the modern house No. 7. Scale: 1:100

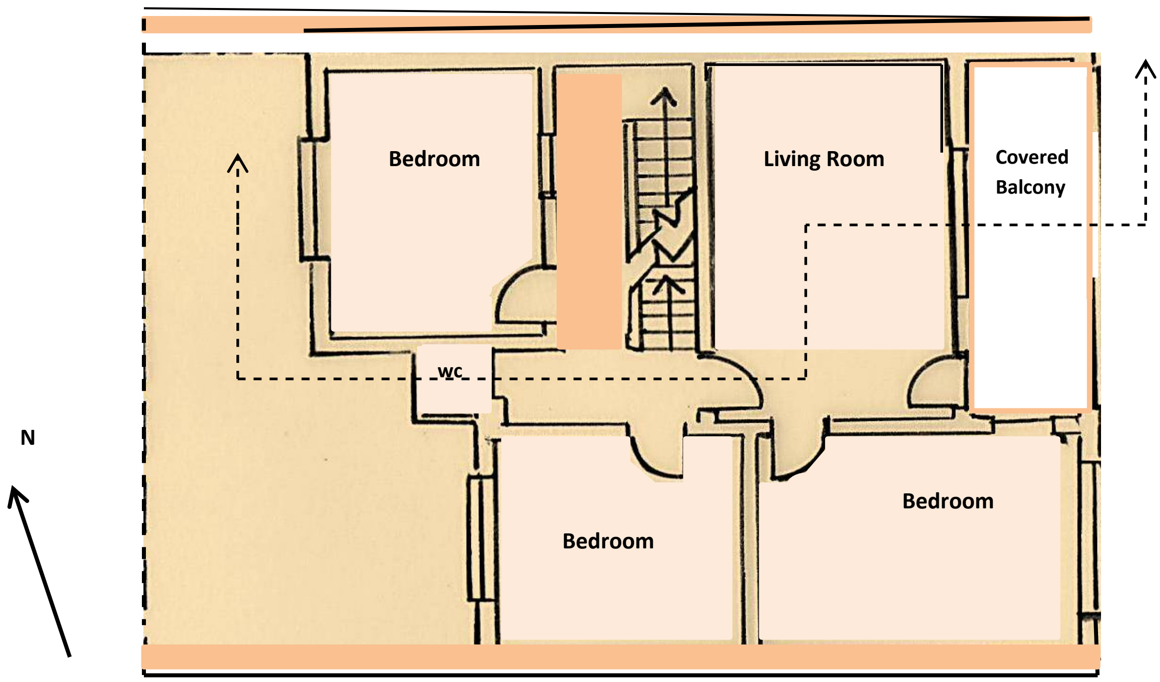


Fig. 4.43. First floor level plan of the modern house No. 7. Scale: 1:100

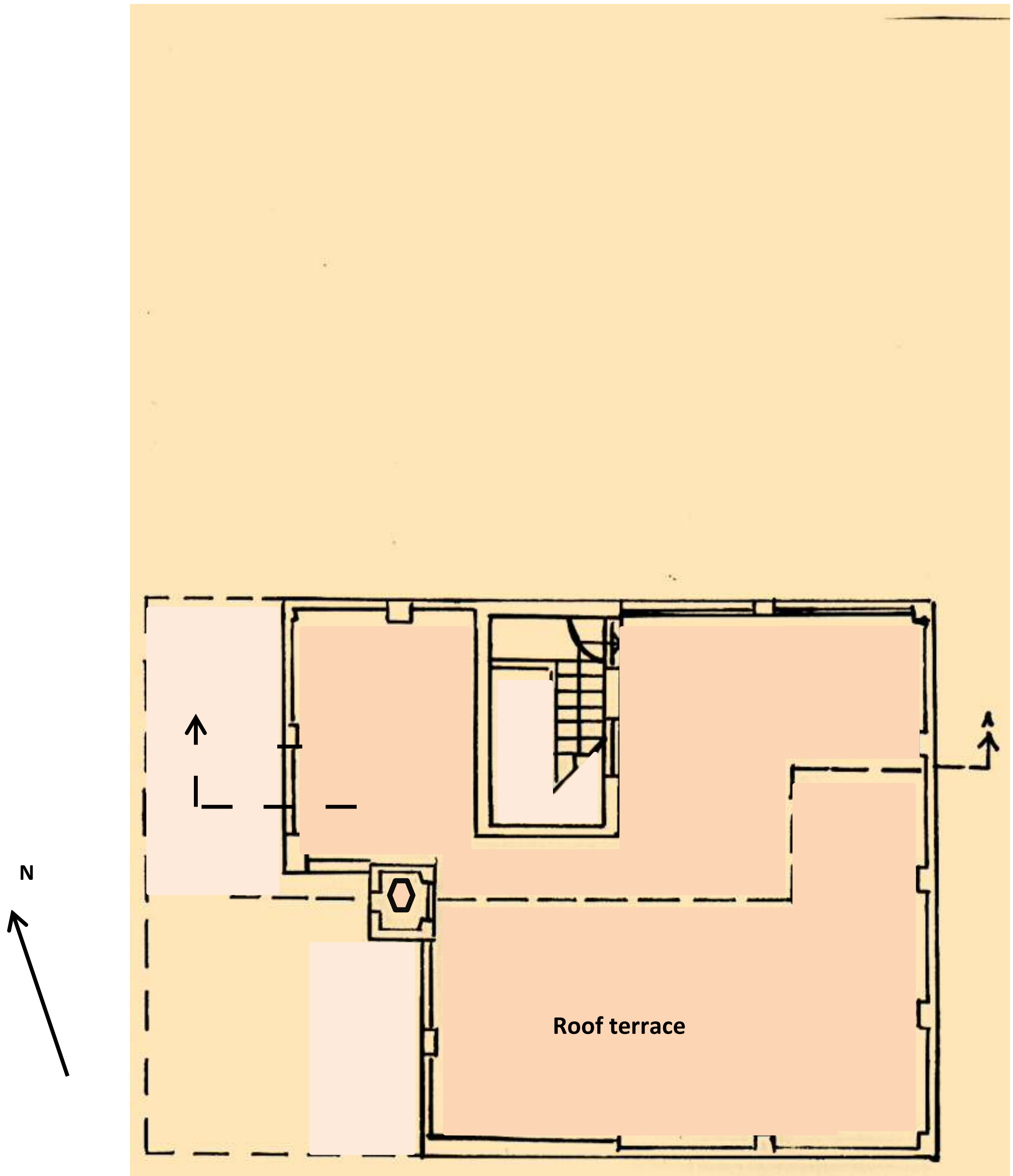


Fig. 4.44. **Roof terrace level plan of the modern house No. 7. Scale: 1:100**

Table 4.40. Services for internal and external spaces in MH7

Internal Spaces	Services: Cooling/Heating
Living room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Reception room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Dining room (ground floor)	**Cooling:** A/C **Heating:** Electric heating
Living room (first floor)	**Cooling:** A/C **Heating:** Electric heating
Bedrooms (first floor)	**Cooling:** A/C **Heating:** Electric heating
External Spaces	
Garden	N/A
Open space (Tarma)	N/A
Concrete area	N/A
Terrace tarma	N/A
Roof terrace	N/A

In plan the modern house No. 7 (MH7) is considered a large-sized house (450 m^2). It consists of two storeys (ground floor level, first floor level and the roof terrace level). The house has been built as a detached house (see Figures 4.42–4.44).

At the ground floor level the house has open space (Tarma) at the front and an entrance hall which leads to the interior of the house. Inside the house there is a living room which is facing NE of the house, with a window overlooking the Tarma. The interior of the house incorporates a reception room which is facing S of the house, with a large window overlooking the road. The ground floor level has a separate dining room. The internal corridor leads to the kitchen which has a window overlooking the corridor and a back window overlooking the concrete area at the back of the house.

The kitchen has a mini door which is leads to the terrace Tarma. The ground floor level has one bathroom and WC. The house has a rear garden which is facing N of the house.

At the first floor level the house incorporates a living room which has a window overlooking the covered balcony and there are three bedrooms. A large-sized bedroom faces S of the house, with a large window overlooking the road and a small-sized bedroom faces S of the house, again with a window and the third bedroom is facing N of the house.

This house has a roof terrace level which partially covers the first floor level. The house has an air conditioning system which functions in each habitable room in the house.

The inhabitants of this house have different activities during the four seasons while they are using their house.

Occupant Observation

Summer: The inhabitants of this house have not been using the outdoors garden during the day in summer. The garden was used sometimes, particularly in the evening, and sometimes in the very late afternoon after it has been washed with water a few times during the day to increase the humidity and reduce the high air temperature during the hot days. The garden was used for family social gatherings and for receiving visitors.

Inside the house the inhabitants have used the living room as the main habitable room in the house most of the day for their daily habitation and also for receiving visitors, such as close friends or neighbours. The other visitors who are not related to the family were received in the reception room and have their lunch or dinner in the dining room if they have been invited for lunch/dinner.

The inhabitants' breakfast, lunch and dinner take place in the kitchen and sometimes the kitchen has been used as a sitting area by the female inhabitants.

The terrace Tarma was used sometimes by the younger family members for sitting/studying or receiving visitors such as friends. The concrete area was used sometimes by the male inhabitants for sitting, while the female inhabitants are using the garden during the evening.

The living room at the first floor level was used by all inhabitants of the house during the summer while the air conditioning system operates in the living room. The room has been used during the day and evening for sitting and watching TV and the covered balcony used in the late evening to prevent overlooking by neighbours or passers-by. The bedrooms were used just during the day for sleeping in the afternoon and not used during the night.

The roof terrace was used by the inhabitants overnight in summer.

In winter: The inhabitants rarely used the outdoor space of the garden during the day in winter due to the cold air temperature and high relative humidity. It has been used just during the sunny days.

Inside the house the inhabitants used the living room almost all day for their daily winter habitation and in the afternoon they moved to the first floor level to use the bedrooms for the afternoon siesta. As during the summer, the reception/dining rooms have been used just for receiving visitors of the male and female inhabitants.

The inhabitants have their breakfast, lunch and dinner in the kitchen. The living room at the first floor level was used just by the female inhabitants during the evening in winter. The bedrooms at the first floor level were used by the inhabitants for sleeping during the day and overnight in winter.

The roof terrace was not used by the inhabitants for sleeping during the winter.

Transition seasons, spring and autumn: The outdoor space of the garden was used by the inhabitants almost every day in the spring and autumn as they are cool seasons. The habitable rooms and spaces of the house were used in the same way during spring and summer and also the habitable rooms and spaces were used in the same way during the autumn and winter. But during the spring and autumn the inhabitants used the ceiling fans instead of the air conditioning system and the roof terrace was not used by the inhabitants during the spring and autumn.

The MH7 is exposed to the spring/summer dust storms and as in the other modern houses this house is not protected from the dust and provides no protection to the inhabitants.

Table 4.41. **Summer occupation of internal and external spaces in MH7**

Summer	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Reception room (ground floor)	N/U	N/U	Socialise	Socialise
Dining room (ground floor)	N/U	Eat	Eat	Eat
Living room (first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	N/U
External Spaces				
Garden	N/U	N/U	Socialise	Socialise
Open space (Tarma)	N/U	N/U	Socialise	Socialise
Concrete area	N/U	N/U	Socialise	Socialise
Terrace tarma	N/U	N/U	Socialise	Socialise
Roof terrace	N/U	N/U	N/U	

Table 4.42. **Winter occupation of internal and external spaces in MH7**

Winter	Morning	Lunch	Afternoon	Evening
Internal Spaces				
Living room (ground floor)	Eat	Eat	Socialise	Socialise
Reception room (ground floor)	N/U	N/U	Socialise	Socialise
Dining room (ground floor)	N/U	Eat	Eat	Eat
Living room (first floor)	Socialise	Socialise	Socialise	Socialise
Bedrooms (first floor)	Sleep	N/U	Sleep	Sleep
External Spaces				
Garden	N/U	Eat/ Socialise	N/U	N/U
Open space (Tarma)	N/U	Eat/ Socialise	N/U	N/U
Concrete area	N/U	Socialise	N/U	N/U
Terrace tarma	N/U	Socialise	N/U	N/U
Roof terrace	N/U		N/U	N/U

Key: Red: Never used N/U at this time Amber: Sometimes used at this time
Green: Frequently used at this time

4.2.2.8. *Discussion*

Physical survey: In general the modern houses have been built as detached or semi-detached houses which are located on wide roads. Because the modern houses were not built in a group there is no direct social connection between neighbours. The houses have been built as two-storey houses or partially two-storey houses (ground floor level, first floor level and the roof terrace).

Inside the house the researcher has found that there are no specific habitable rooms and spaces which have been designed particularly for summer or winter habitation. Most of the selected modern houses have incorporated a reception/dining room which have been designed to receive visitors.

The selected modern houses have incorporated either a front garden or a rear or side garden that incorporates the open space (Tarma). It has been found from the survey that all the habitable rooms and spaces do not open directly to the garden and as result heating to warm such a house is less expensive during the winter. The floor to ceiling height at the ground floor level (4000 mm) is higher than the floor to ceiling height (3000 mm) at the first floor level; this is due to the possibility of using the ceiling fans at the ground floor level.

The modern houses have been fitted with an air conditioning system and there is no possibility for the modern house to be serviced naturally by the natural ventilation system (Badgir).

The researcher has been found that the roof terrace at the selected modern houses incorporates a parapet wall which is not high enough to prevent overlooking by neighbours and that has adversely affected the inhabitants' privacy.

The construction and building materials are mostly concrete and glass that make the house hot in summer and cold in winter.

Occupant observation: The researcher has found that the inhabitants of the modern houses have used the same habitable rooms and spaces during the summer and winter. They used the habitable rooms at the ground floor level and at the first floor level during the day in summer and have the same daily activities during the summer/winter and during the transition seasons, spring/autumn.

The modern house does not incorporate an entrance lobby and that has affected the privacy of the inhabitants. The garden is the only open space at the modern house and it is not private as the external walls of the house are not high enough to prevent overlooking by passers-by and that has affected the inhabitants' privacy when they have used it for social gatherings.

4.3. QUESTIONNAIRE ANALYSIS: TRADITIONAL COURTYARD HOUSES AND MODERN HOUSES IN BAGHDAD

In order to establish the socio-cultural performance and responsiveness of traditional and modern houses throughout the year, a questionnaire was designed and administered to a total of 56 respondents from seven selected traditional courtyard houses and seven selected modern houses in Baghdad, where each house has four respondents.

The inhabitants of the traditional houses and modern houses were very helpful in answering the questions, although the researcher had difficulties in translating and explaining each question in the Arabic language to each respondent.

Although the survey did address the four seasons, including the spring and autumn which are cool transition seasons in Iraq, the results presented here focus on the hot summer and cold winter, as in terms of thermal comfort these are the most challenging seasons.

The questionnaire was administered during the fieldwork study in Baghdad in February/March 2014. The two full questionnaires are reproduced in their English translation.

This section will present the results of questions asked of the occupants of both traditional houses and modern houses regarding the groups of factors listed below:

- **Socio-cultural factors**
- **Economic factors**
- **Neighbourhood factors**
- **Architectural factors**
- **Services factors**
- **Environmental factors**

Table 4.43 shows the key questions for the occupants of the selected traditional and modern houses in Baghdad in relation to each group of factors above.

Table 4.43. Key questions included in questionnaire

TRADITIONAL HOUSES	MODERN HOUSES
SOCIO-CULTURAL FACTORS	
Do you feel secure on your roof terrace?	
Does the roof terrace provide you with privacy when you use it as a sleeping area in summer?	
Does the ***courtyard*** provide you with privacy?	Does the ***garden*** provide you with the privacy?
Do you feel comfortable when you use the ***courtyard*** for social gatherings?	Do you feel comfortable when you use the ***garden*** for social gatherings?
How often do you use the outdoor space ***(courtyard)*** for social gathering?	How often do you use the outdoor space ***(garden)*** for social gathering?
ECONOMIC FACTORS	
Why were you attracted to the house when you decided to buy/occupy/rent?	
Would you like to move and live in a modern house?	Do you have an experience of traditional houses?
How much energy do you spend in your house?	
What does it cost to provide you with thermal comfort?	
How do you pay your bills?	
Is it affordable for you?	
NEIGHBOURHOOD FACTORS	
Do you know your neighbours?	
Are you happy with your neighbourhood?	
Do you have problems associated with the surface of the ***alleyways?***	Do you have problems associated with surface of the ***pavements?***
ARCHITECTURAL FACTORS	
Have you had any conservation work to upgrade your house in the last four years?	N/A
Do you use the outdoor space in your house for your daily activities?	

TRADITIONAL HOUSES	MODERN HOUSES
SERVICES FACTORS	
Are you satisfied with your sanitation system?	
ENVIRONMENTAL FACTORS	
Does the roof terrace provide you with thermal comfort when you use it as a sleeping area in summer?	
In your opinion, is it important for the ***traditional house*** to be equipped with an air conditioning system to provide you with a thermal comfort zone?	Is it important for the ***modern house*** to be air-conditioned all the times to provide you with a thermal comfort zone?
Do you feel comfortable in your living room without air conditioning?	
Do you think that your ***traditional house*** is well adapted to the climate?	Do you think that your ***modern house*** is well adapted to the climate?
In terms of your thermal comfort, are you generally happy with the house you live in?	
In terms of environmental and climate conditions, to what extent does the ***traditional house*** satisfy your needs?	In terms of environmental and climate conditions, to what extent does the ***modern house*** satisfy your needs?
To what extent do you think that ***the natural ventilation system*** (***Badgir***) contributes to comfort within your house though the year?	To what extent do you think that your comfort is affected ***by the lack of a natural ventilation system?***
Is your house exposed to the spring/summer dust storms?	
Does your house remain protected from the sun at any time of the day?	

The intentions of the questions have been presented in Chapter III Phase 1 Methodology. The questionnaire results will be analysed in order to explore and evaluate:

1. The extent to which there are different points of view between the two generations living in the same house. Is there a difference in perspective between the younger and older generations:
    a. In general about their traditional/modern house?
    b. Are they happy living in their house
    c. Are they looking for a new and modern design?

2. The differences in responses between occupants of the different house types presented through comparison of findings from the two questionnaires.

4.3.1. Questionnaire Respondents

4.3.1.1. Traditional houses

Firstly it has to be mentioned here that five of the seven heads of families have identified themselves as owners and two of them have identified themselves as tenants; both groups have sons and daughters (living with the family).

The age groups of the occupants were adults aged 60+, adults aged 19–59 and children aged 0–18. Please note that there were no occupants within the age <5 years.

Table 4.44 shows the number and age of the respondents for each of the case studies.

Table 4.44. Characteristics of occupants of traditional houses

Case Study Code	Tenure	Respondents	Age of Respondent		
			60+	19–59	0–18
TH1	Owner	4	1	3	0
TH2	Tenants	4	1	2	1
TH3	Tenants	4	1	3	0
TH4	Owner	4	1	2	1
TH5	Owner	4	1	2	1
TH6	Owner	4	1	3	0
TH7	Owner	4	1	3	0
TOTAL		28	7	18	3

4.3.1.2. Modern houses

Firstly it has to be mentioned here that four of the seven heads of families have identified themselves as owners and three of them have identified themselves as tenants; both groups have sons and daughters (living with the family).

The age groups of the occupants were adults aged 60+, adults aged 19–59 and children aged 0–18. Please note that there were no occupants within age <5 years.

Table 4.45 shows the number and age of the respondents for each of the case studies.

Table 4.45. Characteristics of occupants of modern houses

Case Study Code	Tenure	Respondents	Age of Respondent		
			60+	19–59	0–18
MH1	Owner	4	2	1	1
MH2	Tenants	4	2	2	0
MH3	Owner	4	2	1	1
MH4	Tenants	4	2	1	1
MH5	Tenants	4	2	2	0
MH6	Owner	4	2	2	0
MH7	Owner	4	2	2	0
TOTAL		28	14	11	3

4.3.2. Socio-Cultural Factors

4.3.2.1. *Courtyard/garden & privacy*

Traditional Houses

The views of the occupants of the traditional houses were sought on the following question regarding their privacy in the courtyard:

- ***Does the courtyard provide you with privacy?***

All the inhabitants (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that the courtyard of the traditional house provides them with privacy.

	Yes	*No*
Older generation (7)	7	0
Younger generation (21)	21	0
Total (28)		

Also they were asked:

- ***Do you feel comfortable or not when they use the courtyard for social gatherings?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that they feel very comfortable when they use the courtyard for social gatherings.

	Very comfortable	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Older generation (7)	**7**	**0**	**0**	**0**	**0**
Younger generation (21)	**21**	**0**	**0**	**0**	**0**
Total (28)					

Modern Houses

The inhabitants of the modern houses were asked to reply to this question regarding their privacy in the garden:

- ***Does the garden provide you with privacy?***

Responses were received from all occupants (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) confirming that the garden in the modern house does not provide them with privacy.

	Yes	*No*
Older generation (14)	**0**	**14**
Younger generation (14)	**0**	**14**
Total (28)		

Also they were asked:

- ***Do you feel comfortable or not when you use the garden for social gatherings?***

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that they feel very uncomfortable when they use the garden for social gatherings.

	Very comfortable	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Older generation (14)	**0**	**0**	**0**	**14**	**0**
Younger generation (14)	**0**	**0**	**0**	**14**	**0**
Total (28)					

Discussion

All the inhabitants of all the traditional houses (28), both the older and younger generations, have responded that the courtyard provides them with privacy when they used it for daily activities and they feel comfortable when using it for social gatherings. This is due to the external walls of the traditional house being high enough to prevent overlooking by passers-by and neighbours. On the other hand, all the inhabitants of all the modern houses (28), both the older and younger generations, have responded that the garden does not provide them with privacy and they do not feel comfortable when using it for social gatherings. This is due to the lower height of the external walls of the modern house; they are not high enough to prevent overlooking by passers-by and neighbours.

Socio-Cultural Factor	Traditional House	Modern House
Privacy Courtyard/Garden	**Completely achieved**	**Not achieved**

4.3.2.2. *Roof terrace for summer sleeping*

Traditional Houses

Respondents were asked to reply to the following question regarding roof terrace usage in summer:

- ***Do you feel secure on your roof terrace?***

All the inhabitants of the traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters) answered that they feel very secure when they use the roof terrace as a sleeping area in summer.

	Very secure	*Fairly secure*	*Fairly unsecure*	*Not at all*
Older generation (7)	**7**	**0**	**0**	**0**
Younger generation (21)	**21**	**0**	**0**	**0**
Total (28)				

An additional question was posed regarding their privacy on the roof terrace:

- ***Does the roof terrace provide you with privacy when you use it as a sleeping area in summer?***

All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and younger generation (sons and daughters) (21/75%) have answered ‘Yes’.

	Yes	*No*
Older generation (7)	**7**	**0**
Younger generations (21)	**21**	**0**
Total (28)		

Modern Houses

Respondents from the modern houses were asked to reply to the following question regarding roof terrace usage:

- ***Do you feel secure on your roof terrace?***

All the inhabitants of the modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters) have answered that they feel fairly insecure on the roof terrace when they use it as a sleeping area in summer.

	Very secure	*Fairly secure*	*Fairly unsecure*	*Not at all*
Older generation (14)	**0**	**0**	**14**	**0**
Younger generation (14)	**0**	**0**	**14**	**0**
Total (28)				

Another question was posed regarding their privacy on the roof terrace in summer:

- ***When you use it as a sleeping area in summer, does the roof terrace provide you with privacy?***

	Yes	*No*
Older generation (14)	**0**	**14**
Younger generations (14)	**0**	**14**
Total (28)		

Discussion

All the inhabitants of all the traditional houses (28), the older and younger generations, have responded that they feel very secure on their roof terrace and it does provide them with privacy. This is due to the roof terrace walls being high enough to prevent overlooking by neighbours. All the inhabitants of all the modern houses (28), the older and younger generations, have responded that they feel fairly insecure on their roof terrace, as it does not provide them with privacy because the roof terrace walls are not high enough to prevent overlooking by neighbours.

Socio-Cultural Factors	Traditional House	Modern House
Roof terrace for summer sleeping	**Completely achieved**	**Not achieved**

4.3.3. Economic Factors

4.3.3.1. *Location*

Traditional Houses

The inhabitants of the traditional houses were asked to reply to this question:

- ***Why were you attracted to the house you decided to buy/occupy/rent?***

All respondents from the traditional houses (28), the older generation (fathers) and the younger generation (sons and daughters), answered that the following factors were influential in this decision:

- Location of the house is very attractive in the neighbourhood.
- It is a good house.
- It is suitable for living.
- It is a low cost energy house.

Of the responses from the older generation (fathers), three respondents placed greatest importance on the location in the neighbourhood; two respondents on the house providing suitable living conditions and also it being a low cost energy house; and another two that it should be a good house in a nice neighbourhood. For answers from the younger generation (sons and daughters), important factors were felt to be the location of the house in the neighbourhood (eight respondents); that is should be a good house and low cost energy (10 respondents); and suitable for living (three respondents).

Modern Houses

The inhabitants of the modern houses were also asked this question:

- ***Why were you attracted to the house you decided to buy/occupy/rent?***

All respondents from the modern houses (28), the older generation (fathers and wives) and the younger generation (sons and daughters), that the following factors were influential in this decision:

- Location of the house is attractive.
- Good neighbourhood.

- Attractive new design.

Among the older generation (fathers and wives) seven respondents placed greatest importance on the location of the house being attractive; four on a good neighbourhood; and three on an attractive new design. From the younger generation (sons and daughters), nine respondents have answered the attractive new design was influential; two respondents have answered the good neighbourhood; and three respondents indicated that the location of the house was important.

Discussion

Both generations of the families living in traditional and modern houses indicated factors influencing their choice of house were location of the house, that it should be attractive and good quality and provide suitable living conditions. There was no difference between the responses of the inhabitants of the two types of housing regarding the location.

Economic Factors	**Traditional House**	**Modern House**
Location	Achieved	Achieved

4.3.3.2. ***Alternative housing***

Traditional Houses

The inhabitants of all the traditional houses were asked whether they would like to relocate to a modern house:

- ***Would you like to move and live in a modern house?***

All occupants (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered they would not like to move and live in a modern house because they like their traditional house and feel comfortable in their home. None of them would like to move to a modern house because, in general, all the inhabitants of the traditional houses, both the older and younger generations, are happy with the house they live in.

	Yes	***No***
Older generation (7)	**0**	**7**
Younger generations (21)	**0**	**21**
Total (28)		

Modern Houses

The inhabitants of the modern houses were asked this question of whether they have any experience of traditional houses:

- ***Do you have any experience of traditional houses?***

Almost all the inhabitants of all the modern houses (28), the older generation (fathers and wives) (13/49%) and the younger generation (sons and daughters) (14/50%) answered 'No' they do not have any experience of traditional houses, just one father of the older generation has responded that he had experience of living in a traditional house in his childhood.

	Yes	***No***
Older generation (14)	**1**	**13**
Younger generations (14)	**0**	**14**
Total (28)		

Discussion

All the inhabitants of the traditional houses, both the older and younger generations indicated they would not like to move and live in a modern house because they feel comfortable and they are happy with the house they live in. Almost all the inhabitants of the modern houses have no experience of traditional houses, except for one father of the older generation who had this experience during his childhood.

4.3.3.3. ***Energy bills***

Traditional Houses

The inhabitants of the traditional houses were asked to reply to the following questions regarding their energy bills:

- ***Do you consider your energy bills to be: HIGH……. LOW……***

All people from the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) responded that they consider their energy bills to be low.

	High	***Low***
Older generation (7)	**0**	**7**
Younger generations (21)	**0**	**21**
Total (28)		

- ***What does it cost to provide you with thermal comfort?***

In Summer	***In Winter***	***In Spring***	***In Autumn***
Low: 28/ high: 0	*Low: 28/ high: 0*	*Low: 28/ high: 0*	*Low: 28/ low: 0*

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that the energy bills were of low cost in summer, winter, spring and autumn and they experienced thermal comfort in their house.

- ***How do pay your bill?***

Monthly	***Every three months***	***Every six months***
28	*0*	*0*

All respondents from the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) have answered that they pay their bills monthly.

- ***Is it affordable for you?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that the bills are affordable for them.

	Yes	***No***
Older generation (7)	**7**	**0**
Younger generations (21)	**21**	**0**
Total (28)		

Modern Houses

The inhabitants of the modern houses were asked to reply to the following questions regarding their energy bills:

- ***How much does it cost for:*** ***Cooling in summer:*** *Expensive bills..*

  Heating in winter: *Expensive bills..*

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that because they use the air conditioning system almost all the time in summer that this cost was expensive and also because the heating system operates almost all the day in winter their fuel bills were expensive; the modern house is a high cost energy house.

- ***How do you pay your bills?***

Monthly	*Every three months*	*Every six months*
28	*0*	*0*

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that they pay their bills monthly.

- ***Is it affordable for you?***

All respondents from the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that although the energy bills are expensive for cooling and heating, they consider these bills are affordable because the working inhabitants receive high salaries so they can afford to pay high bills.

	Yes	***No***
Older generation (14)	**14**	**0**
Younger generations (14)	**14**	**0**
Total (28)		

Discussion

All the inhabitants of the traditional houses (28), the older and younger generations, have responded that their energy bills are low in summer, winter and the transition seasons, spring and autumn, and it costs them little to provide themselves with thermal comfort; it is affordable for them as the traditional house is a low cost energy house and sometimes the inhabitants rely on the natural ventilation system (Badgir). On the other hand, all the inhabitants of the modern houses (28), the older and younger generations, have responded that their energy bills are high and they have high costs for energy, especially for cooling in summer and heating in winter; the fuel costs of the householders are expensive to provide thermal comfort but they consider it affordable in view of their high income.

Economic Factors	Traditional House	Modern House
Energy bills	**Completely achieved**	**Partially achieved**

4.3.4. Neighbourhood Factors

4.3.4.1. *Neighbourhood and friendship*

Traditional Houses

The inhabitants of the traditional houses were asked to reply to these questions regarding their social connections within the neighbourhood and friendships:

- ***Do you know your neighbours?***
- ***Do you socialise with them?***

All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered they know their neighbours and they socialise with them.

Families in the traditional houses were asked about the frequency of their visits to their neighbours:

- ***How often do you visit them?***

All respondents from the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) indicated that they visit their neighbours once a week.

	Once a week	*Twice a month*	*Once a month*	*Once every two or three months*
Old generation (7)	**7**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**
Total (28)				

Modern Houses

The inhabitants of the modern houses were also asked to reply to questions regarding their social connections within the neighbourhood and friendships:

- ***Do you know your neighbours?***
- ***Do you socialise with them?***

All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered they know their neighbours and they socialise with them.

The next question concerned the frequency of their visits to their neighbours:

- ***How often do you visit them?***

All the older generation from the modern houses (fathers and wives) (14/50%) answered they visit their neighbours once a month. All the younger generation of all the modern houses (sons and daughters) (14/50%) answered they visit their neighbours twice a month.

	Once a week	*Twice a month*	*Once a month*	*Once every two or three months*
Old generation (14)	**0**	**14**	**0**	**0**
Young generation (14)	**0**	**0**	**14**	**0**
Total (28)				

Discussion

All the inhabitants of the traditional houses (28), the older and younger generations, have a social connection with their neighbours and they visit them once a week. The inhabitants of the modern houses (28), the older and younger generations, also know their neighbours and they socialise with them; the older generation visit neighbours once a month and the younger generation twice a month; however, due to the compact layout of the modern houses these houses are not close to each other.

Neighbourhood Factors	**Traditional House**	**Modern House**
Neighbourhood & Friendship	**Completely achieved**	**Partially achieved**

4.3.4.2. *Travel*

Traditional Houses

All inhabitants of the traditional houses were asked to reply to this question regarding their daily travel:

- ***How long does your journey to work, shops, markets and school/university typically take?***

Destination		***30 minutes or less***	***One hour***	***One and half hours***	***Two hours***
Work	*Older (7)*	*7*	*0*	*0*	*0*
	Younger (9)	*0*	*9*	*0*	*0*
Shops	*Older (7)*	*7*	*0*	*0*	*0*
	Younger (21)	*21*	*0*	*0*	*0*
Markets	*Older (7)*	*7*	*0*	*0*	*0*
	Younger (21)	*21*	*0*	*0*	*0*
School/university	*Older (0)*	*0*	*0*	*0*	*0*
	Younger (12)	*1*	*0*	*11*	*0*

Work: For families living in the traditional houses, all the older generation (7/25%) (fathers) answered that their journey to work takes 30 minutes or less and for the younger generation who are working (9/27%) (sons and daughters) their journey to work takes one hour.

Shops & Market: All inhabitants of the traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters), answered that their journey to the shops takes 30 minutes or less.

School/University: The younger generation of the traditional houses No. 2, 3, 4, 5, 6 (11/47%) (sons and daughters) answered that their journey to university takes one and a half hours. One son of the family living in traditional house No. 5 indicated that his journey to school takes 30 minutes or less.

Modern Houses

The inhabitants of all the modern houses were asked to reply to this question regarding their daily travel:

- ***How long does your journey to work, shops, markets and school/university typically take***

Destination		***3o minutes or less***	***One hour***	***One and half hours***	***Two hours***
Work	*Older (6)*	*0*	*6*	*0*	*0*
	Younger (7)	*0*	*7*	*0*	*0*
Shops	*Older (14)*	*14*	*0*	*0*	*0*
	Younger (14)	*14*	*0*	*0*	*0*
Markets	*Older (14)*	*12*	*2*	*0*	*0*
	Younger (14)	*12*	*2*	*0*	*0*
School/university	*Older (0)*	*0*	*0*	*0*	*0*
	Younger (7)	*0*	*4*	*3*	*0*

Work: Of those who travel to work, all of the older generation (6/46%) (fathers) and all of the younger generation (7/54%) have answered their journey to work takes one hour.

Shops & Market: The inhabitants of the modern houses (28), the older generation (14/50%) (fathers) and the younger generation (14/50%) (sons and daughters) have answered that their journey to the shops takes 30 minutes or less. This is the same as the journey to the market for all but the occupants of the MH1, for whom a journey to the market takes one hour.

School/University: The younger generation of the modern houses No. 1, 2, 3, 4 (4 /57%) (sons and daughters) answered that their journey to university takes one hour. However, for the younger generation of the modern houses no: 5, 6, 7 (3/43%) this journey takes one and a half hours.

Discussion

The older generation of the traditional houses (7) (fathers) seem to work in the same neighbourhood so their journey to work is 30 minutes or less, but the younger generation (9) (sons and daughters) work in offices which are located in the city and as a result their journey to work takes one hour. Also for the younger generation who are going to university (11) (sons and daughters), their journey takes one and a half hours because all the universities are located in the centre of the city. For the older and younger generations (28), their journey to the shops and markets takes 30 minutes or less because they are located in the same neighbourhood and they are within walking distance.

For the modern houses, the older generation (6) (fathers) and the younger generation (7) (sons and daughters) who travel to work have a journey of one hour because they need to travel to a different neighbourhood. The younger generation of the houses No.1, 2, 3, 4 (4) (sons and daughters) have a journey of one hour but for the sons and daughters of houses No. 5, 6, 7 (3) their journey takes one and a half hours as they need to use public transport which takes more time. All the older and younger generations travelling to the shops and markets take 30 minutes or less because they are located in the same neighbourhood.

Neighbourhood Factors	**Traditional House**	**Modern House**
Journeys: ***Work***	**Partially achieved**	**Not achieved**
Shops/Markets	**Completely achieved**	**Completely achieved**
School/University	**Not achieved**	**Not achieved**

4.3.5. Architectural Factors

4.3.5.1. *Conservation work*

Traditional Houses

In terms of architectural factors conservation was a significant theme for the traditional courtyard house occupants in the questionnaire:

- ***Have you had any conservation work to upgrade your house in the last four years?***

(There was a supplementary question requesting a summary of what had been done.)

The inhabitants of the traditional houses **TH2 and TH3** reported that they have had conservation work done to upgrade their house in the last four years (two out of seven houses 29%). The work was described as changes to the fabric including renewal of the wooden columns and doors/windows frames and replacing them with a new ones. It can be seen that the improvements to doors and windows may have had a beneficial impact on thermal comfort. It is not known whether the changes included insulation or double or secondary glazing.

Respondents were asked whether they felt the building work had improved their house:

- ***To what extent do you consider that the building work which has been undertaken has improved your living conditions?***

To great extent	To some extent	Not particularly	Not at all	Not the purpose of the works
8	**0**	**0**	**0**	**0**

The table above shows the number of responses from the families in **TH2 and TH3**; the occupants of the other five traditional houses answered that there had not been any conservation work carried out in their houses in the last four years.

In order to understand further the types of support available to occupants of traditional courtyard houses, the following question was asked:

- ***Please state what kind of support did you receive from the local authority?***

The respondents (who had received support) have answered that their house had been the subject of renovation and conservation work undertaken by the local authority.

A further probing question was then asked to ascertain:

- ***What more support would you like to/do you need to receive?***

The older generation of all the traditional houses (fathers) (7/25%) responded that it is important for their house to be checked every two or three years for renovation and conservation work. The younger generation (sons and daughters) (15/51%) answered that they should receive support from the local authority as these houses have been considered as a heritage of the city; the younger generation (sons and daughters) (6/24%) answered they should continue receiving support and the local authority should increase their support. Although two traditional houses from seven have been the subjects of conservation work, all the respondents indicated that they are fairly happy with the local authority support.

Discussion

As it has been seen from the responses of the occupants of the traditional houses, just two houses from seven have had conservation work in the last four years. The local authority of Baghdad has a plan to conserve the traditional houses but this depends on funds from the government (**Municipality of Baghdad 2014**). Some of the houses had conservation work every three or four years and some of them are in the waiting list but in general all the traditional houses in Baghdad are under the responsibility of the local authority as these houses have been considered as a heritage of Baghdad and they should be protected.

All the traditional houses should have conservation work carried out at least every three years and the local authorities should protect these houses as many of the traditional houses have been demolished because they were in a bad condition due to lack of conservation. The local authorities are not responsible for the maintenance of modern houses.

4.3.5.2. *House type preference*

Traditional Houses

The occupants of the traditional houses were asked:

- ***Would you like to move and live in a modern house?***

	Yes	*No*
Older generation (7)	**0**	**7**
Younger generations (21)	**0**	**21**
Total (28)		

Modern Houses

The inhabitants of the modern houses were asked to reply to this question:

- ***Do you have experience of traditional courtyard houses?***

	Yes	*No*
Older generation (14)	**1**	**13**
Younger generations (14)	**0**	**14**
Total (28)		

The only respondent from the older generation answered that when he was a child he lived in a traditional house and he was happy with the house.

Discussion

When the inhabitants of the traditional houses (28), the older and younger generations were asked whether they would like to move and live in a modern house the response was '*No*' from all the older and younger generations of all the traditional houses. This is due to the traditional house providing occupants with thermal comfort and also with complete privacy and as result the occupants are happy with the house they live in. When the inhabitants of all the modern houses, both the older and younger generations were asked whether they have any experience of traditional houses, only one person from the older generation had this experience in his childhood.

Architectural Factors	Traditional House	Modern House
House Type Preference	**Achieved**	**Not achieved**

4.3.5.3. *Outdoor space usage*

Traditional Houses

The respondents were asked to reply to the following two questions regarding their behaviour in the summer, winter and transition seasons, spring and autumn:

- ***Do you use the outdoor space in your house for daily activities?***

In this question the occupants were asked to consider both the roof terrace and the courtyard.

Courtyard /roof terrace Usage		***Always – every day***	***Sometimes 2–3 times a week***	***Rarely – once a month***	***Almost never***
Summer	*Older (7)*	*Roof terrace 7*	*Courtyard 7*	*0*	*0*
	Younger (21)	*Roof terrace 21*	*Courtyard 21*	*0*	*0*
Winter	*Older (7)*	*0*	*0*	*7*	*0*
	Younger (21)	*0*	*0*	*21*	*0*
Transition	*Older (7)*	*7*	*0*	*0*	*0*
	Younger (21)	*21*	*0*	*0*	*0*

- ***How often do you use the courtyard for your daily activities?***

While in this question they were asked to focus on the courtyard.

Courtyard usage		***Always – every day***	***Sometimes 2–3 times a week***	***Rarely – once a month***	***Almost never***
Summer	*Older (7)*	*0*	*7*	*0*	*0*
	Younger (21)	*0*	*21*	*0*	*0*
Winter	*Older (7)*	*0*	*0*	*7*	*0*
	Younger (21)	*0*	*0*	*21*	*0*
Transition	*Older (7)*	*7*	*0*	*0*	*0*
	Younger (21)	*21*	*0*	*0*	*0*

Summer: All inhabitants of traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters) responded that they all use the outdoor space (courtyard) sometimes 2–3 times a week during the summer for their daily activities.

Winter: All inhabitants of traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters) answered that the courtyard usage dropped to only 'rarely'. During the administration of the questionnaires the respondents indicated this was usage related to when it was a sunny day.

Transition seasons: All inhabitants of traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters) answered that the courtyard was used almost every day during the spring and autumn.

Modern Houses

The respondents from the modern houses were asked to reply to the following two questions regarding their behaviour in the summer, winter and transition seasons spring and autumn.

- ***Do you use the outdoor space in your house for your daily activities?***

In this question the occupants were asked to consider both the roof terrace and garden.

Roof terrace	***Yes***	***No***
Older generation (14)	**14**	**0**
Younger generations (14)	**14**	**0**

All inhabitants of the modern houses (28), the older generation (fathers) (14/50%) and the younger generation (sons and daughters) (14/50) indicated that they use the roof terrace every night for sleeping overnight during the summer.

Garden	***Yes***	***No***
Older generation (14)	**0**	**14**
Younger generations (14)	**0**	**14**

All the inhabitants of the modern houses (28), the older generation (fathers) (14/50%) and the younger generation (sons and daughters) (14/50) answered that they do not use the garden for their daily activities during the summer and winter due to the high air temperature in summer and low air temperature in winter.

In this question the occupants were asked to consider just the garden.

- ***How often do you use the outdoor space (garden) for social gatherings?***

Garden usage		Always – every day	Sometimes 2–3 times a week	Rarely – once a month	Almost never
Summer	Older (14)	0	14	0	0
	Younger (14)	0	14	0	0
Winter	Older (14)	0	0	0	14
	Younger (14)	0	0	0	14
Transition	Older (14)	14	0	0	0
	Younger (14)	14	0	0	0

Summer: All the inhabitants of modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters) have answered they all use the garden sometimes 2–3 times a week for social gatherings in summer. However, due to the high temperatures in summer they only use it in the late afternoon and in the evening.

Winter: All the inhabitants of modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters) have answered they all never use the outdoor garden for social gatherings in winter because of the low air temperatures, as they prefer to stay indoors. In conversation they commented that they do use it on rare occasions during the sunny days.

Transition seasons: All the inhabitants of modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters) answered they all use the garden almost every day in spring and autumn because of the cool air temperature.

Discussion

Firstly, all the inhabitants of the traditional houses (28) and the modern houses (28), use the roof terrace every night as a sleeping area overnight in summer. For the traditional houses all the inhabitants (28) use the courtyard sometimes for their daily activities during the summer because the courtyard is surrounded by the habitable rooms and spaces, which makes the floor area of the courtyard shaded and protected from the sun at certain times of the day. However, all the inhabitants of the modern houses do not use the garden for their daily activities during the summer because the garden is an open space and it is not protected from the sun. In winter all the inhabitants of the traditional houses (28), use the courtyard rarely and just when it is a sunny day. For the modern houses, all the inhabitants (28) never use the garden in winter for their daily activities but they suggested it may be used during the sunny days.

During the cool seasons of spring and autumn all the inhabitants of the traditional and modern houses use the courtyard and garden almost every day.

For the social gatherings, all the inhabitants of the traditional houses use the courtyard sometimes during the summer and rarely in winter when there are sunny days and every day in spring and autumn. For the modern houses there is a difference, for the social gatherings the inhabitants use the garden sometimes during the summer and never during the winter and almost every day in spring and autumn.

Outdoor Space Usage ***Courtyard/Garden***	**Traditional**	**Modern**
Summer	**Partially achieved**	**Not achieved**
Winter	**Partially achieved**	**Partially achieved**
Transition seasons	**Completely achieved**	**Completely achieved**

4.3.5.4. *Noise*

Modern Houses

The inhabitants of all modern houses were asked to reply to this question regarding the sound insulation in their living room. This was included in response to anecdotal reports that sound transmission was problematic in modern houses.

- ***Is it uncomfortably noisy in the main living room in your house?***

	Yes	***No***
Older generation (14)	**14**	**0**
Younger generation (14)	**14**	**0**
Total (28)		

All the inhabitants of all modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters) answered it is uncomfortably noisy in their main living room. In discussion this appeared to be due to the external noise from nearby roads.

Discussion

All the inhabitants of the modern houses (28) feel the main living is uncomfortably noisy due to traffic noise from the roads. This is because the external walls of modern house are not thick enough to provide adequate sound insulation.

4.3.6. Services Factors

4.3.6.1. *Kitchen*

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to this question regarding their comfort zone in their kitchen:

- ***A kitchen in an average-sized house is usually a medium-sized or small-sized room overlooking the courtyard but without any fittings; do you think that such a kitchen is physically comfortable?***

All the older generation (fathers) (7/25%) have answered 'agree' that the kitchen of their traditional house is physically comfortable. However, the younger generation (sons and daughters) (21/75%) disagreed; they did not find the kitchen physically comfortable.

	Strongly agree	*Agree*	*Strongly disagree*	*Disagree*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**0**	**21**	**0**
Total (28)					

Modern Houses

Respondents in the modern houses were asked to reply to this question regarding their comfort zone in their kitchen:

- ***A kitchen in an average-sized house is a medium-sized room incorporated in the plan of the house, with full fittings, and in some houses overlooking the garden. Do you think that such a kitchen is physically comfortable?***

All the inhabitants of all the modern houses (28) the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) have answered 'agree' that the fitted kitchen is physically comfortable.

	Strongly agree	*Agree*	*Strongly disagree*	*Disagree*	*Don't know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

Discussion

There are two different opinions between the older generation (fathers) and the younger generation (sons and daughters) of the traditional houses regarding their unfitted kitchen. The older generation believed that such a kitchen is physically comfortable but the younger generation believed that such kitchen is not comfortable and they wish to have a fitted kitchen in their house. However, the inhabitants of the modern house, both older and younger generations, are happy with their fitted kitchen and they agree that such a kitchen is physically comfortable.

Services Factors	**Traditional House**	**Modern House**
Kitchen	**Partially achieved**	**Completely achieved**

4.3.6.2. ***Water Supply***

Traditional Houses

The inhabitants of the traditional houses were asked to reply to the following questions regarding their water supply system in their house:

- ***Generally, the traditional courtyard house incorporates only one water tap which is located in the courtyard; and one in the kitchen and bathroom at ground floor and another at first floor. Does this system satisfy your needs?***

All of the older generation occupants (fathers) (7/25%) answered that they are 'fairly satisfied' while the younger generation (sons and daughters) (21/75%) have answered 'very unsatisfied'.

	Very satisfied	*Fairly satisfied*	*Fairly unsatisfied*	*Very unsatisfied*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**0**	**21**	**0**
Total (28)					

- ***Do you suffer inconvenience whenever the water supply is cut off while maintenance work is carried out?***

All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered 'Yes' they agreed that they suffer inconvenience whenever the water supply is cut off during the maintenance work.

	Yes	***No***
Older generation (7)	**7**	**0**
Younger generations (21)	**21**	**0**
Total (28)		

- ***Where is the cold water tank located?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that the cold water tank is located on the roof terrace.

	In the courtyard	*On the roof terrace*
Old generation (7)	**0**	**7**
Young generation (21)	**0**	**21**
Total (28)		

The inhabitants of all the traditional houses were asked to reply to the following questions regarding the cold water tank and hot water system:

- ***Do you think that it is important to provide each house with a cold water tank?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that it is very important to provide each house with a cold water tank.

	Very important	*Important*	*Least important*	*Not important*
Old generation (7)	**7**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**
Total (28)				

- ***Does your house incorporate a hot water system?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) responded that their house does not incorporate a hot water system.

	Yes	***No***
Older generation (7)	**0**	**7**
Younger generations (21)	**0**	**21**
Total (28)		

Modern Houses

Respondents from the modern houses were asked to reply to the following questions regarding their water supply system in their house:

- ***Does your house incorporate cold water tanks?***

All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that their house incorporates a cold water tank.

	Yes	***No***
Older generation (14)	**14**	**0**
Younger generations (14)	**14**	**0**
Total (28)		

- ***Do you think that it is important to provide each house with a cold water tank?***

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that it is very important to provide each house with a cold water tank.

	Very important	*Important*	*Least important*	*Not important*
Old generation (14)	**14**	**0**	**0**	**0**
Young generation (14)	**14**	**0**	**0**	**0**
Total (28)				

- ***Where is the cold water tank located?***

In the garden	*In the roof terrace*

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that the cold water tank is located on the roof terrace.

Another question concerned exposure of water to solar radiation:

- ***As the cold water tank is left exposed on the roof terrace, the water in it is heated by solar radiation during the day in summer, do you think that is very inconvenient?***

All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered 'agree' that this is very inconvenient for them.

	Strongly agree	*Agree*	*Strongly disagree*	*Disagree*	*Don't know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

Respondents from the modern houses were asked this question regarding the lack of water supply in the morning.

- ***As the cold water tank is left exposed on the roof terrace, the water in the rising main and the distribution downpipe sometimes freezes in winter,***

causing the lack of water supply in the morning. To what extent is this a hardship?

All occupants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that the lack of water supply in the morning affected them and it is to a great extent a hardship.

	To great extent	*To some extent*	*Not particularly*	*Not at all*	*Not the purpose of the works*
Old generation (14)	**14**	**0**	**0**	**0**	**0**
Young generation (14)	**14**	**0**	**0**	**0**	**0**
Total (28)					

Discussion

The older generation of all the traditional houses are fairly satisfied with the system of the water taps in their house and the younger generation are very unsatisfied with this system; they believed the house needs more water taps. Both the older and younger generations suffer inconvenience when the water supply is cut off during maintenance work and both the older and younger generation believe that it is important to provide each house with a cold water tank.

For the modern houses, all the inhabitants, both the older and younger generations, also believed that it is important to provide each house with a cold water tank and agree that it is inconvenient for them when the water is heated by solar radiation caused by the location of the water tank on the roof terrace. Also all agreed that that the lack of water supply caused by freezing of pipes in winter caused hardship. The traditional houses have an inadequate water supply system while the inhabitants of the modern houses are satisfied with the water supply system.

Services Factors	**Traditional House**	**Modern House**
Water supply	**Not achieved**	**Achieved**

4.3.6.3. *Sanitation*

Traditional Houses

The inhabitants of the traditional houses were asked to reply to this question regarding their sanitation system:

- ***Are you satisfied with your sanitation system?***

All responded (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) that they are not satisfied with their sanitation system of their traditional house. They explained that this system was very noisy for them and their neighbours when they emptied the septic tanks. They consider this system to be old and that it needs to be updated.

	Yes	***No***
Older generation (7)	**0**	**7**
Younger generations (21)	**0**	**21**
Total (28)		

Modern Houses

The inhabitants of the modern houses were asked to reply to this question regarding their sanitation system.

- ***Are you satisfied with your sanitation system?***

All occupants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered they are satisfied with their sanitation system.

	Yes	***No***
Older generation (14)	***14***	***0***
Younger generations (14)	***14***	***0***
Total (28)		

Discussion

The inhabitants of the traditional houses, both the older and younger generations, are not satisfied with the sanitation system in their house, as this system causes noise for them and their neighbours when they empty the septic tanks. They believe this system needs to be changed to a new one. On other hand, all inhabitants of the modern houses, both the older and younger generations, are satisfied with the sanitation system in their house as it is considered a new system.

Services Factors	Traditional House	Modern House
Sanitation	**Not achieved**	**Completely achieved**

4.3.6.4. ***Waste disposal***

Traditional Houses

The inhabitants of the traditional houses were asked to reply to the following questions regarding their arrangements for rubbish:

- ***Where do keep your rubbish?***

All respondents from the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that they keep their rubbish in the courtyard.

Then the inhabitants of all the traditional houses were asked if they considered this a health risk.

- ***Do you consider this to represent a risk to health?***

All the younger generation of the traditional houses (sons and daughters) (21/75%) answered 'agree' that this represents a risk to health, while all the older generation (fathers) (7/25%) answered 'disagree'.

	Strongly agree	*Agree*	*Strongly disagree*	*Disagree*	*Don't know*
Old generation (7)	**0**	**0**	**0**	**7**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**
Total (28)					

Modern Houses

The inhabitants of all the modern houses were asked to reply to this question regarding arrangements for rubbish.

- ***Where do you keep your rubbish?***

All respondents from the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered that they keep their rubbish in the rear garden.

Then the inhabitants of all the modern houses were asked do they consider this a health risk.

- ***Do you consider this to represent a risk to health?***

All (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered 'agree' that this represents a risk to health.

	Strongly agree	*Agree*	*Strongly disagree*	*Disagree*	*Don't know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

Discussion

As all the inhabitants of the traditional houses are keeping their rubbish in the courtyard, the younger generation (sons and daughters) have agreed that this represents a risk to health while the older generation disagreed with this opinion; they feel it is acceptable to keep rubbish in the courtyard. On the other hand, while the inhabitants of all the modern houses, both the older and younger generation, are also keeping rubbish in the rear garden, both have agreed that this to represents a risk to health.

Services Factors	**Traditional House**	**Modern House**
Waste Disposal	**Not achieved**	**Partially achieved**

4.3.6.5. *Highway/byway drainage*

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to this question regarding the surface of the alleyways.

- ***When there is heavy rain, do you have any problems associated with the surface of the alleyways?***

All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered 'Yes' they do have a problem associated with the surface of the alleyways, as heavy rain causes the alleyways to be flooded causing muddy surfaces

	Yes	*No*
Older generation (7)	**7**	**0**
Younger generations (21)	**21**	**0**
Total (28)		

Modern Houses

The inhabitants of the modern houses were asked to reply to this question regarding the pavements' surfaces.

- ***Do you have any problems associated with the surface of the pavements?***

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) answered they experience problems associated with the surface of the pavements. Some of the pavements are unpaved and they are very hot and dusty in summer. Strong gusts of the local winds drive dust inside the home. During the winter the pavements are cold and muddy.

	Yes	*No*
Older generation (14)	**14**	**0**
Younger generations (14)	**14**	**0**
Total (28)		

Discussion

All the inhabitants of the traditional houses, both the older and younger generations, have problems associated with the surface of the alleyways during the winter when heavy rain causes them to be flooded and muddy. Also the inhabitants of the modern houses, both the older and younger generations, have problems associated with the surface of some of the unpaved pavements as they become very hot and dusty during eth summer and muddy during the winter.

Services Factors	**Traditional House**	**Modern House**
Highway/Byway Drainage	**Not achieved**	**Partially achieved**

4.3.7. Environmental Factors

The following characteristics will be reviewed and evaluated within this group of factors:

1. The use of the roof terrace for sleeping
2. Air conditioning
3. Climate adaption
4. Thermal comfort with minimal services
5. Thermal comfort without minimal services
6. Passive systems
7. Solar protection
8. Dust storms
9. Courtyard landscape.

4.3.7.1. *Roof terrace for summer sleeping*

Traditional Houses

The occupants of the traditional houses were asked to reply to this question regarding their thermal comfort on the roof terrace in summer.

- ***Does the roof terrace provide you with thermal comfort when you use it as a sleeping area in summer?***

	Very comfortable	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Older generation (7)	**7**	**0**	**0**	**0**	**0**
Younger generation (21)	**21**	**0**	**0**	**0**	**0**

All the inhabitants of traditional houses (28), the older generation (7/25%) (fathers) and the younger generation (21/75%) (sons and daughters) have answered they all feel very comfortable when they use the roof terrace as a sleeping area in summer.

Modern Houses

The inhabitants of all the modern houses were asked to reply to this question regarding their thermal comfort zone on the roof terrace in summer.

- ***Does the roof terrace provide you with thermal comfort when you use it as a sleeping area in summer?***

	Very comfortable	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Older generation (14)	**0**	**14**	**0**	**0**	**0**
Younger generation (14)	**0**	**14**	**0**	**0**	**0**

All the inhabitants of all modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters), answered that they feel fairly comfortable when they use the roof terrace as a sleeping area in summer.

Discussion

The roof terrace has been used as a sleeping area overnight in summer by the occupants of both traditional and modern houses. All the occupants of the traditional houses (28), both older and younger generations, feel very comfortable when they use their roof terrace because this roof terrace provides them with thermal comfort; however, the occupants of all the modern houses (28), the older and younger generations, feel fairly comfortable when they use their roof terrace as this roof terrace provides them with inadequate thermal comfort.

Environmental Factors	**Traditional House**	**Modern House**
Roof terrace for summer sleeping	**Completely achieved**	**Partially achieved**

4.3.7.2. *Air conditioning*

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to the following questions regarding their thermal comfort in their house:

- ***In your opinion, is it important for a traditional courtyard house to be equipped with air conditioning to provide you with thermal comfort?***

	Very important	*Important*	*Not very important*	*Not at all important*
Older generation (7)	**0**	**0**	**7**	**0**
Younger generation (14)	**0**	**21**	**0**	**0**

The older generation of all the traditional houses (7/25%) (fathers) answered it is not very important for the traditional house to be equipped with air conditioning to provide them with thermal comfort, but the younger generation (21/75%) (sons and daughters) feel that air conditioning is important to provide them with thermal comfort in the house.

- ***Is your sitting area in your house comfortable without air conditioning?***

	Yes	***No***
Older generation (7)	*7*	***0***
Younger generation (21)	***0***	***21***
Total (28)		

The older generation of all the traditional houses (7/25%) (fathers) have answered that they feel comfortable in their sitting room without air conditioning but the younger generation (21/75%) have answered they do not feel comfortable in their sitting area without air conditioning.

Modern Houses

The inhabitants of all the modern houses were asked to reply to the following questions regarding their thermal comfort zone in their house.

- ***Is it important for your house to be air-conditioned at all times to provide you with thermal comfort?***

	Very important	*Important*	*Not very important*	*Not at all important*
Older generation (14)	**0**	**14**	**0**	**0**
Younger generation (14)	**0**	**14**	**0**	**0**

All the inhabitants of the modern houses (28), the older generation (14/50%) (fathers and wives) and the younger generation (14/50%) (sons and daughters), answered it is important for their house to be air-conditioned at all the times to provide them with thermal comfort.

- ***Do you feel comfortable in your living room without air conditioning?***

	Yes	*No*
Older generation (14)	***0***	***14***
Younger generation (14)	***0***	***14***
Total (28)		

All the inhabitants of the modern houses (28), the older generation (14/50%) (fathers and wives) and the young generation (14/50%) (sons and daughters), answered that they do not feel comfortable in their living room without air conditioning in summer.

Discussion

All the older generation from the traditional houses believe that it is not very important for their house to be equipped with air conditioning to provide them with thermal comfort because they can rely on the natural ventilation system (Badgir) for this, and they also feel comfortable in their sitting room without air conditioning. On the other hand, all the younger generation from the traditional houses disagreed as they believe that it is important for the house to be equipped with air conditioning to provide them with thermal comfort. It has been suggested that the younger generation are working in places that have been equipped with air conditioning systems and they no longer feel comfortable in the sitting room without air conditioning.

All the occupants of the modern houses, both the older and younger generations, believe that it is important for their house to be air-conditioned at all times to provide them with thermal comfort; they do not feel comfortable in the living room without the air conditioning system in operation. That is due to the lack of a natural ventilation system (Badgir) and also the modern house does not have a good response to the climate conditions.

Environmental Factors	**Traditional House**	**Modern House**
Air conditioning	**Not achieved**	**Achieved**

4.3.7.3. *Climate adaption*

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to this question regarding the climatic response of their house during the summer, winter and transition seasons.

- ***Do you think that your traditional courtyard house is well adapted to the climate?***

	In summer		*In winter*		*In transition seasons*	
	Older generation	*Younger generation*	*Older generation*	*Younger generation*	*Older generation*	*Younger generation*
Strongly agree	0	0	0	0	0	0
Agree	7	0	7	21	7	21
Disagree	0	21	0	0	0	0
Strongly disagree	0	0	0	0	0	0
Don't know	0	0	0	0	0	0

In summer: The older generation (fathers) (7/25%) of all the traditional houses answered that their house is well adapted to the climate in summer but all of the younger generations (sons and daughters) (21/75%) of the traditional houses have answered 'disagree'.

In winter: All the inhabitants of the traditional houses (28), both the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), have answered their house is well adapted to the climate in winter.

In transition seasons: All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered their house is well adapted to the climate in spring and autumn.

Modern Houses

The inhabitants of the modern houses were asked to reply to this question regarding climatic response of their house during the summer, winter and transition seasons.

- ***Do you think that your modern house has a good response to the climate conditions?***

	Yes	*No*
Older generation (14)	**0**	**14**
Younger generation (14)	**0**	**14**
Total (28)		

All the inhabitants of all the modern houses (28), both the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered their house does not have a good response to the climate conditions.

Discussion

In all the traditional houses the older generation considered that their house is well adapted to the climate conditions in summer, but the younger generation disagreed with the opinion of the older generation. The younger age group do not believe that the house is well adapted to the climate in summer; as mentioned in the previous section they believe it is important for their house to be equipped with air conditioning. In winter and the transition seasons, all the occupants of all the traditional houses, both the older and younger generations, have agreed that their house is well adapted to the climate conditions as the spring and autumn are very cool seasons which are not associated with uncomfortable temperatures. The occupants of all the modern houses, both the older and younger generations, believe that their house does not have a good response to the climate conditions.

Environmental Factors	**Traditional House**	**Modern House**
Climate Adaption	**Achieved**	**Not achieved**

4.3.7.4. *Thermal comfort with minimal services*

The meaning of minimal services as used within this research study is the use of ceiling fans for a few hours a day without air conditioning during the summer and the use of paraffin heating for a few hours a day without using the heating system during the winter. Transition seasons are cool and there is no need for cooling and heating.

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to the following questions regarding their thermal comfort in their living room and bedroom with the use of minimal services in the house in summer, winter and the transition seasons.

- ***In your main living room, do you feel comfortable with minimal services in your house?***

Summer living room: All the older generation from the traditional houses (fathers) (7/25%) have answered they feel very comfortable in their main living room with the use of minimal services in their house during the summer. All the younger generation of all the traditional houses (sons and daughters) (21/75%) responded that they feel fairly uncomfortable in their living room with the use of minimal services in their house during the summer.

Living room Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**21**	**0**	**0**
Total (28)					

Winter & transition seasons living room: All the older generation of the traditional houses (fathers) (7/25%) answered that they feel very comfortable in their main living room using minimal services in their house in winter, spring and autumn. The younger generation of all the traditional houses (sons and daughters) (21/75%) answered they feel fairly comfortable in their main living room using minimal services in their house in winter, spring and autumn.

Living room Winter/transition seasons	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**
Total (28)					

- ***In your bedroom, do you feel comfortable with the minimal services in your house?***

Summer bedroom: The older generation of all the traditional houses (fathers) (7/25%) indicated that they feel very comfortable in their bedroom with minimal services in the house in summer. The younger generation of the traditional houses (sons and daughters) (21/75%) answered they feel fairly uncomfortable in their bedroom with minimal services in the house in summer.

Bedroom Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**21**	**0**	**0**
Total (28)					

Winter & transition seasons bedroom: All inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), reported that they feel very comfortable in their bedroom with minimal services in the house in winter and the transition seasons.

Bedroom Winter/transition seasons	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**	**0**
Total (28)					

Modern Houses

The occupants of all the modern houses were asked to reply to this question regarding their thermal comfort in their house with minimal services.

- ***Do you feel comfortable with minimal services in your house?***

In summer: All the inhabitants of the all the modern houses (28), both the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that they feel fairly uncomfortable with minimal services in their house in summer.

Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (14)	**0**	**0**	**14**	**0**	**0**
Young generation (14)	**0**	**0**	**14**	**0**	**0**
Total (28)					

Winter and transition seasons: All the inhabitants of the all the modern houses (28), both the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that they feel fairly comfortable with minimal services in their house in winter and the transition seasons.

Winter/transition seasons	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't Know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

Discussion

For all the traditional houses the older generation feel comfortable in the main living room with minimal services such as the ceiling fans operating just a few hours a day, but the younger generation feel fairly uncomfortable with minimal services during the summer. The older generation believed that their traditional house is well adapted to the climate conditions in summer, but the younger generation disagree with this opinion. In winter and the transition seasons the older generation feel comfortable but the younger age group feel fairly comfortable.

For all the traditional houses, in the bedroom the older generation feel very comfortable with the minimal services but the younger generation feel fairly comfortable during the summer for the same reason mentioned above. In winter and the transition seasons the older and younger generations of all the traditional houses feel very comfortable in their bedroom with minimal services; both believed that the house is well adapted to the climate conditions in summer and the transition seasons.

For the modern houses the older generation and younger generation of all the modern houses feel fairly uncomfortable with minimal services in their house in summer and they feel fairly comfortable with minimal services in their house in winter, spring and autumn. In their opinion their house does not have a good response to the climate conditions.

Environmental Factors	**Traditional House**	**Modern House**
Thermal comfort with minimal services	**Partially achieved**	**Not achieved**

4.3.7.5. *Thermal comfort without minimal services*

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to this question regarding the general thermal comfort in their house.

- ***In terms of your thermal comfort, are you generally satisfied with the house you live in?***

General thermal comfort: In terms of thermal comfort, all the inhabitants of all the traditional houses (28), the old generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that they are very satisfied with the house they live in.

	Very satisfied	*Fairly satisfied*	*Fairly unsatisfied*	*Very unsatisfied*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**	**0**
Total (28)					

The inhabitants of all the traditional houses were asked to reply to this question regarding the environmental and climate conditions.

- ***In terms of environmental and climate conditions, to what extent do the traditional courtyard houses satisfy your needs?***

Summer environmental and climate conditions: The older generation of all the traditional houses (fathers) (7/25%) answered that the house satisfies their needs in summer very much. The younger generation of all the traditional houses (sons and daughters) (21/57%) answered the house satisfies their needs in summer to a fair extent.

	Very satisfied	*Fairly satisfied*	*Fairly unsatisfied*	*Very unsatisfied*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**
Total (28)					

The inhabitants of all the traditional houses were asked to reply to the following question regarding their thermal comfort in their living room and bedroom without minimal services in the house in summer, winter and transition seasons*:*

- ***In your main living room, do you feel comfortable without minimal services in your house?***

Summer living room: For all the traditional houses the older generation (fathers) (7/25%) answered that they feel fairly comfortable in their main living room without minimal services in the house in summer, while the younger generation (sons and daughters) (21/75%) answered they feel very uncomfortable in these conditions.

Living room Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**0**	**21**	**0**
Total (28)					

Winter & transition seasons: All the inhabitants of all the traditional houses (28) the older generation (fathers) (7/25%), indicated that they feel very comfortable without minimal services in their main living room in winter and transition seasons and the younger generation (sons and daughters) (21/75%) answered they feel fairly comfortable in these circumstances.

Living room Winter/transition seasons	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**
Total (28)					

- ***In your bedroom, do you feel comfortable without heating and cooling in your house?***

Household thermal comfort in summer: For all the traditional houses the older generation (fathers) (7/25%) answered they feel fairly comfortable without cooling in their bedroom in summer, while the younger generation (21/75%) feel very uncomfortable without cooling in their bedroom in summer.

Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**0**	**21**	**0**
Total (28)					

Summer thermal comfort without air conditioning: For all the traditional houses the older generation (fathers) (7/25%) answered they feel fairly comfortable around the house without air conditioning during the summer, while the younger generation of all the traditional houses (sons and daughters) (21/75%) indicated they feel fairly uncomfortable in these conditions.

Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**21**	**0**	**0**
Total (28)					

Household thermal comfort winter and transition seasons: All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%) answered that they feel fairly comfortable around the house without heating during the winter and transitions seasons.

Winter/transition seasons	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**
Total (28)					

Modern Houses

The inhabitants of all the modern houses were asked to reply to this question regarding their thermal comfort in their house without the minimal services.

- ***With regard to your thermal comfort, are you happy with the house you live in?***

General thermal comfort: In terms of the thermal comfort, all the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered they are not happy with the general thermal comfort in their house.

	Yes	***No***
Older generation (14)	**0**	**14**
Younger generation (14)	**0**	**14**
Total (28)		

- ***In terms of environment and climate conditions, to what extent does the modern house satisfy your needs?***

All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that they are fairly satisfied with the house they live in, in terms of environment and climate conditions.

	Very satisfied	*Fairly satisfied*	*Fairly unsatisfied*	*Very unsatisfied*	*Don't know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

The inhabitants of all the modern houses were asked to reply to this question regarding their thermal comfort in their house without minimal services.

- ***Do you feel comfortable without the minimal services in your house?***

In summer: All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that they feel very uncomfortable without minimal services in their house in summer.

Summer	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (14)	**0**	**0**	**0**	**14**	**0**
Young generation (14)	**0**	**0**	**0**	**14**	**0**
Total (28)					

In winter & transition seasons: All the inhabitants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered they feel fairly uncomfortable in winter without minimal services in their house in winter and fairly comfortable without minimal services in spring and autumn.

Winter	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (14)	**0**	**0**	**14**	**0**	**0**
Young generation (14)	**0**	**0**	**14**	**0**	**0**
Total (28)					

Spring/Autumn	*Very comfortable*	*Fairly comfortable*	*Fairly uncomfortable*	*Very uncomfortable*	*Don't know*
Old generation (14)	**0**	**14**	**0**	**0**	**0**
Young generation (14)	**0**	**14**	**0**	**0**	**0**
Total (28)					

Discussion

For the traditional house in terms of thermal comfort, all the inhabitants, the older and younger generations are very satisfied with the house they live in; in terms of meeting their needs in summer the older generation are very satisfied and the younger generation are fairly satisfied. For all the traditional houses, the older generation feel fairly comfortable in their living room without minimal services in summer and the younger generation feel very uncomfortable in the living room under these circumstances. During the winter and transition seasons the older generation feel very comfortable and the younger feel fairly comfortable in the living room. In their bedroom during the summer the older generation of the traditional houses feel fairly comfortable without the use of the cooling system, but the younger generation feel very uncomfortable under these circumstances. The older generation of the traditional houses feel fairly comfortable around the house without air conditioning in summer with the younger generation feeling fairly uncomfortable. During the winter and transition seasons, both the older and younger generations of the traditional houses feel fairly comfortable around the house without heating.

For the modern houses: in terms of the thermal comfort, the older and younger generations of the modern houses are happy with the house they live in and they are fairly satisfied with their house in terms of environment and climate conditions.

The older and younger generation of the modern houses feel very uncomfortable in their house without minimal services in summer and fairly uncomfortable in winter and feel fairly comfortable in spring and autumn.

Environmental Factors	**Traditional House**	**Modern House**
Thermal comfort without minimal services	**Partially achieved**	**Partially achieved**

4.3.7.6. *Passive system*

Traditional Houses

The inhabitants of all the traditional houses were asked the following questions regarding their natural ventilation system in their house:

- ***How comfortable you are in the basement level room (Sirdab) during the summer?***

Sirdab – summer: All the inhabitants of the all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that they feel cool when they use the basement level room (Sirdab) during the daytime and they feel cold when they use the basement level room (Sirdab) during the night-time.

Daytime	*Cold*	*Cool*	*Slightly cool*	*Neutral*	*Slightly warm*	*Warm*	*Hot*
Old generation (7)	**0**	**7**	**0**	**0**	**0**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**	**0**	**0**	**0**
Total (28)							

Night-time	*Cold*	*Cool*	*Slightly cool*	*Neutral*	*Slightly warm*	*Warm*	*Hot*
Old generation (7)	**7**	**0**	**0**	**0**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**	**0**	**0**	**0**
Total (28)							

- ***To what extent, do you think that the natural ventilation system (Badgir) contributes to comfort within your house throughout the year?***

Badgir – summer: The older generation (fathers) (7/25%) answered that the natural ventilation system (Badgir) makes a 'good' contribution to thermal comfort within their house in summer. The younger generation (sons and daughters) (21/75%) of all the traditional houses have answered that the natural ventilation system (Badgir) makes a 'fairly good' contribution to thermal comfort within their house in summer.

Summer	*Very good*	*Good*	*Fairly good*	*Poor*	*Don't know*
Old generation (7)	**0**	**7**	**0**	**0**	**0**
Young generation (21)	**0**	**0**	**21**	**0**	**0**
Total (28)					

Badgir – winter & transitions seasons: All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that the natural ventilation system (Badgir) makes a very good contribution to thermal comfort within their house throughout the winter and transition seasons.

Winter/Transition seasons	*Very good*	*Good*	*Fairly good*	*Poor*	*Don't know*
Old generation (7)	**7**	**0**	**0**	**0**	**0**
Young generation (21)	**21**	**0**	**0**	**0**	**0**
Total (28)					

Modern Houses

The inhabitants of the all modern houses were asked to reply to this question regarding the lack of an integrated natural ventilation system in their house:

- ***To what extent has your thermal comfort been affected by the lack of natural ventilation system?***

All the older generation of the modern houses (fathers and wives) (14/50%) answered that their thermal comfort is affected to a great extent by the lack of the natural ventilation system in their house. All the younger generation of the modern houses (sons and daughters) (14/50%) answered that to some extent their thermal comfort has been affected by the lack of the natural ventilation system in their house.

	To great extent	*To some extent*	*Not at all*
Old generation (14)	**14**	**0**	**0**
Young generation (14)	**0**	**14**	**0**
Total (28)			

Discussion

All the traditional houses incorporate a basement level room (Sirdab) which depends on a natural ventilation system (Badgir). The older and younger generations feel cool when they used the Sirdab during the day and feel cold during the night-time in this room. The older generation of all the traditional houses believe that the natural ventilation system makes a good contribution to thermal comfort within their house in summer but the younger generation believe that it makes a fairly good contribution to thermal comfort within their house in summer. Both generations, the older and younger of the traditional houses, believe that this system makes a very good contribution to thermal comfort within their house in winter and the transition seasons.

Because of the absence of the natural ventilation system (Badgir) in the modern houses the older generation of the modern houses believe that their thermal comfort is affected to a great extent by the lack of a natural ventilation system, but the younger generation believe that their thermal comfort is affected to some extent by the lack of a natural ventilation system.

Environmental Factors	Traditional House	Modern House
Passive System	**Completely achieved**	**N/A**

4.3.7.7. ***Solar protection***

Traditional Houses

The inhabitants of the traditional houses were asked to reply to this question regarding the solar protection of their house during the day in summer, winter and the transition seasons:

- ***Does the main façade of your house remain protected from the sun throughout the day?***

All the inhabitants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that the main façade of their house remains protected from the sun during the day in summer, winter, spring and autumn; this is due to the cut-off angles to direct sunlight provided by the close proximity of the houses on both sides of the alleyways.

Main façade protected from the sun	*In summer*	*In winter*	*In spring*	*In Autumn*
Old generation (7)	**7**	**7**	**7**	**7**
Young generation (21)	**21**	**21**	**21**	**21**
Total (28)				

Modern Houses

The inhabitants of the modern houses were asked to reply to the following questions regarding the solar protection of their house during the day in summer, winter and transition seasons:

- ***Is the inside of your house protected from the sun at any time of the day?***

The inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that the inside of their house is not protected from the intense heat and direct sunlight during the day in summer, but in the winter and transition seasons the cloud cover gives some protection to the house.

Inside of house protected from the sun	*In summer*	*In winter*	*In spring*	*In Autumn*
Old generation (14)	**0**	**14**	**14**	**14**
Young generation (14)	**0**	**14**	**14**	**14**
Total (28)				

- ***If your house is not protected from sun in summer, do agree or disagree that this is because the wide streets leaves the house exposed to the weather variation?***

All the inhabitants of all the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that they strongly agree that the wide streets do not protect their house from the sun in summer, but leaves it exposed to the weather variations.

	Strongly agree	*Agree*	*Disagree*	*Strongly disagree*	*Don't know*
Old generation (14)	**14**	**0**	**0**	**0**	**0**
Young generation (14)	**14**	**0**	**0**	**0**	**0**
Total (28)					

Discussion

All the inhabitants of the traditional houses, the older and younger generations, agreed that the main façade of their house is protected from the sun during the day in summer, winter and transition seasons due to the close proximity of the houses which allows the houses to protect each other from the sun in summer and winter and transition seasons. While all the inhabitants of the modern houses, both the older and younger generations, agreed that the inside of their house is not protected from the sun during the day in summer but that the solar radiation is not as intense during the winter and transition seasons. All occupants strongly agreed that the wide streets expose the house to the weather variations.

Environmental Factors	**Traditional House**	**Modern House**
Solar protection	**Completely achieved**	**Not achieved**

4.3.7.8. ***Dust storms***

Traditional Houses

The inhabitants of all the traditional houses were asked to reply to this question regarding the spring/summer dust storms:

- ***Is your house exposed to the spring/summer dust storms?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered that their house is exposed to the spring/summer dust storms.

	Yes	***No***
Older generation (7)	**7**	**0**
Younger generation (21)	**21**	**0**
Total (28)		

Questionnaire respondents were then asked:

- ***What is the impact of this on your thermal comfort?***

The older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), of all the traditional houses agreed that their comfort is affected by the spring and summer dust storms, especially when it is very hot. They feel uncomfortable and they need to shut all the windows and doors to avoid the dust; they cannot sleep on the roof terrace and they have to stay indoors.

Modern Houses

The inhabitants of all the modern houses were asked to reply to this question regarding the spring/summer dust storms:

- ***Is your house exposed to the spring/summer dust storms?***

All occupants of the modern houses (28), the older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%), answered that their house is exposed to the spring/summer dust storms.

	Yes	***No***
Older generation (14)	**14**	**0**
Younger generation (14)	**14**	**0**
Total (28)		

The inhabitants of all the modern houses were asked:

- ***What is the impact of this on your thermal comfort?***

The older generation (fathers and wives) (14/50%) and the younger generation (sons and daughters) (14/50%) of all the modern houses have agreed that their comfort is affected by the spring and summer dust storms, especially when it is very hot. They feel very uncomfortable and need to shut all the windows and doors to avoid the dust; they cannot sleep in the roof terrace and they have to stay indoors.

Discussion

Both traditional and modern houses are exposed to the spring/summer dust storms and both housing types are not protected from the dust during this period of time. The thermal comfort of all the inhabitants are affected by the spring/summer dust storms especially when it is very hot; the inhabitants of both types of houses need to stay indoors to avoid the dust and keep all the doors and windows shut during this period of time.

Environmental Factors	**Traditional House**	**Modern House**
Dust Storms	**Not achieved**	**Not achieved**

4.3.7.9. *Courtyard landscape*

Traditional Houses

The inhabitants of all the traditional houses were asked these questions regarding the outdoor space of their house:

- ***Do you have fountains?***
- ***Do you have trees?***

All occupants of the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), responded that they have fountains and trees in the courtyard of their house.

They were then asked to reply to this question regarding their thermal comfort:

- ***How important do you think the fountains in the open courtyard are in providing thermal comfort during the summer?***

All the inhabitants of all the traditional houses (28), the older generation (fathers) (7/25%) and the younger generation (sons and daughters) (21/75%), answered it is important to have a fountains in the open courtyard to reduce the intense air temperature and increase the relative humidity in summer.

	Very important	*Important*	*Not very important*	*Not at all important*
Old generation (7)	**0**	**7**	**0**	**0**
Young generation (21)	**0**	**21**	**0**	**0**
Total (28)				

Discussion

All the traditional houses have trees and fountains in the open courtyards and all the inhabitants of the traditional houses have agreed that it is important to have trees and fountains to reduce the intense air temperature and increase the relative humidity during the summer. On the other hand, the modern house have just trees in their gardens, which also reduce the high air temperature and increase the relative humidity during the summer.

Environmental Factors ***Courtyard Landscape***	**Traditional House**	**Modern House**
Trees	**Achieved**	**Achieved**
Fountains	**Achieved**	**N/A**

4.4. PHASE 2 DISCUSSION: PART 1/ QUESTIONNAIRE FINDINGS

This section will present the findings from the questionnaires of the occupants from the traditional and modern houses for each factor.

4.4.1. Socio-Cultural Factors

- **Courtyard/garden & privacy**

Socio-Cultural Factors	**Traditional House**	**Modern House**
Privacy: Courtyard/garden	**Completely achieved**	**Not achieved**

It was found from the questionnaire responses that the courtyard of the traditional house provides occupants with complete privacy when they use it for their daily activities and for social gatherings. However, it was found that the garden in modern houses does not provide occupants with complete privacy when they use it for social gatherings. So the courtyard of the traditional house provides complete privacy.

- **Roof terrace for summer sleeping**

Socio-Cultural Factors	Traditional House	Modern House
Privacy: Roof terrace for summer sleeping	**Completely achieved**	**Not achieved**

It was found from questionnaire responses that the occupants of traditional houses feel very secure on their roof terrace when they used it as a sleeping area overnight during the summer as it provides them with privacy. However, it was found that the occupants of the modern houses feel fairly insecure in the roof terrace when they used it as a sleeping area overnight in summer as this roof terrace does not provide them with privacy. So the traditional house has completely achieved the socio-cultural factors of privacy for the roof terrace summer sleeping.

4.4.2. Economic Factors

- **Location**

Economic Factors	Traditional House	Modern House
Location	**Achieved**	**Achieved**

Questionnaire responses indicate that the occupants of both traditional and modern houses feel the most important factors influencing their choice of house was that it should have an attractive location in a good neighbourhood; good design; and provide suitable living conditions. So the traditional and modern houses in the case study selection have achieved the economic factors regarding location.

- **Energy bills**

Economic Factors	Traditional House	Modern House
Energy bills	**Completely achieved**	**Partially achieved**

It was found from the questionnaire responses that the occupants of traditional houses have low costs for energy bills in summer, winter and transitions seasons to provide them with thermal comfort; this is also affordable for them. However, the occupants of the modern houses indicate that their energy bills are expensive for cooling and heating to provide them with thermal comfort; but they consider such bills are affordable for them. So the traditional house has completely achieved the economic factors regarding low energy bills.

4.4.3. Neighbourhood Factors

- **Neighbourhood and friendship**

Neighbourhood Factors	Traditional House	Modern House
Neighbourhood & friendship	**Completely achieved**	**Partially achieved**

It was found from the questionnaire responses that all the inhabitants of the traditional houses have a social connection with their neighbours and visit them once a week. The occupants of the modern houses also know their neighbours and socialise with them but there are two different opinions among the older and younger generation regarding their neighbourhood and friendships: the older generation visit their neighbours once a month but the younger generation visit them twice a month. So the traditional house (and its associated social networks) has completely achieved the neighbourhood factors regarding the neighbourhood and friendships, on the other hand the modern house has partially achieved this.

- **Travel**

Neighbourhood Factors	Traditional House	Modern House
Journeys: ***Work***	**Partially achieved**	**Not achieved**
Shops/markets	**Completely achieved**	**Completely achieved**
School/university	**Not achieved**	**Not achieved**

It was found from the questionnaire responses from the occupants of the traditional houses on daily travel that those among the older generation who travel to work have a journey of 30 minutes or less but for the younger generation their journey takes one hour; some of the younger generation travelling to university have a journey of one and a half hours; and the shops and markets are located within walking distance. Respondents from the modern houses indicate that both older and younger generations have longer journeys to work of one hour; and some of the younger generation have a journey time of one and a half hours; the shops and markets are located in the same neighbourhood. So the traditional house has partially achieved the neighbourhood factors regarding the journey to work and completely achieved the journey to shops/markets and not achieved the journey to school-university. The modern house has not achieved the journey to work and to school/university but completely achieved the journey to shops/markets.

4.4.4. Architectural Factors

- **Conservation work**

The research has found that just two traditional houses from seven had conservation work in the last four years. The local authority is responsible for the conservation of the traditional houses. It has been found from the occupants' responses that traditional houses should receive support from the local authority at least every three years to protect these houses. No conservation work has been carried out on the modern houses.

- **House type preference**

Architectural Factors	Traditional House	Modern House
House type preference	**Achieved**	**Not achieved**

It was found from the questionnaire responses that all occupants of traditional houses would not like to move and live in a modern house because they feel comfortable and they are happy with the house they live in. The occupants of the modern houses indicated that they had no experience of traditional houses, as just one father from the older generation had lived in a traditional house as a child. So the traditional house has achieved the architectural factors regarding the house type preference.

- **Outdoor space usage**

Outdoor Space Usage ***Courtyard/garden***	**Traditional House**	**Modern House**
Summer	**Partially achieved**	**Not achieved**
Winter	**Partially achieved**	**Partially achieved**
Transition seasons	**Completely achieved**	**Completely achieved**

It was found that all the occupants of the traditional house use the courtyard sometimes in summer for their daily activities and for social gatherings and rarely use it in winter, just when it is a sunny day. However, they use the courtyard for their daily activities and social gatherings almost every day in spring and autumn. It was found that all the occupants of the modern houses do not use the garden for their daily activities during the summer, but they do use it sometimes for social gatherings in summer; they rarely use it in winter, just when it is a sunny day; and use it almost every day in spring and autumn. So the traditional house has partially provided outdoor usage in summer and winter and completely achieved it in spring and autumn. The modern house has not provided outdoor usage in summer and partially achieved in winter and completely achieved in spring and autumn.

- **Noise**

It was found from questionnaire responses that occupants of the modern houses feel their main living room is uncomfortably noisy and this noise is caused by road traffic; the external noise pollution is due to the thin external walls providing inadequate sound insulation. So the modern house does not achieve the sound insulation.

4.4.5. Services Factors

- **Kitchen**

Services Factors	Traditional House	Modern House
Kitchen	**Partially achieved**	**Completely achieved**

Responses from the occupants in the traditional houses regarding their unfitted kitchen revealed that there are two opinions between the older and younger generation; the older generation believed that the unfitted kitchen is physically comfortable but the younger generation have responded that this kitchen is uncomfortable and they would prefer to have a fitted one. Respondents from the modern houses indicate that all occupants feel comfortable in their fitted kitchen. So the modern house has provided a satisfactory kitchen factor and the traditional house has partially achieved it.

- **Water supply**

Services Factors	Traditional House	Modern House
Water Supply	**Not achieved**	**Achieved**

It was found from questionnaire responses from the occupants of the traditional houses regarding their water supply system that there are two opinions between the older and younger generation; the older generation are fairly satisfied with the water supply system in their house but the younger generation are unsatisfied with the water supply system as the younger age group feel they need more water taps. However, both the older and younger generations believed that it is important to provide each house with a cold water tank. For the modern houses both the older and younger generations are satisfied with the water supply system in their house and both believed that it is important to provide each house with a cold water tank. So the modern house achieved the water supply factor while in the traditional house it is not achieved.

- **Sanitation**

Services Factors	Traditional House	Modern House
Sanitation	**Not achieved**	**Completely achieved**

It was also found that all occupants of the traditional houses are not satisfied with the sanitation system in their house because it is noisy when the septic tanks are emptied disturbing householders and their neighbours. It was found that all the occupants of the modern houses are satisfied with their sanitation system. So the modern house has achieved a satisfactory services factor for sanitation but the traditional house has not.

- **Waste disposal**

Services Factors	Traditional House	Modern House
Waste disposal	**Not achieved**	**Partially achieved**

It was found that the occupants of the traditional houses keep their rubbish in the courtyard; the younger generation believed that this represents a risk to health while the older generation disagreed with this opinion. It was found rubbish was also kept in the rear garden of the modern houses; all occupants believed this to represent a risk to health. So the modern house has partially achieved the waste disposal factor but the traditional house has not achieved this factor.

- **Highway/byway drainage**

Services Factors	Traditional House	Modern House
Highway/byway drainage	**Not achieved**	**Partially achieved**

From the questionnaire responses it was found all occupants of the traditional houses have problems associated with the surface of the alleyways during the winter and all occupants of the modern houses have problems associated with some unpaved pavements during the summer and winter. So the modern house has partially satisfied this factor and the traditional house does not achieve it.

4.4.6. Environmental Factors

- **Roof terrace for summer sleeping**

Environmental Factors	**Traditional House**	**Modern House**
Roof terrace for summer sleeping	**Completely achieved**	**Partially achieved**

From the questionnaire responses it was found that all occupants of traditional houses feel very comfortable when they use the roof terrace as a sleeping area during the summer and this roof terrace provides them with thermal comfort. However, it was found that all occupants of the modern houses feel fairly comfortable when they use the roof terrace as a sleeping area during the summer and this roof terrace provides them with inadequate thermal comfort. So the traditional house has completely achieved this factor but the modern house has not achieved it.

- **Air conditioning**

Environmental Factors	**Traditional House**	**Modern House**
Air conditioning	**Not achieved**	**Achieved**

It was found from questionnaire responses that there are two different opinions regarding the need for air conditioning in traditional houses; the older generation believe that it is not very important for their house to be equipped with air conditioning to provide them with thermal comfort and they feel comfortable in their sitting room without air conditioning. But the younger generation disagreed with this opinion; they believe that it is important for the traditional house to be equipped with air conditioning to provide them with thermal comfort. It was found that both the older and younger generations from modern houses believe that it is important for their house to be air-conditioned at all times to provide them with thermal comfort; they do not feel comfortable in the living room without the air conditioning system operating. So the modern house has achieved this factor but the traditional house has not achieved it.

- **Climate adaption**

Environmental Factors	**Traditional House**	**Modern House**
Climate adaption	**Achieved**	**Not achieved**

It was found there are two different opinions regarding climate adaption in traditional houses: the older generation believed that the house is well adapted to the climate in summer, but the younger generation disagreed with this opinion. However, both the older and younger generations believed that the traditional house is well adapted to the climate in winter and the transition seasons. For the modern houses all the occupants believed that the modern house does not have a good response to the climate conditions. So the traditional house has achieved this factor but the modern house has not achieved it.

- **Thermal comfort with minimal services**

Environmental Factors	**Traditional House**	**Modern House**
Thermal comfort with minimal services	**Partially achieved**	**Not achieved**

It was found there are two different opinions regarding thermal comfort with minimal services in traditional houses: all the older generation feel comfortable in the main living room with minimal services during the summer, but all the younger generation feel fairly uncomfortable with minimal services. In traditional houses during winter and the transition seasons the older generation feel comfortable with minimal services, but the younger age group feel fairly comfortable. The older generation of the traditional houses feel very comfortable with the minimal services in the bedroom but the younger generation feel fairly comfortable during the summer. In winter and transition seasons the older and younger generation of all the traditional houses feel very comfortable in their bedroom with minimal services.

For all the modern houses it was found that both older and younger generations feel fairly uncomfortable with minimal services in their modern house in summer and fairly comfortable with minimal services in winter, spring and autumn. So the traditional house has partially achieved this factor but the modern house has not achieved this factor.

- **Thermal comfort without minimal services**

Environmental Factors	**Traditional House**	**Modern House**
Thermal comfort without minimal services	**Partially achieved**	**Partially achieved**

It was found that in terms of thermal comfort without minimal services in traditional houses, the older and younger generation of all traditional houses are very satisfied with the house they live in; all the older generation were very satisfied that their needs had been met in summer and the younger generation fairly satisfied. The older generation feel fairly comfortable in the living room of the traditional house without air conditioning but the younger generation feel very uncomfortable. In winter and the transition seasons in traditional houses the older generation feel very comfortable but the younger feel fairly comfortable. In the bedroom of the traditional house during the summer the older generation are fairly comfortable but the younger are fairly uncomfortable without cooling. In winter and the transition seasons the older and younger generation feel fairly comfortable without heating.

For the modern houses in terms of the thermal comfort of the occupants without minimal services, both the older and younger generation are happy with the house they live in, but they are fairly satisfied with their house in terms of environment and climate conditions; they feel very uncomfortable in their modern house without minimal services in summer and fairly uncomfortable in winter. So both the traditional and modern house has partially achieved this factor.

- **Passive system**

Environmental Factors	**Traditional House**	**Modern House**
Passive system	**Completely achieved**	**N/A**

The research has found that all the traditional houses incorporate a basement level room (Sirdab) which depends on a natural ventilation system (Badgir). From the questionnaire responses it was found that the older generation of the traditional houses believe that this passive natural ventilation system makes a good contribution to thermal comfort within their house in summer, but the younger generation believe that this system makes a fairly good contribution to thermal comfort in summer. Both believe that the natural ventilation system makes a very good contribution to thermal comfort within their traditional house in winter and the transition seasons. It was found, however, that the older generation in the modern houses believe the absence of the natural ventilation system adversely affects their thermal comfort to a great extent, but the younger generation believe that their thermal comfort is affected to some extent by the lack of a natural ventilation system.

- **Solar protection**

Environmental Factors	Traditional House	Modern House
Solar Protection	Completely achieved	Not achieved

It was found from questionnaire responses that the main façade of the traditional house is protected from the sun during the day in summer, winter and the transition seasons. However, all the occupants of the modern houses have responded that the inside of their house is not protected from the sun during the day in summer but it does get protection from the sun in winter and the transition seasons. So the traditional house has achieved the solar protection factor but the modern house has not achieved it.

- **Dust storms**

Environmental Factors	Traditional House	Modern House
Dust storms	Not achieved	Not achieved

It was found from the occupants' responses that both traditional and modern houses are exposed to the spring/summer dust storms and both house types are not protected from the dust storms during this period of time. The thermal comfort of the occupants of both traditional and modern houses is affected by the spring/summer dust storms, especially when it is very hot. So the traditional and modern house have not achieved protection from the dust storms factor.

- **Courtyard landscape**

Environmental Factors ***Courtyard landscape***	**Traditional House**	**Modern House**
Trees	**Achieved**	**Achieved**
Fountains	**Achieved**	**N/A**

It was found from the responses regarding the courtyard landscape that all the traditional houses have trees and fountains in the open courtyard to reduce the high air temperature and increase the relative humidity during the summer. Also it has been found that the modern houses have trees only in the gardens for the same function of reducing the high air temperature and increasing the relative humidity. The modern house does not incorporate a fountain. So the traditional house has achieved the courtyard landscape for trees and fountains but the modern house has achieved this factor for only trees.

PART 2/SURVEY MEASUREMENT FINDINGS

Traditional Houses

In general all the traditional courtyard houses have been built in groups and this is an advantage of one of the traditional characteristics of this house type as the closeness between the houses provides the inhabitants with direct social connections with their neighbours. Also it has been found that all the traditional houses are built of two storeys (ground floor level, first floor level and the roof terrace).

The researcher has found that although the traditional houses are of different sizes they incorporate the same habitable rooms and spaces and there are specific habitable rooms that have been designed particularly for summer and winter habitation, such as the basement level room (Sirdab) and semi-basement level room (Neem) at ground floor level for summer and the winter living room (Ursi) at the first floor level. As the researcher has found, these habitable rooms are essential for the traditional courtyard house.

Some of the selected traditional houses have not incorporated an adequate number of bedrooms so some of the habitable rooms have been converted for this purpose, such as the winter room (Ursi) and the mezzanine level room (Kabishkan) which could be used by the inhabitants as a bedroom.

At the traditional house the floor to ceiling height at the ground floor is lower than the floor to ceiling height at the first floor level; this is because when the first traditional houses have been built they were designed to be serviced naturally by the natural ventilation system (Badgir) and as a result the room does not need to be installed with ceiling fans. The traditional house has been fitted with a cooling system; this was due to the climate changes in the last 30 years producing a need for the traditional house to be equipped with a cooling system to provide the inhabitants with thermal comfort. The roof terrace at all the traditional houses incorporates a parapet wall which is high enough to prevent overlooking by neighbours; this roof terrace provides the inhabitants with privacy.

The building materials are mostly bricks and wood; there are many columns at the ground and first floors and the building techniques involved in creating these features are no longer used in the building industry **(details in Chapter II).**

Modern Houses

In general the modern houses have been built as detached or semi-detached houses which are located along wide roads. Because the modern houses are not built in a group there is no direct social connection between neighbours. The houses have been built as two storeys or partially as a two-storey house (ground floor level, first floor level and the roof terrace).

Inside the house the researcher has found that there are no specific habitable rooms and spaces which have been designed particularly for summer or winter habitation. Most of the selected modern houses incorporate a reception/dining room which has been designed to receive visitors. The selected modern houses incorporate either a front garden or rear or side garden with open space (Tarma).

The researcher has found from the physical survey that all the habitable rooms and spaces do not open directly to the garden and as result heating costs to warm such a house are less expensive during the winter. The floor to ceiling height at the ground floor level (4000 mm) is higher than the floor to ceiling height (3000 mm) at the first floor level; this is due to the possibility of using ceiling fans at the ground floor level.

The modern houses have been with an air conditioning system and none of the modern houses have been serviced naturally by the natural ventilation system (Badgir).

It has been found that the roof terrace at the selected modern houses incorporates a parapet wall which is not high enough to prevent overlooking by neighbours and that has affected the inhabitants' privacy when they use the roof terrace as a sleeping area during the summer. The construction and building materials are mostly concrete and glass and that makes the house hot in summer and cold in winter **(details in Chapter II).**

Table 4.46. Comparison of building materials of traditional and modern houses

	Traditional	**Modern**
Foundations:	***Materials/Thickness***	
	Hard-burnt bricks	Strip of concrete footing
	700–1200 mm thickness	350–450 mm thickness
Walls:	***Thickness***	
Retaining:	700–900 mm thickness	N/A
External:	500–700 mm thickness	220–320 mm thickness
Party:	500–700 mm thickness	230–340 mm thickness
Internal: Sirdab/Neem	500–700 mm thickness	220–225 mm thickness
Roofs:	***Thickness***	
Parapet walls:	250–225 mm thickness	150–180 mm thickness

PART 3/OCCUPANT OBSERVATION

Traditional Houses

The researcher has found that all the inhabitants of the selected traditional houses have been using their house in the same way and have the same daily activities during the summer/winter and transition seasons, spring and autumn.

The ground floor level has been used by the inhabitants during the summer more than the first floor level. They used the 'summer rooms' during the day, the main living room and main bedroom at the ground floor level during the summer. In winter the habitable rooms and spaces at the first floor level were used by the inhabitants during this season. The courtyard remains one of the most important spaces in the house and some of the daily activities take place in the courtyard during the summer and in the winter during the sunny days.

The inhabitants of the traditional houses have been using the courtyard at different times of the day during the summer and winter and transition seasons, spring and autumn, for their daily activities.

In summer: The courtyard has been used by the inhabitants sometimes in the early morning for having breakfast, washing and sometimes cooking. It was used in the late afternoon for the afternoon tea after it was washed with water to reduce the high temperature and increase the relative humidity; and was also used for social gatherings.

The courtyard was used in the late evening for watching TV and for social gatherings and receiving visitors such as neighbours, friends and relatives and sometimes for having dinner.

In winter: The courtyard has been used by the inhabitants sometimes in the morning when it was a sunny day for having breakfast, cooking or for family gatherings. During the lunch time the inhabitants used the courtyard when it was a sunny day, for having lunch.

In spring/autumn: The courtyard has been used by the inhabitants during the spring and autumn almost every day in the morning for having breakfast, washing clothes and in the afternoon and early evening for receiving visitors and family social gatherings.

Each house of the seven selected traditional houses has adequate space which has been designed in response to the social requirements for males and females in the house. There are habitable rooms designed to be used by the adult male visitors and the other habitable rooms have been designed to be used by the female inhabitants and their visitors.

During the investigation it has been discovered that the habitable rooms and spaces designed for winter habitation such as the Ursi room has the best orientation in winter because its external windows are oriented towards the sun. And the habitable rooms and spaces designed for summer habitation such as the basement level room (Sirdab) and semi-basement level room (Neem) have the best orientation in summer because these habitable rooms and spaces are positioned underneath the courtyard floor and as a result they are shaded from the sun.

Modern Houses

The researcher has found that the inhabitants of the selected modern houses have used the same habitable rooms and spaces during the summer and winter and they have been using the habitable rooms at ground floor level and at first floor level during the day in summer and have the same daily activities during the summer/winter and during the transition seasons, spring and autumn.

The modern house does not incorporate an entrance lobby (Mejaz) and that has affected the privacy of the inhabitants. The garden is the only open space at the modern house and it is not private as the external walls of the house are not high enough to prevent overlooking by passers-by and neighbours and that has affected the inhabitant's privacy when they have used the garden for social gatherings.

4.5. CONCLUSION

This research has presented a detailed investigation of the following factors based on the findings from the literature survey and the investigations during fieldwork:

Socio-cultural factors:

Traditional houses

Table 4.47. Findings on factors for traditional houses

Socio-Cultural Factors	Literature	Physical Measurement	Observation	Questionnaire
Entrance	X	X		
Outside Spaces	X	X	X	X
Internal Privacy between Genders	X		X	
Privacy for Outside Sleeping Spaces	X	X	X	X

It has been found from the literature and fieldwork investigation that the traditional house has been designed to satisfy the occupants' historic socio-cultural requirements with regard to privacy both in terms of preventing overlooking by neighbours and passers-by while the inhabitants are using the habitable rooms and spaces, as well as with regard to gender separation. It also satisfies the inhabitants' needs for complete privacy for outside sleeping spaces.

Modern houses

Table 4.48. Findings on factors for modern houses

Socio-Cultural Factors	Literature	Physical Measurement	Observation	Questionnaire
Entrance		X		
Outside Spaces	X	X	X	X
Internal Privacy between Genders	X		X	
Privacy for Outside Sleeping Spaces	X	X	X	X

It has been found from the literature and fieldwork investigation that the modern house does not satisfy the inhabitants' needs for complete privacy by preventing overlooking by neighbours and passers-by and there were no habitable rooms and spaces designed especially for male or female inhabitants. The modern house does not satisfy the inhabitants' needs for complete privacy for the outside sleeping spaces.

So those aspects of the traditional house designed to meet the socio-cultural factors desired by modern day culture in Baghdad would be appropriate in the future ideal house and it is suggested they be applied to the optimal design strategies.

Table 4.49. Comparison of findings for traditional and modern houses

Socio-Cultural Factors Privacy	Traditional House	Modern House
Entrance	Satisfied	Not satisfied
Outside Spaces	Satisfied	Not necessarily satisfied
Internal Privacy Between Genders	Satisfied	Not necessarily satisfied
Privacy for Outside Sleeping Spaces	Satisfied	Not satisfied due to detailed design concerns
Socio-Cultural Factors	**Completely achieved**	**Not achieved**

Architectural factors:

Traditional houses

Table 4.50. Findings on factors for traditional houses

Architectural Factors	Literature	Physical Measurement	Observation	Questionnaire
Planning	X	X		
Basement Spaces	X	X	X	X
Seasonal Use of Spaces	X		X	X

The architectural factors of the traditional houses have been identified in the literature and through investigation. Understanding of the occupation of traditional houses is dependent on an inherent understanding of the passive functioning of the houses, indeed it requires an understanding of the climate and seasonally responsive living strategies.

Modern houses

Table 4.51. Findings on factors for modern houses

Architectural Factors	Literature	Physical Measurement	Observation	Questionnaire
Planning	X	X		
Basement Spaces				
Seasonal Use of Spaces	X		X	X

The architectural factors of the modern houses (planning & seasonal use of spaces) have been identified in the literature and from fieldwork investigation. It can be seen from the plans that the modern house is more simple and compact in comparison to the traditional house, while the relationship to the climate is less explicit.

Table 4.52. Comparison of factors for traditional and modern houses

Factor		Traditional House	Modern House
Planning		Both housing typologies are capable of providing a response to the requirements in terms of scale and number and type of spaces required.	
Basement Spaces		Provided	Not provided
Seasonal Use of Spaces		Enabled	Not Enabled
Architectural Factors	***Functional Programme of Use***	**Achieved**	**Achieved**
	Seasonal Programme of Use	**Enabled**	**Not achieved**

So the architectural factors of traditional houses and some of the architectural factors of modern houses would be appropriate in the future ideal house in Baghdad and it is suggested they be applied to the optimal design strategies.

Environmental factors:

Summer environmental factors

Traditional houses

Table 4.53. Summer environmental factors for traditional houses

Environmental Factors: Summer	Literature	Physical Measurement	Observation	Questionnaire
Urban Planning	**X**	**X**		**X**
External Spaces	**X**	**X**	**X**	**X**
Dust Storms	**X**		**X**	**X**
Seasonal Usage of Spaces	**X**	**X**	**X**	**X**
Thermal Mass	**X**	**X**		
Basement Rooms	**X**	**X**	**X**	**X**
Natural Ventilation System (Badgir)	**X**	**X**	**X**	**X**

The summer environmental factors of traditional houses have been identified in the literature and investigation and it has been found that the traditional courtyard house has been designed to respond to the occupants' thermal comfort through a series of passive design strategies that have been integrated into the design of the houses.

Modern houses

Table 4.54. Summer environmental factors for modern houses

Environmental Factors: Summer	Literature	Physical Measurement	Observation	Questionnaire
Urban Planning	X	X		X
External Spaces	X	X	X	X
Dust Storms	X		X	X
Seasonal Usage of Spaces	X	X	X	X
Thermal Mass	X	X		
Basement Rooms				
Natural Ventilation System (Badgir)				

The summer environmental factors of modern houses have been identified in the literature and during fieldwork investigation and it has been found that the modern house is less successful in responding to the environmental/climatic demands of the location. The age of the literature available is less of a concern as the limitations discussed relate to passive strategies, in particular solar shading and the use of thermal mass, that would serve to reduce energy demand for air conditioning were they to be integrated into modern housing design.

Table 4.55. Comparison of summer environmental factors of traditional and modern houses

Factors	Traditional House	Modern House
Urban Planning	**Satisfied**	**Not satisfied**
External Space	**Satisfied**	**Not satisfied (*Although possible*)**
Dust Storms	**Partially satisfied**	**Not satisfied**
Seasonal Usage of Spaces	**Satisfied**	**Partially satisfied**
Thermal Mass	**Satisfied**	**Not satisfied**
Basement Rooms	**Satisfied**	**N/A**
Natural Ventilation System (Badgir)	**Satisfied**	**N/A**
Summer Environmental Factors	**Achieved**	**Not achieved**

It has been found that the aspects of design in the traditional house that achieve the summer environmental factors would have a good influence on the future ideal house and it is suggested they be applied to the optimal design strategies.

Winter environmental factors

Traditional houses

Table 4.56. Winter environmental factors for traditional house

Environmental Factors: Winter	Literature	Physical Measurement	Observation	Questionnaire
Urban Planning	X	X		X
Built Form	X	X		
Seasonal Usage of Spaces	X	X	X	X

The winter environmental factors of the traditional houses have been identified in the literature and during fieldwork investigation. From both the literature and investigation it has been found that the traditional house has been designed to respond to the occupants' thermal comfort through a series of passive design strategies that have been integrated into the design of the houses. In particular these include:

- Urban design strategies that promote protection from rain and wind.

- Seasonal usage of space strategies that enable functional response to climate.

It has been found that there is a negative aspect of the design for the built form for the winter context as all the habitable rooms and spaces are looking inwards towards the courtyard with all the windows and doors open to this external space. As a result they are cold in winter because of heat loss.

Modern houses

Table 4.57. Winter environmental factors for modern house

Environmental Factors: Winter	Literature	Physical Measurement	Observation	Questionnaire
Urban Planning	X	X		X
Built Form	X	X		
Seasonal Usage of Spaces				

Winter environmental factors have been identified in the literature and during investigation and it has been found that the modern house is less successful in responding to the environmental/climatic demands of the location in terms of negative exposure to wind and rain and positive solar gain.

Table 4.58. Comparison of winter environmental factors of traditional and modern houses

Factors	Traditional House	Modern House
Urban Planning	**Achieved**	**Not achieved**
Built Form	**Not achieved**	**Achieved**
Seasonal Usage of Space	**Achieved**	**Not achieved**
Winter Environmental Factors	**Achieved**	**Partially achieved**

It has been found that the winter environmental factors of traditional houses (urban planning & seasonal usage of space) would have a good influence on the future ideal house and it is suggested they be applied to the optimal design strategies. But it is suggested that the built form factor of the modern house be applied to the optimal design strategies.

So in summary, from literature and investigation it can be seen that the two housing typologies have achieved or might "enable" achievement of socio-cultural, architectural and environmental factors to a differing level.

Table 4.59. Comparison of the three factors of traditional and modern houses

Factors	Traditional House	Modern House
Socio-Cultural Factors	**Completely achieved**	**Not achieved**
Architectural Factors	**Enable**	**Not Enabled**
Summer Environmental Factors	**Completely achieved**	**Not achieved**
Winter Environmental Factors	**Mostly achieved**	**Partially achieved**

CHAPTER V

PHASE II: METHODOLOGY

5.1. INTRODUCTION

In order to achieve the main aim of this research a comparative study of the environmental performance of traditional courtyard houses and modern houses has been undertaken. In both house types the courtyard, garden and habitable rooms and spaces were measured environmentally during the summer and winter for a period of two weeks to evaluate the microclimates and internal thermal environmental conditions of both houses.

The measurements recorded the indoor and outdoor air temperature and relative humidity every five minutes. Four case study houses were selected to be monitored; these are the traditional houses **TH1** and **TH2** and the modern houses **MH1** and **MH2** as have been previously described in Chapters **III** and **IV** of this research.

This chapter will present the methods used to achieve **objective 4 of the research:**

> ***Establish the occupant comfort, satisfaction and thermal performance of the traditional and modern houses throughout the year.***

Two example case studies from each typology were selected for in-depth study to include:

> ***Environmental monitoring (air temperature & relative humidity) in the two selected traditional houses and two selected modern houses for the summer and winter periods.***

Occupants' comfort diaries were utilised during these two monitoring periods.

Chapter VI Phase 2 Results Performance, Comfort & Analysis then goes on to present the findings of this phase of the research. The chapter will evaluate the thermal performance of each house type and the occupants' comfort and satisfaction as recorded in the diaries. The chapter also aims to establish the comparison between the environmental performance of the traditional houses and modern houses.

This chapter aims to justify the development of the proposed methodology and to present and describe the chosen case study houses which have been used for the monitoring. Also the chapter provides information on the spaces monitored in the summer and winter periods for the two traditional houses and modern houses in tables.

In order to achieve objective 4 Primary Data Collection will be required.

Consistent with the view of **Easterby–Smith et al. (2000)** who draw a thin line between qualitative and quantitative techniques, this research will adopt a mixed methods approach. **Burrel and Morgan (1979)** argue that quantitative and qualitative research methods are mutually exclusive because their underlying assumptions are seen as contradictory. However, writers such as **Gable (1994)** and **Remenyi and Williams (1996)** disagree, insisting that these alternate research methods should be seen as the ends of a continuum.

In order to respond to objective 4, two example case studies from each typology were selected and an in-depth study conducted for each house. Environmental monitoring (air temperature and relative humidity) of two selected traditional courtyard houses and two selected modern houses was undertaken in summer 2014 and also in winter 2015. The data analysis for both periods has been completed.

Occupants' comfort diaries were utilised during these two monitoring periods. These were completed by four occupants from the traditional courtyard houses and modern houses (one representative from each house for the time period of the summer and winter measurements).

5.2. HOUSING FOR MONITORING

The researcher chose one large-sized house and one medium-sized house as examples of the two types of houses in order to begin to understand how these houses perform environmentally. In addition, the TH1 and TH2 are located in close proximity to each other in the same alleyway and the modern houses MH1 and MH2 are located in the same road, thus making it easy for the researcher to visit the houses and check the locations and functioning of the equipment regularly during the monitoring periods. This was the reason for choosing these houses from among the original case study sample of 14 houses.

In all the houses selected for environmental monitoring it was straightforward to place the equipment in the habitable rooms and spaces. Finally, the inhabitants of each of the selected case study houses did not have any objections to the placement of the equipment in their house and were very helpful in keeping the equipment safe at all times.

The table below describes the two traditional case study houses selected for this phase of the research.

Table 5.1. Case study of the two selected traditional houses

Case Study Code	Floors	Living/Reception Rooms	Bedrooms	External Spaces
TH1	2 floors	Ground floor:1 First floor: 2 Ursi	3	1 Courtyard 1 Roof terrace
TH2	3 floors	Ground floor: 1 First floor: 2 Ursi	5	1 Courtyard 1Roof terrace

The table below describes the two modern case study houses selected for this phase of the research.

Table 5.2. Case study of the two selected modern houses

Case Study Code	Floors	Living/Reception Rooms	Bedrooms	External Spaces
MH1	2 floors	Ground floor: 1 reception 1 living room First floor: None	4	1Garden 1Roof terrace
MH2	2 floors	Ground floor: 1 reception 1 living room First floor: None	5	1 Garden 2 Roof terraces

5.3. PHASE 1 METHOD: BUILDING MONITORING

In order to establish the occupant comfort, satisfaction and thermal performance of the traditional houses and modern houses throughout the year, the following process was followed. Environmental monitoring (air temperature & relative humidity) of the selected traditional houses and modern houses for the summer and winter periods was undertaken in summer 2014 and in winter 2015. The four case study houses chosen for monitoring are analysed in detail in Chapter IV Phase 1 Results: Buildings/Occupants. The four case study houses were monitored for a period of two weeks during the summer and winter. The measurements recorded the maximum and minimum indoor and outdoor air temperature and relative humidity every five minutes.

The equipment (loggers) were used to measure the microclimate and internal environmental conditions of the four selected case studies (two traditional houses and two modern houses) for the summer and winter period. Four spaces in each house were measured environmentally; two loggers were used for indoor measurements and two loggers used for the outdoor measurements.

One logger was placed in the living room, bedroom, courtyard and roof terrace of each selected traditional house and one logger was placed in the living room, bedroom, garden and roof terrace of each selected modern house. These spaces were chosen to be measured environmentally for the summer and winter periods because they are the spaces most used by the inhabitants during the two seasons of the year.

The loggers in the **living room and the bedroom** of all the case study houses were placed on small tables beside the sitting place of the inhabitants in the case of the living room, and on a small bedside table in the case of the bedrooms. The researcher located the loggers in such locations because they were considered as directly representative of the occupied zones by the inhabitants in each of these spaces. It should be noted that all the external loggers were covered about 15 cm above the loggers and where possible the loggers were placed in locations that were considered by the inhabitants as occupied zones for them.

In the **courtyard of the traditional houses** each logger was placed in the corner near the colonnaded gallery (Talar) that was shaded; the location was already in a shaded area. In the **garden of the modern houses** loggers were also located in a corner that was shaded. For **all roof terraces** each logger was located in a hidden area near the parapet wall.

The researcher located the loggers in such locations at the roof terrace of the two traditional and modern houses in order to optimise the shade.

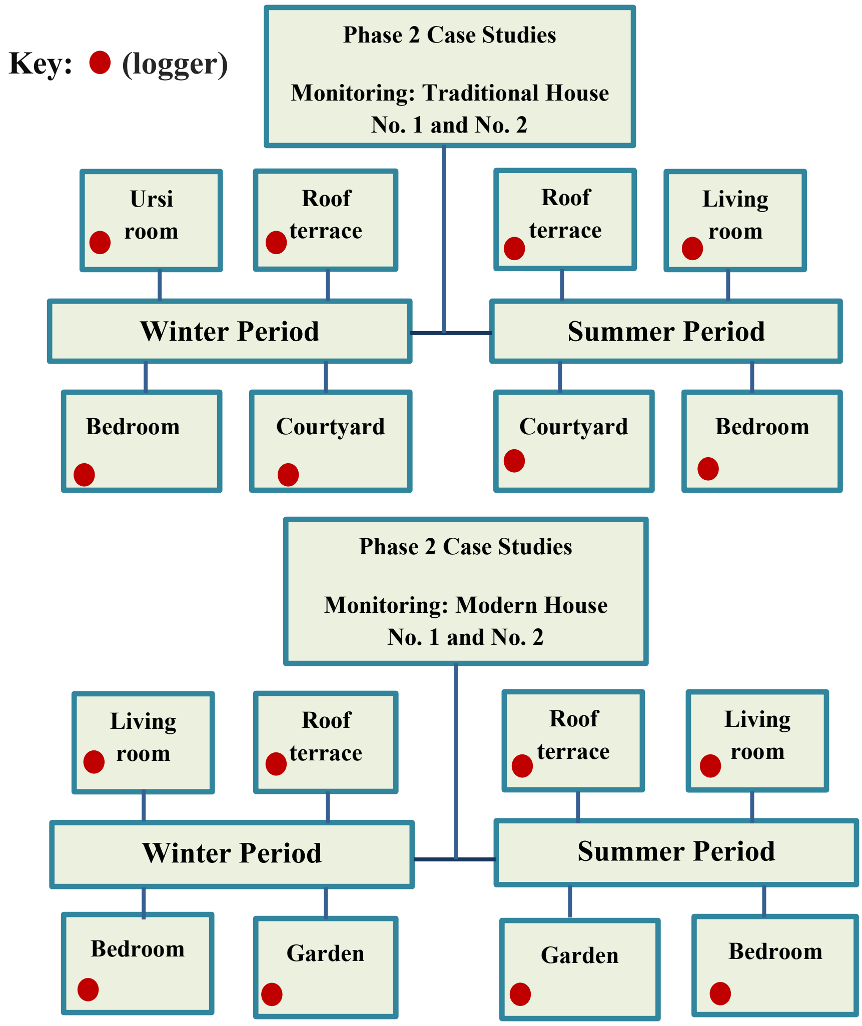


Fig. 5.1. Location of loggers in traditional and modern houses for summer and winter measurements

The inhabitants of both traditional and modern houses agreed to have the equipment (loggers) placed in the habitable rooms and spaces of their house. Ethics approval has been obtained and the consent letter has been signed to allow this work to start (the Ethics Approval form and consent letter are in Appendix 1).

The researcher has explained the reasons for undertaking the building monitoring in the summer and winter periods to the inhabitants of the two traditional and modern houses. The occupants were told that the measurements were important in order to establish occupant comfort and satisfaction, and the thermal performance of their house. Also evaluation of the findings of the summer and winter measurements would be valuable in establishing optimal design strategies and inform the design of future houses.

Moreover, an additional reason for the measurements is to establish the comparison of the internal thermal environmental conditions between the traditional and modern houses.

The inhabitants fully agreed to the research study of their houses and were pleased to place the equipment (loggers) in the habitable rooms and spaces; they also agreed to check the loggers regularly to make sure they remained operative. Between the researcher and the inhabitants of the case study houses, regular visits were agreed during the two-week period of measurements to check that the loggers were functioning and were still in the right locations.

The researcher had intended to measure the basement level room (Sirdab) of the two traditional houses to have a good example of a habitable room which was serviced naturally; however, this was not possible as the inhabitants did not allow access to this space as it was used as a store for personal items and they did not wish any stranger to infringe their privacy. The researcher had to respect their point of view, so the measurement of the basement level room (Sirdab) was cancelled.

5.4. CASE STUDIES FOR MONITORING

5.4.1. Traditional House No. 1 – TH1

The **TH1** was considered a medium-sized house. It consists of two storeys (ground floor level and first floor level) and the roof terrace level. At the ground floor level the house incorporates a courtyard which is located in the centre of the house, with a living room and one bedroom which are located around the courtyard. (Further details are provided in Chapter VI, Section 4.2.1 Traditional courtyard houses.)

The plans below show the location of the loggers● ● in the habitable rooms and spaces of the traditional case study 1 for the summer and winter measurements.

Fig. 5.2. **Basement level plan and ground floor level plan (Researcher) Scale: 1:50**

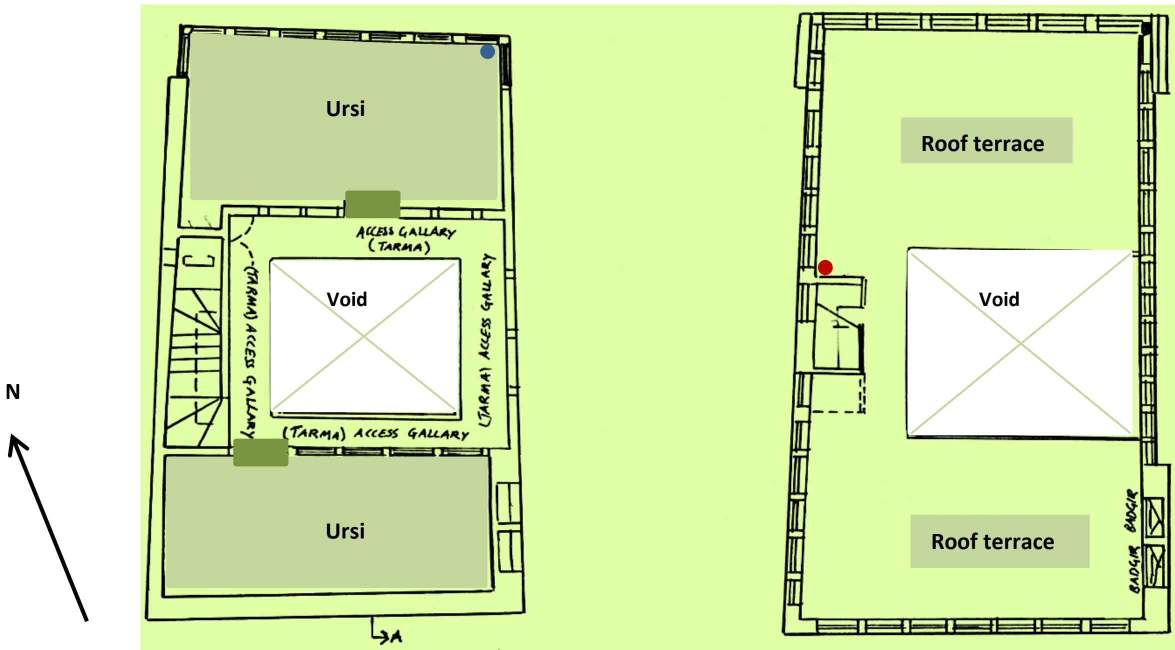


Fig. 5.3. **First floor level plan and roof terrace level plan (Researcher) Scale: 1:50**

5.4.2. Traditional House No. 2 – TH2

In plan the **TH2** was considered a large-sized house. This house consists of ground floor level, first floor level, mezzanine level and roof terrace.

At the ground floor level the house incorporates a large courtyard which is located at the centre of the house with all the habitable rooms and spaces around it. (Further details are presented in Chapter VI, Section 4.2.1 Traditional courtyard houses.)

The plans below show the locations of the loggers● ● in the habitable rooms and spaces of the traditional case study 2 for the summer and winter measurements.

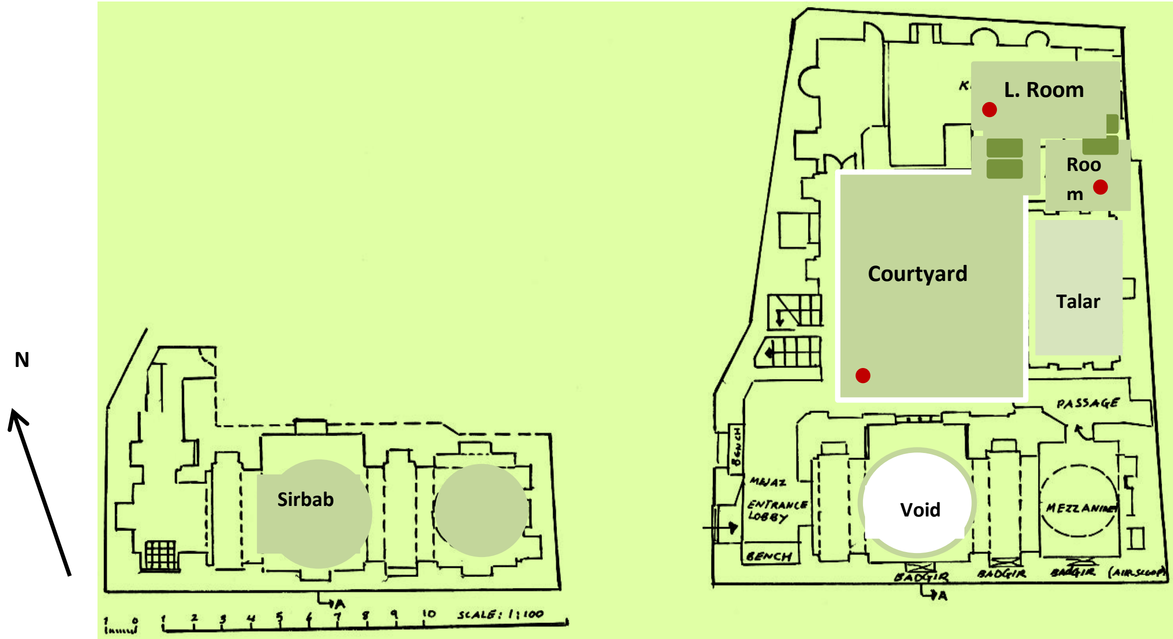


Fig. 5.4. **Basement level (Sirdab) plan and ground floor level plan (Researcher) Scale: 1:50**

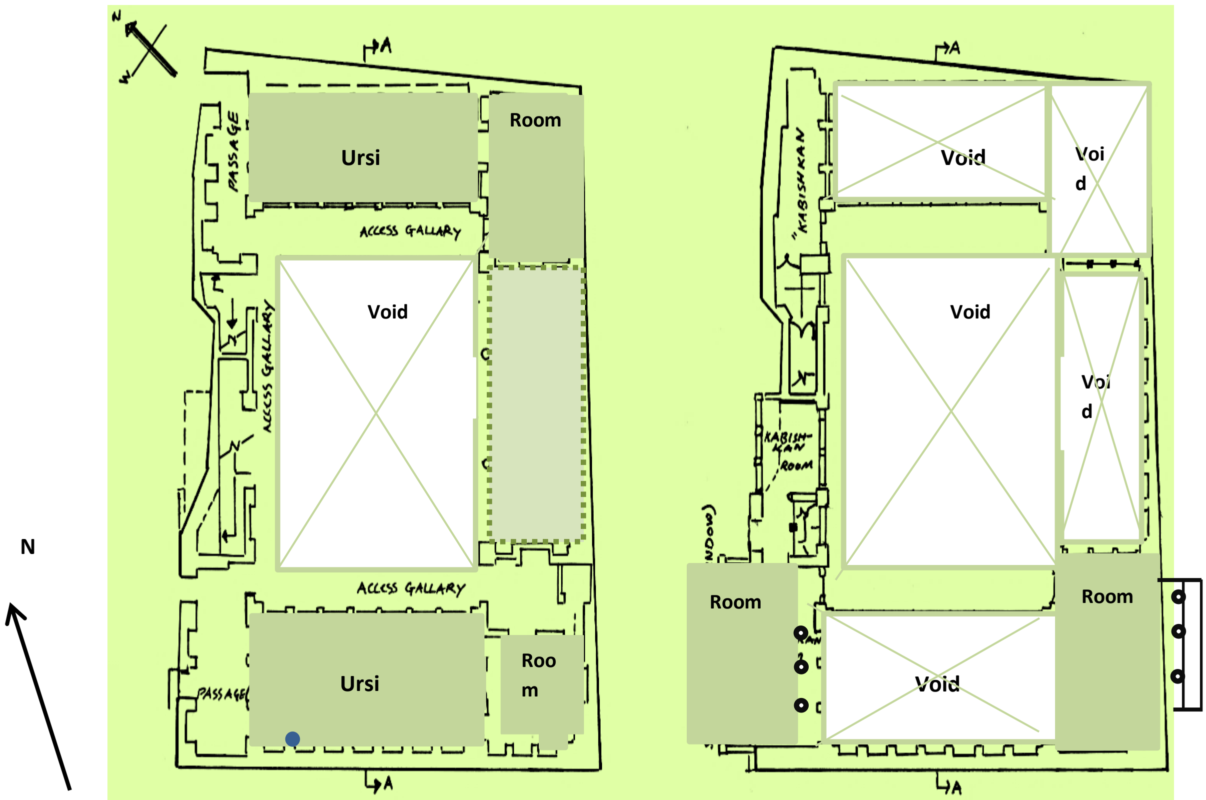


Fig. 5.5. **First floor level plan and second floor level plan (Researcher) Scale: 1:50**

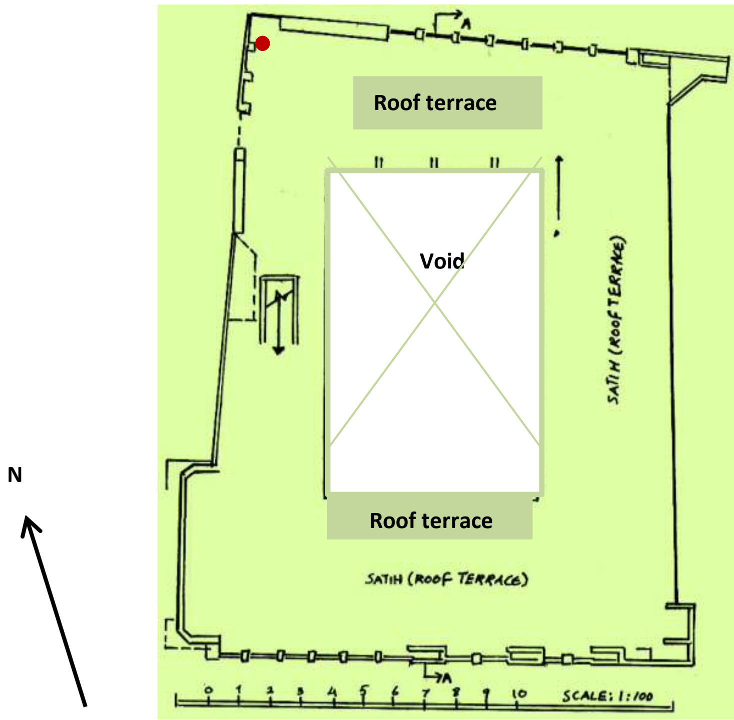


Fig. 5.6. **Roof terrace level plan (Researcher) Scale: 1:50**

5.4.3. Modern House No. 1 – MH1

MH1 was considered a large-sized house. The modern house No. 2 has been built as a detached house and it is two storeys in part (ground floor level, first floor level and second floor level). (Further details are provided in Chapter VI, Section 4.2.2 Modern houses.)

The plans below show the locations of the loggers ● in the habitable rooms and spaces of the modern case study 1 for the summer and winter measurements.

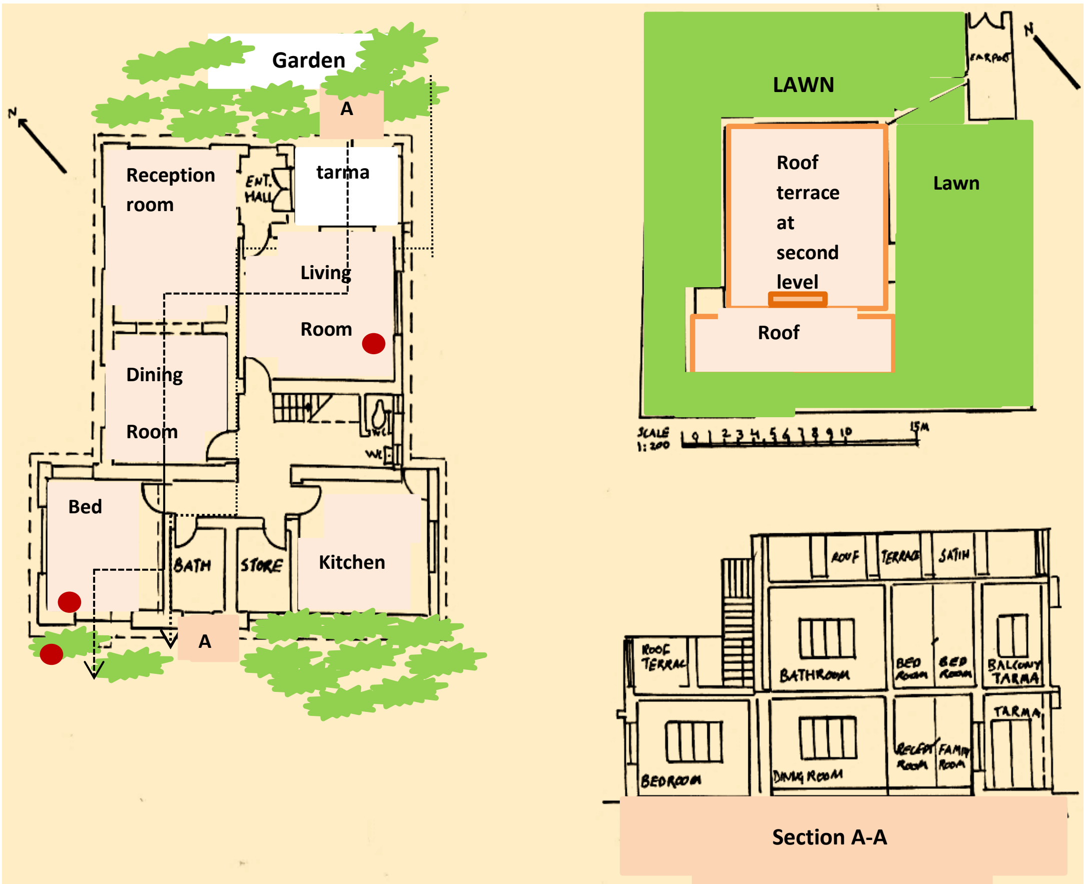


Fig. 5.7. Site plan and ground floor level plan with section A-A (Researcher) Scale 1:100

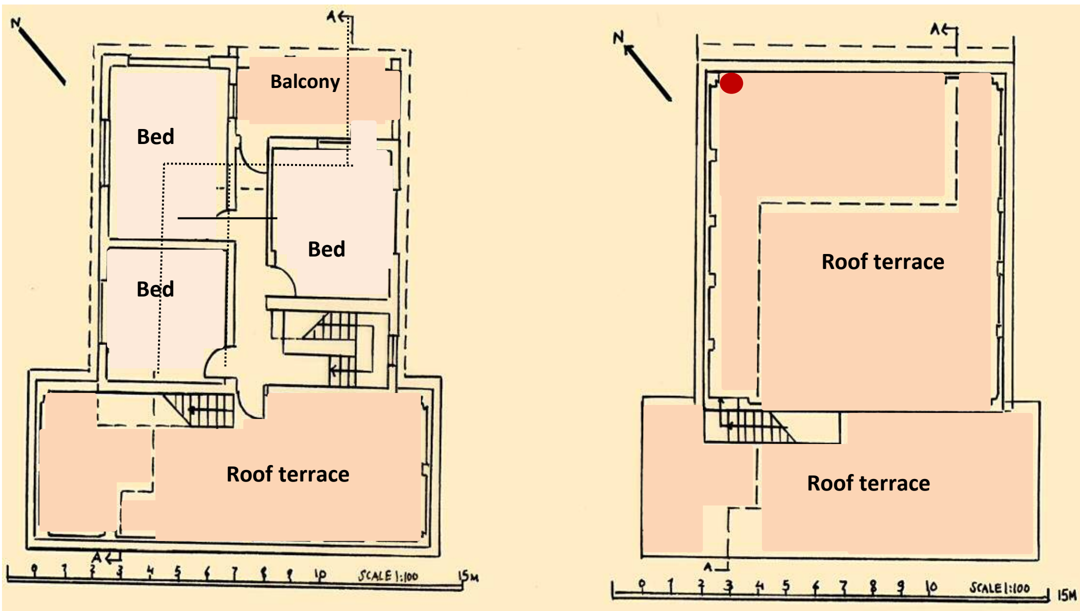


Fig. 5.8 First floor level plan and roof terrace level plan (Researcher) Scale: 1:100

5.4.4. Modern House No. 2 – MH2

The **MH2** was considered a large-sized house. The modern house No. 2 has been built as a detached house and it is two storeys in part (ground floor level, first floor level and second floor level). (Further details are provided in Chapter VI, Section 4.2.2 Modern houses.)

The plans below show the locations of the loggers ● in the habitable rooms and spaces of the modern case study 2 for the summer and winter measurements.

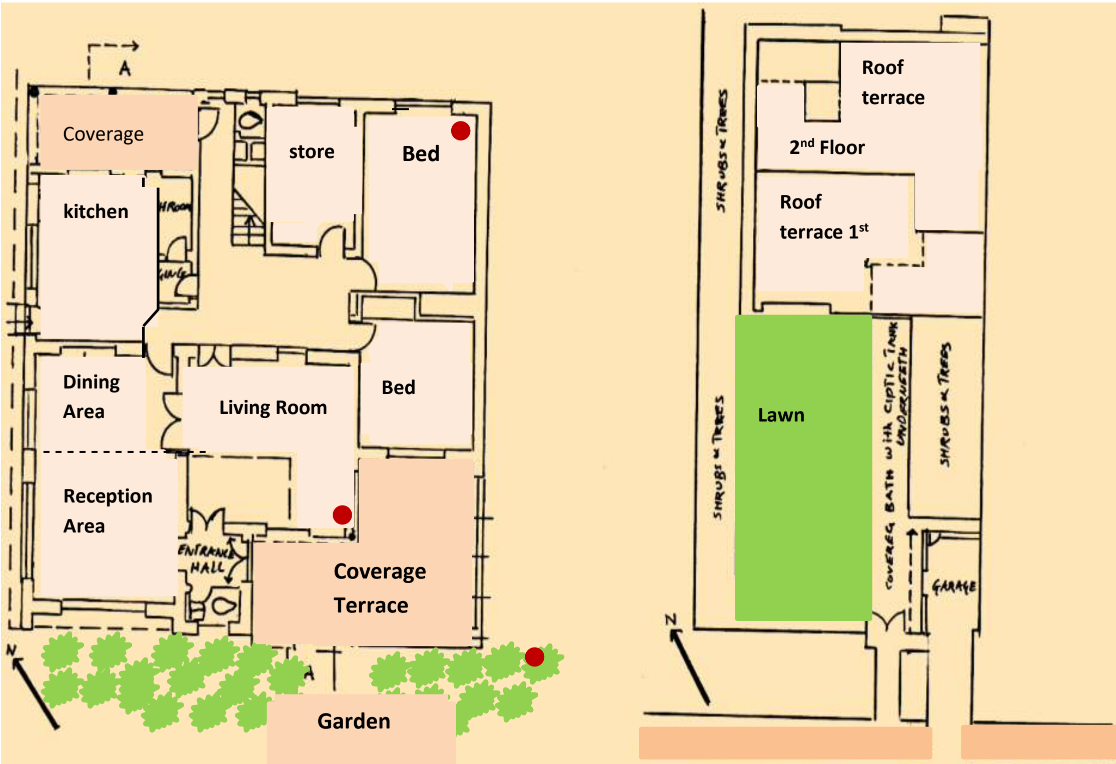


Fig. 5.9. **Site plan and ground floor level plan (Researcher) Scale: 1:100**

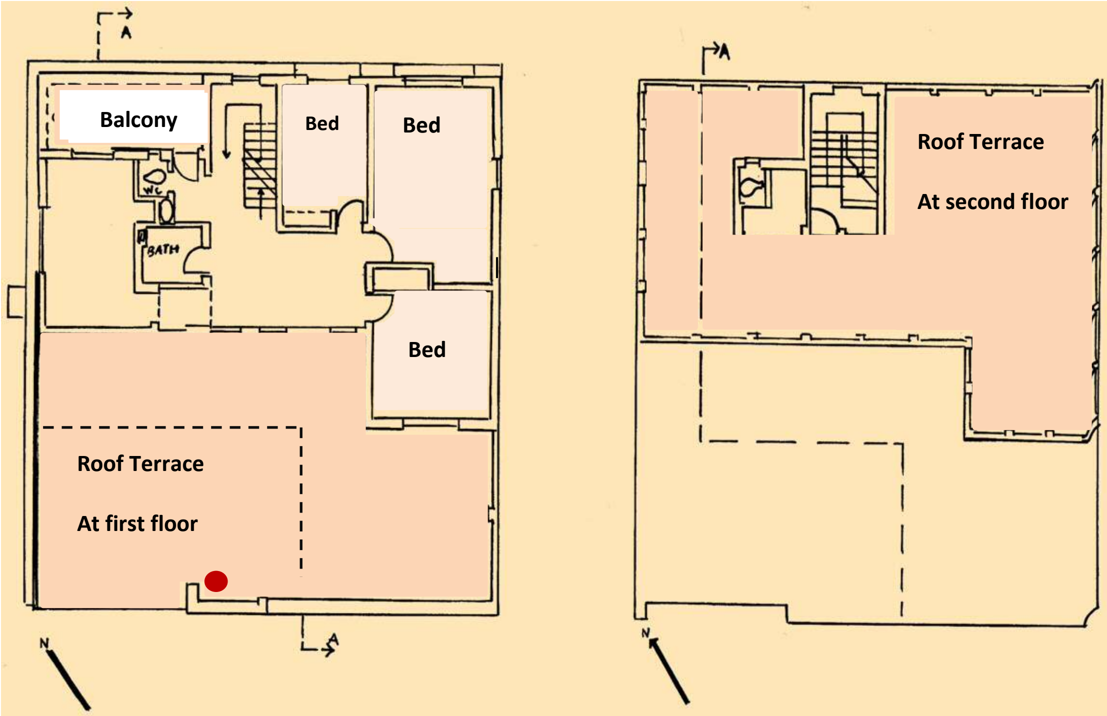


Fig. 5.10. First floor level plan and roof terrace level plan (Researcher) Scale: 1:100

5.5. PHASE 2 METHOD: ANALYSIS & PERFORMANCE

The analysis was undertaken to identify and evaluate the measurement of microclimate and internal thermal environmental conditions for the summer and winter periods. The air temperature and relative humidity data have been presented in a graph against date and time in order to enable the analysis.

The air temperature and relative humidity were measured in the shade in the courtyard and on the roof terrace of the two traditional houses and in the garden and on the roof terrace of the two modern houses. Also the air temperature and relative humidity were measured in the habitable rooms of the two traditional houses and modern houses.

Two summary graphs have been created for each house of the case studies for the summer and winter measurements. The graphs present the four spaces which were measured. The data were analysed according to the average maximum and minimum air temperature and according to the time.

The researcher believes that it is very important to indicate the time in the analysis to present what time the measurement has been recorded during the day in the morning (7:00–11:00), lunch (12:00–14:00), afternoon (14:00–18:00) and evening (19:00–onwards) to help make the analysis easy. For example, if the measurement has been recorded during the first peak in temperatures of the day (11:00–13:00) or second peak in temperatures of the day (13:00–15:00) in the courtyard during the summer, this will explain the high air temperature of the courtyard at this particular time of the day.

As is discussed further in **Chapter VI Phase II Results** one of the traditional houses was equipped with a cooling system and the two modern houses were equipped with air conditioning systems. However, as previously mentioned, there was a schedule of power cuts during the day in Baghdad around the monitoring period. Unfortunately the researcher does not know when these occurred. It must, however, be considered that disruption to the electricity supply will have had an impact on the performance of the houses in terms of thermal comfort for the occupants at these times.

The same circumstances surrounded the winter measurements in that more power cuts occurred; the inhabitants of the traditional and modern houses used paraffin heaters and electric heating respectively, to warm the habitable rooms during their occupation in the cold days. Again the usage of heating systems will influence the comfort; unfortunately, this usage was not recorded and so there is a limit to the analysis that can be undertaken.

However, in both cases it could be assumed that comfort is optimised when the services of either cooling in summer or heating in winter is applied as it is likely that the occupants would act to improve their comfort as per the theory of adaptive thermal comfort.

Comparisons between the findings of the internal thermal environmental conditions of the habitable rooms and spaces of houses of the same type (traditional houses and modern houses) and of houses of different types (traditional houses and modern houses) have been carried out by the researcher. These comparisons enable the researcher to identify what is good about the traditional and modern houses to produce optimal design strategies to inform the design of a future ideal house.

This approach of building monitoring follows previous work undertaken during the 1970s and completed during the 1980s that used the same method of building monitoring **(Al-Azzawi 1984)** of three traditional houses and three modern houses in Baghdad.

This research has applied the same method but has developed the process involved. The equipment used by **Al-Azzawi** in the work in the **1980s was a globe thermometer** but it was difficult to keep the thermometer in the shade during the measurements, so measurements were not taken of the roof terrace of the one of traditional houses nor of the garden of one of the modern houses in the **work of the 1980s.**

This work was completed during the 1980s but the environmental monitoring of buildings was carried out during the 1970s and at that time the traditional houses were serviced naturally and they had not been equipped with a cooling system as they are nowadays. However, the modern houses were monitored with functioning air conditioning systems in place.

The most recent relevant work has been done by (**Foruzanmehr 2012**) on summer-time thermal comfort in vernacular earth dwellings in Yazd, Iran. This work involved two surveys undertaken to investigate the provision of comfortable indoor temperatures in the central courtyard houses in Yazd during the summer. The first thermal comfort survey established comfortable temperatures for the inhabitants of courtyard houses during the hot days in summer in Yazd. The second survey on the diversity of temperatures that could be found within different spaces in the traditional houses in hot days in summer involved measuring the temperature variations. Measured temperatures are compared with the comfort zone temperatures obtained from the thermal comfort survey. **Foruzanmehr** intended to do these surveys in order to explore whether the indoor temperatures fall inside or outside the comfort zone.

5.6. EQUIPMENT USED FOR LOGGING

Tinytag equipment was used to measure the microclimate and internal environmental conditions of the four selected case studies (two traditional houses and two modern houses) for the summer and winter periods.

The reason for choosing this equipment (loggers) is because they are designed to measure the microclimate and internal environmental conditions (air temperature & relative humidity) at the same time and it was very convenient for the researcher to use one piece of equipment to measure the air temperature and relative humidity.

Also this equipment was useful in providing the researcher with information to evaluate the performance of any measures put in place to achieve improvements in the environmental conditions. Moreover, the equipment has helped to validate overall building system performance. It is believed that the loggers used for the measurements are very suitable for the temperature range. **Ref: http://tinytag.info**

5.7. PHASE 3 METHOD: OCCUPANTS' COMFORT DIARIES

The occupants' comfort diaries method was utilised by the researcher in order to establish the occupant comfort and satisfaction and the thermal performance of traditional and modern houses throughout the year. The diaries were utilised during the two monitoring periods and were completed by one occupant from each house (four in total); each occupant responded on behalf of the other occupants within the house. (Full occupants' diaries are in Appendix 2.)

The researcher intended to use the diaries in order to know what the occupants of the two traditional and modern houses feel during different times of the day and which particular times are considered as comfortable periods for them. The responses have been taken during the different times of the day in the morning (7:00–11:00), lunch (12:00–14:00), afternoon (14:00–18:00) and evening (19:00–onwards).

Thermal comfort is defined in British Standards BS EN ISO 7730 as '*that condition of mind which expresses satisfaction with thermal environment*' **(Health & Safety Executive 2005).** According to the ISO 7730 standard, people are always striving to create a thermally comfortable environment. This is reflected in building tradition around the world – from ancient history to the present day. Today, creating a thermally comfortable environment is still one of the most important parameters to be considered when designing buildings.

According to the **ANSI/ASHRAE standard 55–2010** thermal comfort is defined as '*that condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation*'. Also known as human comfort, thermal comfort is the occupant's satisfaction with the surrounding thermal conditions and is essential to consider when designing a structure that will be occupied by people.

The researcher has found that the ISO standards definition of thermal comfort and also the ASHRAE standards definition are relevant to this work. It will be useful consider these in relation to the domestic environment as thermal comfort in hot and dry conditions will be measured according to satisfaction with the thermal environment, in particular the thermal comfort surrounding the occupants. The data and the diary entries have been analysed according to the occupants' assessment of when they feel comfort or discomfort when using the habitable rooms and spaces during the four seasons of the year and during the different times of the day. The data and the responses of the occupants during different times of the day have been analysed according to the **ASHRAE standard 55–2010: very hot, hot, warm, slightly warm, neutral and cool**.

To consider adaptive comfort in habitable rooms and spaces there should be openings such as doors and windows and no air conditioning or cooling system, with the inhabitants either adding or removing clothing to adapt to the thermal environment.

5.8. PHASE 3 DISCUSSION: OPTIMAL DESIGN STRATEGIES

5.8.1. Optimised Design & Evaluation

The main aim of this research is:

> ***'To identify and evaluate environmental and socio-cultural performance of traditional houses and modern houses in Iraq, in order to establish optimal design strategies to enable occupant comfort in a context of reduced energy use and socio- cultural responsiveness'.***

This chapter will focus on objectives 5

> ***Objective 5: Establish appropriate design strategies that are responsive to the socio-cultural and environmental context, to inform a 'modern vernacular style' for housing in Baghdad.***

A comparison of findings from objectives 2–4 will be undertaken and will likely require simple modelling of performance and evaluation through application of fundamental building physics to inform the final development of an appropriate set of design strategies. (Details are presented in Chapter VII Optimal Design Strategies.)

Chapter IV Phase 1 Results has achieved objective 2 **to *establish architectural characteristics of case study houses to be studied.*** This objective was established, furthermore an extensive physical survey of the seven selected traditional houses and seven selected modern houses was undertaken to address the research question.

Also Chapter IV has achieved objective 3 ***to establish the socio-cultural, economic, neighbourhood and services performance and responsiveness of the traditional and modern case study houses throughout the year.***

The researcher intends to produce a comparison between the selected traditional houses and modern houses on the findings from the physical survey, the questionnaire survey and also the case study results of environmental performance in order to:

> **Establish appropriate design strategies that are responsive to the socio-cultural and environmental context to inform a 'modern vernacular style' for housing in Baghdad.**

CHAPTER VI

PHASE II RESULTS: PERFORMANCE, COMFORT & ANALYSIS

6.1. INTRODUCTION

In order to respond to objective 4 (establish the occupant's comfort and satisfaction and the thermal performance of traditional courtyard houses and modern houses throughout the year). Two example case studies from each typology were selected for in-depth study. For each house the following processes were undertaken:

- ***Environmental monitoring (air-temperature and relative humidity) for two selected traditional courtyard houses and two selected modern houses for the summer and winter periods.***
- ***Occupant comfort diaries were utilized during these two monitoring periods.***

The four case study houses selected for environmental monitoring for the summer and winter periods have been presented in detail in Chapter IV Phase I Results: Buildings/Occupants. The two selected traditional courtyard houses have been identified in Chapter IV Phase I Results as the traditional houses no. 1 and no. 2 and the two selected modern houses have been identified as the modern houses no. 1 and no. 2. The reason for choosing the selected traditional and modern houses for this phase of the work is because the selected traditional houses are very close to each other and located in the same alleyway and the selected modern houses are also close to each other and located in the same road and as a result it was easy for the researcher to check the equipment regularly.

This chapter will present:

- Introduction to thermal comfort and adaptive thermal comfort.
- Results from the environmental monitoring of the 4 no. Phase II case study houses
- Summer measurements for the period between 20/09/2014 to 04/10/2104
- Winter measurements for the period between 14/02/2015 to 28/02/2015
- Graphs of the monitoring data for the hottest day (for summer period) and coldest day (for the winter period)

- Analysis of the wider environmental performance of four Phase II case study houses for the summer and winter period.

This chapter will also provide a conclusion as to the environmental performance evaluation of the traditional and modern houses.

6.2. SUMMER MEASUREMENT

From 20/09/2014 to 04/10/2014

This section will present the findings in turn for each of the 4 no. Phase II case study houses. The measurements will present the air temperature (average, maximum and minimum) in a table for each house as well as present temperature graphs for each house. Each graph presents the data for the four habitable rooms or spaces that have been measured during the summer monitoring period of two weeks and will present graphs for the extreme day for each season's monitoring period: here the hottest day during the monitoring period.

Further, summary analysis will be presented of the typical occupation pattern of the spaces/rooms monitored, enabling appropriate interpretation and evaluation of the thermal comfort diary thermal comfort votes, in relation to average, maximum, minimum and standard deviation of the internal temperatures for each of the occupied periods.

According to the **ANSI/ASHRAE standard 55-2010** thermal comfort is defined as '*that condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation'*. Also known as human comfort, thermal comfort is the occupant's satisfaction with the surrounding thermal conditions and is essential to consider when designing a structure that will be occupied by people.

The research of **(Kamoona 2016)** 'Passive Design Strategies to Enhance Natural Ventilation in Buildings in Hot-Arid Climate' (Arabic) was the most recent work to discuss adaptive thermal comfort for occupants of houses in Iraq in 2016 and it used the ASHRAE standard to analyse the data. According to this recent work the adaptive thermal comfort standard in Baghdad in summer is 28ºC–32ºC, the relative humidity is 30%–50%, the adaptive thermal comfort standard in winter is 20ºC–22ºC, and the relative humidity is 40%–60%.

Theoretically, adaptive thermal comfort suggests a human connection to the indoor environment that allows them to adapt to (and even prefer) a wider range of thermal conditions than is generally considered comfortable **(Lennox News Room)**. The theory also takes into account that '*people's perceptions of the environment around them changes based on seasonal expectations of temperature and humidity as well as their ability to control the conditions of their personal space*' **(Lennox News Room)**.

Theoretically, these are the adaptive thermal comfort standards according to the ASHRAE standard in hot-arid climate. This refers to the occupants' satisfaction when they feel comfort or discomfort when they use the habitable rooms and spaces during the four seasons of the year and at different times of the day. But these standards need to be compared with the adaptive thermal comfort standard of the occupants of the thermal monitored case studies of traditional and modern houses in Baghdad.

The diary responses of the occupants of the thermal monitored traditional and modern houses have been interpreted according to the ASHRAE thermal comfort standard for a hot-arid climate. These are:

- Very uncomfortable – very hot
- Uncomfortable – hot
- Unacceptable – warm
- Acceptable – slightly warm
- Comfortable – neutral
- Very comfortable – cool
- Very uncomfortable – cold (winter).

As mentioned earlier, the thermal comfort standard in Iraq in summer is 28ºC–32ºC and the thermal comfort standard for A/C buildings is 20ºC–22ºC. In winter the thermal comfort standard is 20ºC–22ºC according to the ASHRAE thermal comfort standard. This range has been considered in the occupants' diary responses during the summer and winter measurements. The occupants' thermal comfort sometimes is higher or lower than the thermal comfort standard. The TH1 is serviced by a natural ventilation system and ceiling fans and its occupants' thermal comfort is higher than the standard. In winter the occupants' thermal comfort is within the thermal comfort standard. For the modern houses the occupants' thermal comfort are within the A/C thermal comfort standard and in winter the thermal environmental conditions prevailing in the living rooms and bedrooms are between comfortable and acceptable due to the use of the heating system.

6.2.1 Traditional House No. 1 – TH1

The traditional house No. 1 was considered a medium-sized house (150 m^2) consisting of two storeys (ground floor level and first floor level) and the roof terrace level. This house is the only monitored free-running building.

The following table illustrates the summary findings for the temperature of TH1 for the monitoring period.

Table 6.1. Average, maximum and minimum temperature of TH1

TH1 Space	Temperature (°C)		
	Average	Max	Min
Living room	32.0°C	34°C	30°C
Bedroom	35.5°C	36°C	34°C
Courtyard	32.0°C	37°C	27°C
Roof terrace	37.0°C	49°C	25°C

It has to mentioned here that the **TH1** doesn't installed by the air-cooling system. The air-cooling system is not an air-conditioning system. This system has been used in Iraq particularly in traditional houses and it is known locally by water cooling system. The following description has described the function of this system:

This system is a cube with six faces and inside the cube there is a fan, straw fillers, water delivery pipes, electric pump and electric motor. One of the six cube faces is a window that allows the release of the wet cold air in to the room. The upper face of the cube represents the roof of the air-cooling and the bottom face is a water collecting basin and there is a water buoy to control the water level and quantity. The remaining three waves are metal plates installed from inside by straw fillers and from outside divided into rectangular openings to allow the hot and dry air to pass from outside to inside. Before start operation the air-cooling should be installed by a water hose that keeps the water always available in the basin and the operating flowers on two parts. The first is connected to the electric motor and then to the water pump which is lifts the water from the air cooling basin through the fine pipes to the top of the straw fillers full slowly until completely dissolved in the water and then return this water to the air-cooling basin (**Water air-cooling centre in Baghdad 2017**).

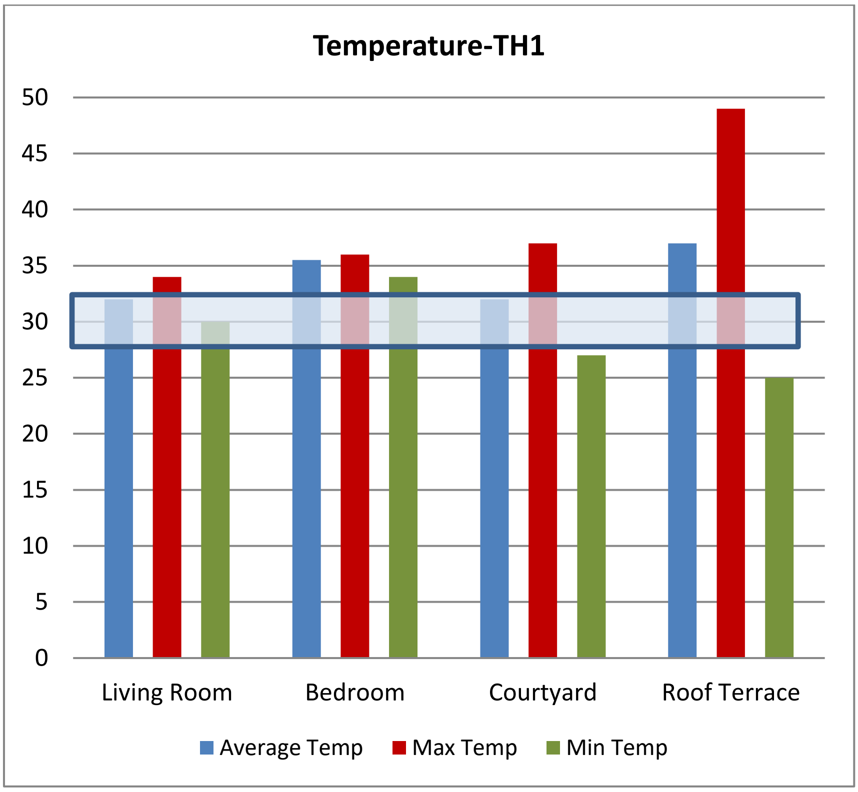


Fig. 6.1. Average, maximum and minimum temperature and comfort band of the monitored spaces of TH1. This range is the thermal comfort band standard during the summer.

It can be seen that the hottest temperatures are experienced on the roof terrace (49°C) which also experience the coldest temperature (25°C). The living room and courtyard experience the lowest average temperature (32°C) while the lowest internal monitored temperature is experienced in the living room (30°C).

The temperatures in the bedroom are relatively stable with a range of just 2°C through the period.

The following table illustrates the summary findings for relative humidity in TH1 for the monitoring period.

Table 6.2. Average, maximum and minimum relative humidity of TH1

TH1 Space	Humidity (%)		
	Average	Max	Min
Living room	29.7%	37%	22%
Bedroom	33.6%	31%	16%
Courtyard	27.4%	39%	16%
Roof terrace	24.4%	41%	8%

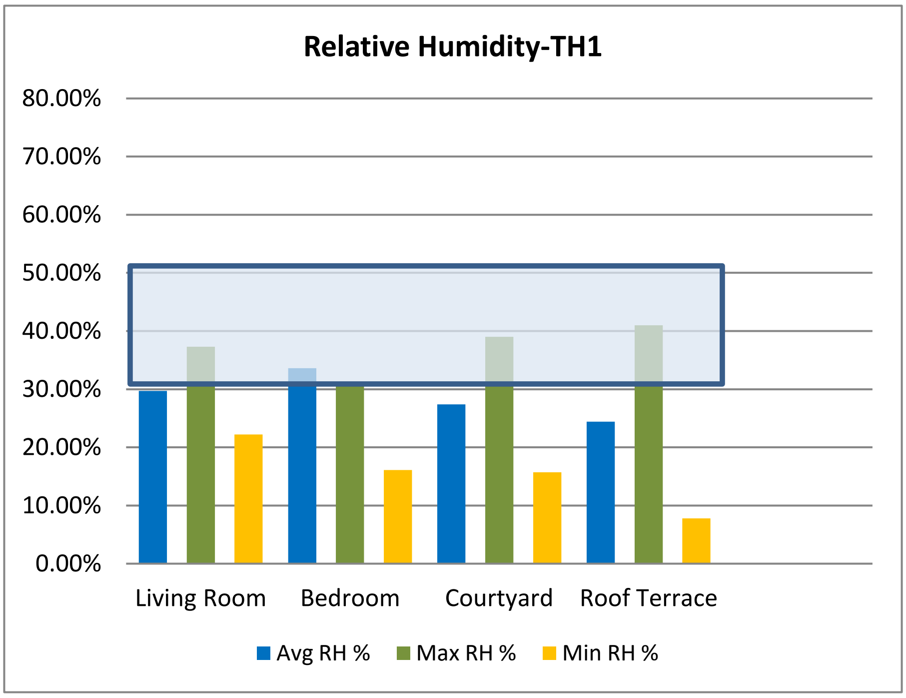


Fig. 6.2. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of TH1. This range is the comfort band standard during the summer.

The range in relative humidity is 7.8%–41% with both the maximum and minimum for the period being experienced on the roof terrace.

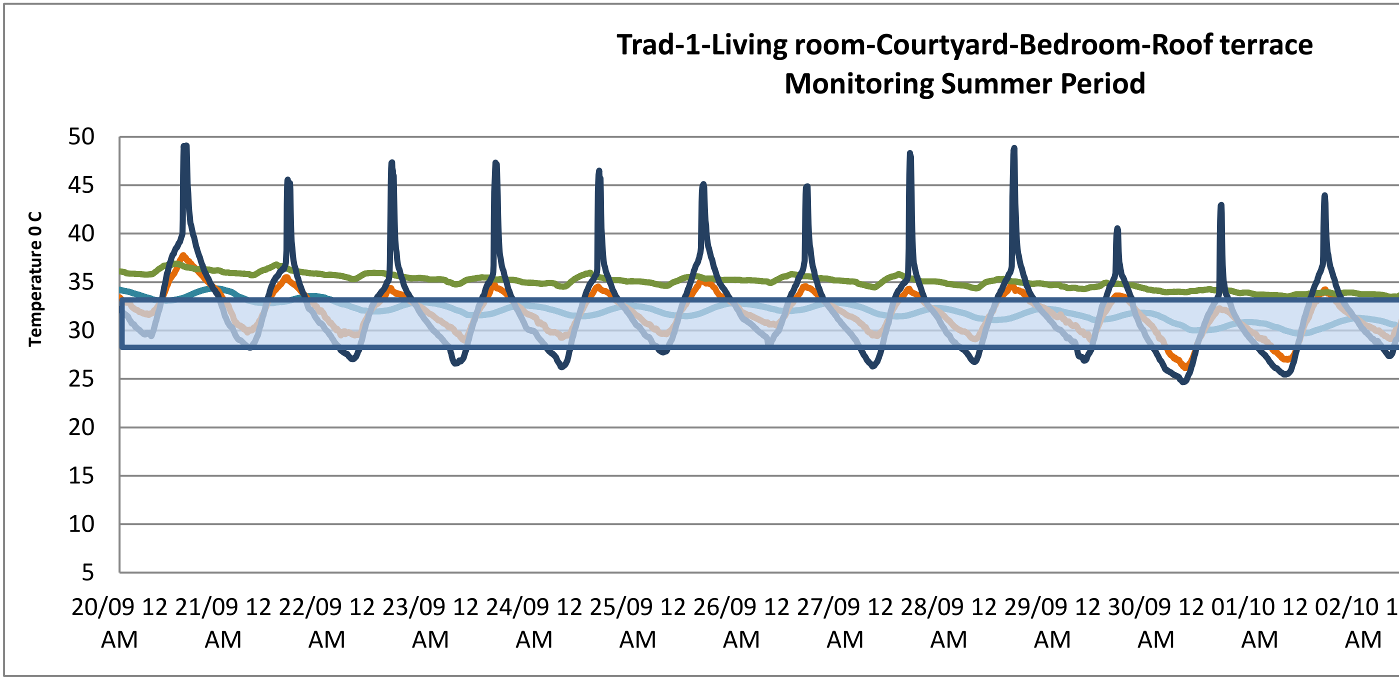


Fig. 6.3. Living room, bedroom, courtyard and roof terrace of traditional house No. 1 TH1

The graph shows the thermal comfort band range for the four spaces of TH1 for the summer period.

It should be noted that in this case study the equipment (loggers) on the roof terrace have been affected by th resulted in the air temperature of the roof terrace being recorded as substantially higher than that in the courty highlighted on the graph above

TH1: Hottest Day Analysis

The graph below shows the hottest day of the monitoring period for the four spaces of traditional courtyard house No. 1. Although the air temperature of the living room and bedroom was stable, there is a rise in air temperature of the courtyard and roof terrace. As mentioned earlier, the air temperature of the roof terrace is higher than in the courtyard due to the equipment (loggers) being affected by direct sunlight.

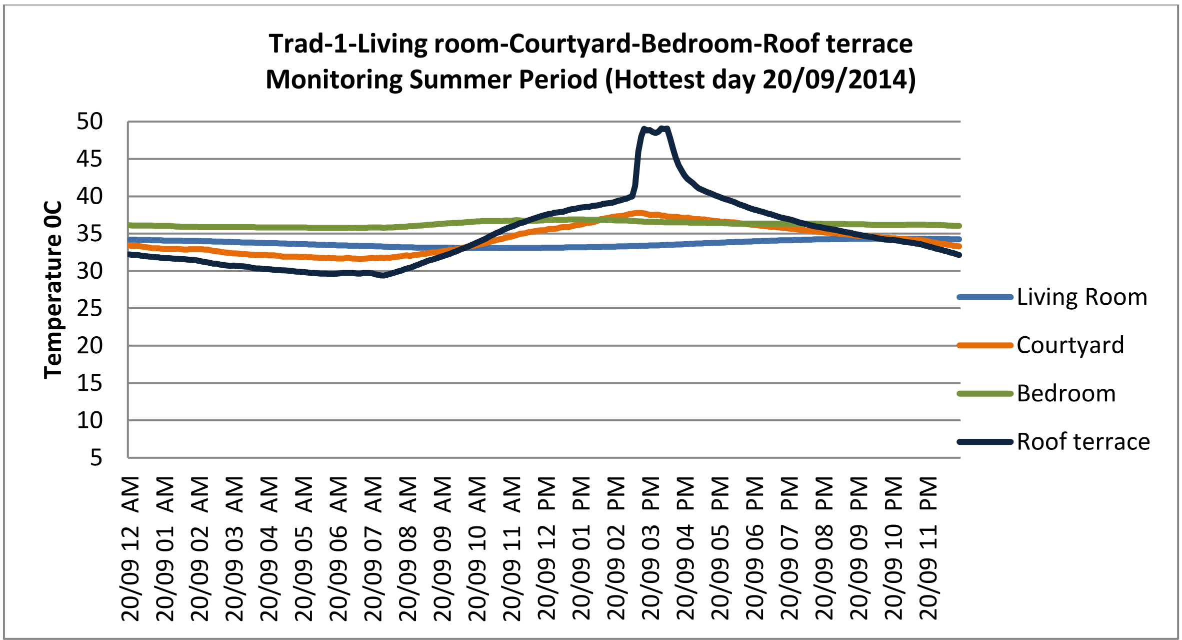


Fig. 6.4. Shows the hottest day of the monitoring period of the living room, courtyard, bedroom and roof terrace.

Typical Occupation Patterns of TH1

As a result of observation, the following typical occupation patterns were identified. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.3. TH1 occupants' typical habitation pattern in monitored rooms & spaces

TH1 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room No A/C	Occupied	Occupied	Occupied	Occupied	
Bedroom No A/C	Occupied (7:00-8:30)		Occupied (14:00-18:00)		
Courtyard N/A	Occupied (8:00-10:00)		Occupied (18:00-22:00)	Occupied	
Roof terrace N/A					Occupied

OCCUPANT'S DIARY TH1

The findings of the occupant's diary from the monitored spaces in TH1 can be summarised as follows.

Table 6.4. TH1 occupant's responses for occupied rooms & spaces

Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening/Night (18:00-7:00)
Living room No A/C				
Bedroom No A/C				
Courtyard (N/A)				
Roof terrace (N/A)				
Key: Average response of TH1 occupants for each period and monitored space				
Not Occupied	Hot	Slightly Warm	Neutral	Cool

Table 6.5. Occupant's diary responses of TH1

Traditional House No.1	Occupant's Response
Living room	According to the occupant's diary of the living room, the internal thermal environmental conditions are acceptable (slightly warm) during the day (morning, lunch and afternoon) without the cooling system, and their comfortable period (neutral responses) started in the evening (18:00–onwards); they feel comfortable during this period of time.
Bedroom	According to the occupant's diary of the bedroom, the internal thermal environmental conditions are acceptable (slightly warm) during the day (morning and afternoon) without the cooling system.
Courtyard	According to the occupant's diary of the courtyard, the occupants feel uncomfortable in the late morning and afternoon (hot) when they use the courtyard sometimes and they feel comfortable (neutral) in the evening, their comfortable period (neutral responses) started in the evening (18:00–22:00).
Roof terrace	According to the occupant's diary of the roof terrace, the occupants feel very comfortable (cool) when the use the roof terrace for sleeping in the night and they continue to feel very comfortable (cool) until the early morning of the following day.

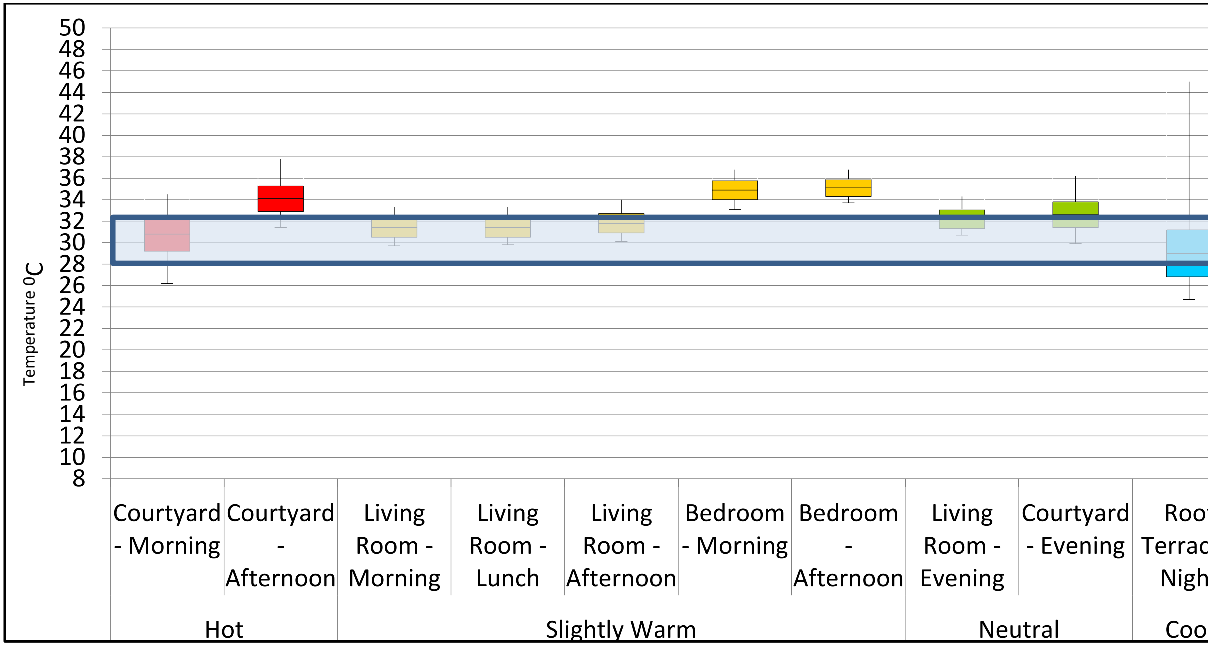


Fig. 6.5. **The occupant's responses during different times of the day with standard comfort band in plot box. T**
and +/-1 std deviation which is equal to +/-34.1% of the data.

Table 6.6. The occupant's responses during different times of the day

TH1 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room No cooling system	Slightly warm Avg: 31.4 C Max: 33.3 C Min: 29.7 C Std Dev: 0.9 C	Slightly warm Avg: 31.4 C Max: 33.3 C Min: 29.8 C Std Dev: 0.9 C	Slightly warm Avg: 31.8 C Max: 34.0 C Min: 30.1 C Std Dev: 0.9 C	Neutral Avg: 32.2 C Max: 34.3 C Min: 30.7 C Std Dev: 0.9 C	Not occupied
Bedroom No cooling system	Slightly warm Avg: 34.9 C Max: 36.8 C Min: 33.1 C Std Dev: 0.9 C	Not occupied	Slightly warm Avg: 35.1 C Max: 36.8 C Min: 33.7 C Std Dev: 0.8 C	Not occupied	Not occupied
Courtyard N/A	Hot Avg: 30.8 C Max: 34.5 C Min: 26.2 C Std Dev: 1.6 C	Not occupied	Hot Avg: 34.1 C Max: 37.8 C Min: 31.4 C Std Dev: 1.2 C	Neutral Avg: 32.6 C Max: 36.2 C Min: 29.9 C Std Dev: 1.2 C	Not occupied
Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool Avg: 29.0 C Max: 45.0 C Min: 24.7 C Std Dev: 2.2 C

Hot

Courtyard morning

According to the thermal comfort standard:

- For 25% of this period the temperature is above the adaptive thermal comfort range.
- For 75% of this period the temperature is within the adaptive thermal comfort range.

Courtyard afternoon

According to the thermal comfort standard:

- For 97% of this period the temperature is above the adaptive thermal comfort range.
- For 3% of this period the temperature is within the adaptive thermal comfort range.

The occupants of TH1 sometimes used the courtyard in the morning for their daily activities and also in the afternoon for afternoon tea or receiving visitors; the thermal environmental conditions prevailing in the shade in the courtyard during the morning and afternoon are uncomfortable (hot).

The uncomfortable thermal environmental conditions prevailing in the shade in the courtyard most of the day are likely to be influenced by the following:

- Floor finish called terrazzo tiles (Kashi) which have a high thermal capacity are used in the floor finish found on the roof terrace and as result there is a high surface temperature which is likely to influence a higher air temperature.
- Wall materials consist of sand-cement render which also result in high surface temperature which will produce a higher air temperature. Historically, occupants of traditional courtyard houses used to regularly wash the courtyard floor with water during the afternoon (14:00–18:00) to reduce the high temperature and increase relative humidity. NB: It was observed during this research that the occupants of TH1 are still doing this activity until nowadays.

Slightly warm

Living room morning

According to the thermal comfort standard:

- For 33% of this period the temperature is above the adaptive thermal comfort range.
- For 77% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 25% of this period the temperature is above the adaptive thermal comfort range.
- For 75% of this period the temperature is within the adaptive thermal comfort range.

Living room afternoon

According to the thermal comfort standard:

- For 39% of this period the temperature is above the adaptive thermal comfort range.
- For 61% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

As mentioned earlier, the TH1 is not equipped with a cooling system but it does have a natural ventilation system (Badgir) and also ceiling fans have been installed in the living room and bedrooms of the house. According to the occupant's diary responses, in living room the occupants feel slightly warm in the morning, lunch and afternoon; this means that the internal thermal environmental conditions are acceptable for them in terms of the maximum temperatures in the morning, lunch and afternoon. They feel slightly warm in the bedroom during the morning when they use the bedroom for sleeping in the early morning after they wake up on the roof terrace and they feel slightly warm in the afternoon during their afternoon siesta. It is expected that the maximum temperature of the living room (34ºC) is influenced by the architecture of the space that opens onto the courtyard. The occupants were observed to keep the door and windows open, presumably to enable access to daylight and natural ventilation and as a result warm air enters the space during the day. This house is not equipped with a mechanical cooling system, just ceiling fans in the living room and bedroom that the occupants use when necessary.

The bedroom of this house is warmer than the living room (average +2ºC & max +3.5ºC). The bedroom is occupied by the inhabitants in the early morning at 7:00 am and in the afternoon (14:00–18:00 pm) for the afternoon siesta. Because the bedroom also opens onto the courtyard, the space receives warm air from the courtyard, particularly during the first and second peak in temperature of the day. In the hot and dry climate there are a series of the peaks during the day; the first peak is 11:00 am–13:00 pm and the second peak is 13:00 pm–15:00 pm and the third peak is 15:00 pm – 18:00 pm.

Neutral

Living room evening

According to the thermal comfort standard:

- For 65% of this period the temperature is above the adaptive thermal comfort range.
- For 35% of this period the temperature is within the adaptive thermal comfort range.

Courtyard evening

According to the thermal comfort standard:

- For 72% of this period the temperature is above the adaptive thermal comfort range.
- For 28% of this period the temperature is within the adaptive thermal comfort range.

The occupants of TH1 used the living room in the evening; the ceiling fan operates during this period of time and the thermal environmental conditions prevailing in the living room are comfortable during this period of time according to the occupant's diary responses. The occupants used the courtyard in the evening (18:00–22:00) for the family gathering, and receiving visitors. During this period of time the thermal environmental conditions prevailing in the shade in the courtyard are comfortable.

Cool

Roof terrace night

According to the thermal comfort standard:

- For 8% of this period the temperature is above the adaptive thermal comfort range.
- For 92% of this period the temperature is within the adaptive thermal comfort range.

The occupants of TH1 used the roof terrace as a sleeping area during the night (22:00–7:00) and the thermal environmental conditions prevailing in the shade on the roof terrace are very comfortable (cool) during the night and continue to be very comfortable until the early morning of the following day, according to the occupant's diary responses.

6.2.2. Traditional house No. 2 – TH2

The traditional house No. 2 was considered a large-sized house (220 m^2) consisting of ground floor level, first floor level, mezzanine level and roof terrace level.

The following table illustrates the summary findings for temperature in TH2 for the monitoring period. It should be noted that a cooling system is in operation in the monitored internal spaces of this house.

Table 6.7. Average, maximum and minimum temperature of TH2

TH2 Space	Temperature (°C)		
	Average	Max	Min
Living room	24.5°C	27°C	22°C
Bedroom	23°C	29°C	17°C
Courtyard	39°C	48°C	30°C
Roof terrace	40.5°C	50°C	31°C

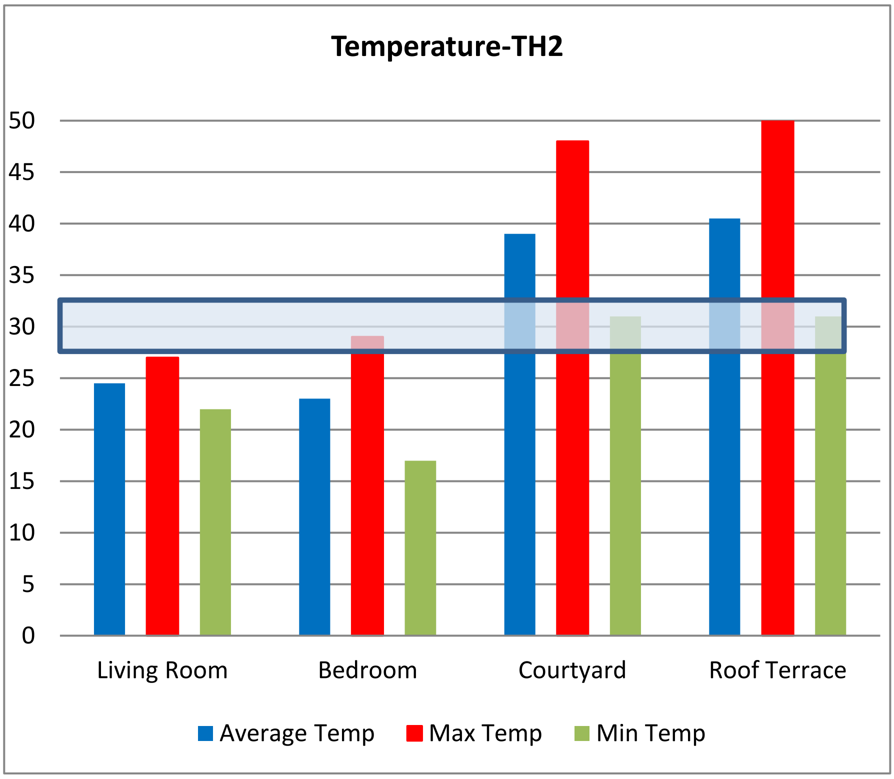


Fig. 6.6. Average, maximum and minimum temperature and comfort band of the monitored spaces of TH2. This range is the comfort band standard during the summer.

It can be seen that the hottest temperature is experienced on the roof terrace (50°C) and the lowest temperature is experienced in the bedroom (17°C). The bedroom experienced the lowest average temperatures (23°C). The temperatures in the living room are relatively stable with the range of (5°C).

The following table illustrates the summary findings for relative humidity in TH2 for monitoring period.

Table 6.8. Average, maximum and minimum relative humidity of TH2

Space TH2	Humidity (%)		
	Average	Max	Min
Living room	42.35%	56.0%	28.7%
Bedroom	48.8%	68.4%	29.2%
Courtyard	22.45%	35.2%	9.7%
Roof terrace	51.8%	32.7%	19.1%

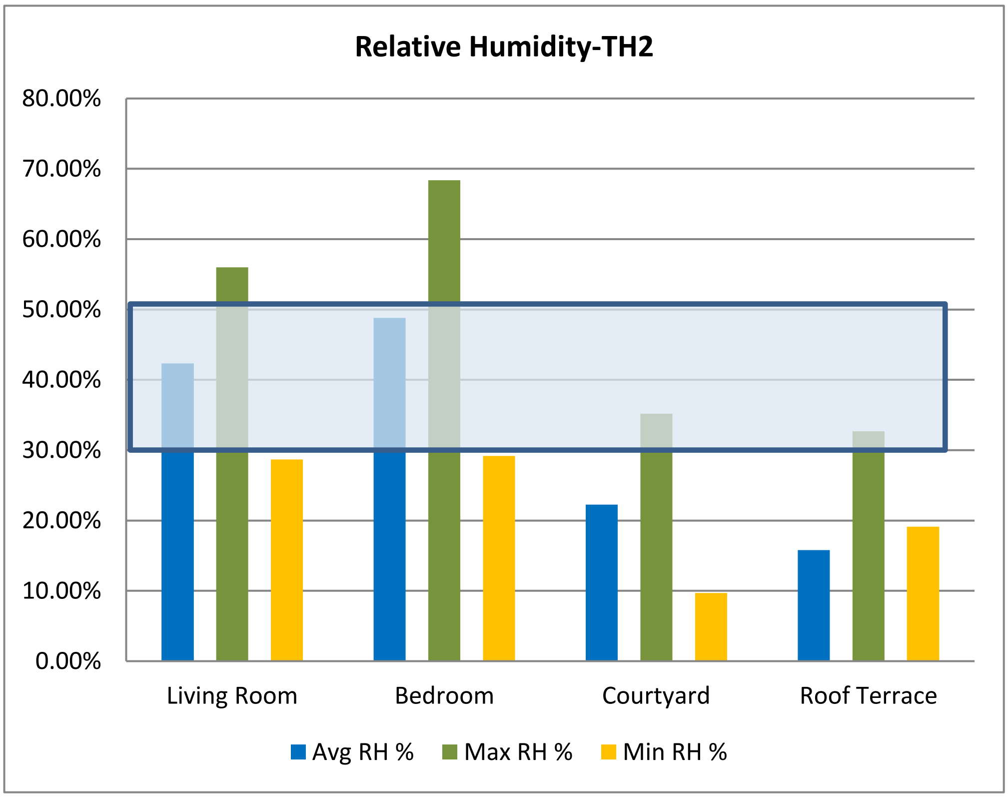


Fig. 6.7. Average, maximum and minimum relative humidity and comfort band of monitored spaces of TH2. This range is the comfort band standard during the summer.

The range of the relative humidity is 29.2%–68.4% with both maximum and minimum for the period being experienced in the bedroom.

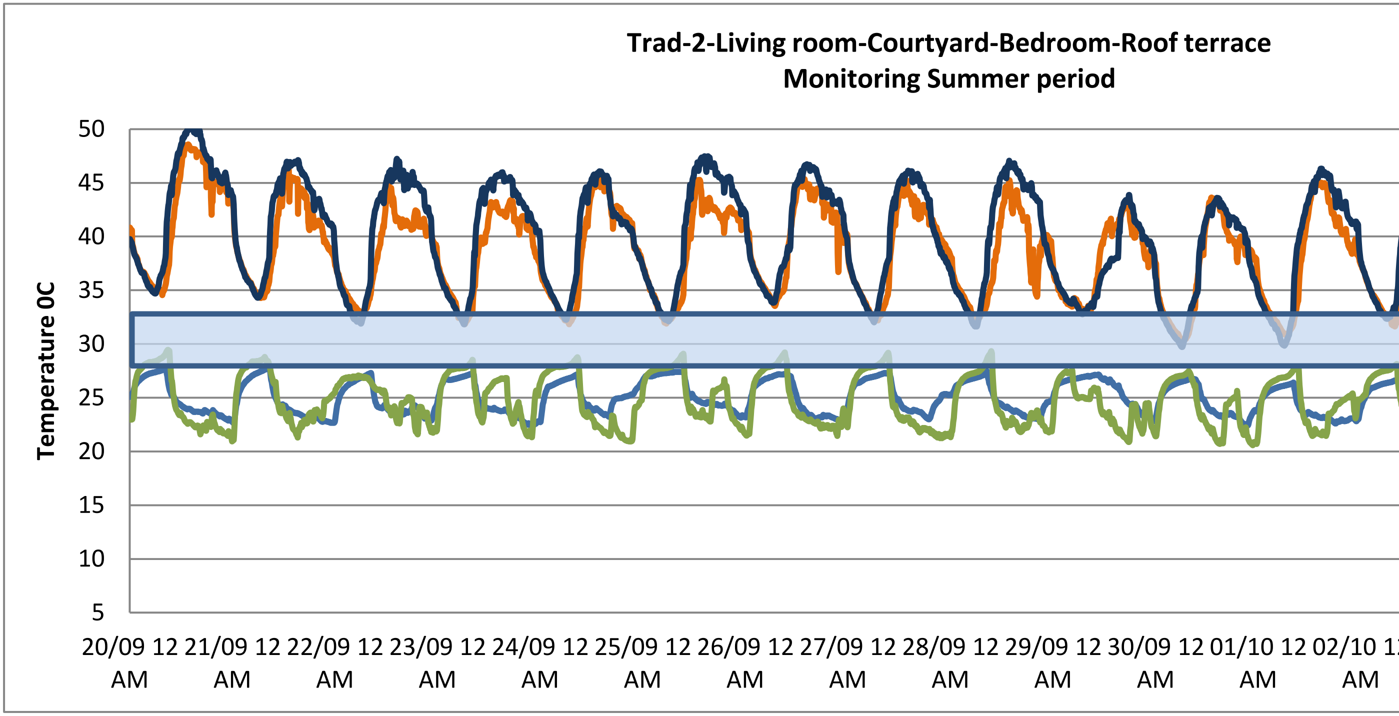


Fig. 6.8. Living room, bedroom, courtyard and roof terrace of traditional house No. 2 TH2

The graph shows the thermal comfort band range of the four spaces of TH2 for the summer period.

TH2: Hottest Day Analysis

The graph below shows the hottest day of the monitoring period for the four spaces of the traditional courtyard house No. 2. The air temperature of the living room and bedroom was stable with a slight difference between the two rooms, the outdoor temperature of the courtyard and roof terrace was very high during the first and second peaks of this hottest day. The researcher has presented the four spaces of this house in one graph to show the difference between the indoor and outdoor air temperature during this typical day.

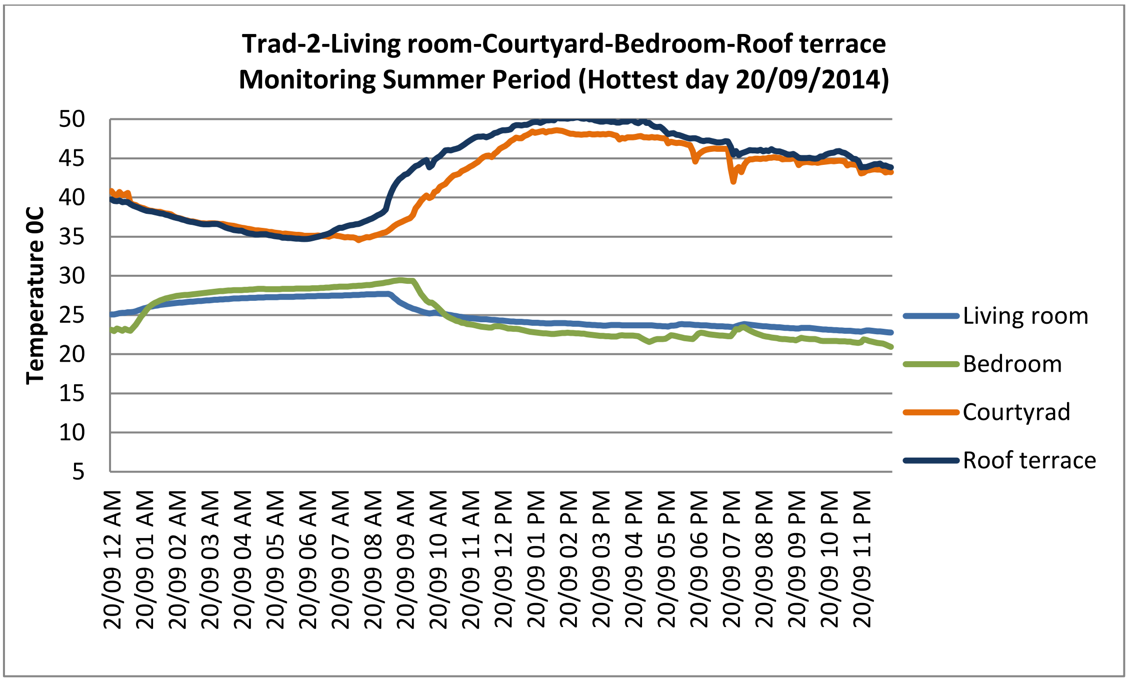


Fig. 6.9. The graph presents the hottest day of the monitoring period of the living room, bedroom, courtyard and roof terrace of the traditional courtyard house No. 2

Typical Occupation Patterns of TH2

As a result of observation, the following typical occupation patterns were identified in TH2. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.9. **TH2 occupants' typical habitation pattern in monitored rooms & spaces**

TH2 Space	Morning (7:00- 2:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room Air cooling	Occupied	Occupied	Occupied	Occupied	
Bedroom Air cooling	Occupied Early morning (7:00-8:30)		Occupied (14:00-18:00)		
Courtyard N/A	Occupied (8:00-10:00)		Occupied (18:00-22:00)	Occupied	
Roof terrace N/A					Occupied

OCCUPANT'S DIARY

The findings of occupant's diary for the monitored spaces in TH2 can be summarised as follows:

Table 6.10. **TH2 occupant's responses for occupied rooms & spaces**

Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening/ Night (18:00-7:00)
Living room Air cooling				
Bedroom Air cooling				
Courtyard (N/A)				
Roof terrace (N/A)				
Key: Average response of TH2 Occupants for each period and monitored space				
Not Occupied	Hot	Slightly Warm	Neutral	Cool

Table 6.11. Occupant's diary responses for TH2

Traditional House No. 2	Occupant's Response
Living room	According to the occupant's dairy, they feel comfortable (neutral) in the morning and lunch and they feel very comfortable in afternoon (14:00–18:00) and evening (18:00–22:00). The comfortable period for the occupants at this period of time starts from the afternoon–evening (18:00–22:00).
Bedroom	According to the occupant's dairy, they feel comfortable (neutral) in the morning and feel very comfortable (cool) in the afternoon (14:00–18:00). The comfortable period for the occupants in the bedroom is during this period of time, in the afternoon.
Courtyard	According to the occupant's dairy, they feel uncomfortable (hot) during the day in the morning (7:00–12:00) and in the afternoon (14:00–18:00) and in the early evening (18:00–22:00).
Roof terrace	According to the occupant's dairy, the occupants feel comfortable (neutral) in the night (22:00–7:00) when they use the roof terrace for sleeping until early morning of the following day.

Table 6.12. Occupant's responses during different times of the day

TH2 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room Air cooling	Neutral Avg: 25.9 C Max: 27.8 C Min: 23.4 C Std Dev: 1.3 C	Neutral Avg: 24.2 C Max: 26.8 C Min: 22.9 C Std Dev: 0.8 C	Cool Avg: 23.7 C Max: 26.4 C Min: 22.6 C Std Dev: 0.7 C	Cool Avg: 23.4 C Max: 25.4 C Min: 22.4 C Std Dev: 0.7C	Not occupied
Bedroom Air cooling	Neutral Avg: 26.0 C Max: 29.4 C Min: 21.8 C Std Dev: 2.1 C	Not occupied	Cool Avg: 22.5 C Max: 26.8 C Min: 18.6 C Std Dev: 1.6 C	Not occupied	Not occupied
Courtyard N/A	Hot Avg: 36.4 C Max: 46.2 C Min: 29.2 C Std Dev: 3.7 C	Not occupied	Hot Avg: 42.7 C Max: 48.4 C Min: 37.2 C Std Dev: 2.1 C	Hot Avg: 40.5 C Max: 46.2 C Min: 34.4 C Std Dev: 2.2 C	Not occupied
Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Neutral Avg: 35.4 C Max: 45.9 C Min: 29.7 C Std Dev: 3.4 C

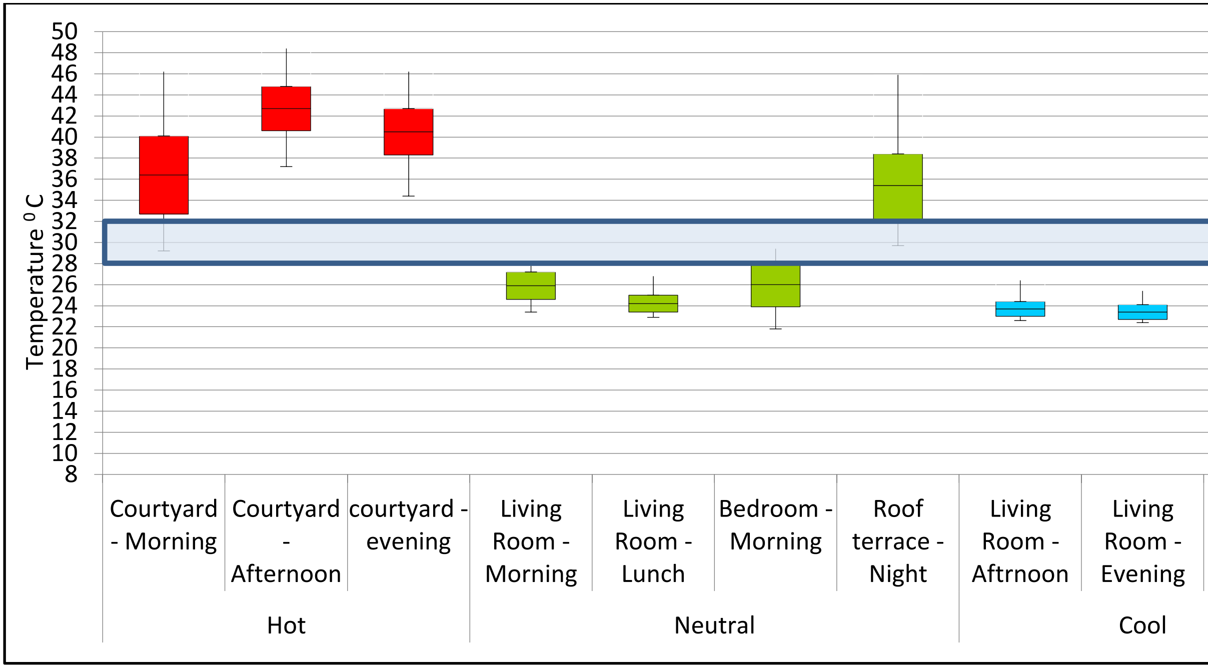


Fig. 6.10. The occupant's responses during different times of the day with standard comfort band in plot box. T and +/-1 std deviation which is equal to +/-34.1% of the data.

Hot

Courtyard morning

According to the thermal comfort standard:

- For 90% of this period the temperature is above the adaptive thermal comfort range.
- For 10% of this period the temperature is within the adaptive thermal comfort range.

Courtyard afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Courtyard evening

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

The TH2 is equipped with an air cooling system and this system operates at different times of the day.

The occupants of the TH2 used the courtyard in the morning, afternoon and evening; the thermal environmental conditions prevailing in the shade in the courtyard during this period of time are uncomfortable (hot) according to the occupant's diary responses. The outdoor air temperature of the ***courtyard*** in the morning and afternoon was recorded during the first and second peaks of the day because the area of the courtyard floor receives direct sunlight during the first peak of the day.

Neutral

Living room morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Roof terrace night

According to the thermal comfort standard:

- For 12% of this period the temperature is above the adaptive thermal comfort range.
- For 88% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the TH2 have used the living room in the morning, lunch and during this period of time they feel the conditions are neutral. The thermal environmental conditions prevailing in the living room during this period of time are comfortable; this is due to the air cooling system operating in the living room. Also they occupy the bedroom in the morning after they wake up from the roof terrace; the occupants feel the conditions are neutral in the morning and the thermal environmental conditions prevailing in the bedroom are comfortable in the morning.

The peak temperature of the ***bedroom*** of this house is warmer than the ***living room*** (Max +2ºC). This is likely to be influenced by the fact that the inhabitants occupy the living room more than the bedroom and during their occupation the air cooling system operates in the living room. The inhabitants occupy the living room almost all the day in the morning (7:00–12:00), lunch (12:00–14:00), afternoon (14:00–18:00) and evening (18:00–22:00).

The air temperature of the living room and bedroom was less stable during the monitoring period than that found in the TH1 with a range of 9ºC in the living room and 12ºC in the bedroom. The indoor air temperature of the living room and the bedroom was almost at the same level with a slight difference, according to the recorded temperature and the occupant's diary observations about their occupation of the living room and bedroom.

It is important mention here there was a schedule of power cuts during the day in Baghdad and that has affected the occupants' comfort during their occupation of the habitable rooms. The researcher does not know the exact time of the power cuts during the day.

The occupants of TH2 have used the roof terrace for sleeping during the night and they feel the conditions are neutral (comfortable) during this period of time. The thermal environmental conditions prevailing in the shade on the roof terrace are comfortable in the night and the early morning of the following day.

Cool

Living room afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room evening

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the TH2 used the living room in the afternoon and evening and they feel cool during the occupation times. They occupy the bedroom in the afternoon for the afternoon siesta and they feel cool during this period of time. The thermal environmental conditions prevailing in the living and bedroom during this period of time are very comfortable according to the occupant's diary responses.

6.2.3. Modern house No. 1 – MH1

The MH1 was considered a medium-sized house (250 m^2). The MH1 has been built as a detached house and it is partially two storeys (ground floor level, first floor level and second floor level).

The following table illustrates the summary findings for temperature in MH1 for the monitoring period. It should be noted that the air-conditioning system is in operation in the monitored internal spaces of this house.

Table 6.13. Average, maximum and minimum temperature of MH1

MH1 Space	Temperature (°C)		
	Average	Max	Min
Living room	26.5°C	28°C	25°C
Bedroom	27.5°C	29°C	26°C
Garden	34°C	40°C	28°C
Roof terrace	33°C	38°C	28°C

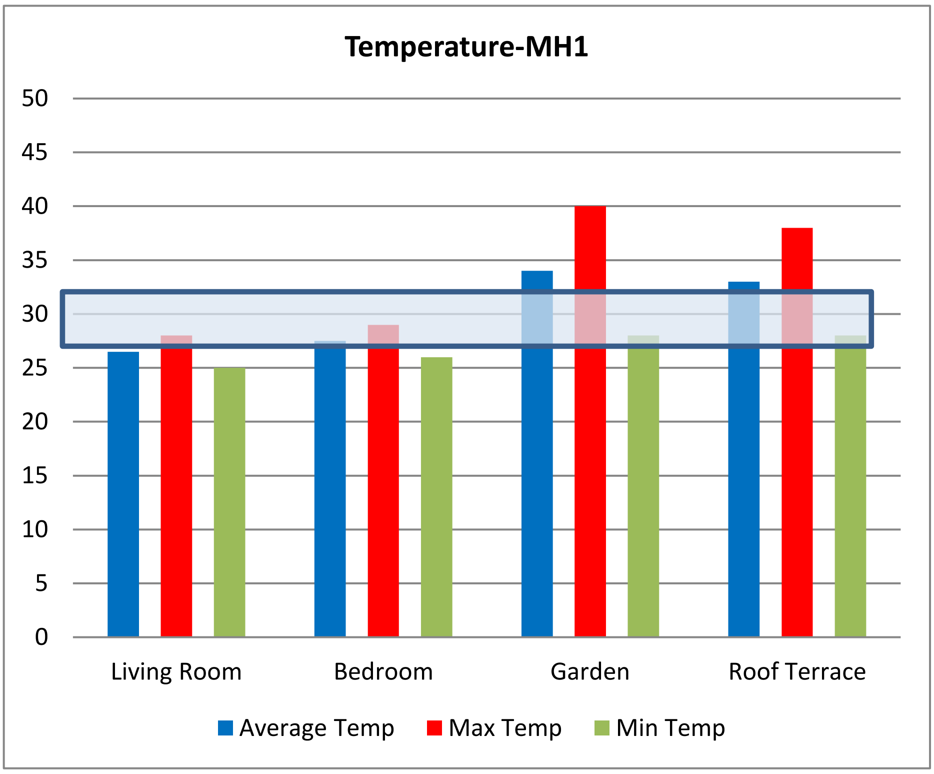


Fig. 6.11. Average, maximum and minimum temperature and comfort band of the monitored spaces of MH1. This range is the comfort band standard during the summer.

It can be seen that the hottest temperature is experienced in the garden (40°C) and the coldest temperature is experienced in the living room (25°C) which also experienced the lowest average temperature (26.5°C). The temperatures in the living room and bedroom are relatively stable with the range of (1°C) through the period.

The following table illustrates the summary findings for relative humidity in MH1 for monitoring period.

Table 6.14. Average, maximum and minimum relative humidity of MH1

MH1 Space	Humidity (%)		
	Average	Max	Min
Living room	54.9%	74.8%	35.0%
Bedroom	50.1%	65.2%	35.0%
Garden	33.5%	53.1%	13.0%
Roof terrace	32%	47.8%	16.2%

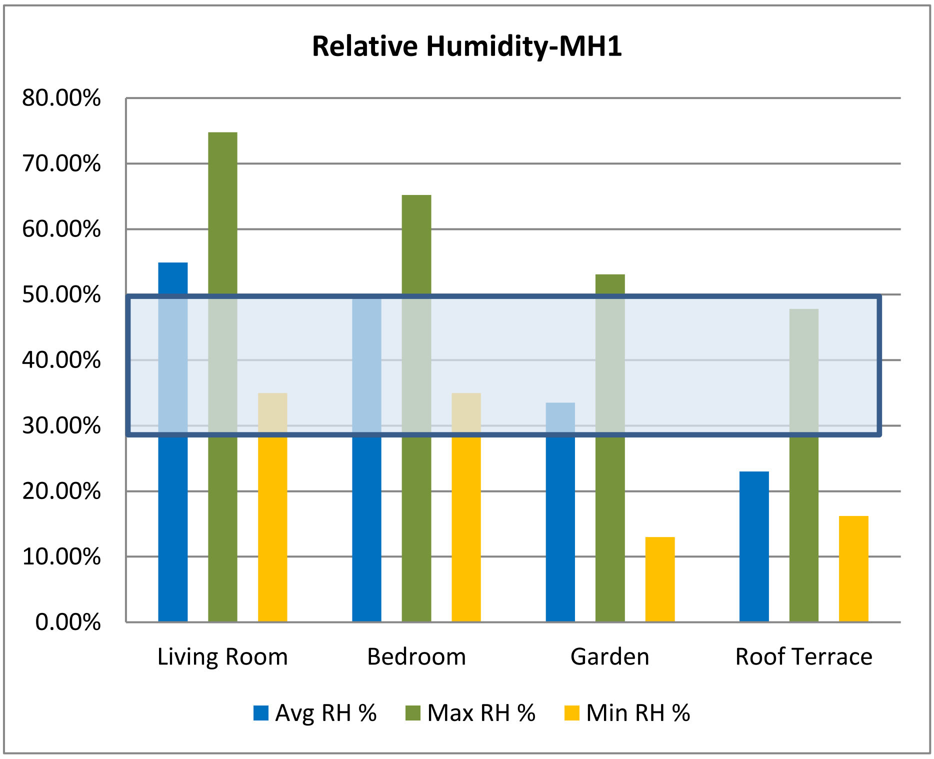


Fig. 6.12. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of MH1. This range is the comfort band standard during the summer.

The range in relative humidity is 35.5%–74.8% with both maximum and minimum for the period being experienced in the living room.

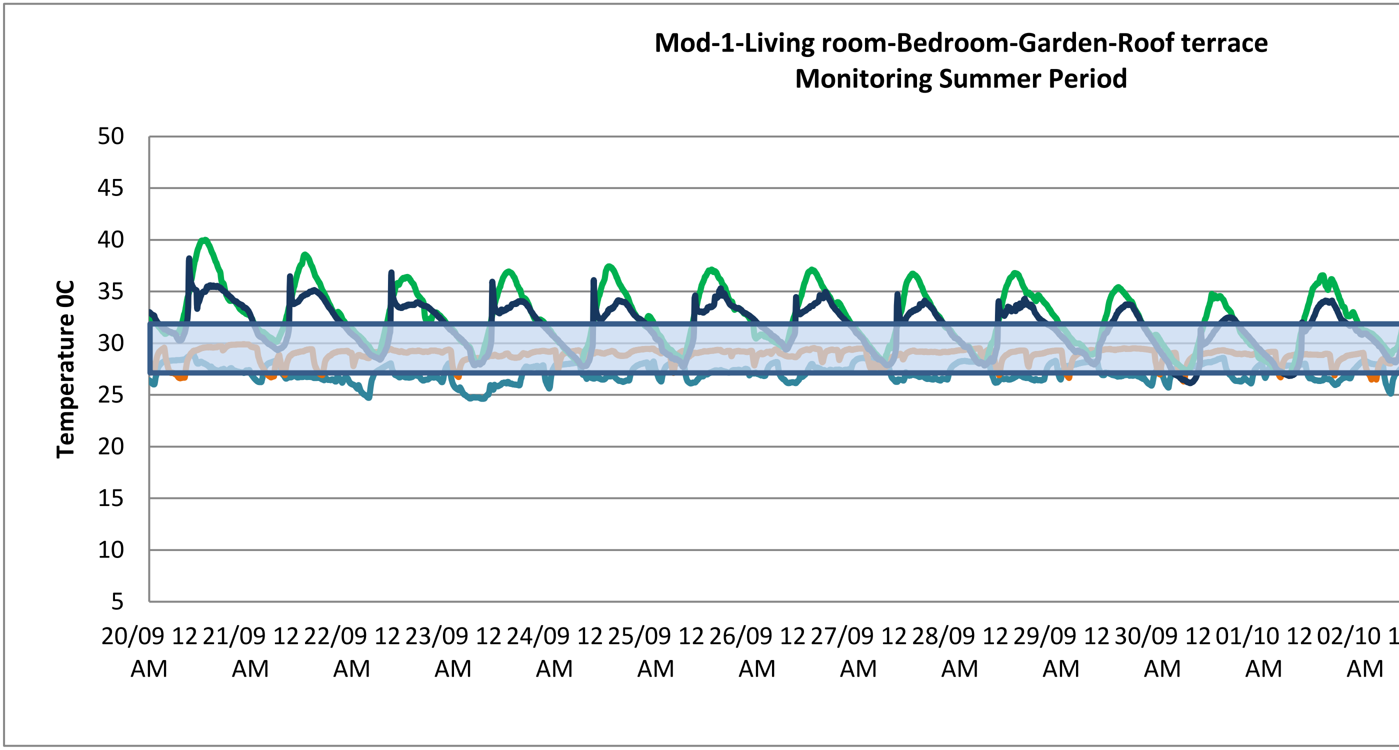


Fig. 6.13. Living room, bedroom, garden and roof terrace of the modern house No. 1 MH1

The graph shows the thermal comfort band rang of the four spaces of MH1 for the summer period.

MH1: Hottest Day Analysis

This graph presents the hottest day of the monitoring period for the four spaces of the modern house No. 1. The air temperature of the living room and bedroom was stable with a slight difference between the two rooms; the outdoor temperature of the garden and roof terrace was very high during the first and second peaks of this hottest day. The researcher has presented the four spaces of this house in one graph to show the difference between the indoor and outdoor air temperature during this typical day.

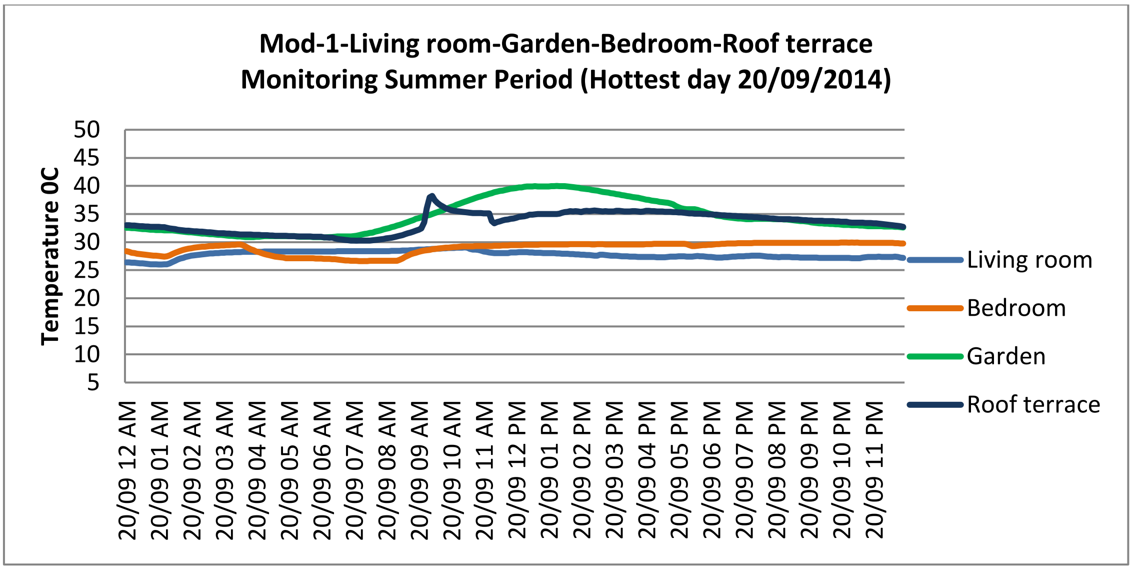


Fig. 6.14. This graph presents the hottest day of the monitoring period for the living room, bedroom, garden and roof terrace.

Typical Occupation Patterns of MH1

As a result of observation, the following typical occupation patterns were identified in MH1. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.15. **MH1 occupants' typical habitation pattern in monitored rooms & spaces**

MH1 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00–7:00)
Living room A/C	Occupied	Occupied	Occupied	Occupied	
Bedroom A/C	Occupied (7:00–8:30)		Occupied		
Garden N/A			Occupied (18:00–22:00)	Occupied	
Roof terrace N/A					Occupied

OCCUPANT'S DIARY

The findings of occupant's diary for the monitored spaces in MH1 can be summarised as follows:

Table 6.16. **MH1 occupant's responses for occupied rooms and spaces**

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/ Night (18:00–7:00)
Living room A/C	Cool	Cool	Cool	Cool
Bedroom A/C	Neutral	Not Occupied	Neutral	Not Occupied
Garden (N/A)	Hot	Not Occupied	Not Occupied	Neutral
Roof terrace (N/A)	Not Occupied	Not Occupied	Not Occupied	Cool
Key: Average response of MH1 occupants for each period and monitored space				
Not Occupied	Hot	Slightly Warm	Neutral	Cool

Table 6.17. Occupant's diary responses for MH1

Modern House No. 1	Occupant's Response
Living room	According to the occupant's diary, the occupants feel very comfortable (cool) in the morning, lunch, afternoon and evening. The thermal environmental conditions are very comfortable in the living room at this period of time.
Bedroom	According to the occupant's diary, the occupants feel comfortable (neutral) in the early morning when they occupy the bedroom and also in the afternoon when they use the bedroom for their afternoon siesta, the comfortable period (neutral responses) during this time of the occupation.
Garden	According to the occupant's diary, the occupants feel uncomfortable (hot) in the late morning when they use the garden sometimes and they feel comfortable (neutral) in the evening (18:00–22:00). The thermal environmental conditions prevailing in the shade in the garden are comfortable in the evening (20:00–22:00).
Roof terrace	According to the occupant's diary, the occupants feel very comfortable (cool) in the night when they use the roof terrace for sleeping and they continue to feel very comfortable (cool) until the morning of the following day.

Table 6.18. The occupant's responses during different times of the day

MH1 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room A/C	Cool Avg: 27.2 C Max: 29.1 C Min: 24.6 C Std Dev: 0.9 C	Cool Avg: 27.0 C Max: 28.5 C Min: 26.0 C Std Dev: 0.6 C	Cool Avg: 26.9 C Max: 28.6 C Min: 25.9 C Std Dev: 0.5 C	Cool Avg: 27.1 C Max: 28.7 C Min: 25.8 C Std Dev: 0.6 C	Not occupied
Bedroom A/C	Neutral Avg: 28.8 C Max: 29.4 C Min: 26.2 C Std Dev: 0.6 C	Not occupied	Neutral Avg: 29.0 C Max: 29.7 C Min: 26.9 C Std Dev: 0.5 C	Not occupied	Not occupied
Garden N/A	Hot Avg: 32.7 C Max: 39.6 C Min: 27.6 C Std Dev: 2.6 C	Not occupied	Not occupied	Neutral Avg: 32.7 C Max: 35.7 C Min: 29.7 C Std Dev: 1.2 C	Not occupied
Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool Avg: 32.1 C Max: 36.9 C Min: 25.9 C Std Dev: 1.9 C

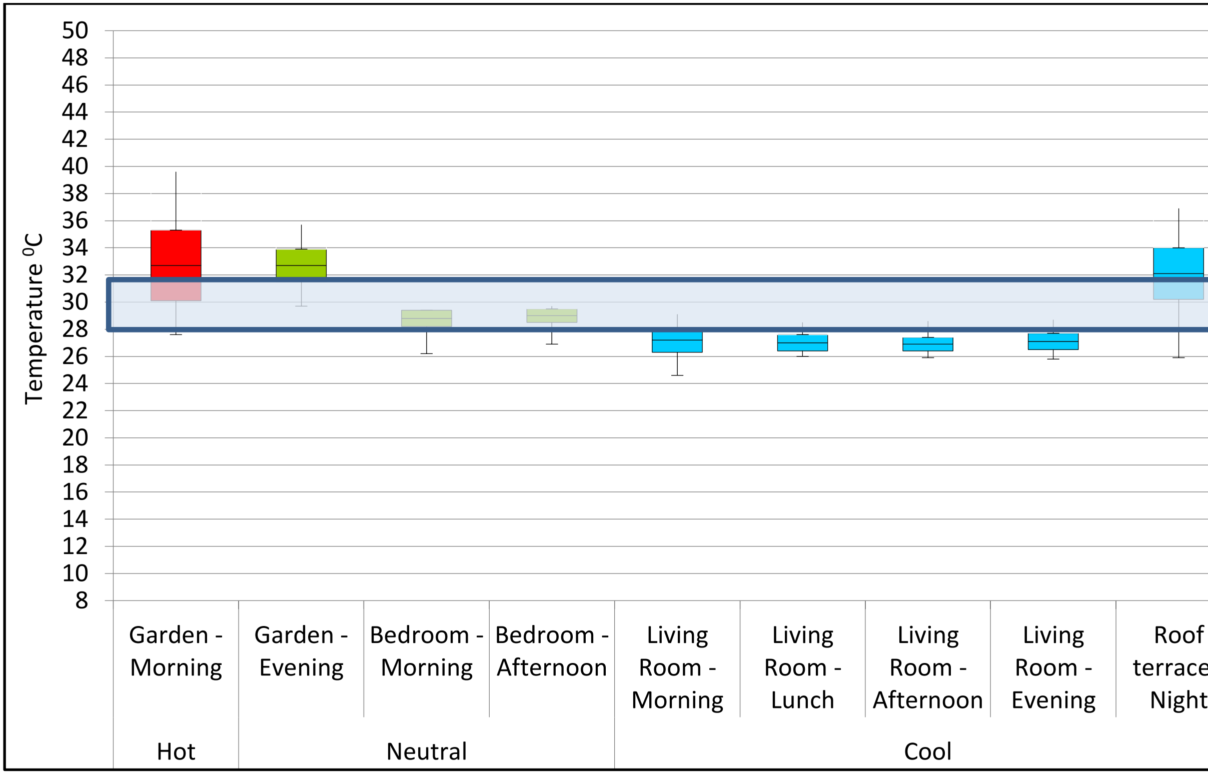


Fig. 6.15. The occupant's responses during the different times of the day with standard comfort band in plot box (average) and +/-1 std deviation which is equal to +/-34.1% of the data.

Hot

Garden morning

According to the thermal comfort standard:

- For 58% of this period the temperature is above the adaptive thermal comfort range.
- For 42% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the MH1 occupy the garden sometimes in the morning and they feel hot during this time of the day. The thermal environmental conditions prevailing in the shade in the garden are uncomfortably hot during this period of time.

The maximum air temperature of the garden is higher than the maximum air temperature of the roof terrace due to the floor area of the garden receiving direct sunlight. It is seen from the graph that the maximum temperature of the garden has been measured during the first and second peak of the day.

Neutral

Garden evening

According to the thermal comfort standard:

- For 75% of this period the temperature is above the adaptive thermal comfort range.
- For 25% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

According to the occupant's diary responses they feel the conditions are neutral (comfortable) when they use the garden during the evening (18:00–22:00). The thermal environmental conditions prevailing in the shade in the garden are comfortable during this period of time.

The bedroom is occupied by the inhabitants in the early morning (7:00) when they wake up on the roof terrace until 8:30 and in the afternoon (14:00–18:00) for the afternoon siesta, particularly in the absence of the basement level room (Sirdab); during this occupation the air conditioning is turned on.

The occupants feel the conditions are neutral when they occupy the bedroom in the morning and afternoon. The thermal environmental conditions prevailing in the bedroom in the morning and afternoon are comfortable. The bedroom of this house provides good thermal environmental conditions from the morning until early evening (18:00). The average temperature of the ***bedroom*** (28.8°C) is higher than in the ***living room*** (27.2°C) as are the peak and minimum temperatures (+1.6°C). This largely depends of the use of bedroom by the inhabitants, as when the bedroom is not occupied by the inhabitants the air conditioning unit is switched off in this room and as the living room is more frequently occupied this makes the bedroom warmer than the living room.

Cool

Living room morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within adaptive thermal comfort range.

Living room evening

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range

  For 0% of this period the temperature is within the adaptive thermal comfort range.

Roof terrace night

According to the thermal comfort standard:

- For 63% of this period the temperature is above the adaptive thermal comfort range
- For 37% of this period the temperature is within the adaptive thermal comfort range.

According to the occupant's diary responses for the living room, the occupants feel cool during their occupation of the living room in the morning, lunch, afternoon and evening; this is due to the A/C system in operation in the living room during this time. The thermal environmental conditions prevailing in the living room are very comfortable during this period of time.

The occupants of the MH1 occupied the roof terrace in the night for sleeping and they feel cool during this period of time; the thermal environmental conditions prevailing in the shade on the roof terrace are very comfortable in the night and continue to be very comfortable until the morning of the following day.

6.2.4. Modern House No. 2 – MH2

The MH2 was considered a large-sized house (360 m^2). The MH2 has been built as a detached house and it is partially two storeys (ground floor level, first floor level and second floor level).

The following table illustrates the summary findings for temperature in MH2 for the monitoring period. It should be noted that the air conditioning system is in operation in the monitored internal spaces of this house.

Table 6.19. Average, maximum and minimum temperature of MH2

MH2 Space	Temperature (°C)		
	Average	Max	Min
Living room	27°C	29°C	25°C
Bedroom	28.5°C	30 °C	27 °C
Garden	34°C	40°C	28°C
Roof terrace	33°C	38°C	28°C

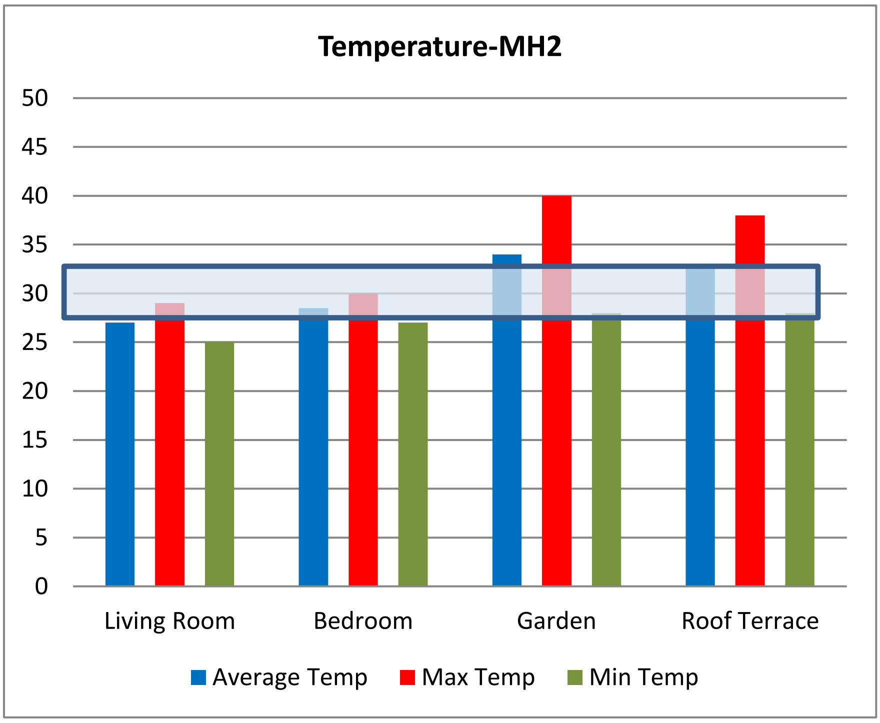


Fig. 6.16. Average, maximum and minimum temperature and the comfort band of the monitored spaces of MH2. This range is the comfort band standard during the summer.

It can be seen that the hottest temperature is experienced in the garden (40°C) and the coldest temperature is experienced in the living room (25°C) which also experience the lowest average temperature (27°C).

The following table illustrates the summary findings for relative humidity in MH2 for monitoring period.

Table 6.20. Average, maximum and minimum of relative humidity of MH2

MH2 Space	Humidity (%)		
	Average	Max	Min
Living room	47.7%	61.1%	34.3%
Bedroom	45.45%	61.5%	29.4%
Garden	33.5%	53.1%	13.0%
Roof terrace	32%	47.8%	16.2%

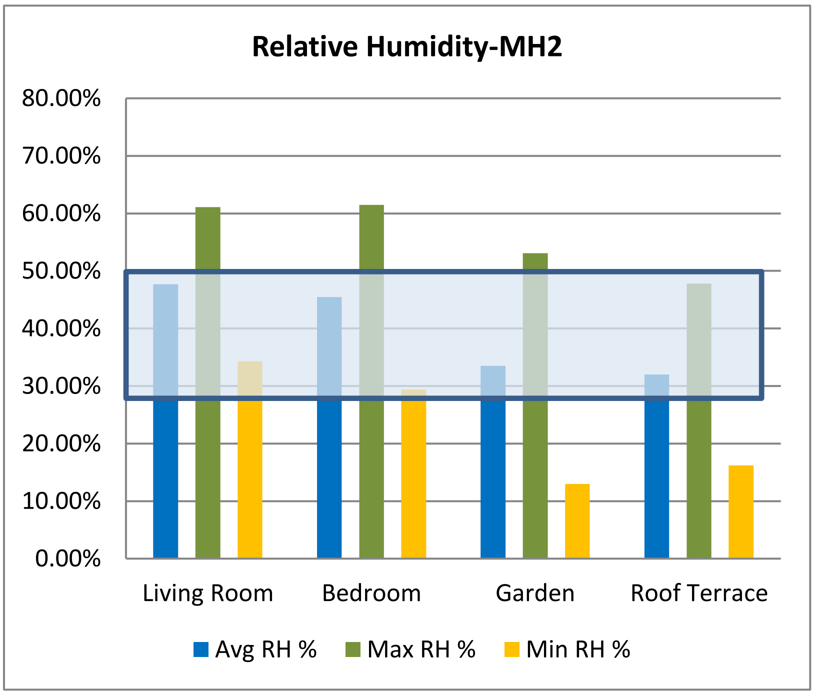


Fig. 6.17. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of MH2. This range is the comfort band standard during the summer.

The range in relative humidity is 29.4%–61.5% with both the maximum and minimum for the period being experienced in the bedroom.

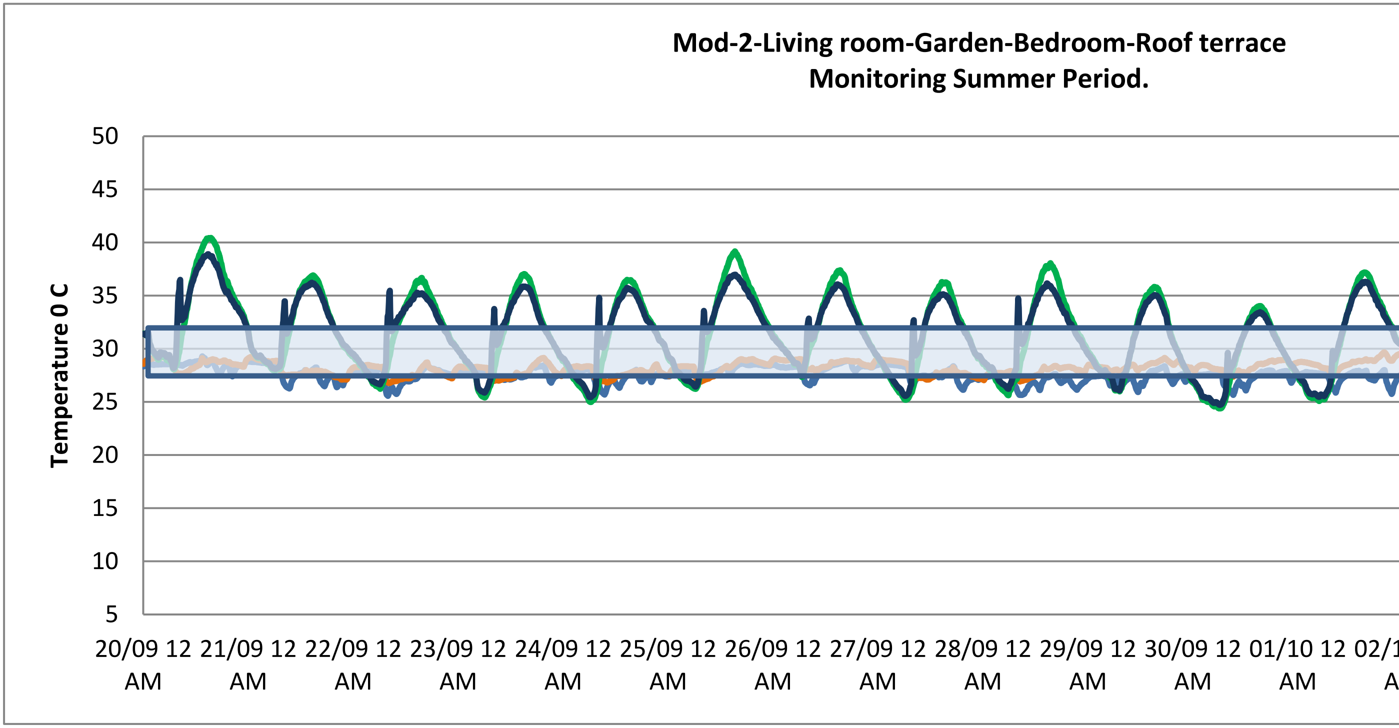


Fig. 6.18. **Living room, bedroom, garden and roof terrace and comfort band of the modern house No. 2 MH2**

MH2: Hottest Day Analysis:

The graph below shows the hottest day of the monitoring period of the four spaces of the modern house No. 2. The air temperature of the living room and bedroom was stable with a slight difference between the two rooms; the outdoor temperature of the garden and roof terrace was very high during the first and second peaks of this hottest day.

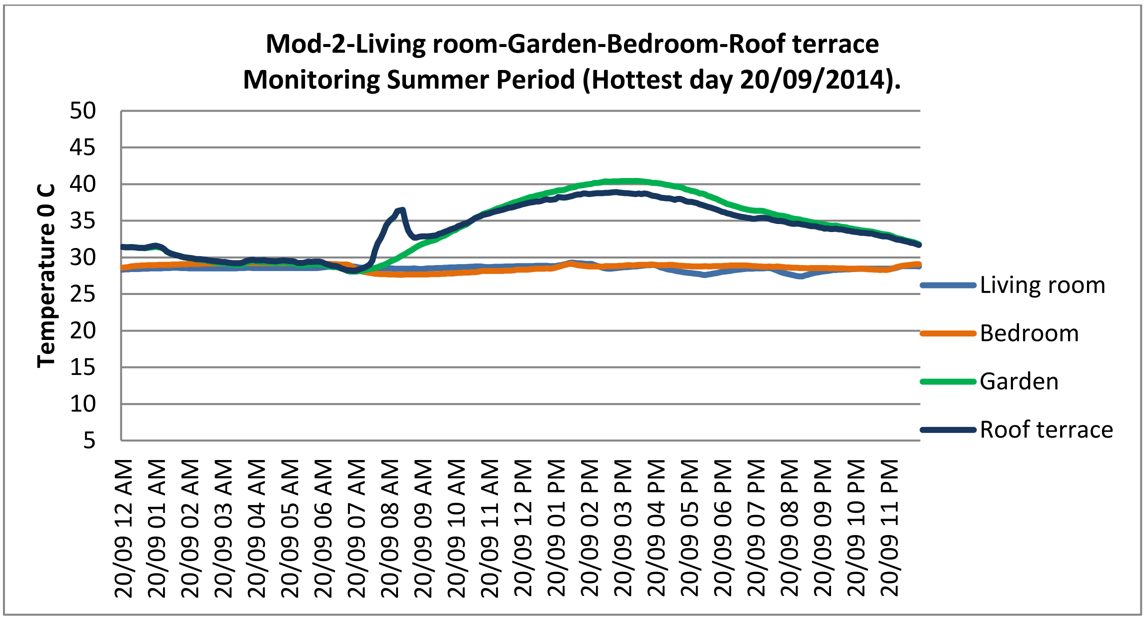


Fig. 6.19. This graph presents the hottest day of the monitoring period of the living room, bedroom, garden and roof terrace of the modern house No. 2

The hottest day was a typical day during the monitoring period; although the air temperature of the living room and bedroom of this house was stable with a slight difference between the air temperature of these two spaces, it was very obviously hottest day for the garden and roof terrace.

It should be pointed here that the maximum and minimum outdoor air temperatures are the same for both modern house No. 1 and modern house No. 2 due to both houses being very close to each other and as a result they have the same macroclimate factors.

Typical Occupation Patterns of MH2

As a result of observation, the following typical occupation patterns were identified in MH2. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.21. **MH2 occupants' typical habitation pattern for monitored rooms & spaces**

MH2 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00–7:00)
Living room A/C	Occupied	Occupied	Occupied	Occupied	
Bedroom A/C	Occupied (7:00–8:30)		Occupied		
Garden N/A			Occupied (18:00–22:00)	Occupied	
Roof terrace N/A					Occupied (22:00–7:00)

OCCUPANTS DIARY MH2

The findings of the occupant's diary for the monitored spaces in MH2 can be summarised as follows:

Table 6.22. **MH2 occupant's responses for occupied rooms and spaces**

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/ Night (18:00–7:00)
Living room A/C				
Bedroom A/C				
Garden (N/A)				
Roof terrace (N/A)				
Key: Average response of MH2 occupants for each period and monitored space				
Not Occupied	Hot	Slightly Warm	Neutral	Cool

Table 6.23. **Occupant's diary responses for MH2**

Modern House No. 2	Occupant's Response
Living room	According to the occupant's diary, the occupants feel comfortable (neutral) in the morning, lunch and afternoon; this is due to the A/C system operating in the living room during this period of time and they feel very comfortable (cool) in the evening (18:00–22:00).
Bedroom	According to the occupant's diary, they feel comfortable (neutral) in the bedroom in the early morning (7:00–8:30) when they occupy the bedroom after waking up on the roof terrace. They feel comfortable (neutral) in the afternoon in the bedroom for the afternoon siesta (14:00–18:00).
Garden	According to the occupant's diary, the occupants feel comfortable (neutral) in the early morning (8:30–10:00) when the use the garden sometimes and they feel comfortable (neutral) in the evening (18:00–22:00) after the garden is washed with water to reduce the intense heat and increase the relative humidity.
Roof terrace	According to the occupant's dairy, they feel comfortable in the night when they use the roof terrace for sleeping and they continue to feel comfortable until early morning of the following day.

Table 6.24. **The occupant's responses during different times of the day**

MH2 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room A/C	Neutral Avg: 27.0 C Max: 28.8 C Min: 25.4 C Std Dev: 0.8 C	Neutral Avg: 27.2 C Max: 29.3 C Min: 24.9 C Std Dev: 0.9 C	Neutral Avg: 27.7 C Max: 29.1 C Min: 24.8 C Std Dev: 0.8 C	Cool Avg: 27.4 C Max: 28.5 C Min: 25.1 C Std Dev: 0.8 C	Not occupied
Bedroom A/C	Neutral Avg: 27.8 C Max: 29.5 C Min: 26.8 C Std Dev: 0.6 C	Not occupied	Neutral Avg: 28.5 C Max: 29.5 C Min: 27.4 C Std Dev: 0.5 C	Not occupied	Not occupied
Garden N/A	Neutral Avg: 30.2 C Max: 37.7 C Min: 24.4 C Std Dev: 2.9 C	Not occupied	Not occupied	Neutral Avg: 32.4 C Max: 37.8 C Min: 28.3 C Std Dev: 1.9 C	Not occupied
Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Neutral Avg: 32.7 C Max: 38.1 C Min: 24.6 C Std Dev: 2.6 C

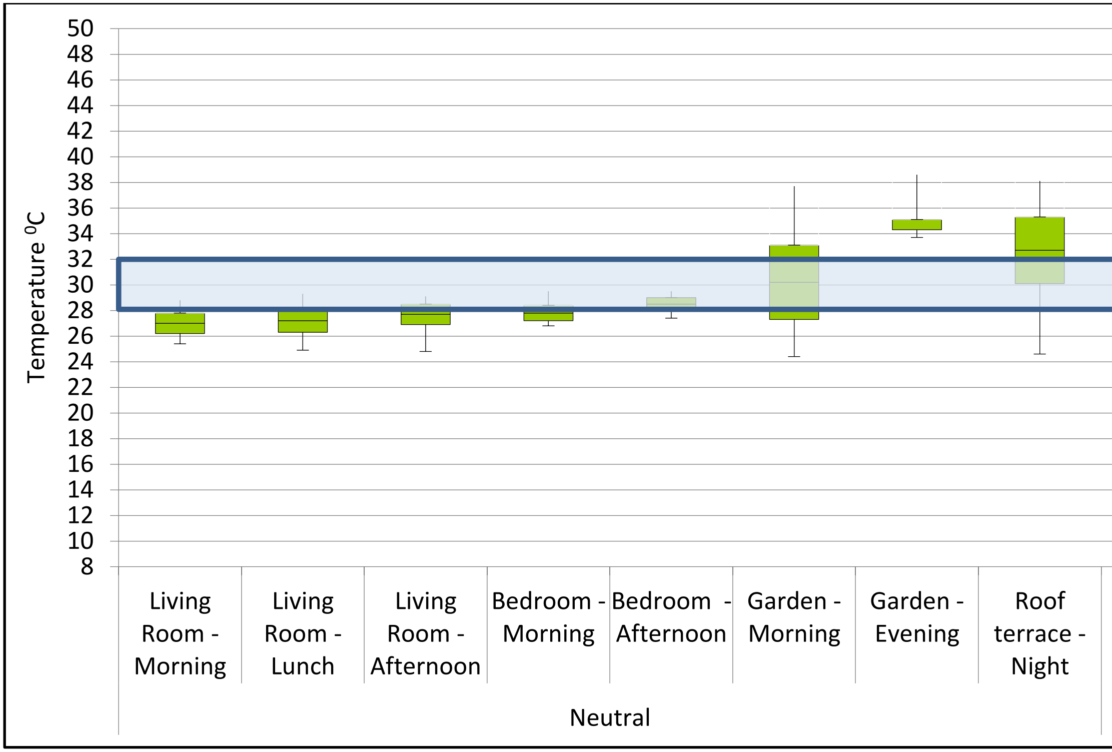


Fig. 6.20. **The occupant's responses during different times of the day with standard comfort band in plot box. T and +/-1 std deviation which is equal to +/-34.1% of the data.**

Neutral

Living room morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Living room afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

Garden morning

According to the thermal comfort standard:

- For 28% of this period the temperature is above the adaptive thermal comfort range.
- For 72% of this period the temperature is within the adaptive thermal comfort range.

Garden evening

According to the thermal comfort standard:

- For 57% of this period the temperature is above the adaptive thermal comfort range.
- For 43% of this period the temperature is within the adaptive thermal comfort range.

Roof terrace night

According to the thermal comfort standard:

- For 63% of this period the temperature is above the adaptive thermal comfort range.
- For 37% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the MH2 occupied the living room almost all the day in the morning (9:00–12:00), lunch (12:00–14:00), afternoon (14:00–18:00) and the A/C system operates during their occupation of the living room. According to the occupant's diary responses, in the living the occupants feel the conditions are neutral (comfortable) in the morning, lunch and afternoon. The thermal environmental conditions prevailing in the living room are comfortable during this period of time.

The occupants of the MH2 occupied the bedroom in the morning and afternoon and they feel neutral (comfortable) during this period of time. The A/C system operates in the bedroom during their occupation to provide them with comfortable thermal conditions. The thermal environmental conditions prevailing in the bedroom are comfortable during this period of time.

The average temperature of the bedroom (28.5ºC) is higher than in the living room (27ºC) during the monitoring period. This differential is likely to be caused by the living room being occupied by the inhabitants of this house more than the bedroom, as the occupants typically only operate the A/C system in the rooms that they are occupying. However, the A/C system sometimes operates in the bedroom while it is not occupied by the inhabitants just to keep it cool all the day.

The occupants of the MH2 sometimes occupied the garden in the morning and also they occupy the garden in the evening. According to the occupant's diary responses, in the garden the occupants feel the conditions are neutral in the morning and they continue to feel comfortable (neutral) in the evening. The thermal environmental conditions prevailing in the shade in the garden are comfortable in the morning and evening.

Cool

Living room evening

According to the thermal comfort standard:

- For 100% of this period the temperature is above the adaptive thermal comfort range.
- For 0% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the MH2 occupied the living room in the evening and during this period of time the A/C system operates in the living room. The occupants feel cool during the evening (18:00–22:00) and the thermal environmental conditions prevailing in the living room are very comfortable during the evening. The living room of this house provides the best thermal environmental conditions in the evening.

6.3. WINTER MEASUREMENT

From 14/02/2015 to 28/02/2015

This section will present the findings in turn for each of the 4 no. Phase 2 case study houses. The measurements will present the air temperature (average, maximum and minimum) in a table for each house as well as presenting temperature graphs for each house. Each graph presents the data for the four habitable rooms or spaces that have been measured during the winter monitoring period of two weeks and will present graphs for the extreme day for each season's monitoring period: here the coldest day during the monitoring period.

Further, summary analysis will be presented of the typical occupation pattern of the spaces/rooms that have been monitored, enabling appropriate interpretation and evaluation of the thermal comfort diary thermal comfort votes, in relation to average, maximum, minimum and standard deviation for each of the occupied periods.

6.3.1. Traditional House No. 1 – TH1

It is important to note that the monitored traditional houses for the winter period are the same as the monitored houses for the summer period.

The following table illustrates the summary findings for temperature in TH1 for the monitoring period. It should be noted that a paraffin heating system is in operation in the monitored internal spaces of this house.

Table 6.25. Average, maximum and minimum temperature of TH1

TH1 Space	Temperature (°C)		
	Average	Max	Min
Ursi room	21°C	24°C	18°C
Bedroom	21°C	26°C	15°C
Courtyard	13.5°C	20°C	7°C
Roof terrace	13.5°C	21°C	6°C

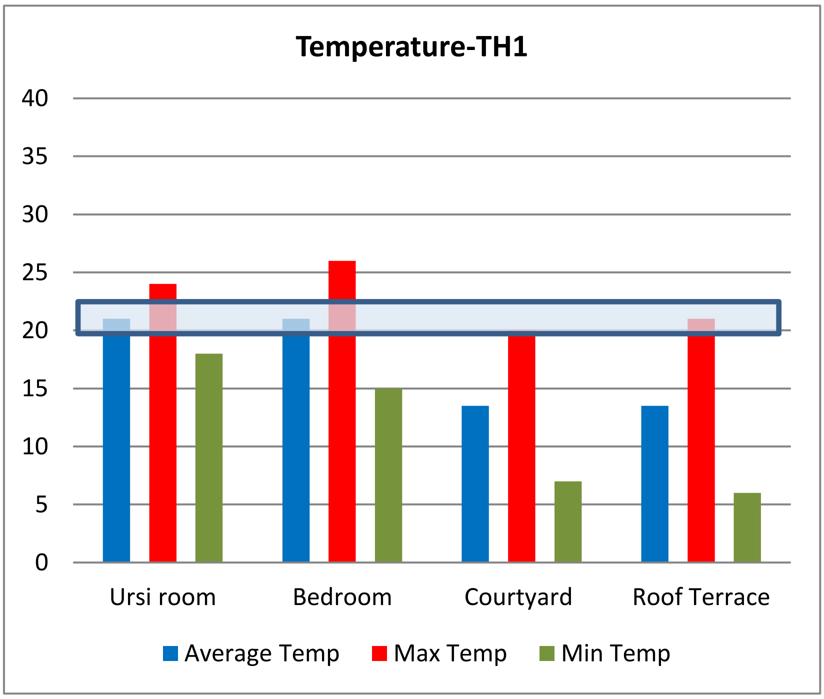


Fig. 6.21. Average, maximum and minimum temperature and comfort band of the monitored spaces of TH1. This range is the comfort band standard during the winter.

It can be seen that the coldest temperature is experienced on the roof terrace (6°C). The lowest internal monitored temperature is experienced in the Ursi room (18°C); the temperatures in the Ursi room and the bedroom are relatively stable during the period. The courtyard and the roof terrace experienced the lowest average temperatures (13.5°C).

The following table illustrates the summary findings for relative humidity in TH1 for monitoring period.

Table 6.26. Average, maximum and minimum relative humidity of TH1

TH1 Space	Humidity (%)		
	Average	Max	Min
Ursi room	42.2%	58.7%	25.7%
Bedroom	45.4%	61.5%	29.4%
Courtyard	57.7%	96.1%	19.4%
Roof terrace	52.6%	87.7%	17.6%

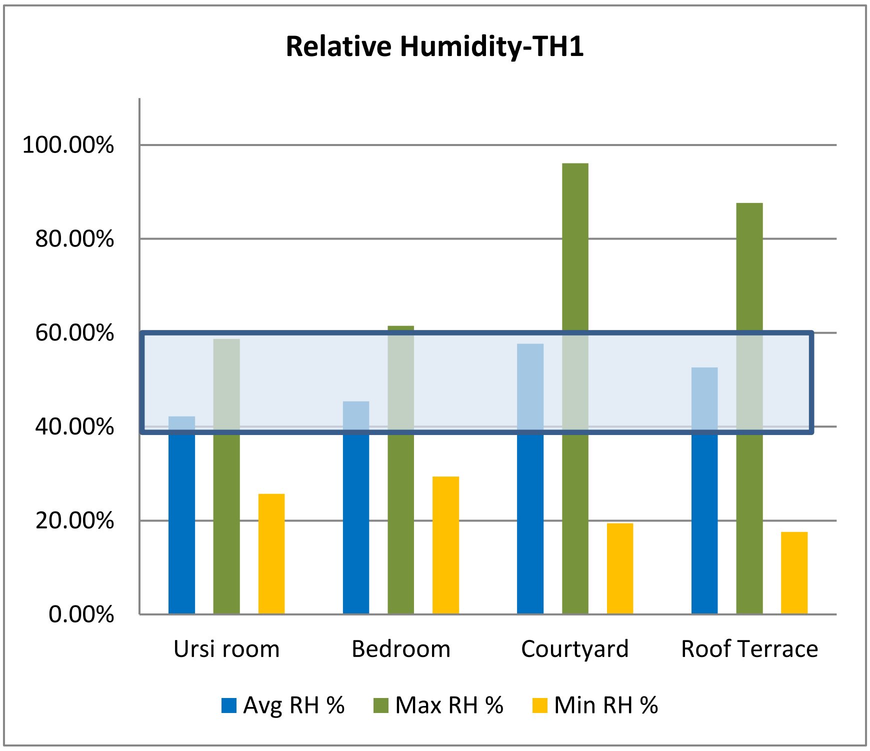


Fig. 6.22. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of TH1. This range is the comfort band standard during the winter.

The range in relative humidity is 17.6%–96.1% with both maximum and minimum. The maximum relative humidity is experienced in the courtyard and the minimum relative humidity is experienced in the roof terrace.

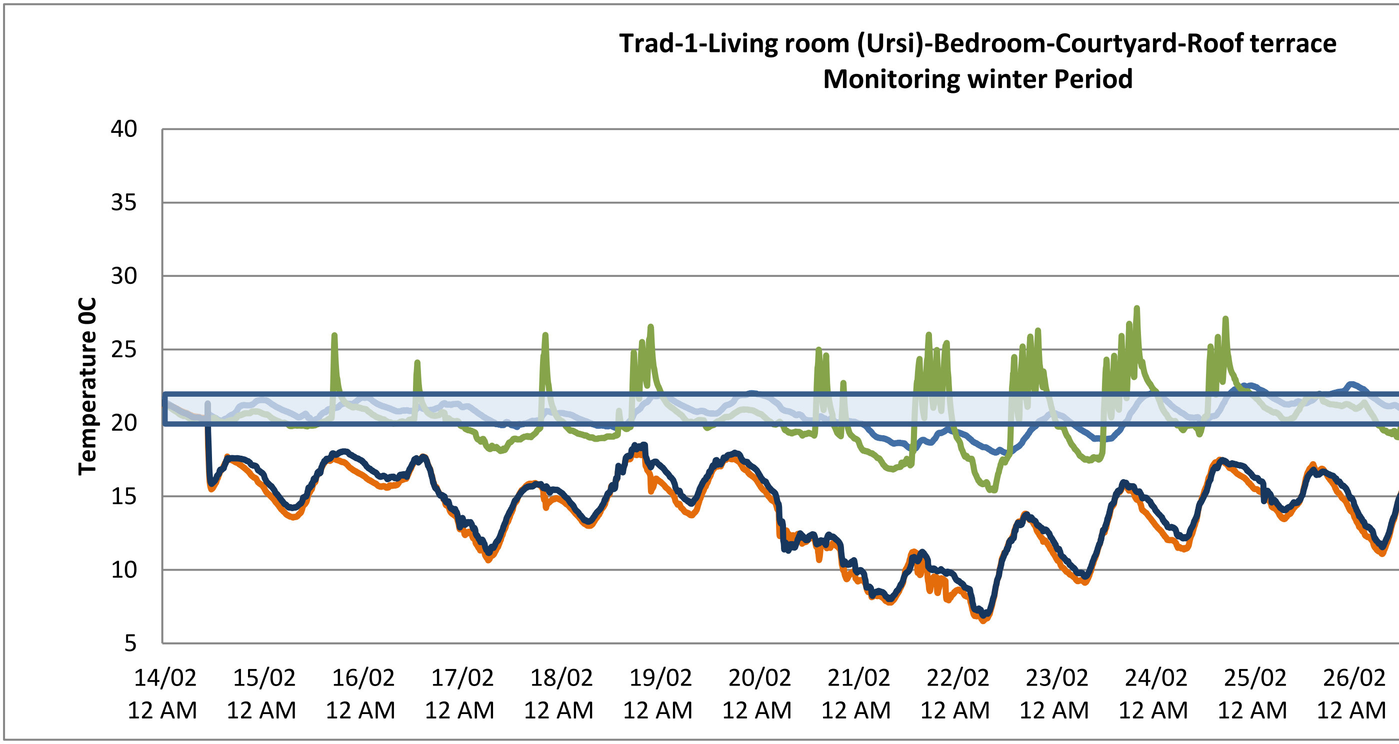


Fig. 6.23. **Living room (Ursi), bedroom, courtyard and roof terrace and comfort band of the traditional house N**

TH1: Coldest Day Analysis

The graph below shows the coldest day of the monitoring period of the four spaces of the traditional courtyard house No. 1. The temperature of the living room (Ursi) and the bedroom was stable although the bedroom at the ground floor level is warmer than the living room (Ursi) at first floor level; this is due to the use of the paraffin heaters during the cold days.

It is shown in this graph that the air temperature of the courtyard and roof terrace has dropped during this coldest day, due to the heavy rain storms on this particular day.

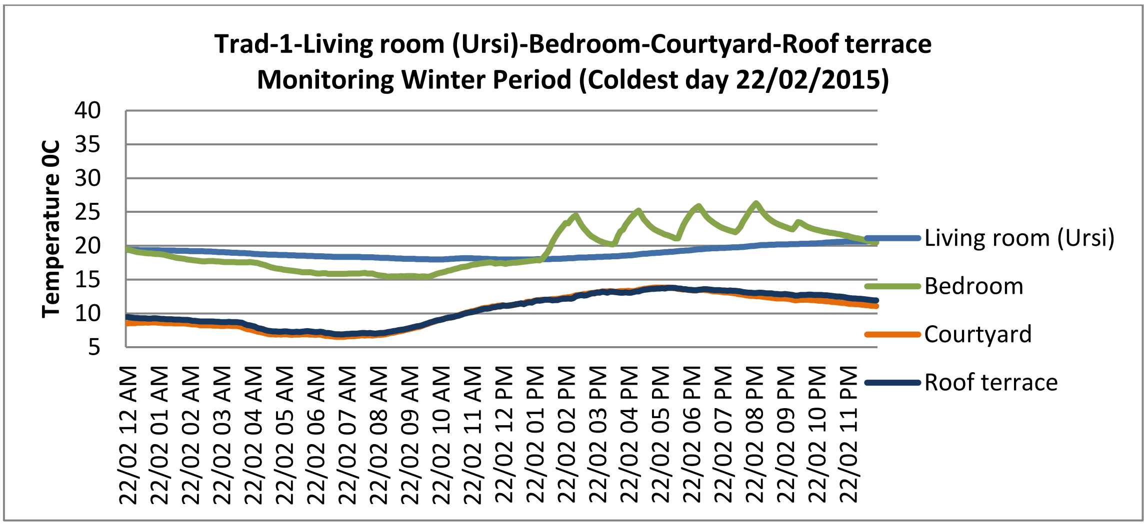


Fig. 6.24. This graph shows the coldest day of the monitoring period of the Ursi room, bedroom, courtyard and roof terrace of TH1

Typical Occupation Patterns of TH1

As a result of observation, the following typical occupation patterns were identified in TH1. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.27. TH1 occupants' typical habitation pattern for monitored rooms & spaces

TH1 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Ursi room Paraffin heating	Occupied	Occupied	Occupied	Occupied	
Bedroom Paraffin heating	Occupied		Occupied		Occupied
Courtyard N/A	Occupied	Occupied			

OCCUPANT'S DIARY TH1

The findings of the occupant's diary for the monitored spaces in TH1 can be summarised as follows.

Table 6.28. TH1 occupant's responses for occupied rooms and spaces

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/ Night (18:00–7:00)
Ursi room Paraffin Heating				
Bedroom Paraffin Heating				
Courtyard (N/A)				
Key: Average response of TH1 occupants for each period and monitored space				
Not Occupied	Slightly warm	Neutral	Cold	

It is important mention here that the occupants of the traditional house have used a different living room during the winter called an Ursi room which is located at the first floor level and is considered as a winter room. The Ursi family winter room is one of the main habitable rooms which is used as a family room during the winter.

Table 6.29. Occupant's diary responses for TH1

Traditional House No. 1	Occupant's Response
Ursi room	According to the occupant's diary, in the Ursi room the occupants feel comfortable (neutral) in the morning, lunch, afternoon and evening; this is due to the paraffin heating operating during the occupants' habitation.
Bedroom	According to the occupant's diary, in the bedroom the occupants feel very uncomfortable (cold) in the early morning but they feel comfortable (neutral) in the night when they occupy the bedroom for the night sleeping.
Courtyard	According to the occupant's diary, in the courtyard the occupants feel very uncomfortable (cold) in the morning when they use the courtyard sometimes for their daily activities and they feel comfortable (neutral) in the lunch during the sunny days.

Table 6.30. The occupant's responses during different times of the day

TH1 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/Night (18:00–7:00)
Ursi room Paraffin heating	Neutral Avg: 20.4 C Max: 22.4 C Min: 18.0 C Std Dev: 1.1 C	Neutral Avg: 20.2 C Max: 22.1 C Min: 18.0 C Std Dev: 1.1 C	Neutral Avg: 20.5 C Max: 23.5 C Min: 18.1 C Std Dev: 1.0 C	Neutral Avg: 21.5 C Max: 24.2 C Min: 18.7 C Std Dev: 1.2 C
Bedroom Paraffin heating	Cold Avg: 19.2 C Max: 21.8 C Min: 15.4 C Std Dev: 1.4 C	Not occupied	Slightly warm Avg: 20.7 C Max: 27.8 C Min: 15.4 C Std Dev: 2.0 C	Neutral Avg: 20.7 C Max: 27.8 C Min: 15.4 C Std Dev: 2.0 C
Courtyard N/A	Cold Avg: 13.2 C Max: 20.5 C Min: 6.5 C Std Dev: 3.0 C	Neutral Avg: 15.2 C Max: 19.3 C Min: 9.9 C Std Dev: 2.3 C	Not occupied	Not occupied

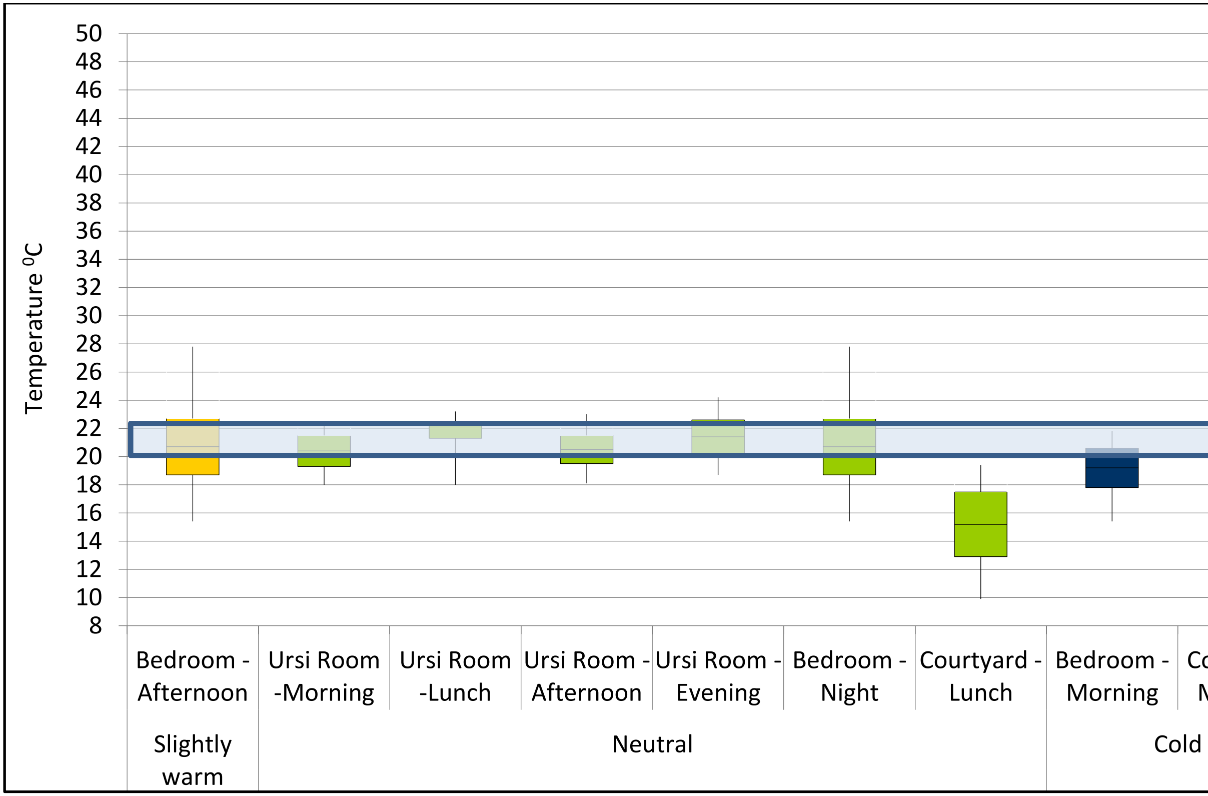


Fig. 6.25. **The occupant's responses during different times of the day with standard comfort band in plot box. T and +/-1 std deviation which is equal to +/-34.1% of the data.**

Slightly warm

Bedroom afternoon

According to the thermal comfort standard:

- For 27% of this period the temperature is above the adaptive thermal comfort range.
- For 73% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the TH1 occupied the bedroom in the afternoon for the afternoon siesta. According to the occupant's diary responses, the occupants feel slightly warm in the afternoon; the heating operates in the bedroom during this period of time. The thermal environmental conditions prevailing in the bedroom are acceptable in the afternoon (14:00–18:00).

Neutral

Living room (Ursi) morning

According to the thermal comfort standard:

- For 7% of this period the temperature is above the adaptive thermal comfort range.
- For 93% of this period the temperature is within the adaptive thermal comfort range.

Living room (Ursi) lunch

According to the thermal comfort standard:

- For 4% of this period the temperature is above the adaptive thermal comfort range.
- For 96% of this period the temperature is within the adaptive thermal comfort range.

Living room (Ursi) afternoon

According to the thermal comfort standard:

- For 5% of this period the temperature is above the adaptive thermal comfort range.
- For 95% of this period the temperature is within the adaptive thermal comfort range.

Living room (Ursi) evening

According to the thermal comfort standard:

- For 28% of this period the temperature is above adaptive thermal comfort range.
- For 72% of this period the temperature is within adaptive thermal comfort range.

Bedroom night

According to the thermal comfort standard:

- For 22% of this period the temperature is above adaptive thermal comfort range.
- For 78% of this period the temperature is within adaptive thermal comfort range.

Courtyard lunch

According to the thermal comfort standard:

- For 0% of this period the temperature is above adaptive thermal comfort range.
- For 100% of this period the temperature is within adaptive thermal comfort range.

The occupants of the TH1 occupied the living room (Ursi) almost all the day in the morning, lunch, afternoon and evening. According to the occupant's diary responses the occupants feel comfortable during their occupation of the living room (Ursi); the heating operates during this period of time. The living room (Ursi) is usually located along one side or two sides of the colonnaded gallery (Tarma).

The occupants keep the door and windows open in the morning and afternoon for natural ventilation and sunlight during their use of the living room (Ursi) and as a result the occupants receive cold air directly from outside, so the heating operates during this period of time. The thermal environmental conditions prevailing in the living room (Ursi) are comfortable during this period of time.

The occupants of TH1 occupied the bedroom during the night for sleeping in winter and according to the occupant's diary responses they feel comfortable in the night due to the use of heating during this period of time.

The maximum air temperature of the bedroom (26ºC) is higher than in the living room (Ursi) (24ºC); this is due to use of the heating (paraffin heaters) in the bedroom during the occupants' occupation. While the minimum temperatures are 15ºC and 18ºC respectively, it should be noted that the average temperatures for this period are 21ºC in both spaces (see Table 6.25).

The occupants of TH1 used the courtyard sometimes during the lunch period, particularly when there are warm and sunny days. According to the occupant's diary responses, the occupants feel comfortable when they occupy the courtyard at lunch time during the sunny days. The thermal environmental conditions prevailing in the shade in the courtyard are comfortable during this period of time.

Cold

Bedroom morning

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range.
- For 100% of this period the temperature is within the adaptive thermal comfort range.

Courtyard morning

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range.
- For 100% of this period the temperature is within the adaptive thermal comfort range.

The occupants of TH1 occupied the bedroom in the night for sleeping until the early morning (8:30). According to the occupant's diary responses, the occupants feel uncomfortable (cold) in the early morning as there was no heating in operation in the bedroom during the early morning. Although for 100% of this period the temperature is within the adaptive comfort range as mentioned above, the occupant's responses indicate that they felt cold during their early morning occupation of the bedroom.

The occupants of TH1 occupied the courtyard sometimes in the morning for their daily activities. During this period of time and according to the occupant's diary responses the occupants feel cold in the early morning and the thermal environmental conditions prevailing in the shade in the courtyard are uncomfortably cold during this period of time.

The maximum (20ºC) and minimum (7ºC) air temperatures of the courtyard have been recorded during the coldest day of the monitoring period.

6.3.2. Traditional House No. 2 – TH2

The following table illustrates the summary findings for temperature in TH2 for the monitoring period. It should be noted that a paraffin heating system is in operation in the monitored internal spaces of this house.

Table 6.31. Average, maximum and minimum temperature of TH2

TH2 Space	Temperature (ºC)		
	Average	Max	Min
Ursi room	21.5ºC	23ºC	20ºC
Bedroom	21.5ºC	23ºC	20ºC
Courtyard	17.5ºC	26ºC	9ºC
Roof terrace	20ºC	31ºC	8ºC

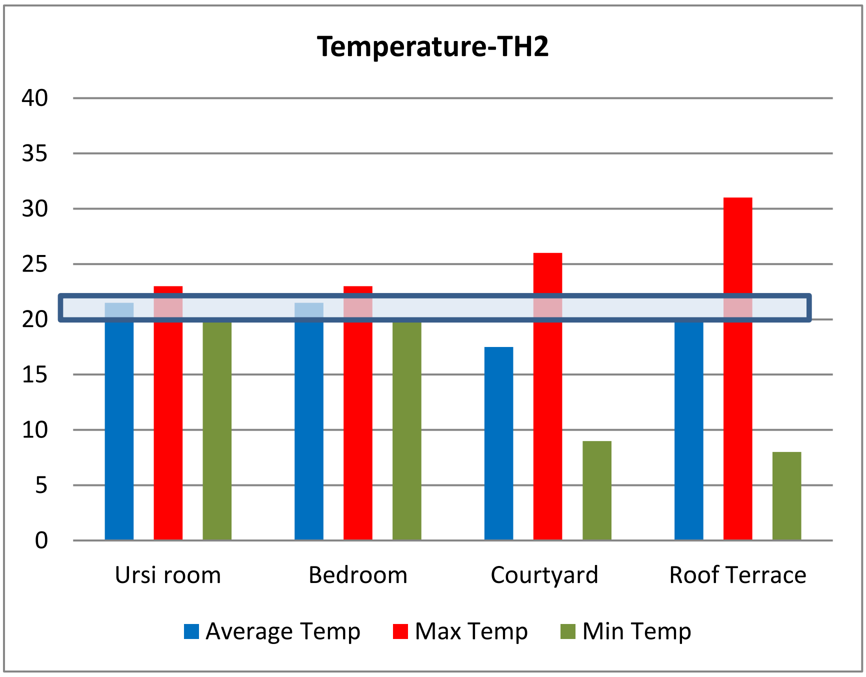


Fig. 6.26. Average, maximum and minimum temperature and comfort band of the monitored spaces of TH2. This range is the comfort band standard during the winter.

It can be seen that the coldest temperatures are experienced in the Ursi room and the bedroom with both maximum and minimum temperatures (23°C) and (20°C). The courtyard experienced the lowest average temperature (17.5°C) and the hottest temperature is experienced on the roof terrace (31°C). The temperatures in the Ursi room and bedroom are relatively stable during the monitoring period.

The following table illustrates the summary findings for relative humidity in TH2 for monitoring period.

Table 6.32. Average, maximum and minimum relative humidity of TH2

TH2 Space	Humidity (%)		
	Average	Max	Min
Ursi room	50.7%	67.7%	33.8%
Bedroom	55.1%	79.1%	31.0%
Courtyard	47.1%	97.9%	19.4%
Roof terrace	52.2%	89.6%	14.9%

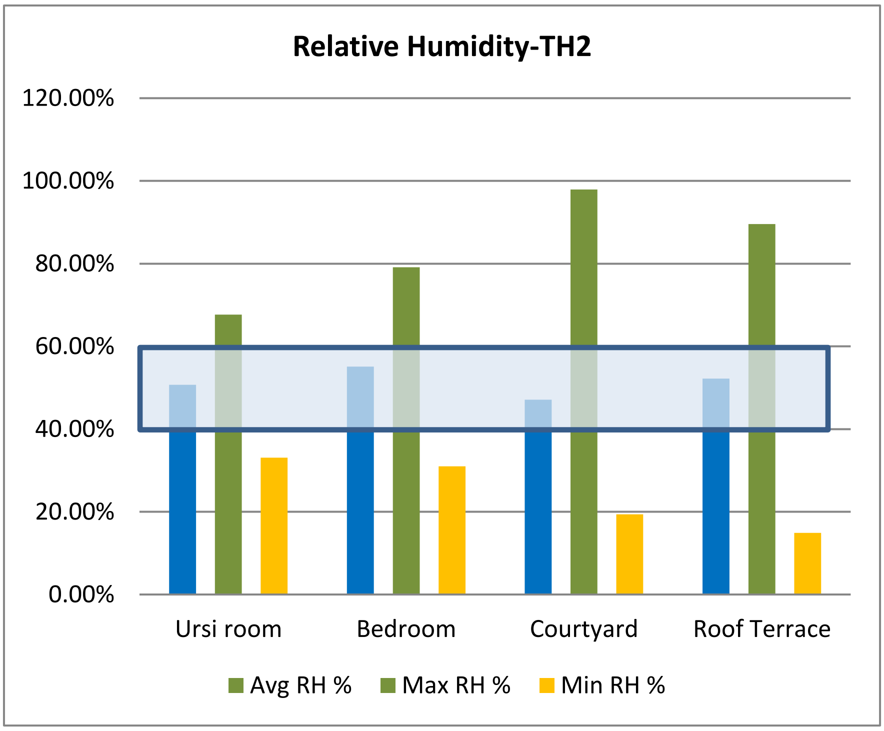


Fig. 6.27. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of TH2. This range is the comfort band standard during the winter.

The range in relative humidity is 14.9%–97.9% with both maximum and minimum. The maximum relative humidity is experienced in the courtyard and the minimum relative humidity is experienced on the roof terrace.

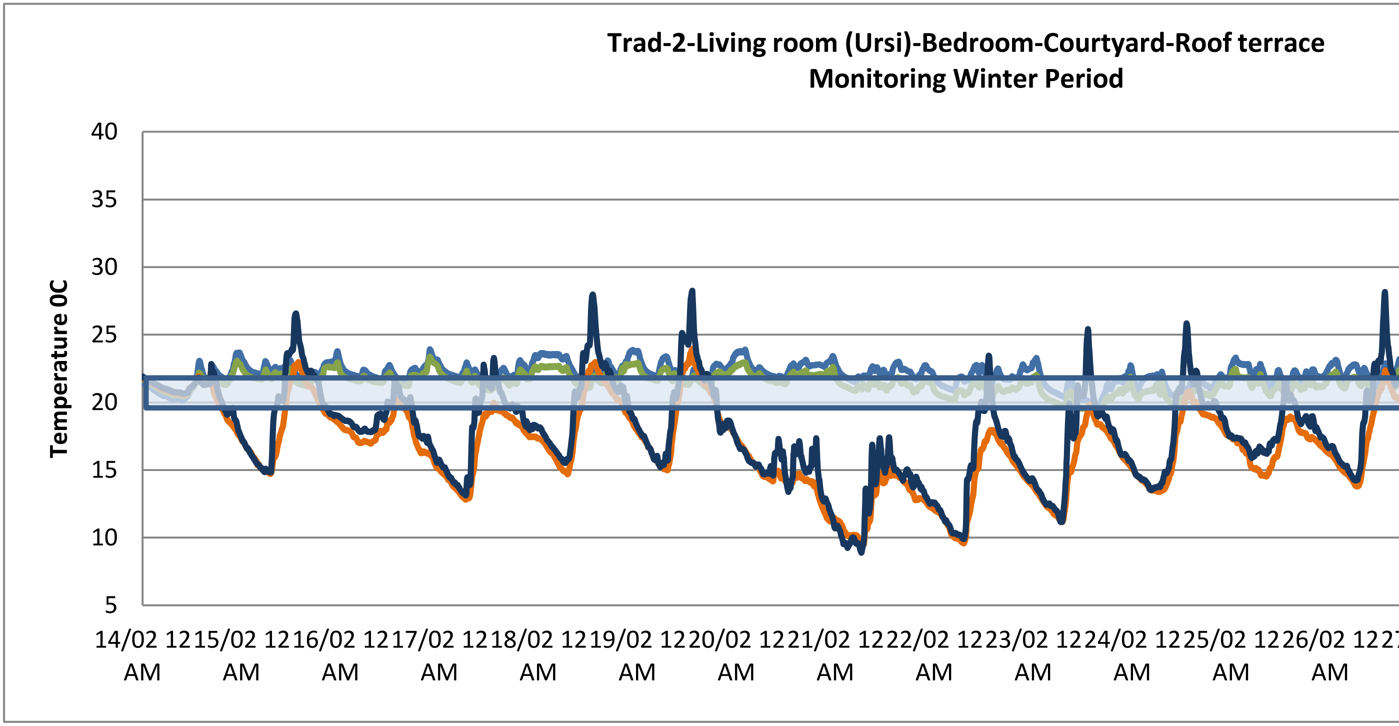


Fig. 6.28. Living room (Ursi), bedroom, courtyard and roof terrace and the comfort band of t

TH2: Coldest Day Analysis

The graph below shows the coldest day of the monitoring period for the courtyard and roof terrace of the traditional courtyard house No. 2.

The graph presents the air temperature of the living room (Ursi) and the bedroom which are stable during the monitoring period; this is due to the use of the heaters during the cold day during the monitoring period. There is a drop in temperature of the courtyard and roof terrace from midnight until the early morning due to the overnight cold air and heavy rain.

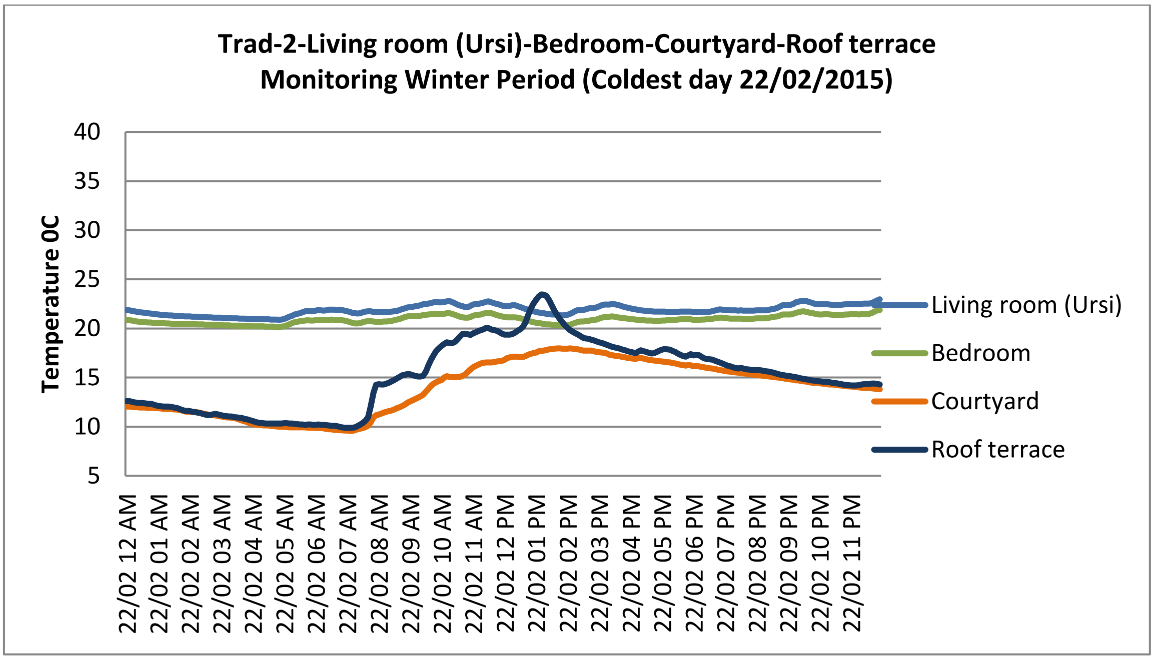


Fig. 6.29. Shows the coldest day of the monitoring period of the living room (Ursi), bedroom, courtyard and roof terrace

Typical Occupation Patterns of TH2

As a result of observation, the following typical occupation patterns were identified in TH2. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.33. **TH2 occupants' typical habitation pattern for monitored rooms and spaces**

TH2 Space	Morning (7:00- 12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Ursi room Paraffin heating	Occupied	Occupied	Occupied	Occupied	
Bedroom Paraffin heating	Occupied		Occupied		Occupied
Courtyard N/A	Occupied	Occupied			

OCCUPANT'S DIARY TH2

The findings of the occupant's diary for the monitored spaces in TH2 can be summarised as follows.

Table 6.34. **TH2 occupant's responses for occupied rooms and spaces**

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/ Night (18:00–7:00)
Ursi room Paraffin Heating				
Bedroom Paraffin Heating				
Courtyard (N/A)				
Key: Average response of TH2 occupants for each period and monitored space				
Not Occupied	Slightly warm	Neutral	Cold	

Table 6.35. Occupant's diary responses for TH2

Traditional house No. 2	Occupant's Response
Ursi room	According to the occupant's diary, in the Ursi room the thermal comfort conditions in the morning are acceptable (slightly warm) for the occupants and comfortable (neutral) in the lunch period, afternoon and evening.
Bedroom	According to occupant's diary, in the bedroom the thermal comfort conditions are acceptable (slightly warm) in the morning and comfortable (neutral) in the afternoon during the afternoon siesta and in the night during the sleeping time.
Courtyard	According to the occupant's diary, in the courtyard the thermal comfort conditions are very uncomfortable (cold) in the morning and comfortable (neutral) during lunch.

Table 6.36. The occupant's responses during different times of the day

TH2 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (222:00-7:00)
Ursi room Paraffin heating	Slightly warm Avg: 21.8 C Max: 23.4 C Min: 20.1 C Std Dev: 0.7 C	Neutral Avg: 21.8 C Max: 23.1 C Min: 20.0 C Std Dev: 0.7 C	Neutral Avg: 22.0 C Max: 23.2 C Min: 19.8 C Std Dev: 0.7 C	Neutral Avg: 22.3 C Max: 23.9 C Min: 21.0 C Std Dev: 0.6 C	Not occupied
Bedroom Paraffin heating	Slightly warm Avg: 21.2 C Max: 22.5 C Min: 19.5 C Std Dev: 0.6 C	Not occupied	Neutral Avg: 21.4 C Max: 22.5 C Min: 19.3 C Std Dev: 0.7 C	Not occupied	Neutral Avg: 21.5 C Max: 23.2 C Min: 19: 3 C Std Dev: 0.8 C
Courtyard N/A	Cold Avg: 17.4 C Max: 24.6 C Min: 9.5 C Std Dev: 3.1 C	Neutral Avg: 20.2 C Max: 26.3 C Min: 13.9 C Std Dev: 3.2 C	Not occupied	Not occupied	Not occupied

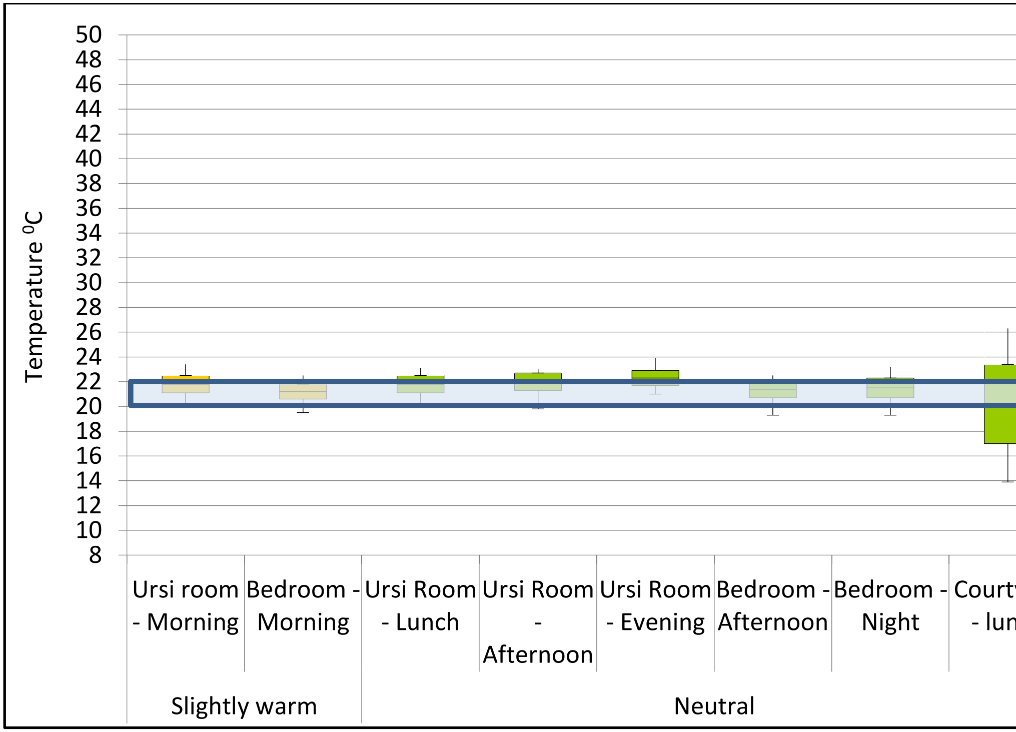


Fig. 6.30. The occupant response's during different times of the day with standard comfort band in plot box. T and +/-1 std deviation which is equal to +/-34.1% of the data.

Slightly warm

Living room (Ursi) morning

According to the thermal comfort standard:

- For 43% of this period the temperature is above the adaptive thermal comfort range.
- For 57% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 9% of this period the temperature is above the adaptive thermal comfort range.
- For 91% of this period the temperature is within the adaptive thermal comfort range.

As mentioned earlier in TH1, the occupants of TH2 used the living room (Ursi) during the day. According to the occupant's diary responses, in the living room (Ursi) they feel slightly warm in the morning due to the heating operating in the living room (Ursi) during this period of time. The thermal environmental conditions prevailing in the living room (Ursi) are acceptable during this time.

The living room (Ursi) which has been monitored in the TH2 is located at the first floor level and opens into the upper part of the courtyard; as a result the occupants are likely to receive cold air from outside during the day, so the heating operates during the occupants' habitation of this room.

The occupants of the TH2 are used the bedroom in the night until they wake up in the early morning (8:30). According to the occupant's diary responses, the occupants feel slightly warm during this period of time. The thermal environmental conditions prevailing in the bedroom are acceptable during this time.

The average temperature of the living room (Ursi) and bedroom is the same (21.5ºC) because they have the same maximum (23ºC) and minimum (20ºC) air temperature. The occupants have been using the paraffin heaters when they occupied the living room (Ursi) and bedroom during the day to keep the rooms warm.

Neutral

Living room (Ursi) lunch

According to the thermal comfort standard:

- For 38% of this period the temperature is above the adaptive thermal comfort range.
- For 62% of this period the temperature is within the adaptive thermal comfort range.

Living room (Ursi) afternoon

According to the thermal comfort standard:

- For 53% of this period the temperature is above the adaptive thermal comfort range.
- For 47% of this period the temperature is within the adaptive thermal comfort range.

Living room (Ursi) evening

According to the thermal comfort standard:

- For 65% of this period the temperature is above the adaptive thermal comfort range.
- For 35% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 17% of this period the temperature is above the adaptive thermal comfort range.
- For 83% of this period the temperature is within the adaptive thermal comfort range.

Bedroom night

According to the thermal comfort standard:

- For 25% of this period the temperature is above the adaptive thermal comfort range.
- For 75% of this period the temperature is within the adaptive thermal comfort range.

Courtyard lunch

According to the thermal comfort standard:

- For 33% of this period the temperature is above the adaptive thermal comfort range.
- For 67% of this period the temperature is within the adaptive thermal comfort range.

The occupants of TH2 occupied the living room (Ursi) in the lunch, afternoon, and evening. According to the occupant's diary responses, during this period of time they feel comfortable in the living room (Ursi), the occupants' comfortable period (neutral responses) during this time. The thermal environmental conditions prevailing in the living room (Ursi) are comfortable in the lunch, afternoon and evening.

The average temperature of the living room (Ursi) and bedroom are the same (21.5ºC) because they have the same maximum (23.0ºC) and minimum (20ºC) air temperature. The occupants have been using the paraffin heaters when they occupied the living room (Ursi) and bedroom during the day and evening to keep the rooms warm.

The occupants occupied the bedroom in the afternoon (14:00–18:00) for the afternoon siesta and also in the night for sleeping. According to the occupant's diary responses, in the bedroom during the afternoon and night the occupants feel comfortable (neutral) at this particular of time. The thermal environmental conditions prevailing in the bedroom are comfortable during this period of time.

The occupants sometimes occupied the courtyard during lunch in the winter, particularly during warm and sunny days. According to the occupant's diary responses, the occupants feel comfortable (neutral) when they occupy the courtyard during lunch. The thermal environmental conditions prevailing in the shade in the courtyard are comfortable during lunch.

Cold

Courtyard morning

According to the thermal comfort standard:

- For 5% of this period the temperature is above the adaptive thermal comfort range.

- For 95% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the TH2 occupied the courtyard in the morning for their daily activities. According to the occupant's diary responses the occupants feel very uncomfortable (cold) during the early morning (8:30–10:00). Although for 95% of the period (7:00-12:00) the temperature is within adaptive thermal comfort, the occupants' responses indicate that they were uncomfortably (cold) in the early morning of this period of time. The thermal environmental conditions prevailing in the shade in the courtyard are uncomfortably cold during the early morning.

6.3.3. Modern House No. 1 – MH1

The following table illustrates the summary findings for temperature in MH1 for the monitoring period. It should be noted that the electric heating system is in operation in the monitored internal spaces of this house.

Table 6.37. Average, maximum and minimum temperature of MH1

MH1 Space	Temperature (^{0}C)		
	Average	Max	Min
Living room	20.5°C	25°C	16°C
Bedroom	20°C	23°C	17°C
Garden	15.5°C	25°C	8°C
Roof terrace	16°C	26°C	6°C

It can be seen that the coldest internal monitored temperature is experienced in the living room (16°C) and the hottest external monitored temperature is experienced in the roof terrace (26°C) which is also experienced the lowest monitored temperature (6°C). The garden experienced the lowest average temperature (15.5°C). The temperature in the living room and bedroom are relatively stable with the range of (2°C) with the maximum and (1°C) with the minimum through the period.

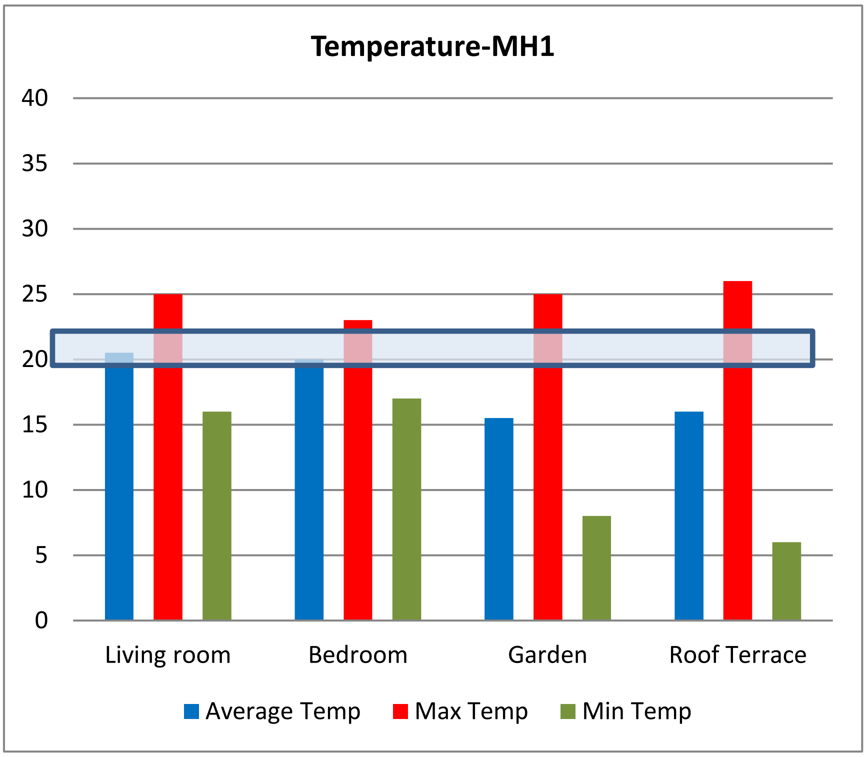


Fig. 6.31. Average, maximum and minimum temperature and the comfort band of the monitored spaces of MH1. This range is the comfort band standard during the winter.

The following table illustrates the summary findings for relative humidity in MH1 for monitoring period.

Table 6.38. Average, maximum and minimum relative humidity of MH1

MH1 Space	Humidity (%)		
	Average	Max	Min
Living room	45.4%	57.0%	33.8%
Bedroom	42.8%	51.4%	34.2%
Garden	49.0%	80.0%	18.1%
Roof terrace	57.8%	99.1%	16.5%

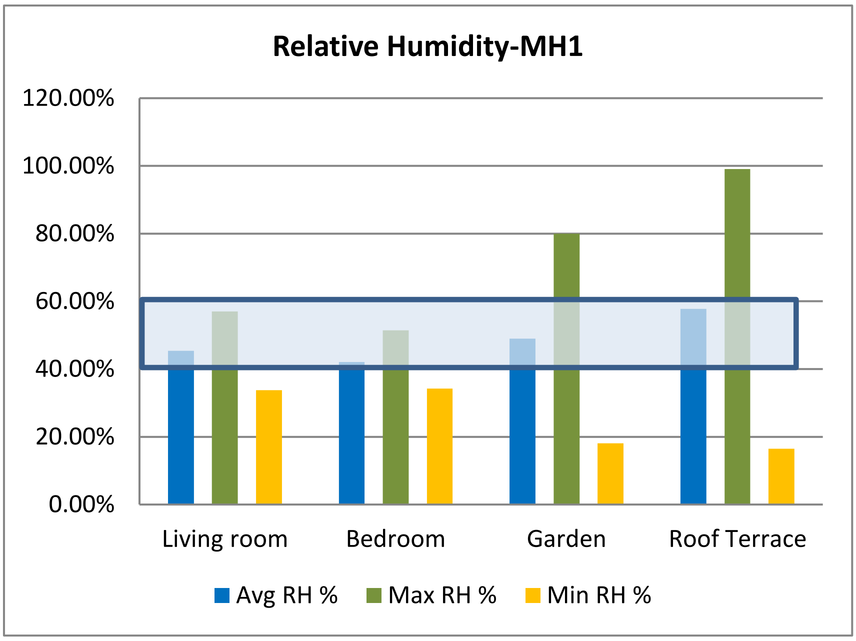


Fig. 6.32. Average, maximum and minimum relative humidity and comfort band of the monitored spaces of MH1. This range is the comfort band standard during the winter.

The range in relative humidity is 16.5%–99.1% with both maximum and minimum for the period experienced on the roof terrace.

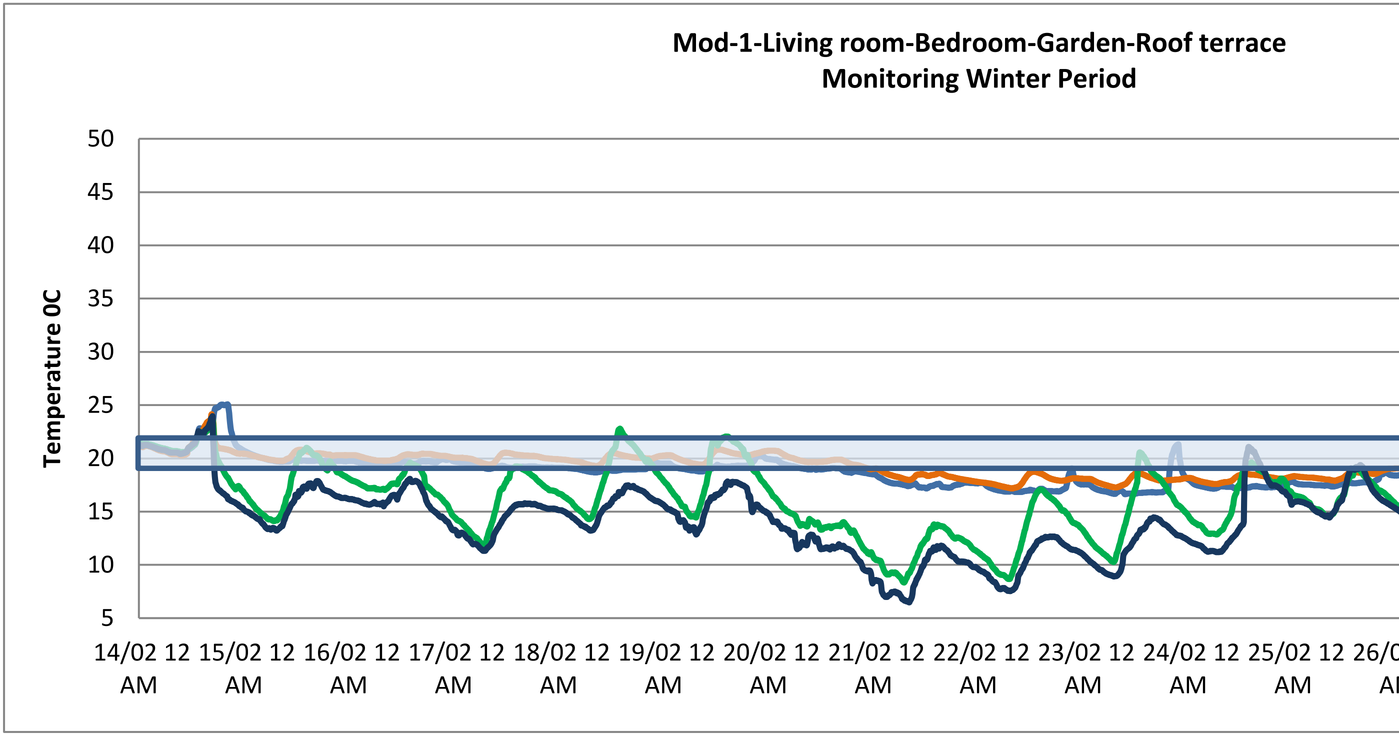


Fig. 6.33. Living room, bedroom, garden and roof terrace and comfort band of the

MH1: Coldest Day Analysis

The graph below presents the indoor and outdoor air temperature of the four spaces; it was the coldest day of the monitoring period for the garden and roof terrace and the air temperature of the living room and bedroom was stable during the day. Overnight cold air temperatures and a heavy rain storm during the night and the following morning produced the coldest day in the garden and roof terrace.

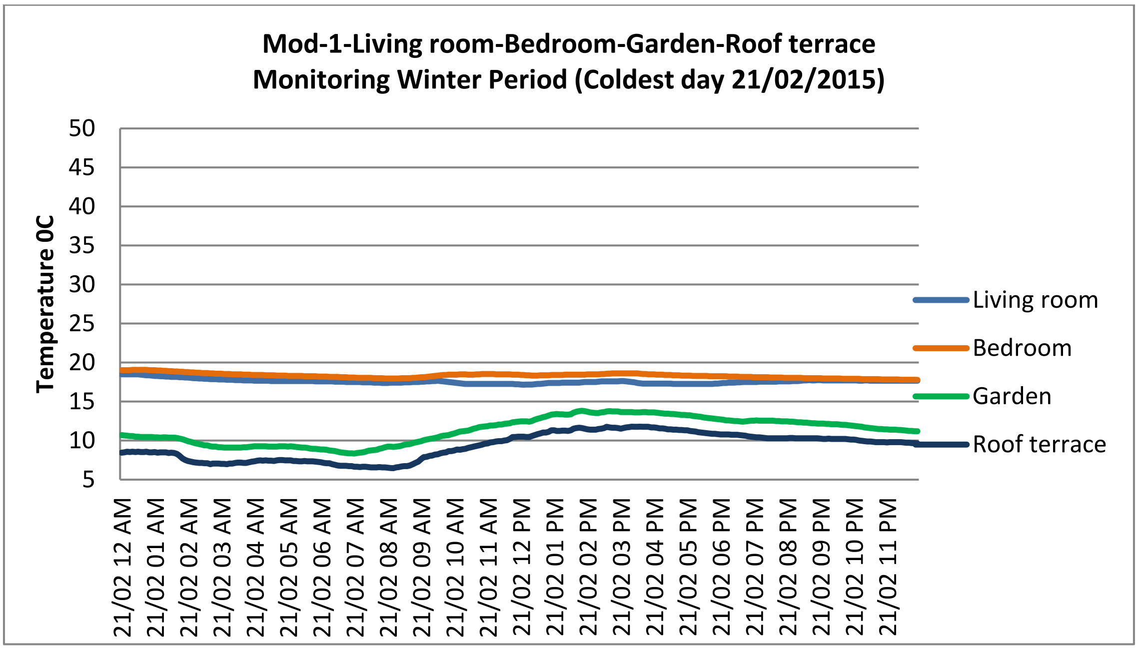


Fig. 6.34. Shows the coldest day of the monitoring period of living room, bedroom, garden and roof terrace

Typical Occupation Patterns of MH1

As a result of observation, the following typical occupation patterns were identified in MH1. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.39. **MH1 occupants' typical habitation pattern of monitored rooms & spaces**

MH1 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room Heating system	Occupied	Occupied	Occupied	Occupied	
Bedroom Heating system	Occupied		Occupied	Occupied	Occupied
Garden N/A		Occupied In the sunny days			

OCCUPANT'S DIARY MH1

The findings of the occupant's diary for the monitored spaces in MH1 can be summarised as follows.

Table 6.40. **MH1 occupant's responses for occupied rooms and spaces**

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/Night (18:00–7:00)
Living room Heating system				
Bedroom Heating system				
Garden (N/A)				
Key: Average response of MH1 occupants for each period and monitored space				
Not Occupied	Slightly warm	Neutral		Cold

Table 6.41. Occupant's diaries responses for MH1

Modern house No.1	Occupant's Response
Living room	According to the occupant's diary, in the living room the occupants feel comfortable (neutral) in the morning and lunch, and the thermal conditions in the afternoon and evening are acceptable (slightly warm responses) in the afternoon and evening.
Bedroom	According to the occupant's diary, in the bedroom the thermal conditions are acceptable (slightly warm responses) in the morning; this is due to use of heating in the early morning, particularly in the cold days. Conditions were also acceptable (slightly warm responses) in the night during the sleeping time and comfortable (neutral) in the afternoon when the occupants use the bedroom for the afternoon siesta.
Garden	According to the occupant's diary, the thermal environmental conditions prevailing in the garden are very uncomfortable (cold) in the early morning and comfortable (neutral) in the lunch when the occupants use the garden sometimes during the sunny days.

Table 6.42. The occupant's responses during different times of the day

MH1 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00-7:00)
Living room Heating System	**Neutral Avg: 18.4 C Max: 21.0 C Min: 16.6 C Std Dev: 1.6 C**	**Neutral Avg: 18.6 C Max: 22.8 C Min: 16.7 C Std Dev: 1.3C**	**Slightly warm Avg: 18.8 C Max: 24.8 C Min: 16.8 C Std Dev: 1.7C**	**Slightly warm Avg: 19.2 C Max: 25.1 C Min: 16.8 C Std Dev: 1.8C**	**Not occupied**
Bedroom Heating System	**Slightly warm Avg: 19.1 C Max: 21.2 C Min: 17.2 C Std Dev: 1.0 C**	**Not occupied**	**Neutral Avg: 19.7 C Max: 24.2 C Min: 17.9 C Std Dev: 1.2C**	**Not occupied**	**Slightly warm Avg: 19.2 C Max: 20.7 C Min: 17.2 C Std Dev: 1.0C**
Garden N/A	**Cold Avg: 15.7 C Max: 22.6 C Min: 8.3 C Std Dev: 3.1 C**	**Neutral Avg: 19.2 C Max: 25.1 C Min: 12.4 C Std Dev: 3.0C**	**Not occupied**	**Not occupied**	**Not occupied**

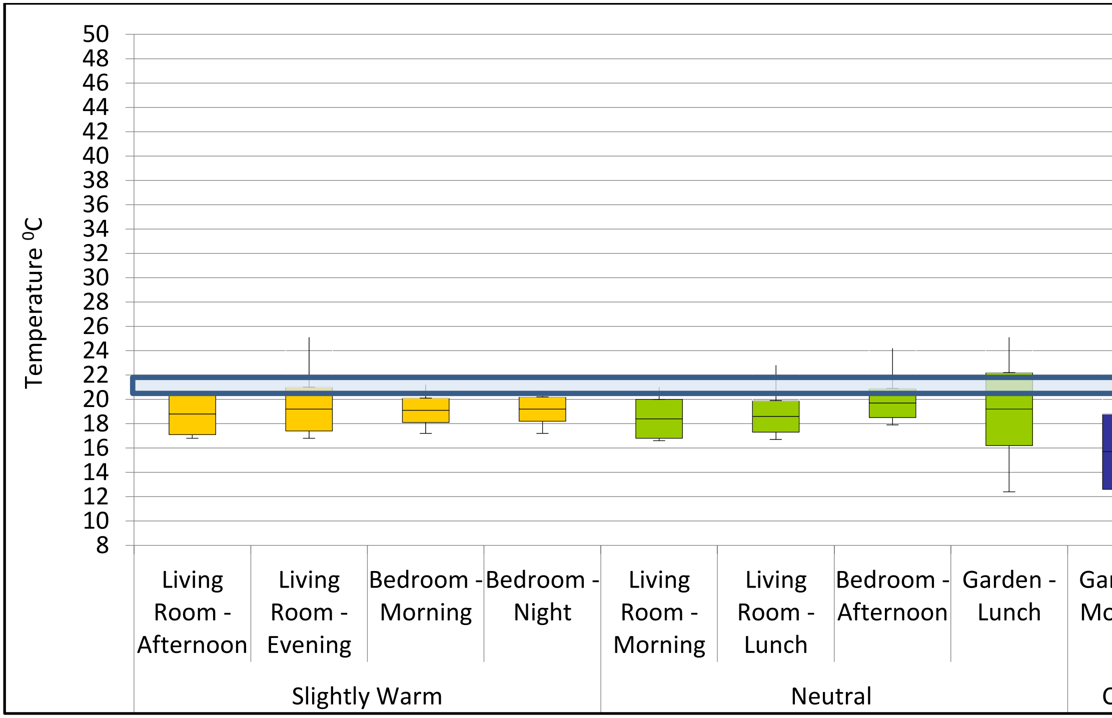


Fig. 6.35 **The occupant's responses during different times of the day with standard comfort band in plot box. T and +/-1 std deviation which is equal to +/-34.1% of the data.**

Slightly warm

Living room afternoon

According to the thermal comfort standard:

- For 9% of this period the temperature is above the adaptive thermal comfort range.
- For 91% of this period the temperature is within the adaptive thermal comfort range.

Living room evening

According to the thermal comfort standard:

- For 8% of this period the temperature is above the adaptive thermal comfort range.
- For 92% of this period the temperature is within the adaptive thermal comfort range.

Bedroom morning

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range.
- For 100% of this period the temperature is within the adaptive thermal comfort range.

Bedroom night

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range.
- For 100% of this period the temperature is within adaptive thermal comfort range.

The occupants of MH1 occupied the living room in the afternoon and evening. According to the occupant's diary responses, the occupants feel slightly warm during this period of time due to the heating system being in operation during their use of the living room. The thermal environmental conditions prevailing in the living room are acceptable during the afternoon and evening. The air temperature in the living room is largely influenced by the heating system during the day (avg: 20.5°C/max: 25°C/min: 16°C).

The occupant's responses indicate that the bedroom was slightly warm during the morning and night. The bedroom was occupied by the occupants in the morning, in the afternoon for the afternoon siesta and in the night for the night sleeping; the heating system operates during the inhabitants' occupation (avg: 20°C/max: 23°C/min: 17°C). The thermal environmental conditions prevailing in the bedroom are acceptable during the morning and night.

Neutral

Living room morning

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range.
- For 100% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 2% of this period the temperature is above the adaptive thermal comfort range.
- For 98% of this period the temperature is within the adaptive thermal comfort range,

Bedroom afternoon

According to the thermal comfort standard:

- For 5% of this period the temperature is above the adaptive thermal comfort range.
- For 95% of this period the temperature is within the adaptive thermal comfort range.

Garden lunch

According to the thermal comfort standard:

- For 16% of this period the temperature is above the adaptive thermal comfort range.
- For 84% of this period the temperature is within adaptive thermal comfort range.

The occupants of the MH1 occupied the living room in the morning, lunch and afternoon and the occupant's responses during this period of time indicated conditions were felt to be neutral which means they feel comfortable in the living room. The thermal environmental conditions prevailing in the living room are comfortable during this period of time. It has to be noted that the heating system operates in the living room during the occupants' occupation.

The occupants used the bedroom in the afternoon and they feel comfortable during this time of the day; the thermal environmental conditions prevailing in the bedroom are comfortable in the afternoon.

The occupant's responses during the lunch in the garden were neutral; they feel comfortable when they use the garden sometimes during the warm and sunny days. The thermal environmental conditions prevailing in the shade in the garden are comfortable during the lunch.

Cold

Garden morning

According to the thermal comfort standard:

- For 1% of this period the temperature is above the adaptive thermal comfort range.
- For 99% of this period the temperature is within the adaptive thermal comfort range.

The occupants sometimes occupy the garden in winter because of the low air temperature and high relative humidity. They occupy it during the warm and sunny days. The occupants sometimes occupied the garden in the morning and they feel very uncomfortable (cold) during this period of time. Although 99% of this period the temperature is within adaptive thermal comfort range the occupants responses indicate that they were cold during the early morning (8:30–10:000. The thermal environmental conditions prevailing in the shade in the garden are uncomfortably cold during the early morning.

6.3.4. Modern House No. 2 – MH2

The following table illustrates the summary findings for temperature in MH2 for the monitoring period. It should be noted that the electric heating system is in operation in the monitored internal spaces of this house.

Table 6.43. Average, maximum and minimum temperature of MH2

MH2 Space	Temperature (°C)		
	Average	Max	Min
Living room	20.5ºC	24ºC	17ºC
Bedroom	21ºC	24ºC	18ºC
Garden	16ºC	25ºC	7ºC
Roof terrace	17.5ºC	26ºC	7ºC

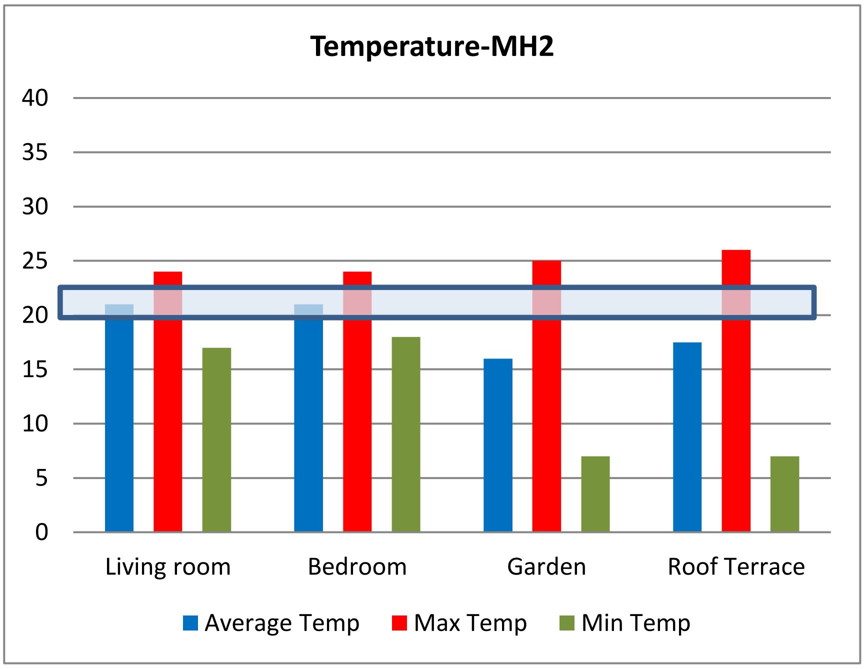


Fig 6.36. Average, maximum and minimum temperature and the comfort band of the monitored spaces of MH2. This range is the comfort band standard during the winter.

It can be seen that the warmest temperatures are experienced in the living room and bedroom (24°C).The garden experienced the lowest average temperature (16°C). The maximum temperatures in the garden and the roof terrace are relatively stable with the range of (1°C) through the period.

The following table illustrates the summary findings for relative humidity in MH2 for monitoring period.

Table 6.44. Average, maximum and minimum humidity of MH2

MH2 Space	Humidity (%)		
	Average	Max	Min
Living room	36%	47.2%	24.8%
Bedroom	41.9%	53.2%	30.7%
Garden	49.2%	82.0%	16.4%
Roof terrace	51.3%	84.8%	17.8%

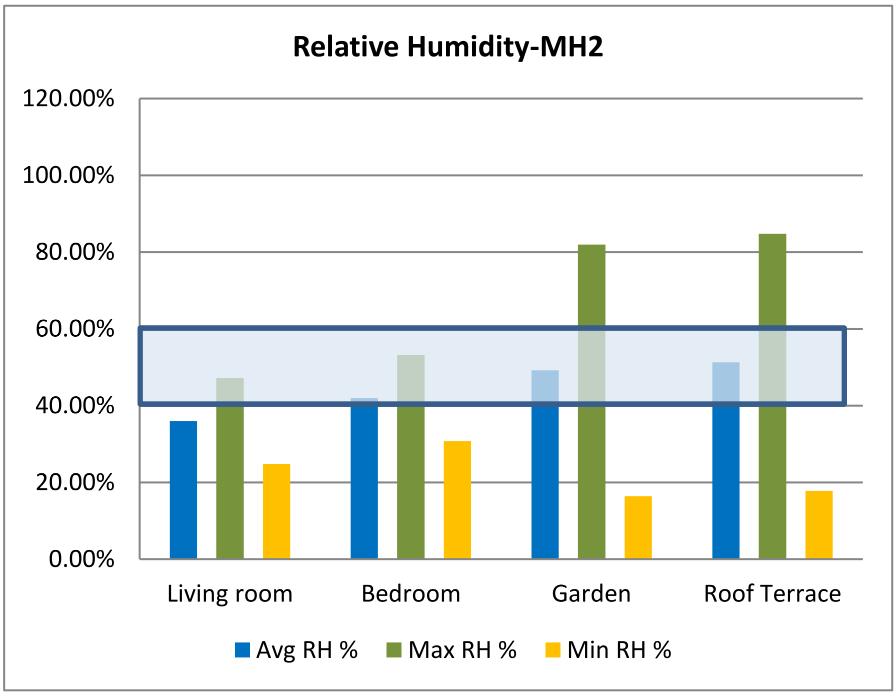


Fig. 6.37. Average, maximum and minimum temperature with comfort band of the monitored spaces of MH2. This range is the comfort band standard during the winter.

The range in relative humidity is 16.4%–84.8% with both maximum and minimum. The maximum relative humidity is experienced on the roof terrace and the minimum relative humidity is experienced in the garden.

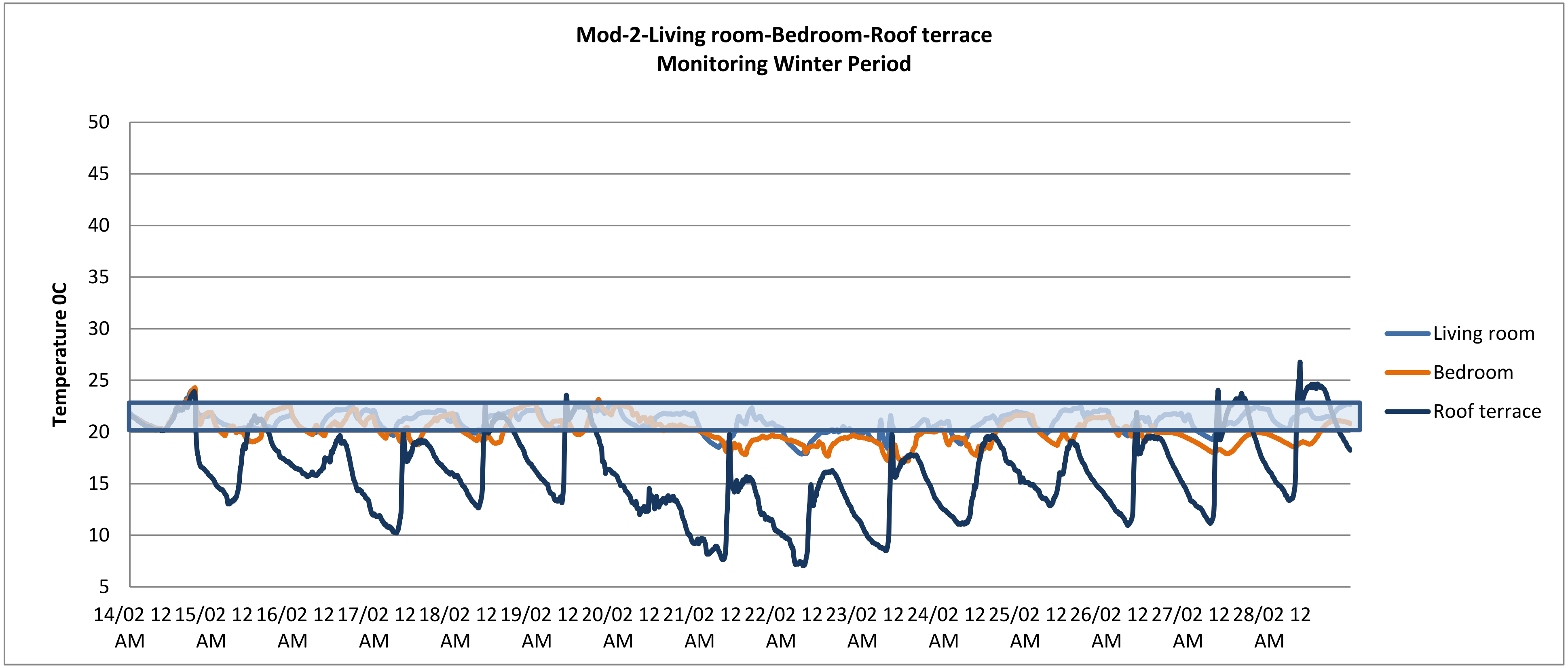


Fig. 6.38. **Living room, bedroom, and roof terrace with comfort band of the modern house No. 2 MH2**

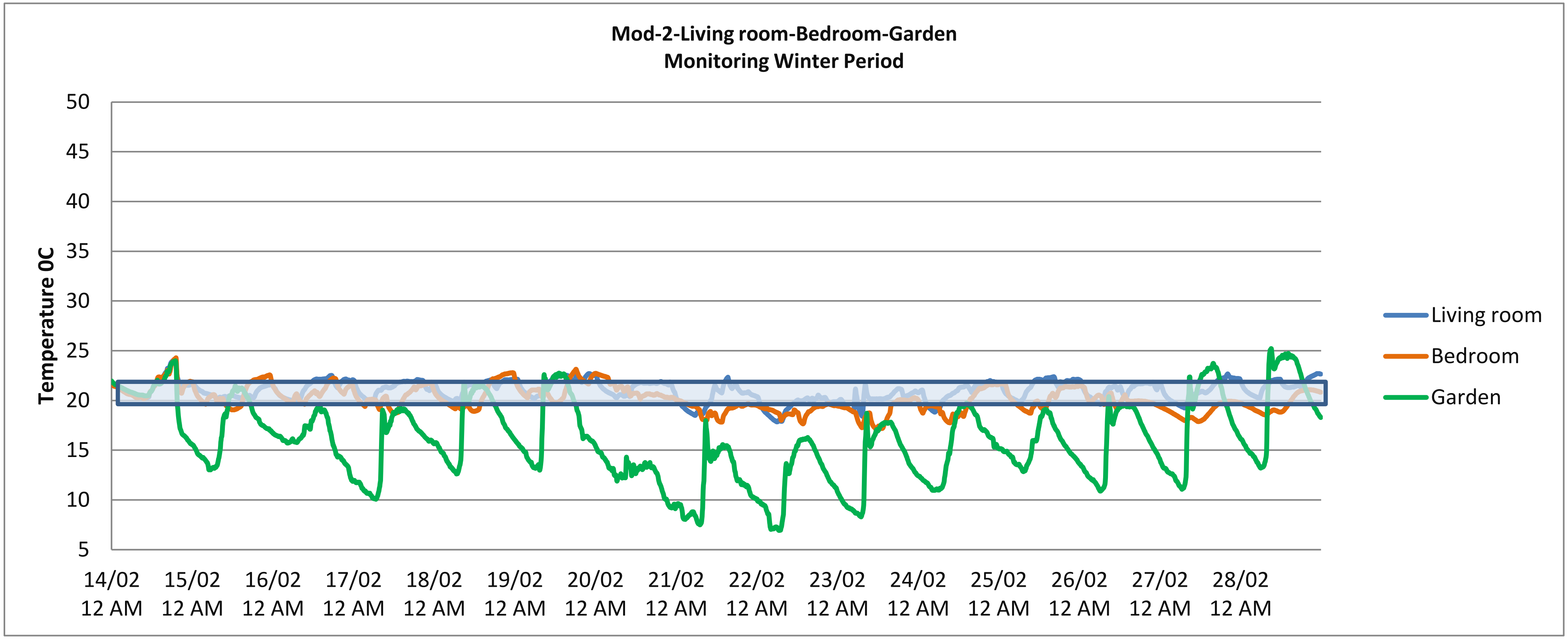


Fig. 6.39. Living room, bedroom and garden with comfort band of the modern house No. 2 MH2

Typical Occupation Patterns of MH2

As a result of observation, the following typical occupation patterns were identified in TH1. This pattern has been used to structure the detailed analysis and interpretation of the performance analysis of the spaces, focusing on performance of a space only when utilised.

Table 6.45. MH2 occupants' typical habitation pattern for monitored rooms and spaces

MH2 Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00–7:00)
Living room Heating system	Occupied	Occupied	Occupied	Occupied	
Bedroom Heating system	Occupied	Occupied	Occupied	Occupied	Occupied
Garden N/A	Occupied Sometimes (9:00–10:00)	Occupied In the sunny days			

OCCUPANT'S DIARY MH2

The findings of the occupant's diary for the monitored spaces in MH2 can be summarised as follows:

Table 6.46. MH2 occupant's responses for occupied rooms and spaces

Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening/Night (18:00–7:00)
Living room Heating system				
Bedroom Heating system				
Garden (N/A)				

Key: Average response of MH1 occupants for each period and monitored space

Not Occupied	Slightly warm	Neutral	Cold

Table 6.47. Occupant's diary responses for MH2

Modern House No. 2	Occupant's Response
Living room	According to the occupant's diary responses, in the living room the thermal environmental conditions in the morning, lunch, afternoon and evening are acceptable (slightly warm) for them. The heating system operates during this period of time in the living room.
Bedroom	According to the occupant's diary responses, in the bedroom the thermal environmental conditions in the early morning are comfortable (neutral) for them when the occupants are still sleeping in the bedroom and acceptable (slightly warm) during the lunch, afternoon and evening.
Garden	According to the occupant's diary responses, in the garden the thermal environmental condition, prevailing in the shade in the garden are very uncomfortable (cold) when the occupants sometimes occupied the garden. The thermal environmental conditions prevailing in the shade in the garden are comfortable (neutral responses) in the lunch when the occupants occupy the garden sometimes during warm and sunny day for having their lunch.

Table 6.48. The occupant's responses during different times of the day

MH2 Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
Living room Heating System	Slightly warm Avg: 20.7 C Max: 22.5 C Min: 17.9 C Std Dev: 0.9 C	Slightly warm Avg: 21.3 C Max: 22.6 C Min: 19.9 C Std Dev:0.7 C	Slightly warm Avg: 21.6 C Max: 23.9 C Min: 20.0 C Std Dev: 0.8 C	Slightly warm Avg: 21.6 C Max: 24.2 C Min: 19.6 C Std Dev: 0.7 C	Not occupied
Bedroom Heating system	Neutral Avg: 19.3 C Max: 21.4 C Min: 17.1 C Std Dev: 1.0 C	Slightly warm Avg: 19.3 C Max: 22.4 C Min: 17.2 C Std Dev: 1.2 C	Slightly warm Avg: 20.5 C Max: 23.9 C Min: 17.7 C Std Dev: 1.2 C	Not occupied	Slightly warm Avg: 20.2 C Max: 22.8 C Min: 17.4 C Std Dev: 1.1 C
Garden N/A	Cold Avg: 16.3 C Max: 25.2 C Min: 7.0 C Std Dev: 3.8 C	Neutral Avg: 19.4 C Max: 24.7 C Min: 12.6 C Std Dev: 3.C	Not occupied	Not occupied	Not occupied

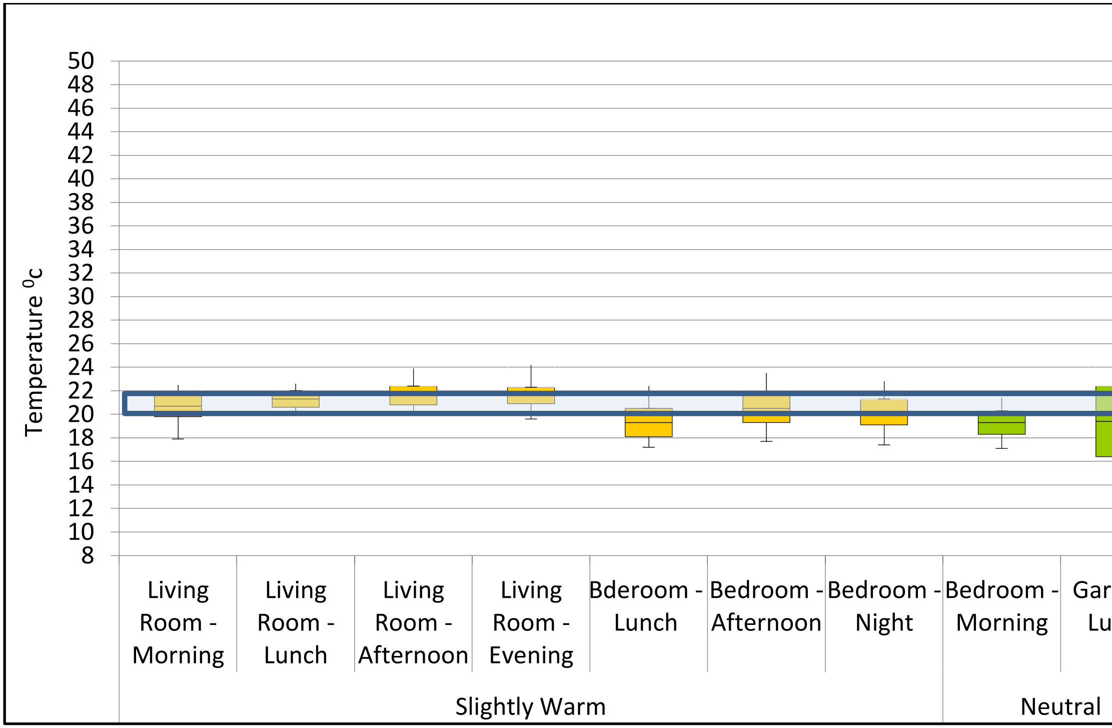


Fig. 6.40. **The occupant's responses during different times of the day with standard comfort band in plot box. Th and +/-1 std deviation which is equal to +/-34.1% of the data.**

Slightly warm

Living room morning

According to the thermal comfort standard:

- For 7% of this period the temperature is above the adaptive thermal comfort range.
- For 93% of this period the temperature is within the adaptive thermal comfort range.

Living room lunch

According to the thermal comfort standard:

- For 21% of this period the temperature is above the adaptive thermal comfort range.
- For 79% of this period the temperature is within the adaptive thermal comfort range.

Living room afternoon

According to the thermal comfort standard:

- For 29% of this period the temperature is above the adaptive thermal comfort range.
- For 71% of this period the temperature is within the adaptive thermal comfort range.

Living room evening

According to the thermal comfort standard:

- For 28% of this period the temperature is above the adaptive thermal comfort range.
- For 72% of this period the temperature is within the adaptive thermal comfort range.

Bedroom lunch

According to the thermal comfort standard:

- For 2% of this period the temperature is above the adaptive thermal comfort range
- For 98% of this period the temperature is within the adaptive thermal comfort range.

Bedroom afternoon

According to the thermal comfort standard:

- For 14% of this period the temperature is above the adaptive thermal comfort range.
- For 86% of this period the temperature is within the adaptive thermal comfort range.

Bedroom night

According to the thermal comfort standard:

- For 7% of this period the temperature is above the adaptive thermal comfort range.
- For 93% of this period the temperature is within the adaptive thermal comfort range.

The occupants of the MH2 occupied the living room in the morning, lunch period, afternoon and evening and they feel slightly warm during this period of time according to their responses about the living room. The thermal environmental conditions prevailing in the living room during this period of time are acceptable due to the heating system operating in the living room.

The bedroom was occupied by the inhabitants during the afternoon and during the night for sleeping; the occupant's responses about the bedroom indicated that during the afternoon and night they were slightly warm; so the thermal environmental conditions prevailing in the bedroom are acceptable during this period of time.

Neutral

Bedroom morning

According to the thermal comfort standard:

- For 0% of this period the temperature is above the adaptive thermal comfort range
- For 100% of this period the temperature is within the adaptive thermal comfort range

The bedroom was occupied in the early morning for sleeping and the inhabitants feel comfortable during this time of the day. As seen above, for 100% of this period the temperature is within the adaptive thermal comfort range. The thermal environmental conditions prevailing in the bedroom are comfortable during this period of time. The bedroom of MH2 provides good thermal conditions.

Garden lunch

According to the thermal comfort standard:

- For 20% of this period the temperature is above the adaptive thermal comfort range.
- For 80% of this period the temperature is within the adaptive thermal comfort range.

The occupants sometimes occupied the garden in winter during the warm and sunny days, and according to the occupant's responses, in the garden during lunch they feel comfortable during this period of time.

Cold:

Garden morning

According to the thermal comfort standard:

- For 6% of this period the temperature is above the adaptive thermal comfort range.
- For 94% of this period the temperature is within the adaptive thermal comfort range.

The garden was used by the occupants sometimes in the morning and the occupant's responses indicated that during this period of time they were cold. The occupants feel very uncomfortably cold in the garden during the morning. Although for 94% of this period the temperature is within the adaptive thermal comfort range the occupants still feel uncomfortably cold, particularly in the early morning.

6.4. ANALYTICAL COMPARISON BETWEEN TRADITIONAL AND MODERN HOUSES FOR SUMMER AND WINTER MEASUREMENTS

The criteria for comparing the microclimate and internal thermal environmental condition of the habitable rooms and spaces of two types of houses are that:

- The habitable rooms should be located at the same floor level, i.e. at the ground floor level, first floor level or second floor level.

Unfortunately this is not achievable as some of the habitable rooms and spaces of the traditional house and modern house are located at different floor levels. For example the living room (Ursi) of the traditional courtyard house is located at the first floor level while the living room of the modern house is located at the ground floor level.

- The compared houses should have the same cooling or air conditioning system or be running naturally in summer and have the same heating system in winter.

  In this case, one of the compared traditional houses has no air cooling system and the other is serviced by an air cooling system. The compared modern houses have the same air conditioning systems. Also the traditional courtyard houses have paraffin heaters but the modern houses have the electric heating.

However, it is argued that the comparison remains informative in that comparison between the objective data – monitoring and the subjective data – thermal comfort diaries of occupants will still provide relevant and useful findings to this research.

A comparison between houses of the same type. **Undertaken here**

The habitable rooms and spaces of the traditional courtyard houses have been compared with each other and the habitable rooms and spaces of the modern houses have been compared with each other.

A comparison between houses of different types. **Undertaken here**

The habitable rooms and spaces of the traditional houses have been compared with the habitable rooms and spaces of the modern houses. Courtyards and the roof terraces of the traditional houses have been compared with the gardens and roof terrace of the modern houses.

6.5. COMPARISON BETWEEN THE HOUSES OF THE SAME TYPE

6.5.1. Summer Measurement

6.5.1.1. *Traditional houses*

The living room of both traditional courtyard houses were occupied by the inhabitants all the day in the morning, lunch, afternoon and evening. The air temperature of the living room and bedroom for both houses was stable during the monitoring period with slight difference.

Table 6.49. **Comparison of living room and bedroom in TH1 and TH2**

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Living room**	32°C	34°C	30°C	29.7%	37.31%	22.2%
TH2	**Living room**	24.5°C	27°C	22° C	42.35%	56.0%	28.7%
TH1-TH2		***7.5°C***	***7°C***	***8°C***	***-12.65%***	***-18.7%***	***-6.5%***
TH1	**Bedroom**	35.5°C	36°C	34°C	33.55%	31%	16.1%
TH2	**Bedroom**	23°C	29°C	17°C	48.8%	68.4%	29.2%
TH1-TH2		***12.5°C***	***11°C***	***17°C***	***-14.4%***	***-37.4%***	***-13.1%***

Living room/Bedroom TH1–TH2

The living room temperature in TH2 is approximately 7°C–8°C lower than that found in TH1; this is due to the presence of air cooling in TH2 while TH1 is a free-running building. The humidity is affected by air cooling and is consistently higher in TH2 than in TH1 3.5°C (-18.7% & -6.5%). The temperature in the bedroom in TH1 is approximately 12.5°C higher than that found in TH2. The humidity in TH2 is affected by air cooling and is consistently higher in TH2 than that found in TH1 (-37.4% & -13.1%).

Table 6.50. **The occupant's responses during different times of the day**

TH1–TH2	Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00–7:00)
TH1	**Living room No Air cooling**	**Slightly warm**	**Slightly warm**	**Slightly warm**	**Neutral**	**Not occupied**
TH2	**Living room Air cooling**	**Neutral**	**Neutral**	**Cool**	**Cool**	**Not occupied**
TH1	**Bedroom No Air cooling**	**Slightly warm**	**Not occupied**	**Slightly warm**	**Not occupied**	**Not occupied**
TH2	**Bedroom Air cooling**	**Neutral**	**Not occupied**	**Cool**	**Not occupied**	**Not occupied**

The occupants of TH1 feel a neutral temperature to be an average of 32.2°C with a maximum of 34.3°C and a minimum of 30.7°C as found in the living room in the evening. While those in TH2 consider an average neutral temperature to lie between 24.2°C & 25.9°C, with a maximum of 27.8°C and minimum of 22.9°C as found in the living room in the morning and at lunch.

The occupants of TH1 feel a slightly warm temperature to be an average of 32.2°C with a maximum of 34.3°C and minimum of 30.7°C as found in the living room in morning, lunch and afternoon and a slightly warm temperature to be an average of 35.5°C with maximum 36°C and minimum 34°C as found in bedroom morning and afternoon.

The occupants of TH2 feel a cool temperature to be an average of 24.5°C with maximum of 27°C and minimum 22°C as found in the living room afternoon and evening and also found in the bedroom during the afternoon due to the presence of air cooling in TH2.

The air temperature of the roof terrace for both houses is higher than the average temperature of the courtyard**.**

Table 6.51. Comparison of the courtyard and roof terrace in TH1 and TH2

Space		**Temperature (°C)**			**Humidity (%)**		
		Average	**Max**	**Min**	**Average**	**Max**	**Min**
TH1	**Courtyard**	32°C	37°C	27°C	27.4%	39.0%	15.7%
TH2	**Courtyard**	39.0°C	48.0°C	30.0°C	22.5%	35.2%	9.7%
TH1-TH2		***-7°C***	***-11°C***	***-3°C***	***4.9%***	***3.8%***	***6%***
TH1	**Roof terrace**	37.0°C	49.0°C	25°C	24.41%	41.0%	7.8%
TH2	**Roof terrace**	40.5°C	50.0°C	31°C	51.8%	32.7%	19.1%
TH1-TH2		***-3.5°C***	***-1°C***	***-6°C***	***-27.4%***	***8.3%***	***-11.3%***

Courtyard/Roof terrace TH1–TH2

The courtyard temperature in TH1 is approximately -7°C lower than that found in TH2. The maximum humidity for the courtyard in TH1 is higher than in TH2 (3.8%). The average temperature on the roof terrace in TH1 is approximately -3.5°C lower than that found in TH2. The maximum humidity in TH1 is higher than that found in TH2 by 8.3%.

Table 6.52. The occupant's responses during different times of the day

TH1-TH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	Courtyard N/A	Hot	Not occupied	Hot	Neutral	Not occupied
TH2	Courtyard N/A	Hot	Not occupied	Hot	Neutral	Not occupied
TH1	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool
TH2	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool

The occupants of TH1 feel a hot temperature to be an average of 32°C with a maximum of 37°C and a minimum of 27°C, as found in the courtyard morning and afternoon. The occupants of TH2 feel a hot temperature to be an average of 39°C with a maximum of 48°C and a minimum of 30°C, as found in the courtyard morning and afternoon.

The occupants of TH1 feel a cool temperature to be 37°C with a maximum of 49°C and a minimum of 25°C, the minimum temperature as found in the roof terrace at night. However, the occupants of TH2 feel a cool temperature to be an average of 40.5°C with a maximum of 50°C and minimum of 31°C, the minimum temperature as found on the roof terrace during the night.

6.5.1.2. *Modern houses*

Table 6.53. Comparison of the living room and bedroom in MH1 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
MH1	Living room	26.5 °C	28°C	25°C	54.9%	74.8%	35.0%
MH2	Living room	27°C	29°C	25°C	47.7%	61.1%	34.3%
MH1-MH2		*-0.5°C*	*-1°C*	*0°C*	*7.2%*	*13.7 %*	*0.7%*
MH1	Bedroom	27.5°C	29°C	26°C	50.1%	65.2%	35.0%
MH2	Bedroom	28.5°C	30°C	27°C	45.45%	61.5%	29.4%
MH1-MH2		*-1°C*	*-1°C*	*-1°C*	*4.65 %*	*3.7%*	*5.6 %*

Living room/Bedroom MH1–MH2

The living room temperature in MH1 is approximately -0.5°C lower than that found in MH2. The humidity in MH1 is affected by air conditioning and is consistently higher than in MH2 (13.7%–0.7%). In the bedroom the temperature in MH2 is approximately -1°C higher than that found in MH1. The humidity in MH1is higher than that found in MH2 (3.7%–5.6%).

Table 6.54. The occupant's responses during different times of the day

MHI-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
MH1	Living room A/C	Cool	Cool	Cool	Cool	Not occupied
MH2	Living room A/C	Neutral	Neutral	Neutral	Cool	Not occupied
MH1	Bed-room A/C	Neutral	Not occupied	Neutral	Not occupied	Not occupied
MH2	Bed-room A/C	Neutral	Not occupied	Neutral	Not occupied	Not occupied

The occupants of MH1 feel a cool temperature to be an average of 26.5°C with a maximum of 28°C and a minimum of 25°C as found in the living room in the morning, lunch, afternoon and evening. However, the occupants of MH2 feel a neutral temperature to be an average of 27°C with a maximum of 29°C and a minimum of 25°C as found in the living room in the morning, lunch and afternoon and they feel a cool temperature as found in the living room in the evening.

The occupants of MH1 feel a neutral temperature to be an average of 27.5°C with a maximum of 29°C and a minimum of 26°C as found in the bedroom in the morning and afternoon. The occupants of MH2 feel a neutral temperature, as well, to be an average of 28.5°C with a maximum of 30°C and a minimum of 27°C as found in the bedroom in the morning and afternoon.

Table 6.55. Comparison of garden and the roof terrace inMH1 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
MH1	Garden	34°C	40°C	28°C	33.5%	53.1%	13.0%
MH2	Garden	34°C	40°C	28°C	33.5%	53.1%	13.0%
MH1-MH2		*0°C*	*0°C*	*0°C*	*0%*	*0 %*	*0%*
MH1	Roof terrace	33°C	38°C	28°C	32%	47.8%	16.2%
MH2	Roof terrace	33°C	38°C	28°C	32%	47.8%	16.1%
MH1-MH2		*0° C*	*0°C*	*0°C*	*0 %*	*0%*	*0 %*

Garden/Roof terrace MH1–MH2

The garden and roof terrace temperatures in MH1 and MH2 are the same with average, maximum and minimum. The garden and roof terrace humidity in MH1 and MH2 are the same, as well, with the average, maximum and minimum; this is because MH1 and MH2 are located very close to each other and as a result they have the same microclimate factors.

Table 6.56. The occupant's responses during different times of the day

MHI-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
MH1	Garden N/A	Neutral	Not occupied	Not occupied	Neutral	Not occupied
MH2	Garden N/A	Neutral	Not Occupied	Not occupied	Neutral	Not occupied
MH1	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool
MH2	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Neutral

The occupants of MH1 and MH2 feel a neutral temperature to be an average of 34°C with a maximum of 40°C and a minimum of 28°C, as found in the garden of MH1 and MH2 in the morning and evening. The occupants of MH1 feel a cool temperature to be an average of 33°C with a maximum of 38°C, and a minimum temperature of 28°C, as found on the roof terrace in the night. However, the occupants of MH2 feel a neutral temperature exists on the roof terrace at night, although the MH2 has the same average, maximum and minimum temperatures as found in MH1. The minimum temperature of 28°C is found on the roof terrace during the night for both houses.

6.6. COMPARISON BETWEEN HOUSES OF DIFFERENT TYPES

6.6.1. Summer Measurements

6.6.1.1. *Traditional houses and modern houses*

Both type of houses, the traditional courtyard houses and modern houses, are located in the same neighbourhood and have been monitored environmentally during the summer and winter periods; the measurements recorded the air temperature and relative humidity every five minutes for a period of two weeks. The microclimate of the traditional houses and modern houses has been taken to be the thermal environmental conditions prevailing on the roof terrace at the first or second floor.

The air temperature and relative humidity in the shade have been recorded by the equipment (loggers); such measurements are also recorded in the courtyard at the traditional courtyard house and in the garden at the modern house.

Table 6.57. Comparison of living room and bedroom in TH1 and MH1

Space		Temperature (^{0}C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Living room**	32°C	34°C	30°C	29.7%	37.31%	22.2%
MH1	**Living room**	26.5°C	28°C	25°C	54.9%	74.8%	35.0%
TH1-MH1		***5.5°C***	***6°C***	***5°C***	***-25.2 %***	***-37.4%***	***-12.8 %***
TH1	**Bedroom**	35.5°C	36°C	34°C	33.55%	31%	16.1%
MH1	**Bedroom**	27.5°C	29°C	26°C	50.1%	65.2%	35.0%
TH1-MH1		***8°C***	***7°C***	***8°C***	***-16.5%***	***-34.2 %***	***-18.9%***

Living room/Bedroom TH1–MH1

The living room temperature in MH1 is approximately 5.5°C lower than that found in TH1; this is due to the presence of air conditioning in MH1 while the TH1 is a free-running building. The humidity is affected by air conditioning and is consistently higher in MH1 than in TH1 (-37.4% & -12.8%). The temperature in MH1 is approximately 8°C lower than that found in TH1; this is due to air conditioning operating in the bedroom in MH1. The humidity in MH1 is affected by the air conditioning; it is approximately higher that that found in TH1 (-34.2% & -18.9%).

Table 6.58. TH1 and MH1 occupants' responses during different times of the day

TH1-MH1	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	Living room No air cooling	Slightly Warm	Slightly Warm	Slightly Warm	Neutral	Not occupied
MH1	Living room A/C	Cool	Cool	Cool	Cool	Not occupied
TH1	Bedroom No air cooling	Slightly Warm	Not occupied	Slightly Warm	Not occupied	Not occupied
MH1	Bedroom A/C	Neutral	Not occupied	Neutral	Not occupied	Not occupied

The occupants of TH1 feel a slightly warm temperature to be an average of 32°C with a maximum of 34°C and a minimum of 30°C, as found in the living room in the morning, lunch and afternoon; this is due to the TH1 being a free- running building with just ceiling fans in operation. Also they feel a neutral temperature exists in the living room in the evening. However, the occupants of MH1 feel a cool temperature to be an average of 26.5°C with a maximum of 28°C and a minimum 25°C, as found in the living room in the morning, lunch, afternoon and evening; this is due to the air conditioning in operation in the living room.

In the bedroom, the occupants of TH1 feel a slightly warm temperature to be an average of 35.5°C with a maximum of 36°C and a minimum of 34°C, as found in the bedroom in the morning and afternoon. While the occupants of MH1 feel a neutral temperature to be an average of 27.5°C with a maximum of 29°C and a minimum of 26°C.

Table 6.59. Comparison of courtyard and garden in TH1 and MH1

Space		Temperature (^{0}C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	Courtyard	32°C	37°C	27°C	27.4%	39.0%	15.7%
MH1	Garden	34°C	40°C	38°C	33.5%	53.1%	13.0%
TH1-MH1		*-2°C*	*-3°C*	*-11°C*	*-6.1%*	*-14.1%*	*2.7%*
TH1	Roof terrace	37.0°C	49.0°C	25°C	24.41%	41.0%	7.8%
MH1	Roof terrace	33°C	38°C	28°C	32%	47.8%	16.2%
TH1-MH1		*4 °C*	*11°C*	*-3°C*	*-7.59%*	*-6.8%*	*-8.4%*

Courtyard/Garden-Roof terrace TH1–MH1

The garden temperature in MH1 is approximately -2°C higher than that found in the courtyard of TH1. The courtyard of TH1 has a fountain to reduce the intense heat during the summer. The roof terrace temperature in TH1 is approximately 4°C higher than that found in MH1, while the humidity is consistently lower in TH1 that that found in MH1 (-6.85% & -8.4%).

Table 6.60. TH1 and MH1 occupants' responses during different times of the day

TH1-MH1	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	Courtyard N/A	Hot	Not occupied	Hot	Neutral	Not occupied
MH1	Garden N/A	Neutral	Not occupied	Not occupied	Neutral	Not occupied
TH1	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool
MH1	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool

The occupants of TH1 feel a hot temperature to be an average of 32°C with a maximum of 37°C and a minimum of 27°C, as found in the courtyard in the morning and afternoon and feel a neutral temperature exists in the courtyard during the evening. The occupants of MH1 feel a neutral temperature to be an average of 34°C with a maximum of 40°C and a minimum of 38°C, as found in the garden in the morning and evening.

The occupants of the TH1 feel a cool temperature to be an average of 37.0°C with a maximum of 49°C and a minimum of 25°C, as found on the roof terrace; the minimum temperature has been recorded in the roof terrace during the night. The occupants of MH1 feel a cool temperature to be an average of 33°C with a maximum of 38°C and a minimum of 28°C, as found on the roof terrace; the minimum temperature has been recorded in the roof terrace during the night.

Table 6.61. Comparison of the living room and bedroom of TH2 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	**Max**	**Min**	**Average**	**Max**	**Min**
TH2	**Living room**	24.5°C	27°C	22°C	42.35%	56.0%	28.7%
MH2	**Living room**	27°C	29°C	25°C	47.7 %	61.1 %	34.3%
TH2-MH2		***-2.5°C***	***-2°C***	***-3°C***	***-5.35%***	***5.1%***	***-5.6 %***
TH2	**Bedroom**	23°C	29°C	17°C	48.8%	68.4%	29.2%
MH2	**Bedroom**	28.5°C	30°C	27°C	45.45%	61.5%	29.4%
TH2-MH2		***-5.5°C***	***-1°C***	***-10°C***	***-3.35%***	***6.9%***	***-0.2%***

Living room/Bedroom TH2–MH2

The living room temperature in MH2 is approximately -2.5°C higher than that found in TH2. The TH2 is serviced by an air cooling system and MH2 is serviced by an air conditioning system. The humidity is affected by air conditioning and is consistently higher in MH2 than in TH2 (5.1% & -5.6%).

The bedroom temperature in MH2 is consistently approximately -5.5°C higher than that found in TH2, while the humidity is consistently higher in TH2 than in MH2 (6.9% & -0.2%).

Table 6.62. **TH2 and MH2 occupants' responses during different times of the day**

TH2-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH2	Living room Air cooling	Neutral	Neutral	Cool	Cool	Not occupied
MH2	Living room A/C	Neutral	Neutral	Neutral	Cool	Not occupied
TH2	Bedroom Air cooling	Neutral	Not occupied	Cool	Not occupied	Not occupied
MH2	Bedroom A/C	Neutral	Not occupied	Neutral	Not occupied	Not occupied

The occupants of TH2 feel a neutral temperature to be an average of 24°C with a maximum of 27°C and a minimum of 22°C, as found in the living room in the morning and lunch and also they do feel a cool temperature as found in the living room during the afternoon and evening; the neutral and cool temperatures are due to the air cooling system in the living room. However, the occupants of MH2 feel a neutral temperature to be an average of 27°C with a maximum of 29°C and a minimum of 25°C, as found in the living room in the morning, lunch and afternoon and they feel a cool temperature as found in the living room in the evening.

The occupants of TH2 feel a neutral temperature to be an average of 23°C with a maximum of 29°C and a minimum of 17°C, as found in the bedroom in the morning and feel a cool temperature as found in the bedroom in the afternoon. However, the occupants of MH1 feel a neutral temperature as found in bedroom in the morning and afternoon.

Table 6.63. Comparison of courtyard/garden and roof terrace in TH2 and MH2

Space		Temperature (℃)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH2	Courtyard	39℃	48℃	30°C	22.45%	35.2%	9.7%
MH2	Garden	34℃	40℃	28℃	33.5%	53.1%	13.0%
TH2-MH2		*5°C*	*8°C*	*2°C*	*-11.05%*	*-17.9%*	*-3.3%*
TH2	Roof terrace	40.5℃	50℃	31℃	25.9%	32.7%	19.1%
MH2	Roof terrace	33℃	38℃	28℃	32%	53.1%	13.0%
TH2-MH2		*7.5°C*	*12°C*	*3°C*	*-6.1%*	*-20.4%*	*6.1%*

Courtyard/Garden-Roof terrace TH2–MH2

The courtyard temperature in TH2 is approximately 5°C higher than that found in the garden of MH2. The humidity in the courtyard in TH2 is lower than that found in the garden in MH2; the humidity in TH2 is affected by the fountain in the courtyard which reduces the intense heat and increases the humidity.

The temperature on the roof terrace in TH2 is approximately 7.5°C higher than that found in MH2; that is due to the roof terrace floor receiving direct sunlight. The maximum humidity in TH2 is consistently -20.4% lower than in MH2.

Table 6.64. TH2 and MH2 occupants' responses during different times of the day

TH2-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH2	Courtyard N/A	Hot	Not occupied	Hot	Neutral	Not occupied
MH2	Garden N/A	Neutral	Not occupied	Not occupied	Neutral	Not occupied
TH2	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Cool
MH2	Roof terrace N/A	Not occupied	Not occupied	Not occupied	Not occupied	Neutral

While occupying the roof terrace overnight, the occupants of TH2 feel a cool temperature to be an average of 40.5°C with a maximum of 50°C and a minimum of 31°C; the minimum temperature has been recorded on the roof terrace during the night. However, the occupants of MH2 feel a neutral temperature to be an average of 33°C with a maximum of 38°C and a minimum of 28°C; the minimum temperature has been recorded on the roof terrace during the night.

6.7. COMPARISON

Living room TH1–TH2

As the occupants of TH1 and TH2 feel slightly warm, neutral and cool – all considered to be comfortable – it can be seen that the living room in both TH1 (free running) and TH2 (air cooling) can be seen to be comfortable and to perform well. It must be noted however that TH1 is considered to provide comfort with no active system, only ceiling fans operating throughout the day. Therefore the energy required to achieve comfort would be substantially lower in this context. Both living rooms in TH1 and TH2 performed well in summer.

Bedroom TH1-TH2

The occupants of TH1 feel slightly warm temperature in the bedroom during the morning and afternoon but they considered these to be acceptable thermal conditions with ceiling fans operating in the bedroom. The bedroom of TH2 provides the occupants with neutral and cool temperatures in the morning due to the air cooling operating in the bedroom and provides the occupants with comfortable thermal conditions. Both bedrooms in TH1 and TH2 performed well in summer.

Courtyard TH1–TH2

Both courtyards in TH1 and TH2 provide the occupants with hot temperatures, particularly in the morning and afternoon during the first and second temperature peaks of the day and as a result the thermal environmental conditions prevailing in the shade in the courtyard in both TH1 and TH2 are uncomfortably hot. But there are comfortable thermal conditions in the evening in TH2. Both courtyards have not performed well during the day.

Roof terrace TH1–TH2

The roof terraces in TH1 and TH2 provide the occupants with neutral and cool temperatures during the night when the occupants are using the roof terrace for sleeping. Both roof terraces in TH1 and TH2 performed well in the night.

Living room MH1–MH2

The living room of MH1 provides the occupants with a cool temperature during the day and the living room of MH2 provides the occupants with a neutral temperature and all may be considered as comfortable. The air conditioning operates in the bedroom of MH1 and MH2 to provide the occupants with comfortable thermal conditions. Both living rooms in MH1 and MH2 performed well in the summer.

Bedroom MH1–MH2

With air conditioning in the houses, the bedrooms in both houses MH1 and MH2 provide the occupants with neutral temperatures and may be considered as a comfortable thermal conditions during the occupation period. Both bedrooms performed well in the summer

Garden MH1–MH2

The occupants in the gardens in both MH1 and MH2 experience neutral temperatures in the morning and evening when the inhabitants occupy the garden. Both gardens in MH1 and MH2 are providing the occupants with comfortable thermal conditions.

Roof terrace MH1–MH2

The roof terrace of MH1 provides the occupants with a cool temperature during the night while the roof terrace of MH2 provides the occupants with a neutral temperature, all of which may be considered as comfortable for the occupants. Both roof terraces in MH1 and MH2 provide the occupants with comfortable thermal conditions and both performed well in the night during the summer.

6.8. COMPARISON BETWEEN HOUSES OF THE SAME TYPE

6.8.1. Winter Measurement

6.8.1.1. *Traditional houses*

The inhabitants of the traditional courtyard houses have used a different living room during the winter period. This living room called the Ursi room is considered as a winter room; the Ursi living room is located at first floor level and it is also used during the cool periods of spring and autumn.

Table 6.65. Comparison of the Ursi room and bedroom of TH1 and TH2

Space		Temperature (^{0}C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Ursi room**	21°C	24°C	18°C	42.2%	58.7%	25.7%
TH2	**Ursi room**	21°C	23°C	20°C	50.7%	67.7%	33.8%
TH1-TH2		***0°C***	***1°C***	***-2°C***	***-8.5%***	***-9%***	***-8.1%***
TH1	**Bedroom**	21°C	26°C	15°C	45.4%	61.5%	29.4%
TH2	**Bedroom**	21°C	23°C	20°C	55.1%	79.1%	31.0%
TH1-TH2		***0°C***	***3°C***	***-5°C***	***-9.7 %***	***-17.6 %***	***-1.6%***

Ursi room/Bedroom TH1–TH2

The Ursi room average temperature in TH1 and TH2 is the same level of 21°C; this is due to the use of heating during the day in both Ursi rooms. The humidity is affected by the heating and is consistently higher in TH2 than in TH1 (-9% & -8.1%).

The average temperatures in the bedroom of TH1 and TH2 are the same level; the temperatures in both bedrooms are stable. The humidity is affected by the heating in TH2 and is consistently higher in TH2 than in TH1 (-17.6% & -1.6%).

Table 6.66. TH1 and TH2 occupants' responses during different times of the day

TH1-TH2	Space	Morning (7:00- 12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	**Ursi room Paraffin heating**	**Slightly warm**	**Neutral**	**Neutral**	**Neutral**	**Not occupied**
TH2	**Ursi room Paraffin heating**	**Slightly warm**	**Neutral**	**Neutral**	**Neutral**	**Not occupied**
TH1	**Bedroom Paraffin heating**	**Cold**	**Not occupied**	**Slightly warm**	**Not occupied**	**Neutral**
TH2	**Bedroom Paraffin heating**	**Slightly warm**	**Not occupied**	**Neutral**	**Not occupied**	**Neutral**

The occupants of TH1 feel a neutral temperature to be an average of 21°C with a maximum of 24°C and a minimum of 15°C, as found in the Ursi room in the lunch, afternoon and evening and consider a slightly warm temperature to be found in the morning. The occupants of TH2 feel a neutral temperature to be an average of 21°C with a maximum of 23°C and a minimum of 20°C as found in the Ursi room in lunch, afternoon and evening and have received a slightly warm temperature as found in the morning.

The occupants of the TH1 feel cold, slightly warm and neutral temperatures to exist in the bedroom with an average of 21°C and a maximum of 26°C and a minimum of 15°C, as found in the bedroom in the morning, afternoon and night. The occupants of TH2 feel slightly warm and neutral temperatures to be an average of 21°C with a maximum of 23°C and a minimum of 20°C, as found in the bedroom morning, afternoon and night. The heating was operating during the inhabitants' occupation.

Table 6.67. Comparison of the courtyard in TH1 and TH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Courtyard**	13.5°C	20°C	7°C	57.7%	96.1%	19.4%
TH2	**Courtyard**	17.5°C	26°C	9°C	58.6%	97.9%	19.4%
TH1-TH2		***-4°C***	***-6°C***	***-2°C***	***-0.9%***	***-1.8 %***	***0 %***

Courtyard TH1–TH2

The courtyard temperature of TH2 is approximately -4°C higher than that found in TH1; this is due to the presence of heating in TH2. The humidity is affected by the heating and the average humidity in TH2 is higher than in TH1 by -0.9%.

Table 6.68. TH1 and TH2 occupants' responses during different times of the day

TH1-TH2	Space	Morning (7:00-11:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	**Courtyard N/A**	**Cold**	**Neutral**	**Not occupied**	**Not occupied**	**Not occupied**
TH2	**Courtyard N/A**	**Cold**	**Neutral**	**Not occupied**	**Not occupied**	**Not occupied**

The occupants of TH1 feel cold and neutral temperatures to be an average of 13.5°C with a maximum of 20°C and a minimum of 7°C as found in the courtyard during the morning and lunch. The occupants of TH2 feel cold and neutral temperatures to be an average of 17.5°C with a maximum of 26°C and a minimum of 9°C, as found in the courtyard during the morning and lunch. The cold temperatures for both houses were due to the presence of cloud and high humidity and the neutral temperatures of both houses were recorded during sunny days.

6.8.1.2. *Modern houses*

The thermal environmental conditions prevailing in the living room of MH1 is comfortable during the morning, lunch and acceptable during the afternoon and evening.

Table 6.69. Comparison of the living room and bedroom of MH1 and MH2

Space		Temperature (^{0}C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
MH1	**Living room**	20°C	25°C	16°C	45.41%	57.0%	33.8%
MH2	**Living room**	21°C	24°C	17°C	36%	47.2%	24.8%
MH1-MH2		***-1°C***	***1°C***	***-1°C***	***9.41%***	***9.8%***	***9%***
MH1	**Bedroom**	20°C	23°C	17°C	42.8%	51.4%	34.2%
MH2	**Bedroom**	21°C	24°C	18°C	41.9%	53.2%	30.7%
MH1-MH2		***-1°C***	***-1°C***	***-1°C***	***0.9%***	***-1.8%***	***3.5%***

Living room/Bedroom MH1-MH2

The average temperature of the living room in MH1 is approximately -1°C lower than that found in MH2 while the humidity in MH2 is affected by the heating system and is consistently lower than that found in MH1 (9.8%–9%).

The temperature in the bedroom of MH2 is approximately 1°C higher than that found in MH1 and the average humidity of MH2 is lower than that found in MH1 (0.9%).

Table 6.70. MH1 and MH2 occupants' responses during different times of the day

MH1-MH2	Space	Morning (7:00–12:00)	Lunch (12:00–14:00)	Afternoon (14:00–18:00)	Evening (18:00–22:00)	Night (22:00–7:00)
MH1	Living room Heating system	Neutral	Neutral	Slightly warm	Slightly warm	Not occupied
MH2	Living room Heating system	Slightly warm	Slightly warm	Slightly warm	Slightly warm	Not occupied
MH1	Bedroom Heating system	Slightly warm	Not occupied	Neutral	Not occupied	Slightly warm
MH2	Bedroom Heating system	Neutral	Not occupied	Slightly warm	Not occupied	Slightly warm

The occupants of MH1 feel neutral and slightly warm temperatures to be an average of 20°C with a maximum of 25°C and a minimum of 16°C, as found in the living room during the morning, lunch, afternoon and evening the slightly warm temperatures are due to the heating system operating during this period of time. The occupants of MH2 feel a slightly warm temperature to be an average of 21°C with a maximum of 24°C and a minimum of 17°C, as found in the living room in the morning, lunch, afternoon and evening due to the operation of the heating system.

The occupants of MH1 feel slightly warm and neutral temperatures to be an average of 20°C with a maximum of 23°C and a minimum of 17°C as found in the bedroom morning, afternoon and night. The occupants of MH2 feel slightly warm and neutral temperatures to be an average of 21°C with a maximum of 24°C and a minimum of 18°C as found in the bedroom during the morning, afternoon and night.

Table 6.71. Comparison of the garden and roof terrace of MH1 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
MH1	Garden	16.5°C	25°C	8°C	49.0%	80.0%	18.1%
MH2	Garden	16°C	25°^{0}C	7°^{0}C	49.2%	82.0%	16.4%
MH1-MH2		*0.5°C*	*0°C*	*1°C*	*-0.2 %*	*-2 %*	*1.7 %*

Garden MH1-MH2

The average temperature in the garden of MH1 is approximately 0.5°C higher than the average temperature in MH2. The humidity in the garden of both houses was at almost the same level with a slight difference (-2% & 1.7%).

Table 6.72. MH1 and MH2 occupants' responses during different times of the day

MH1 MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
MH1	Garden N/A	Cold	Neutral	Not occupied	Not occupied	Not occupied
MH2	Garden N/A	Cold	Neutral	Not occupied	Not occupied	Not occupied

The occupants of MH1 feel cold and neural temperatures to be an average of 15.5°C with a maximum of 25°C and a minimum of 8°C as found in the garden during the morning and lunch. The occupants of MH2 feel cold and neutral temperatures, as well, to be an average of 16°C with a maximum of 25°C and a minimum of 7°C, as found in the garden during the morning and lunch.

6.9. COMPARISON BETWEEN HOUSES OF DIFFERENT TYPES

6.9.1. Winter Measurements

69.1.1. *Traditional houses and modern houses*

The microclimate of both traditional courtyard houses and modern houses has been taken to be the thermal environmental conditions prevailing in the roof terrace at first or second floor.

The air temperature and relative humidity in the shade have recorded by the equipment (loggers); such measurements are also recorded in the courtyard at the traditional courtyard house and in the garden at the modern house.

Table 6.73. **Comparison of the Ursi/living room and bedroom of TH1 and MH1**

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Ursi room**	21°C	24°C	18°C	42.2%	58.7%	25.7%
MH1	**Living room**	20.5°C	25°C	16°C	45.4%	57.0%	33.8%
TH1-MH1		***0.5°C***	***-1^{o0}C***	***2°C***	***-3.2 %***	***1.7 %***	***-8.1%***
TH1	**Bedroom**	21°C	26°C	15°C	45.4%	61.5%	29.4%
MH1	**Bedroom**	20°C	23°C	17°C	42.8%	51.4%	34.2%
TH1-MH1		***1°C***	***3°C***	***-2°C***	***2.6%***	***10.1 %***	***-4.8 %***

Ursi room/Living room-Bedroom TH1-MH1

The average temperature of TH1 is approximately 0.5°C higher than that found in MH1, and the average humidity in MH1 is consistently higher than that found in TH1 -3.2%.

The temperature in the bedroom of TH1 is consistently higher than that found in MH1 due to the use of heating, while the humidity in MH1 is affected by the heating and is consistently lower than that found in TH1 (10.1%).

Table 6.74. **TH1 and MH1 occupants' responses during different times of the day**

TH1-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	Ursi room Paraffin heating	Slightly warm	Neutral	Neutral	Neutral	Not occupied
MH1	Living room Heating system	Neutral	Neutral	Slightly warm	Slightly warm	Not occupied
TH1	Bedroom Paraffin heating	Cold	Not occupied	Slightly warm	Not occupied	Neutral
MH1	Bedroom Heating system	Slightly warm	Not occupied	Neutral	Not occupied	Slightly warm

The occupants of TH1 feel neutral and slightly warm temperatures to be an average of 21°C with a maximum of 24°C and a minimum of 18°C, as found in the Ursi room in the morning, lunch, afternoon and evening. The occupants of the MH1 feel neutral and slightly warm temperatures, as well, to be an average of 20.5°C with a maximum of 25°C and a minimum of 16°C, as found in the living room morning, lunch, afternoon and evening; the slightly warm temperatures in both houses are due to the use of heating.

The occupants of TH1 feel cold, slightly warm and neutral temperatures to be an average of 21°C with a maximum of 26°C and a minimum of 15°C, as found in the bedroom morning, afternoon and night. The occupants of MH1 feel slightly warm and neutral temperatures to be an average of 20°C with a maximum of 23°C and a minimum of 17°C, as found in the bedroom morning, afternoon and night.

Table 6.75. Comparison of courtyard/garden and roof terrace of TH1 and MH1

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH1	**Courtyard**	13.5°C	20°C	7°C	57.7%	96.1%	19.4%
MH1	**Garden**	15.5°C	25°C	8°C	49.0%	80.0%	18.1%
TH1-MH1		***-2°C***	***-5°C***	***-1°C***	***8.7 %***	***16.1 %***	***1.3 %***

Courtyard/Garden TH1–MH1

The garden temperature in MH1 is approximately -2°C higher than that found in the courtyard in TH1. The humidity in the garden in MH1 is consistently lower than that found in the courtyard in TH1 due to the presence of the cloud during the cold days.

Table 6.76. TH1 and MH1 occupants' responses during different times of the day

TH1-MH1	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH1	**Courtyard N/A**	**Cold**	**Neutral**	**Not occupied**	**Not occupied**	**Not occupied**
MH1	**Garden N/A**	**Cold**	**Neutral**	**Not occupied**	**Not occupied**	**Not occupied**

The occupants of TH1 feel cold and neutral temperatures to be an average of 13.5°C with a maximum of 20°C and a minimum of 7°C. as found in the courtyard in the morning and lunch. The occupants of MH1 feel a cold and neutral temperature to be an average of 15.5°C with a maximum of 25°C and a minimum of 8°C, as found in the garden in the morning and lunch; the minimum temperatures are recorded during the cold days in both houses.

Table 6.77. Comparison of Ursi/living room and bedroom of TH2 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH2	**Ursi room**	21°C	23°C	20°C	50.7%	67.7%	33.8%
MH2	**Living room**	21°C	24°C	17°C	36 %	47.2 %	24.8 %
TH2-MH2		***0°C***	***1°C***	***3°C***	***14.7%***	***25.5 %***	***9%***
TH2	**Bedroom**	21°C	23°C	20°C	55.1%	79.1%	31.0%
MH2	**Bedroom**	21°C	24°C	18°C	41.9%	53.2%	30.7%
TH2-MH2		***0°C***	***1°C***	***2°C***	***13.2 %***	***25.9%***	***0.3%***

Ursi room/Living room-Bedroom TH2-MH2

The maximum temperature of TH2 is approximately 1°C lower than that found in MH2; the average humidity in MH2 is affected by heating and is consistently lower than that found in TH2 (25.5%–9%).

The maximum temperature in the bedroom of TH2 is approximately 1°C lower than that found in MH2, while the minimum temperature in TH2 is higher than that found in MH2. The humidity in MH2 is affected by the heating and is consistently lower than that found in TH2 (25.9%–0.3%).

Table 6.78. TH2 and MH2 occupants' responses during different times of the day

TH1-MH2	Space	Morning (7:00- 12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00- 22:00)	Night 22:00-7:00)
TH2	Ursi room Paraffin heating	Slightly warm	Neutral	Neutral	Neutral	Not occupied
MH2	Living room Heating system	Slightly warm	Slightly warm	Slightly warm	Slightly warm	Not occupied
TH2	Bedroom Paraffin heating	Slightly warm	Not occupied	Neutral	Not occupied	Neutral
MH2	Bedroom Heating system	Neutral	Not occupied	Slightly warm	Not occupied	Slightly warm

The occupants of TH1 feel neutral and slightly warm temperatures to be an average of 21°C with a maximum of 23°C and a minimum of 20°C, as found in the Ursi room in TH2. The occupants of MH2 feel slightly warm temperatures to be an average of 21°C with a maximum of 24°C and a minimum of 17°C, as found in the living room in the morning, lunch, afternoon and evening.

The occupants of TH2 feel neutral and slightly warm temperatures to be an average of 21°C with a maximum of 23°C and a minimum of 20°C, as found in the bedroom morning, afternoon and night. The occupants of MH2 feel slightly warm and neutral temperatures to be an average of 21°C with a maximum of 24°C and a minimum of 18°C, as found in the bedroom morning, afternoon and night.

Table 6.79. Comparison of courtyard/garden and roof terrace of TH2 and MH2

Space		Temperature (°C)			Humidity (%)		
		Average	Max	Min	Average	Max	Min
TH2	Courtyard	17.5°C	26°C	9°C	58.65%	97.9%	19.4%
MH2	Garden	16°C	25°C	7°C	49.2%	82.0%	16.4%
TH2-MH2		*1.5°C*	*1°C*	*2°C*	*9.45 %*	*15.9%*	*3 %*

Courtyard/Garden TH2–MH2

The courtyard temperature in TH2 is approximately 1.5°C higher than that found in the garden of MH2. The maximum humidity in TH2 is consistently higher than in MH2 (15.9%).

Table 6.80. TH2 and MH2 occupants' responses during different times of the day

TH2-MH2	Space	Morning (7:00-12:00)	Lunch (12:00-14:00)	Afternoon (14:00-18:00)	Evening (18:00-22:00)	Night (22:00-7:00)
TH2	Courtyard N/A	Cold	Neutral	Not occupied	Not occupied	Not occupied
MH2	Garden N/A	Cold	Neutral	Not occupied	Not occupied	Not occupied

The occupants of TH2 feel cold and neutral temperatures to be an average of 17.5°C with a maximum of 26°C and a minimum of 9°C, as found in the courtyard during the morning and lunch. The occupants of MH2 feel cold and neutral temperatures to be an average of 16°C with a maximum of 25°C and a minimum of 7°C, as found in the garden during the morning and lunch. The minimum temperatures of the courtyard and garden have been recorded in the coldest day of the monitoring period and the neutral temperatures of the courtyard and garden have been recorded during the sunny days.

6.10. COMPARISON

Ursi room/Living room TH1-MH1

The Ursi room of TH1 provides the occupants with a neutral temperature during the day and this be considered to be comfortable thermal conditions. The living room of MH1 provides the occupants with neutral and slightly warm temperatures during the day and all are considered comfortable for the occupants. The Ursi room in TH1 and living room in MH1 provide the occupants with comfortable thermal conditions and both performed well in winter.

Bedroom- TH1-MH1

The bedroom in TH1 provides the occupants with cold, slightly warm and neutral temperatures during the day and night; the uncomfortably cold thermal conditions in the bedroom during the morning are due to the room receiving a cold air from outside as the bedroom opens directly onto the courtyard and there is a possibility of heat loss and cold gain. The bedroom in MH1 provides the occupants with slightly warm and neutral temperatures during the day, all considered to be comfortable for the occupants.

Courtyard/Garden TH1-MH1

Both the courtyard of TH1 and the garden of MH1 provide the occupants with cold and neutral temperatures in the morning and during lunch. Both courtyard and garden provide the occupants with very uncomfortable cold thermal conditions in the morning and with comfortable conditions in the lunch period.

Ursi room/Living room TH2-MH2

As the slightly warm and neutral temperatures are all to be considered comfortable, the Ursi room of TH2 provides the occupants with comfortable conditions during the day in winter. The living room of MH2 provides the occupants with a slightly warm temperature during the day and as a result the living room provides acceptable thermal conditions to the occupants. Both Ursi room and living room performed well in the winter.

Bedroom TH2-MH2

The bedrooms in TH2 and MH2 provide the occupants with slightly warm and neutral temperatures during the day and night. Both bedrooms in both TH2 and MH2 provide the occupants with comfortable thermal conditions and both performed well.

Courtyard/Garden TH2-MH2

The courtyard of TH2 and the garden of MH2 provide the occupants with cold and neutral temperatures during the morning and lunch. The courtyard of TH2 and the garden of MH2 provide the occupants with very uncomfortable thermal conditions in the morning but they do provide the occupants with comfortable thermal conditions in the lunch during the warm and sunny days.

6.11. CONCLUSION

General information follows about the results of the traditional courtyard houses and modern houses in terms of the summer and winter measurements.

6.11.1. Summer Measurement

6.11.1.1 *Traditional houses*

In general the habitable rooms and spaces such as the living rooms and bedrooms of both traditional houses are providing the occupants with comfortable thermal conditions and they performed well in the summer

The courtyards of both traditional houses did not perform well during the morning and afternoon; the thermal environmental conditions prevailing in the shade in the courtyard are uncomfortably hot during this period of time, particularly in the first and second peaks of the day. This is due to the floor area of the courtyard receiving direct sunlight during this time of the day. But, the courtyards of both traditional houses provided the occupants with comfortable conditions in the evening; they performed adequately.

The roof terraces of both traditional houses are providing the occupants with comfortable thermal conditions during the night. They performed well in the night in summer.

6.11.1.2. *Modern houses*

The living rooms of both modern houses performed well during the day under the air conditioning system. The thermal environmental conditions prevailing in the living room of MH1 are very comfortable and comfortable for the MH2 in the morning, lunch and afternoon and very comfortable in the evening.

The bedrooms of both modern houses provide comfortable thermal environmental conditions in the morning and in the afternoon during the afternoon siesta,

The gardens of both modern houses did not perform well in the late morning, lunch and afternoon according to the recorded measurements during this period of times. The thermal environmental conditions prevailing in the shade in the garden are very uncomfortably hot during the lunch and afternoon particularly during the first and second peaks of the day, but there are comfortable thermal environmental conditions in the early morning and in the evening. The gardens performed adequately.

The roof terraces of both modern houses performed well during the night when the occupants use the roof terrace for sleeping in the night.

Table 6.81. Comparison of findings of traditional and modern houses in summer

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Summer	
Living room		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well
Roof terrace	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well

6.11.2. Winter Measurement

6.11.2.1. *Traditional houses*

In general the habitable rooms and spaces which are designated for winter habitation such as living rooms (Ursi) and bedrooms performed well. The Ursi rooms in both traditional houses provided the occupants with comfortable thermal conditions during the day and they performed well in winter. The thermal environmental conditions prevailing in the bedroom of TH1 are acceptable in the afternoon and comfortable in the evening and the thermal environmental conditions prevailing in the bedroom of TH2 are acceptable in the morning and comfortable in the afternoon and evening. The bedrooms performed well in winter.

The courtyards of both traditional houses did not perform well during the day, particularly in the early morning providing the occupants with very uncomfortable thermal conditions in the morning, but there are comfortable thermal environmental conditions during the warm and sunny days. They performed adequately.

6.11.2.2. Modern houses

In general the living rooms in both modern houses provided the occupants with comfortable thermal conditions during the day and they performed well during the winter.

The bedrooms of both modern houses also provided the occupants with comfortable thermal conditions during the day and night. They performed well in winter.

The gardens of both modern houses did not perform well during the day, particularly in the early morning and they provided the occupants with very uncomfortable thermal conditions in the morning, but there are comfortable thermal environmental conditions during the warm and sunny days. They performed adequately.

Table 6.82. Comparison of findings of the traditional and modern houses in winter

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Winter	
Living room Ursi room for traditional house Winter		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Does not perform well	Does not perform well
Roof terrace	**Day**	Performs well	Performs well
	Night	Does not perform well	Does not perform well

CHAPTER VII

PHASE 3 DISCUSSION- OPTIMAL DESIGN STRATEGIES

7.1. INTRODUCTION

This chapter presents a synthesis of findings from the previous two phases of this research in order to inform the development of an appropriate set of optimal design strategies. This will enable response to the final research objective 5:

- ***Establish appropriate design strategies that are responsive to the socio-cultural and environmental context to inform a 'modern vernacular style' for housing in Baghdad.***

To date the research presented has aimed to achieve the following:

Phase 1:

- Identification of the architectural, environmental and socio-cultural characteristics of traditional and modern houses.
- Understanding of the socio-cultural performance and responsiveness of both types of buildings.

Phase 2:

- Evaluation of occupant comfort, satisfaction and thermal performance of traditional and modern houses in Baghdad.

The findings from Chapters II, IV and VI have informed an emerging understanding of the current performance of the two types of housing, traditional and modern, in terms of selected environmental and socio-cultural factors. This chapter will now apply those findings in order to identify optimal design elements that will be combined with findings from the literature to inform guidelines for future optimal design strategies for a modern vernacular in domestic design in Iraq.

7.2. SOCIO-CULTURAL AND ENVIRONMENTAL PERFORMANCE COMPARISON (Traditional Houses & Modern Houses)

The following table presents a summary of the comparison between the findings for the traditional and modern house types from the results of phase1 of this research.

Table 7.1. Comparison of findings for traditional and modern houses

Factors	Traditional House	Modern House
Socio-Cultural Factors	**Completely achieved**	**Not achieved**
Economic Factors	**Completely achieved**	**Partially achieved**
Neighbourhood Factors	**Partially achieved**	**Partially achieved**
Architectural Factors	**Enable**	**Not Enable**
Services Factors	**Partially achieved**	**Achieved**
Environmental Factors (Summer)	**Achieved**	**Not achieved**
Environmental Factors (Winter)	**Mostly achieved**	**Partially achieved**

It can be seen that the findings from phase 1 of this research established that the traditional house continues to respond effectively to the socio-cultural, economic and architectural factors as well as, to a lesser extent, the summer and winter environmental factors. Also, it has been found that the traditional house is partially effective in its design response to neighbourhood and services factors. However, the modern house design was found to be less effective in its response to socio-cultural, architectural and summer environmental factors, though the modern design is partially effective in responding to economic, neighbourhood and winter environmental factors and effective in its design response to services factors.

The following table presents a summary of the comparison between the findings for the traditional and modern house types from the results of phase 2 for the summer measurement of this research.

Table 7.2. Comparison of findings for traditional and modern houses in summer

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Summer	
Living Room		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well
Roof Terrace	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well

The following table presents a summary of the comparison between the findings for the traditional and modern house types from the results of phase 2 for the winter measurement of this research.

Table 7.3. Comparison of findings for traditional and modern houses in winter

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Winter	
Living Room/Ursi Room		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Does not perform well	Does not perform well
Roof Terrace	**Day**	Performs well	Performs well
	Night	Does not perform well	Does not perform well

It has been found from the investigation that the internal spaces in both the traditional and the modern house have a good thermal performance during both the summer and winter. However, while the traditional house has also been found to be able to deliver internal comfort levels in the absence of air conditioning in TH1, the modern houses relied on this service to achieve thermal comfort. It can be suggested that the passive strategies integrated into the traditional house should therefore be studied further in order that they might be integrated into design guidance for a new modern vernacular for Iraq.

Further, it can be seen that the external spaces of both house types perform well at night in the summer, but that designs could perhaps be improved for both to enable occupant comfort in the daytime in the summer. While the performance of the external spaces of the traditional house perform well during the day in the winter, the modern house performs adequately during the day at this time of the year.

The next stage of this work will therefore explore each group of factors in turn, evaluating the findings of the research to date and supplementing these findings with research findings from literature together with relevant passive design strategies in order to inform and propose a systematic collection of optimal design strategies for this context.

7.3. OPTIMAL DESIGN STRATEGIES

This research has identified a range of factors, which have been presented in the earlier chapters, to be considered in the optimal design strategies. The most important factors to be considered and used to inform the optimal design strategies are the socio-cultural and environmental factors. The socio-cultural factors are a set of largely traditional characteristics, identified through investigation and analysed earlier in the context of literature and from the perspective of the occupants of both house types. In addition there are economic, neighbourhood, architectural and services factors that should be considered. These can be summarised as follows:

Socio-Cultural Factors – Privacy	Economic Factors:
• Entrance • Outside spaces • Internal privacy between genders • Privacy for outside sleeping spaces Services Factors • Sanitation • Site drainage • Waste services • Water services • Other services/kitchen	• Low land cost • Low construction cost • Low running cost Architectural Factors • Functional programme of use • Seasonal programme of use Neighbourhood factors • Compact/walkable access to services • Friendship • Access to vehicles

For the environmental factors, these largely focus on factors that influence the thermal performance and therefore thermal comfort of the occupants of the houses. The following strategies are relevant in this context:

Environmental Factors

- Urban planning
- External space
- Dust storms
- Seasonal usage of spaces
- Thermal mass
- Basement rooms

7.4. FINDINGS OF PHASE 1 RESULTS: BUILDINGS/OCCUPANTS

7.4.1. Socio-Cultural Factors

Through the analysis of traditional and modern houses, the optimal design in terms of socio-cultural factors will be established. There are a range of sub-factor considerations under the socio-cultural category, while privacy from the public realm can be seen as the overarching factor to be adopted in informing contextually appropriate domestic design:

Table 7.4. Comparison of findings for traditional and modern houses

Socio-Cultural Factors Privacy	**Traditional House**	**Modern House**
Entrance	Satisfied	Not satisfied
Outside Spaces	Satisfied	Not necessarily satisfied
Internal Privacy Between Genders	Satisfied	Not necessarily satisfied
Privacy for Outside Sleeping Spaces	Satisfied	Not satisfied due to detailed design concerns
	Completely achieved	**Not achieved**

Traditional house: As presented in Chapter IV, in plan the traditional courtyard house typically consists of a courtyard which is located in the centre of the house and the habitable rooms and spaces face inwards – towards the courtyard. The inhabitants consider the courtyard is private open space where their daily activities can take place without overlooking by neighbours and passers-by, while the alleyway is a public space.

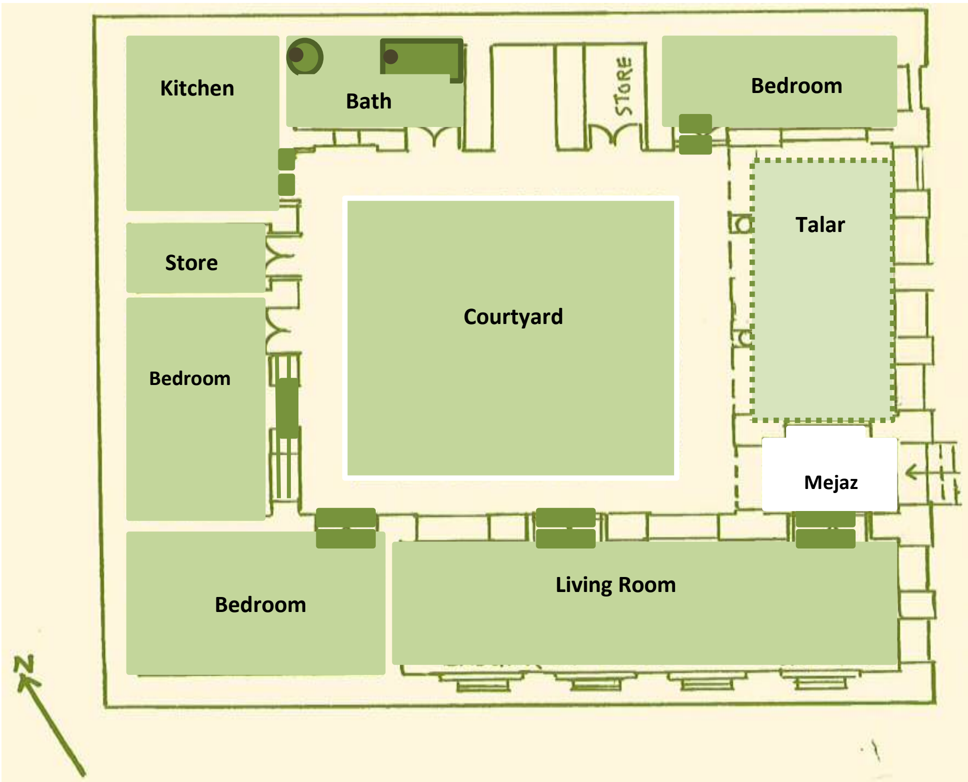


Fig.7.1. Ground floor level plan of the selected traditional courtyard house. Scale: 1:50

Modern house: As presented in Chapter IV, the habitable rooms and spaces of the modern house typically look outward – towards the garden or at the road.

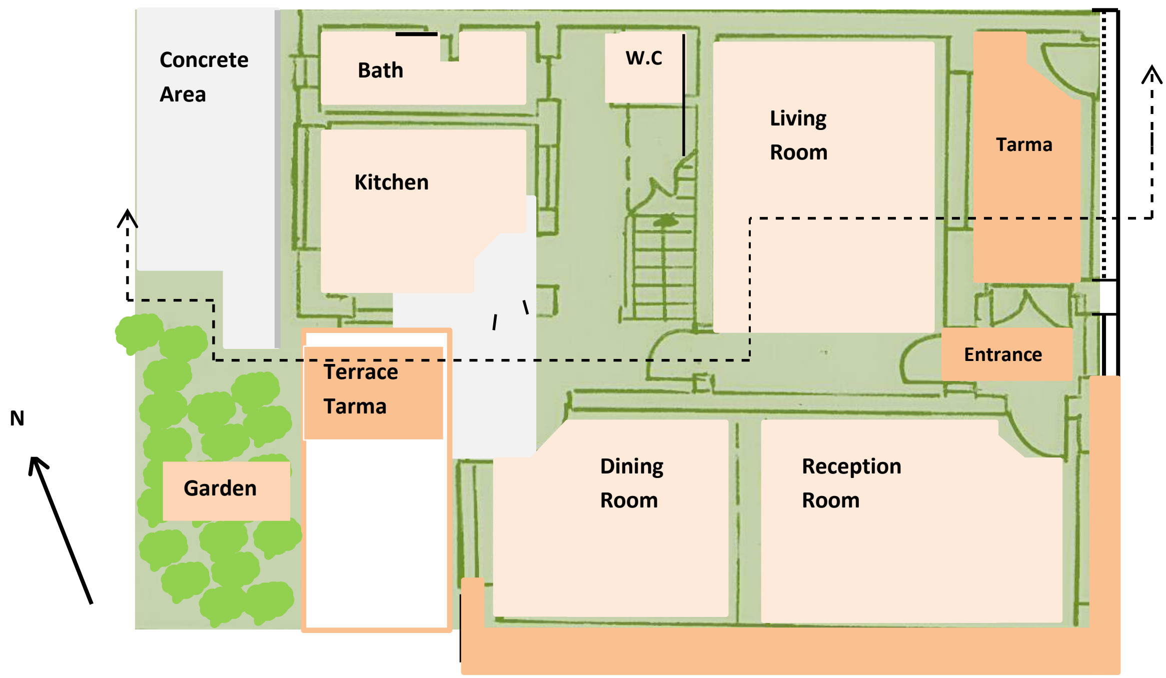


Fig. 7.2. Ground floor level plan of the selected modern house. Scale: 1:100

7.4.1.1. ***Entrance design providing privacy***

Traditional house: The traditional house incorporates an entrance lobby (Mejaz) which comprises the front door and the threshold to the house; a Mejaz is itself a transition space between the public and private zones and doorways lead to the interior of the house. The visitors enter the house through a doorway directly to the reception room or colonnade gallery (Talar) without overlooking the inhabitants while they are in the living room or courtyard; the inhabitants enter the living room through a separate door. Thus the entrance lobby (Mejaz) provides effective separation between the public exterior and the private interior.

The entrance lobby (Mejaz) provides the inhabitants of the traditional house with complete privacy when they use the habitable rooms and spaces even without overlooking or intrusion by visitors. Also when they use the courtyard for their daily activities the courtyard provides the inhabitants with complete privacy because the external walls are high enough to prevent overlooking by neighbours and passers-by.

Further, the traditional houses have been built in groups and this has further enabled the inhabitants of these houses to have a direct social connection between each other.

Modern house: There is no entrance lobby (Mejaz) at the modern house; it incorporates the front open space (Tarma) and the entrance hall which leads to the interior of the house. The visitors enter the reception/dining rooms directly from outside through the open space (Tarma) and the inhabitants enter the living room (Hall) from the same place through the (Tarma) as well.

Discussion

It has been found from the investigation and literature that in the traditional house the entrance lobby (Mejaz) provides the inhabitants with complete privacy by preventing overlooking by the visitors who enter the house through the front door leading directly from the alleyway through the entrance lobby (Mejaz) when the inhabitants used the living room.

It has been found from the investigation and literature that in the modern house the inhabitants and the visitors enter the house from the same entrance through the front open space (tarma) and the entrance hall directly to the inside of the house. This entrance does not provide the inhabitants with privacy.

So the researcher considers the entrance lobby (Mejaz) of the traditional house should be applied to the optimal design strategies as the Mejaz provides the inhabitants with complete privacy.

Optimal Design Strategy

When designing the entrance into the housing, the following should be considered for both the occupants of the house and for visitors. The occupants must be provided with complete privacy from the public realm when people are entering or leaving the property. The entrance design should also support the design response to the requirements for gender privacy throughout the house.

7.4.1.2. ***Outside spaces***

Traditional house: The traditional houses have incorporated an absolutely private outdoor space (courtyard) which is enclosed but open to the sky. The researcher has found that the design of the traditional house around a central courtyard provides the inhabitants with the privacy they require when used for daily activities and for social gatherings.

The traditional house satisfies the absolute need of its inhabitants for complete privacy by preventing overlooking by passers-by and by neighbours of the family domain, particularly in cases where the habitable rooms and spaces have been used by the female inhabitants.

Also, it has to be mentioned here that in addition to the use of the courtyard and the inwards-looking habitable rooms and spaces, the house has only one external elevation overlooking the alleyway, so the only area for overlooking by passers-by and by neighbours has been reduced; it is restricted to the façade. Openings on this façade are limited to the upper floor(s) to further reduce potential for overlooking.

Modern house: The modern house incorporates a garden and this is the only outside open space and is not private. The modern house does not satisfy the inhabitants' need for complete privacy from overlooking by passers-by and neighbours.

Discussion

So what has been found from the investigation and literature is that the courtyard of the traditional house provides the inhabitants with privacy by preventing overlooking by neighbours and passers-by when they use it for daily activities and social gatherings. On the other hand, it has been found that the modern house has the garden as its only open space and it is not private and does not provide the inhabitants with privacy by preventing overlooking by neighbours and passers-by.

Optimal Design Strategy

The researcher would suggest the courtyard to be applied to the optimal design as the courtyard has satisfied the absolute need of the inhabitants for the socio-cultural factors. The concept of the courtyard would be useful in the future ideal house. Also the future ideal house can have the front garden as well with the courtyard as the aim of the optimal design is to satisfy the socio-cultural needs of its inhabitants.

When designing the external walls of the ideal house, they should be high enough to prevent overlooking by neighbours and passers-by. Ideally no windows should be designed to face the public realm. The traditional external walls would be useful to be applied to the optimal design strategies.

7.4.1.3. Internal privacy between genders

Traditional house: The traditional house incorporates habitable rooms and spaces which have been designed to receive visitors, particularly adult male visitors who are not related to the family, such as a reception room at the ground floor level or a habitable room that incorporates a bay window (shanashil) which is located at the first floor level. Culturally this separation is important. The habitable room which has been designed for the winter habitation is the winter room (Ursi) which is located at the first floor level and has been used by the inhabitants, particularly the female inhabitants during the day. This space is also used to receive visitors, particularly the female inhabitants' visitors.

Modern house: At the modern houses the reception/dining rooms have been designed to receive visitors for both male and female inhabitants. In the modern houses there are no habitable rooms and spaces which have been designed particularly for receiving adult male visitors, as the reception room which is located at the ground floor level has been designed to receive both adult male and female visitors.

Discussion

So what has been found from the investigation and literature is that the traditional house has habitable rooms and spaces designed particularly to receive visitors, especially adult male visitors; these rooms could be a reception room at ground floor level and a (shanashil) room in the upper floor level. And also it has been found that the modern house has a reception/dining room at the ground floor level to receive visitors for both male and female inhabitants and there are no habitable rooms and spaces designed especially to receive adult male visitors.

Optimal Design Strategy

The researcher would suggest that the optimal design should have habitable rooms and spaces which are designed particularly for receiving visitors. In particular, the optimal design should be provided with habitable rooms and spaces designed especially for adult male visitors' use.

It can be seen that the design strategies that respond to the socio-cultural factors are almost entirely informed by the traditional houses. The characteristics of the modern house do not respond to the cultural requirements for privacy and so the researcher does not consider that such aspects should be included in optimal design strategies.

7.4.1.4. Privacy for outside sleeping spaces

Traditional house: During the summer the inhabitants use the roof terrace as a sleeping area during the night and this roof terrace provides them with absolute privacy that is due to its parapet wall being high enough to prevent overlooking by neighbours.

As has been found by the researcher, the inhabitants of the traditional houses feel very secure in their roof terrace when they use it as a sleeping area during the summer because that have been provided with privacy

Modern house: During the summer the inhabitants of the modern house use the roof terrace as a sleeping area during the night and this roof terrace does not provide them with complete privacy as the parapet wall is not high enough to prevent overlooking by neighbours.

Discussion

So what has been found from the investigation and literature is that the traditional roof terrace provides the inhabitants with complete privacy when they used it for sleeping in the night during the summer. On the other hand, it has been found that the modern roof terrace does not provide the inhabitants with complete privacy when they used it for sleeping in the night during the summer. Also it has been found from the investigation that the inhabitants of the traditional house feel very secure in their roof terrace but has been found is the inhabitants of the modern house feel fairly insecure in their roof terrace.

Optimal Design Strategy

The other suggestions of the researcher to meet socio-cultural requirements is that the characteristics of the roof terrace in the traditional house should be applied to the optimal design strategies as these characteristics have provided the inhabitants with absolute privacy.

When designing the roof terrace in the ideal house the parapet wall should be high enough to prevent overlooking by neighbours; the appropriate height depends on height and proximity of neighbours.

7.4.1.5. Proposed socio-cultural design strategies

The researcher suggests that with regard to the socio-cultural factors, the future ideal house should satisfy the inhabitants' needs by enabling their absolute privacy indoors when they use habitable rooms and spaces; outdoors when they use the outdoor spaces for their daily activities and for social gatherings; and also when they use the roof terrace as a sleeping area overnight during the summer.

It is suggested that the following features would be useful in meeting socio-cultural requirements in Baghdad and should be applied to the optimal design strategies.

Table 7.5. Informing socio-cultural strategies

Strategy	Source(s) informing strategy		
	Traditional House	**Modern House**	**Literature**
Entrance providing privacy to occupants	X		
Outside spaces providing privacy to occupants	X		
Prevention of overlooking by neighbours and passers-by	X		
Privacy when using outside sleeping spaces	X		
Internal privacy between genders	X		

7.4.2. Economic Factors

Through analysis of the traditional and modern houses, the optimal design in terms of economic factors will be established. There are a range of sub-factors under the economic factors which have been considered by the researcher to inform the optimal design strategies:

Table 7.6. Comparison of findings for traditional and modern houses

Economic Factors	Traditional House	Modern House
Low Land Cost	**Completely achieved**	**Not achieved**
Low Construction Cost	**Completely achieved**	**Not achieved**
Low Running Cost	**Completely achieved**	**Partially achieved**

Also the energy bills for the traditional and modern houses have been considered by the researcher and identified through the investigation. It is important to be noted here that as the traditional houses started to be built in the nineteenth century there is no evidence about costs involved with building regarding the land cost, construction cost and running cost.

7.4.2.1. ***Low land cost***

Traditional house: It was established within this research that the traditional house has been built in a small plot, typically in the region of 100 $m^{2.}$ The traditional house covers the whole plot area and results in an internal courtyard with the habitable rooms and spaces looking inwards – towards the courtyard.

Modern house: In contrast the modern house does not cover the whole plot area; it has been built partially on the plot and the rest left as a garden and such house is expensive to build. The inhabitants have suggested during questionnaire feedback conducted during the research that it would be possible to use the extra land for a green zone to increase the humidity during the summer.

Discussion

So what has been found from the investigation and literature is because the majority of the traditional houses have been built at end of the eighteenth century/beginning of nineteenth century there was no evidence about the land cost; so it is suggested that because the traditional house has been built in a small plot and has covered the whole plot area it has resulted in a low land cost. On the other hand, it has been found that the modern house does not cover the whole plot area and it is expensive to build.

Optimal Design Strategy

The traditional house covers the whole plot area resulting in an internal courtyard with habitable rooms and spaces looking inwards – towards the courtyard and such a house is cheaper to build. The modern house has been built on part of the plot and does not cover the whole plot area with the result that such a house is expensive to build.

When designing the ideal house it should be considered that the house should cover the whole plot area and the first floor level should cover the whole area of the ground floor level; this makes the house cheaper to build.

7.4.2.2. ***Low construction cost***

Traditional house: Because of the layout of the traditional houses which have been built in groups this can result in the public services such as water, drainage and electricity being more economical to install in comparison with the layout of the modern houses. The traditional house consists of two storeys and that makes it more economical to build than the single-storey property with the same number of habitable rooms and spaces.

The researcher has found that because of the use of the small plots of the traditional house this results in less demand on land for houses and alleyways; this leaves more land available for development economically. Feedback from research participants indicates that occupants of the traditional house have suggested they could use the extra land to build other rooms, storage facilities and fitted kitchens. The traditional house covers the whole plot area and has been built wholly two storey which makes the house cheaper to build rather than a partially single-storey house.

Modern house: The other reason that makes the modern house expensive to build is because the first floor level covers only part of the ground floor level and as a result the house is partially single storey. The two-storey house is less expensive than the partially two-storey house for the same floor area.

Discussion

So what has been found from the investigation and literature is that the public services such as water, drainage and electricity are more economical to install in the traditional houses because of the compact layout of these houses. On the other hand, it has been found that modern house has been built partially two storeys or partially single story with the first floor level covering only part of ground floor level and that makes the house expensive to build.

Optimal Design Strategy

When designing the ideal house, the house should be built wholly two storeys and the first floor level should cover the whole area of the ground floor level as this also makes it economical to build.

7.4.2.3. ***Low running cost***

Summer:

Traditional house: The traditional courtyard house has been designed to respond to the hot and dry microclimate conditions prevailing in summer, so the cost of keeping the internal thermal environmental conditions cool and comfortable is likely to be reduced (relatively); the habitable rooms and spaces open directly onto the courtyard.

The researcher has found that the energy bills for the traditional houses are very low for cooling/heating and they are affordable for the inhabitants.

Modern house: The modern house has not been designed to respond to the hot and dry microclimate conditions prevailing in summer and as a result it is likely to be relatively expensive to keep the internal thermal conditions cool and comfortable because the habitable rooms and spaces do not open directly onto the garden

Discussion

It has been found from the research investigation that because the traditional house has a good response to climate conditions to keep the internal conditions comfortable the effect of thermal environmental conditions are reduced. Investigation has also revealed that the external walls of the traditional house are very thick and they are always in the shade, which provides the internal spaces with comfortable thermal environmental conditions. Also, it has been found that the traditional house incorporates a basement level room (Sirdab) which is serviced by a natural ventilation system (Badgir) to provide the inhabitants with comfortable thermal conditions in summer. In addition, it has been found that the energy bills are very low for cooling/heating and they are affordable for the inhabitants. On the other hand, it has been found that because the modern house has no response to the climate conditions it is expensive to keep the internal environmental conditions comfortable; energy bills in modern houses are expensive for cooling/heating but they are affordable for the inhabitants.

So the researcher has found from these factors that the traditional house performs more economically than the modern house and is a good house for energy saving; it would therefore be useful to apply these characteristics to the optimal design strategies.

Optimal Design Strategy

When designing the ideal house it should be taken into consideration that the use of air conditioning in Baghdad is very widespread and the younger generations have grown accustomed to this level of comfort, suggesting that this will continue to be the norm. However, the incorporation of appropriate design strategies that shade the internal environment from the sun would help to reduce the energy usage of such servicing. Further, frequent power outages suggest that the need for houses to function adequately during such times is also necessary.

The traditional houses provide such comfort through passive means, while the modern houses do not. The incorporation of Sirdab-type spaces into the modern houses as well as Badgir natural ventilation would benefit the house in such a situation.

Winter

Traditional house: However the cost of keeping the house warm in winter is not economical for the traditional house as there is more possibility for heat loss with the high proportion of external facing walls. The researcher has found that the energy bills for the traditional houses are very low for cooling/heating and they are affordable for the inhabitants.

Modern house: The results of the research study indicate that it is likely to be relatively cheaper to keep the modern house warm in winter for the same reason, as the habitable rooms and spaces do not open directly to the outside.

Discussion

So what has been found from the investigation is that because all the habitable rooms and spaces of the traditional house open directly onto the courtyard, the cost of keeping the house warm is not economical. On the other hand, because the habitable rooms and spaces of the modern house do not open directly to the outside there is less heat loss and cold gain in winter.

Optimal Design Strategy

When designing the ideal house it has to be considered that the adaption of a more compact form for some of the living areas with enclosed transition spaces between the internal (living spaces) and external spaces (courtyard, garden) would make the future ideal house less expensive to achieve comfort in winter.

7.4.2.4. *Proposed economic design strategies*

The other factors which have been considered are the **economic factors**. The future optimal design aims regarding the economic factors are that the future ideal house should achieve a low land cost, low construction cost and low running cost and should cover the whole building plot. The researcher has suggested that the traditional courtyard house is economical because of the use of small plot which people are able to afford. That means less demand on land for houses and a low stable value of land and even of houses. The researcher has suggested certain factors should be taken into consideration regarding the economic factors applicable to the optimal design strategies and would be useful to be applied to the optimal design.

The optimal design may include different structure and construction techniques and even different materials and also should take advantage of the improved building technology existing in Baghdad. Also, as the researcher has found the modern house is less expensive to warm in winter because all the habitable rooms and spaces do not open directly to the outside, this advantage should be applied to the modern house in the future optimal design to achieve low energy use during the winter.

So the ideal scenario for the optimal design is that the ideal house should have a low land cost and almost cover the whole building site and be less expensive to build. In general the ideal house should satisfy its inhabitants' needs from an economical point of view.

The researcher has suggested that the optimal design must take into the account not just the advantageous characteristics of the traditional house but also the advantageous characteristics of the modern house and also should consider the improved building technology in Baghdad.

It is important that the optimal design is responsive to extreme environments experienced due to the climate in both summer and winter in Baghdad.

Table 7.7. Informing economic strategies

Strategy	Source(s) informing strategy		
	Traditional House	**Modern House**	**Literature**
Low land cost	X		
Low construction cost	X		
Low running cost		X	

7.4.3. Neighbourhood Factors

Through analysis of the neighbourhood of the traditional and modern houses, the optimal design in terms of neighbourhood factors will be established.

A range of neighbourhood sub-factor considerations have been investigated by the researcher to inform the optimal design strategies:

Table 7.8. Comparison of findings for traditional and modern houses

Neighbourhood Factors	Traditional House	Modern House
Compact/Walkable	Completely achieved	Partially achieved
Access to Vehicles/Services	Not achieved	Completely achieved

7.4.3.1. *Compact/walkable*

Traditional house: It has been found from the investigation that the inhabitants of the traditional houses are happy with their neighbourhood as all the shops, markets, schools and even the work places are located within walking distance of the houses. The researcher has found that the inhabitants of the traditional houses know their neighbours; they socialise with them and they visit them frequently.

Modern house: It has been found that the inhabitants of the modern houses are happy with their neighbourhood; they know their neighbours and they socialise with them, although not frequently as the inhabitants of the traditional houses.

Discussion

It has been found from the research investigation that the inhabitants of both traditional and modern houses are happy with their neighbourhood and both know their neighbour and socialise with them. It is therefore suggested that it would be appropriate to apply the mixed characteristics of the traditional and modern neighbourhood to the optimal design strategies

Optimal Design Strategy

When designing the ideal house consideration should be given to the neighbourhood and the distance between the houses and the shops, markets, schools and even places of work. The mixed characteristics from the traditional and modern neighbourhood should be applied.

7.4.3.2 *Access to vehicles/services*

Traditional house: With the traditional houses the car access to the houses is not direct or easy because of the narrow alleyways; also emergency services access such as ambulances are difficult for the same reason.

Modern house: The research study has revealed from the investigation of the modern houses that car access and emergency access to the modern house is easy and direct because of the wide streets.

Discussion

So what has been found from the investigation of the traditional house is that the car access and emergency services access is not possible because of the narrow alleyways. On the other hand, it has been found that the car access and emergency services access to the modern houses is easy and direct because of the wide streets.

Optimal Design Strategy

When designing the ideal house it has to be considered that car access and emergency services access to the house should be easy and direct. It is therefore suggested that the modern neighbourhood characteristics should be applied to the optimal design strategies.

7.4.3.3. *Proposed neighbourhood design strategies*

So the researcher has found that the neighbourhoods of both traditional and modern have advantageous and disadvantageous characteristics.

Table 7.9. Informing neighbourhood strategies

Strategy	Source(s) informing strategy		
	Traditional Houses	**Modern Houses**	**Literature**
Compact/walkable	X		
Access for vehicles/services		X	

7.4.4. Architectural Factors

Through the analysis of the traditional houses and modern houses, the optimal design in terms of further architectural design factors will be established. Many architectural factors have already been established under previous sections, however some remain to be discussed here. The following architectural elements have been considered by the researcher in order to inform the optimal design strategies.

Table7.10. Comparison of findings for traditional and modern houses

Factor		Traditional House	Modern House
Planning		Both housing typologies are capable of providing a response to the requirements in terms of scale and number and type of spaces required	
Basement Spaces		**Provided**	**Not provided**
Seasonal Use of Spaces		**Enabled**	**Not Enabled**
Architectural Factors	***Functional Programme of Use***	**Achieved**	**Achieved**
	Seasonal Programme of Use	**Enabled**	**Not achieved**

As discussed above, the number of habitable spaces and floor to ceiling height should be compared here in order to inform the optimal design strategies.

7.4.4.1. ***Adequate spaces***

Traditional house: The traditional house consists of habitable rooms and spaces which have been designed for summer use such as the basement level room (Sirdab) and semi-basement level room (Neem) which are located underneath the courtyard floor. Also the house consists of the living room and reception and main bedroom. At the first floor level the house consists of the habitable room which is designed for winter use (Ursi) sometimes used as a bedroom; it also consists of the bay window room (Shanashil) and bedrooms.

Modern house: The modern house incorporates the living room and reception/dining rooms which are located at the ground floor level and the bedrooms which are located at the first floor level; some houses have a living room at the first floor level. As mentioned earlier, there are no habitable rooms and spaces designed specifically for summer and winter use.

Discussion

While as mentioned above, the traditional house has rooms set aside for winter and summer habitation, in some cases the habitable winter rooms have been converted into bedrooms as there were insufficient to satisfy the requirements of the household. In such cases the Ursi rooms are considered as multi-purpose rooms

On the other hand, the modern house has no habitable rooms and spaces which have been designed for summer and winter habitation. The modern house has no multi-purpose rooms because it has an adequate numbers of habitable rooms and spaces.

Optimal Design Strategy

When designing the ideal house it has to be considered that the optimal design should have an adequate number of habitable rooms and spaces which satisfy the inhabitants' needs, such as a reception room designed specifically to receive the adult male visitors and also habitable rooms for summer and winter use.

7.4.4.2 ***Floor to ceiling height***

Traditional house: The floor to ceiling height of the ground floor level (3000 mm) is lower than the floor to ceiling height of the first floor level (4500 mm). When the first traditional house was built it had been designed to be serviced naturally, so the habitable rooms and spaces do not need to be installed with ceiling fans at the ground floor level.

Modern house: The floor to ceiling height of the ground floor level (4000 mm) is higher than the floor to ceiling at first floor level (3000 mm); this is due to the use of ceiling fans in the habitable rooms at the ground floor level.

Discussion

It has been found from the investigation of the traditional house that the floor to ceiling height at ground floor level is lower than the floor to ceiling height at first floor level. On the other hand, in the modern house the floor to ceiling height of the ground floor level is higher than the floor to ceiling height at the first floor level that is due to the use of the ceiling fans.

Optimal Design Strategy

When designing the ideal house it has to be considered that the floor to ceiling height at ground floor level should be higher than the floor to ceiling height at first floor level to give the opportunity for installing the ceiling fans.

7.4.4.3. *Proposed architectural design strategies*

This research study has found that both traditional and modern houses have advantageous and disadvantageous characteristics. As mentioned earlier under the Architectural Factors many factors have already established. The following table summarises the findings of the architectural factors.

Table 7.11. Informing architectural strategies

Strategy	Source(s) informing strategy		
	Traditional House	Modern House	Literature
Adequate spaces	X		
Floor to ceiling height	X		

7.4.5. Services Factors

Through analysis of the traditional and modern houses, the optimal design in terms of services design factors will be established to inform the optimal design strategies.

Table 7.12. Comparison of findings for traditional and modern houses

Services Factors	Traditional House	Modern House
Sanitation	Not achieved	Completely achieved
Site Drainage	Not achieved	Partially achieved
Waste Services	Not achieved	Partially achieved
Water Services	Not achieved	Completely achieved
Other Services/Kitchen	Partially achieved	Completely achieved

As has been discussed above, the sanitation and the provision of services should be compared here in order to inform the optimal design strategies.

7.4.5.1. *Sanitation services*

Traditional house: The traditional houses typically have septic tanks which are located inside the house or located in the alleyway.

The inhabitants of the traditional house are not satisfied with the sanitation system in their house because the septic tanks are emptied manually and as result it causes noise and unpleasant smells for them and to the neighbours. The inhabitants of the traditional house are not satisfied with their sanitation system.

Modern House: Modern houses also typically have septic tanks which are located in the main road. The inhabitants of the modern house are satisfied with the sanitation system because their septic tanks are emptied mechanically and do not cause either noise or smells to the inhabitants or to the neighbours.

Discussion

It has been found from the investigation that the inhabitants of the traditional house are not satisfied with their sanitation system because of the inconvenience associated with emptying the septic tanks and these need to be changed to a new system. On the other hand, the inhabitants of the modern house are satisfied with their sanitation system.

Optimal Design Strategy

When designing the ideal house it should be considered that the house should have a septic tank which is emptied mechanically and as a result does not cause noise to the inhabitants and to the neighbours. So the researcher suggests the modern house sanitation system to be applied to the optimal design strategies.

7.4.5.2. ***Site drainage services***

Traditional house: The rainwater gutters on the traditional houses drain off into the alleyways and have been used for the service of water. During the winter, heavy rain pouring from the rainwater gutters causes a build-up of surface water in the alleys giving the inhabitants of traditional houses problems with the surface of the alleyways.

Modern house: The inhabitants of the modern houses have problems associated with unpaved pavements during the summer and winter; they become very dusty in summer and muddy in winter.

Discussion

It has been found from the investigation that the inhabitants of the traditional house have problems with the surface of the alleyways during heavy rain in winter. On the other hand has been found that the inhabitants of the modern house have problems with the unpaved pavements during the summer and winter.

Optimal Design Strategy

When designing the ideal house consideration should be given to the problems with the surface of alleyways in winter and the problems with the unpaved pavements during the summer and during the heavy rain in winter. So the neighbourhood of the optimal design should incorporate paved pavements to avoid problems during the summer and during the heavy rain in winter.

7.4.5.3. ***Waste services***

Traditional house: There is a little availability of public services for the traditional houses, such as public sewers, water drainage and there is a shortage of electricity. With the traditional house the rubbish is kept in the courtyard and the younger generation believed this represents a risk to health.

Modern House: The inhabitants of the modern houses also keep their rubbish in the rear garden and they believe that this represents a risk to the health.

Discussion

It has been found from the investigation that in the traditional houses there is a little availability of public services and also it has been found that the rubbish are kept in the courtyard. On the other hand, with the modern houses the rubbish is kept in the rear garden and the inhabitants believed that this represents a risk to the health.

Optimal Design Strategy

When designing the ideal house it should be considered that the rubbish should be kept in a waste storage area outside the house to avoid a risk to health.

7.4.5.4. ***Water services***

Traditional house: Each house has a cold water tank which located on the roof terrace. As the cold water tank is left exposed on the roof terrace, the water in it is heated by solar radiation during the day in summer; the inhabitants of the traditional houses consider this is an inconvenience for them. The traditional courtyard house incorporates only one water tap which is located in the courtyard, and one the kitchen and bathroom at ground floor and another at first floor level. The inhabitants of the traditional house believed that this system is fairly satisfactory.

Modern house: Each house has a cold water tank which located on the roof terrace; also, the gutters for the modern houses are located in the main road and have been used for the service of water.

As the cold water tank is left exposed on the roof terrace, the water in it is heated by solar radiation during the day in summer; the inhabitants of the modern houses consider this is an inconvenience for them.

Discussion

So what has been found from the investigation of the traditional house is that all the traditional houses have a cold water tank located in the roof terrace and each house has one water tap located in the courtyard and one in the kitchen and bathroom. It has been found that this system fairly satisfies the inhabitants' needs.

All the modern houses have a cold water tank located in the roof terrace; the gutters are located in the main road and have been used for the water services. Through the investigation it has been found that all the modern houses have adequate water taps. This system satisfies the inhabitants' needs.

Optimal Design Strategy

When designing the ideal house it should be considered that the optimal design should incorporate a cold water tank. The researcher suggests that this cold water tank should be covered by cloth to be protected from the sun; it is also recommended that the optimal design should have adequate water taps to satisfy the inhabitants' needs.

7.4.5.5. *Other services*

Traditional house: There is a little availability of public services for the traditional houses such as public sewers, water drainage and there is a shortage of electricity. The research has found that the traditional houses do not have a fitted kitchen. Feedback from questionnaire responses indicate that while the older generation feel that the unfitted kitchen meets their needs, the younger generation tend to disagree.

Modern house: The inhabitants of the modern houses believe that the fitted kitchen provides them with comfort.

Discussion

The research study has been found that in the traditional houses there is little availability of public services. Some points of view believe that the unfitted kitchen of the traditional house does not provide comfort, while on the other hand, the fitted kitchen of modern houses provides the inhabitants with comfort.

Optimal Design Strategy

The researcher suggests that the optimal design should have a fitted kitchen to provide the inhabitants with comfort. Also, there should be a high availability of public services such as electricity, telephone and internet.

7.4.5.6. *Proposed services design strategies*

The researcher has found that both traditional and modern houses have advantageous and disadvantageous characteristics. With regard to the services factors it has been found that the traditional house does not perform well with the sanitation system due to the low availability of public services. It is suggested consideration should be given to the following aspects and applied to optimal design strategies.

Table 7.13. Informing services strategies

Strategy	Source(s) informing strategy		
	Traditional House	Modern House	Literature
Sanitation services		X	
Site drainage services		X	
Waste services		X	
Water services		X	
Other services		X	

7.4.6. Environmental Factors

Environmental performance of the traditional houses and modern houses has been identified and evaluated in Chapter II Literature Review, and also in Chapter IV Phase 1 and Chapter VI Phase 2 from the results of the monitoring and thermal comfort diaries of the occupants of two case study examples of traditional and modern houses for the summer and winter periods.

Through analysis of the traditional and modern houses, the optimal design in terms of internal thermal environmental design factors will be established.

These factors will be considered for the summer and winter periods in turn. Where necessary, discussion of the combination of strategies between the two extreme periods will also be considered in a third section.

7.4.6.1. *Summer environmental factors*

The following table presents the summary of the findings of the summer environmental factors as identified and reviewed in Chapter IV Phase 1 Results, questionnaire analysis section.

Table 7.14. Comparison of findings for traditional and modern houses

Factors	Traditional House	Modern House
Urban Planning	**Satisfied**	**Not satisfied**
External Space	**Satisfied**	**Not satisfied (*Although possible*)**
Dust Storms	**Partially satisfied**	**Not satisfied**
Seasonal Usage of Spaces	**Satisfied**	**Partially satisfied**
Thermal Mass	**Satisfied**	**Not satisfied**
Basement Rooms	**Satisfied**	**N/A**
Natural Ventilation System (Badgir)	**Satisfied**	**N/A**
Summer Environmental Factors	**Achieved**	**Not achieved**

In addition to this finding the following summary of the performance of the monitoring spaces is also of relevance here.

Table.7.15. Comparison of findings for traditional and modern houses in summer

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Summer	
Living Room		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well
Roof Terrace	**Day**	Performs adequately	Performs adequately
	Night	Performs well	Performs well

7.4.6.1.1. *Passive design in a hot-arid context*

In order to inform the strategies to promote low energy, passive thermal performance of house design for optimal performance in this context, it is necessary to analyse the climate.

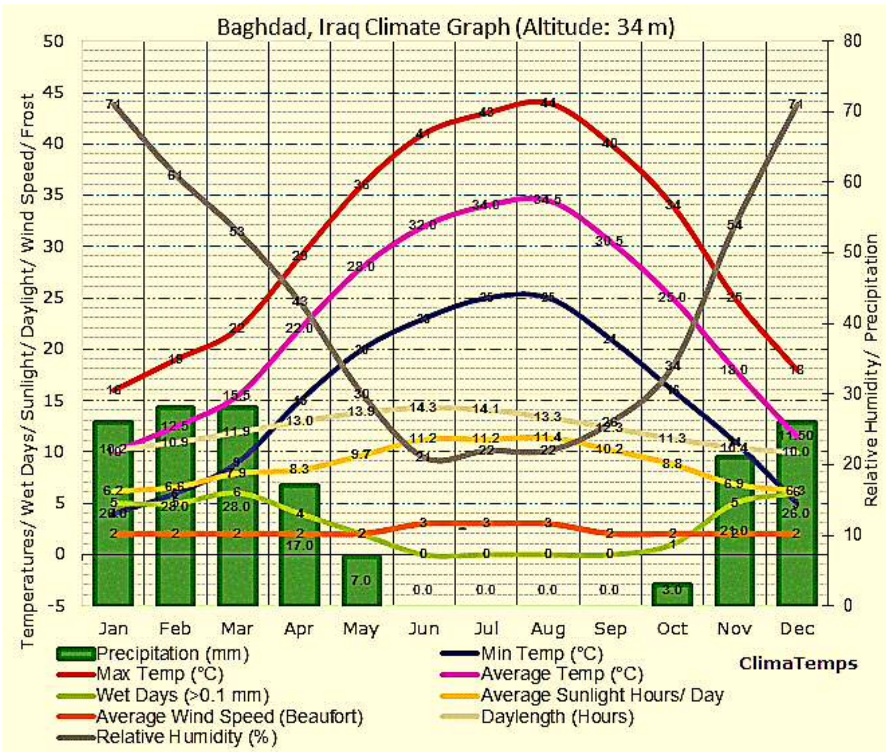


Fig 7.3. The climate in Baghdad, Iraq (Weather Station. Baghdad Airport)

One strategy that is widely applied to inform the selection of appropriate passive design strategies is the bioclimatic chart. The climatic data for the summer months in Baghdad has been plotted on the following bioclimatic chart (**Achard & Gicquel 1986**)

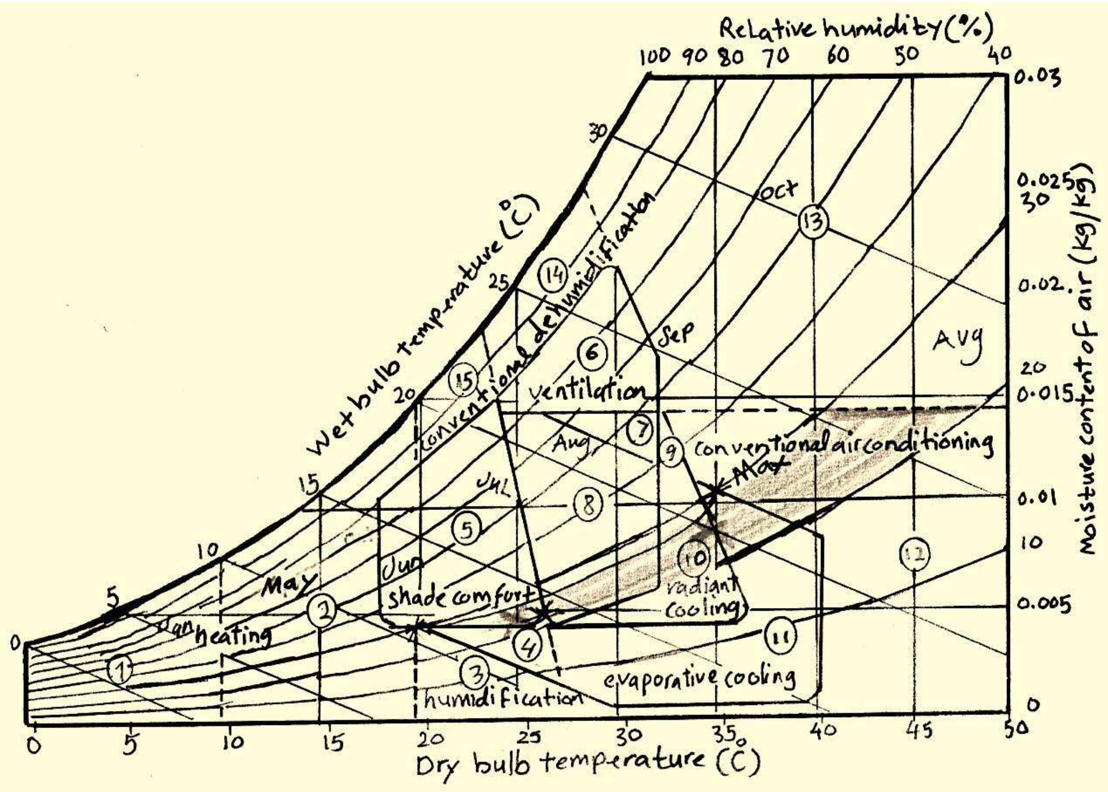


Fig. 7.4. Bioclimatic chart of the climate in Baghdad (Achard & Gicquel 1986)

Thermal Mass

- Shading
- Night-time purge ventilation

Shading: The traditional house has very thick internal walls and they are always in the shade and as a result they provide the internal spaces and the inhabitants with comfortable thermal environmental conditions during the summer. Also the close proximity of neighbouring houses allows houses to protect each other from the sun and intense heat during the summer.

Shading is the first step towards natural cooling house system. Cooling house system is to prevent sun to enter the house during the hot periods in summer. Shading is the first line to protect the house from the intense heat gain. In Iraq's climate the shading is extremely important to avoid the heat gain and unwanted direct sunlight. The shading of the house and outdoor spaces can:

- Reduce summer temperature.
- Improve thermal comfort.
- Saving house energy. (**Al-Musaed 2007**).

Direct sunlight can generate the same heat as a single bar radiator over each square meter of the surface. Shading can up to 90 percent of this heat. The big problem of the sun is a direct sunlight heat and the radiant heat from the sun passes through glass and is absorbed by house elements and furnishing, which then re-radiate it (**Al-Musaed 2007**).

Ventilation: The traditional house has a natural ventilation system (Badgir). The natural ventilation is the most important strategy of the traditional house to get rid of stored heat and provides the inhabitants with comfortable thermal conditions.

The natural ventilation system is considered to be the best way to catch air and bring it inside the house. Usually the Badgir openings are directed towards the prevailing winds in the upper part of the house allowing the cool air to pass into the house in summer and move in the direction of the habitable rooms and spaces though an air duct (shaft) inside the thick walls of the house.

Night-time ventilation: One of the most important natural ventilation solutions that works to cool the house is night-time ventilation. This is more strategic than the other ventilation methods. The house mass is used to keep the air cool during the day; to prevent a large rise of temperature this heat is removed at night when the internal spaces are not used by the inhabitants. This is effected through the large increase in the rate of airflow through the cool air at night and this occurs by the effects of Badgir. The withdrawal of heat from the air at night is due to heat exchange associated with the storage in the mass of the house. Where there is a high flow of cool air at night, the outdoor air temperature is less than the indoor temperature and as result it will be possible to ventilate the house by allowing the air to enter the house and remove the stored heat which is absorbed and stored during the day (**Kamoona 2016**). The aim of considering the ventilation is to provide the inhabitants of the future ideal house with thermal comfort.

Humidifying air: Most of the traditional courtyard houses have fountains in the centre of the courtyard. The function of the fountains is to reduce the intense heat and increase the relative humidity during the summer. The research has found that it is very important for the traditional house to have a fountain, so the fountains would have a good influence on humidifying air and as such would be suggested for consideration in the future ideal house.

It can be seen that these strategies can be combined with the findings from the literature review, questionnaire, observation and monitoring to develop appropriate strategies for this context.

Where the original factors can be combined with passive design strategies they will be discussed here as follows:

Table 7.16. Environmental factors summer strategies

Original Factors	Passive Strategy	Final Strategy
Urban Planning	Shading	Self shading at neighbourhood scale
External Space	Evaporative cooling Shading Night purge ventilation Radiant cooling	External spaces design
Seasonal Usage of Spaces	Shading Thermal mass	Seasonal usage of spaces
Thermal Mass	Integrated into other discussion	
Basement Rooms	Thermal mass Night purge ventilation	Night purge ventilation & thermal mass
Natural Ventilation System (Badgir)	Ventilation	Natural ventilation system (badgir)
Dust Storms	Air tightness	Air tightness

7.4.6.1.2. S*elf shading at neighbourhood scale*

Self Shading

Traditional house: The research has found through the investigation of the traditional houses that the internal walls of the traditional house are very thick and they are always in the shade and as a result they can absorb heat during the day to provide the interiors with comfortable internal thermal environmental conditions. Also, the researcher has suggested that it would be beneficial to adapt the compact layout of the traditional houses as the closeness between the houses makes these houses protect each other from the sun in summer and from the rain in winter.

Modern house: The modern houses are built as detached or semi-detached units and this layout results in these houses not providing protection for each other from the sun in summer because they are not in the shade. They also do not protect each other from the rain in winter for this reason.

The habitable rooms and spaces in the modern house do not open directly to the outside so there is less heat gain during the summer.

Discussion

So what has been found from the investigation and literature of the traditional house is that the compact layout of traditional houses offers protection from the intense heat during the summer and from the rain during the winter. Also the courtyard shading offers a respite from the intense heat in summer. On the other hand, it has been found that the compact layout of the modern houses does not protect these houses from the intense heat in summer and from the rain in winter. It has also been found that the habitable rooms and spaces of the modern house do not open directly to the outside and as a result there is less heat gain in summer.

Optimal Design Strategy

When designing the ideal house it should be considered that it would be beneficial for the main façade of the house to be protected from the intense heat in summer and from the rain in winter. The researcher considers the compact layout of the traditional houses should be applied to the optimal design strategies; also the researcher suggests the concept of the habitable rooms and spaces of the modern house to be applied to the optimal design strategies as these habitable rooms and spaces do not open directly to the outside with the result there is less heat gain from outside in summer.

7.4.6.1.3. *External space design*

Traditional house – washing down spaces/shading fountains/planting: The inhabitants of the traditional houses used to wash down the courtyard, particularly in the afternoon during the summer when they used it for sitting/social gatherings. This action reduces the intense heat and increases the humidity during the summer. Also the house incorporates a fountain in the centre of the courtyard; this fountain has a big role to reduce the intense heat and increase the relative humidity and as result the internal space of the house is provided with comfortable thermal conditions.

Modern house: The garden is the only outside open space and does not incorporate a fountain to reduce the intense heat during the summer. The absence of the fountain and evaporating cooling results in the garden providing the inhabitants with uncomfortable thermal conditions during the day, particularly during the hot days in summer. The garden of the modern house has trees and grass that need to be watered during the day to reduce the heat and increase humidity.

Discussion:

So what has been found from the investigation and literature is that the humidifying air and evaporating cooling are the best options to provide the spaces with comfortable thermal environmental conditions. The researcher has found that the concept of the fountains and tress would be good in the ideal house.

Optimal Design Strategies

When designing the ideal house consideration should be given to the evaporating cooling and humidifying air to provide the spaces with comfortable thermal conditions. So the researcher suggests that the concept of fountains and trees of the traditional house to be applied to the optimal design strategies.

7.4.6.1.4. *Seasonal usage of spaces*

Traditional house: In the traditional house there are a habitable rooms and spaces which have been designed particularly for summer use, such as the basement level room (Sirdab) and semi-basement level room (neem). These rooms are serviced by the natural ventilation system (Badgir) to provide the inhabitants with comfortable thermal conditions and natural daylight during the summer. The researcher considers the basement rooms with the natural ventilation system should be applied to the optimal design strategies.

Modern house: In the modern house there are no habitable rooms and spaces designed particularly for summer use. The inhabitants of the modern house used the same habitable rooms and spaces during the summer and winter. The absence of the basement rooms at the modern house results in the house failing to provide the inhabitants of house with comfortable thermal conditions during the hot days in summer, particularly during the power cutting hours.

Discussion

It has been found from the investigation and literature that the basement level rooms of the traditional houses provide the inhabitants with natural ventilation and natural daylight and that results in comfortable thermal conditions during the hot days in summer. On the other hand, the absence of the basement rooms in the modern house has affected the inhabitants of the house as the modern house is serviced only by air conditioning so the inhabitants' thermal comfort will be affected during the hours of power cuts.

Optimal Design Strategy

When designing the ideal house consideration should be given to providing the inhabitants with comfortable thermal conditions. It should also be considered that the ideal house has habitable rooms and spaces designed particularly for summer habitation. The researcher suggests that the basement rooms be applied in the optimal design strategies to provide the inhabitants with natural ventilation and natural daylight during the summer.

7.4.6.1.5. ***Night-time purge ventilation & thermal mass***

Traditional house: The researcher has found through the investigation of the traditional houses that the internal walls of the traditional house are very thick and they are always in the shade and as a result they can absorb heat during the day to provide the interiors with comfortable internal thermal environmental conditions.

Modern house: The researcher has found through the investigation of the modern house that the internal walls of the modern house are not thick enough to absorb heat during the day to provide the interiors with the comfortable thermal environmental conditions.

Discussion

It has been found from the investigation and literature that the thickness of the internal walls is very important to absorb heat during the day and to provide the inhabitants with comfortable thermal conditions. So the researcher suggests the traditional internal walls be adopted in the optimal design strategies.

Optimal Design Strategy

When designing the ideal house consideration has to be given to the thickness of the internal walls. In the optimal design internal walls should be thick, providing thermal capacity to provide the interiors with the comfortable internal thermal environmental conditions.

7.4.6.1.6. ***Airtightness***

Traditional house: The protection afforded from dust storms by the courtyard, especially when covered, is relatively effective in providing comfort and relief from these occurrences. The garden of the modern house does not provide any protection to the inhabitants during the dust storms.

Modern house: The garden of the modern house is the only open space and it is not protected from the spring/summer dust storms. The garden offered no protection to the inhabitants during this period of the year.

Discussion

So what has been found through investigation and from literature is that an airtight construction with filtered ventilation system is required for this situation.

Optimal Design Strategy

It has been found from the investigation and literature that it will be difficult for the optimal design to be protected from spring/summer storms unless the concept of the courtyard has been applied to the optimal design strategies so the covered courtyard provides some protection to the inhabitants.

7.4.6.1.6. ***Summer environmental design strategies***

The researcher has found that both traditional and modern houses have advantageous and disadvantageous characteristics.

Table 7.17. Environmental factors summer evaluation informing strategies

Strategy	Source(s) Informing Strategy		
	Traditional Houses	Modern Houses	Literature
Self shading at neighbourhood scale	X		X
External space design	X	X	X
Seasonal usage of spaces	X		X
Night purge ventilation & thermal mass	X		X
Airtightness			X

7.4.6.2. *Winter evaluation*

During the winter two selected traditional houses and two selected modern houses have been measured environmentally, for each house four spaces have been measured (Ursi room, bedroom, courtyard and the roof terrace) for the traditional houses and (living room, bedroom, garden and roof terrace) for the modern houses.

Table 7.18. Comparison of findings for traditional and modern houses

Factors	Traditional house	Modern house
Urban Planning	**Achieved**	**Not achieved**
Built Form	**Not achieved**	**Achieved**
Seasonal Usage of Space	**Achieved**	**Not achieved**
Winter Environmental Factors	**Achieved**	**Partially achieved**

In addition to this finding the following summary of the performance of the monitoring spaces is also of relevance here:

Table 7.19. Comparison of findings for traditional and modern houses in winter

SPACE	TRADITIONAL HOUSE	MODERN HOUSE
	Winter	
Living Room/Ursi Room	Performs well	Performs well

Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Does not perform well	Does not perform well
Roof Terrace	**Day**	Performs well	Performs well
	Night	Does not perform well	Does not perform well

7.4.5.2.1 *Passive design in the winter in Baghdad*

It is reiterated here that the summer period is considered to run from May to October. Again, the climate has been plotted on a bioclimatic chart below in order to inform the selection of appropriate passive design strategies.

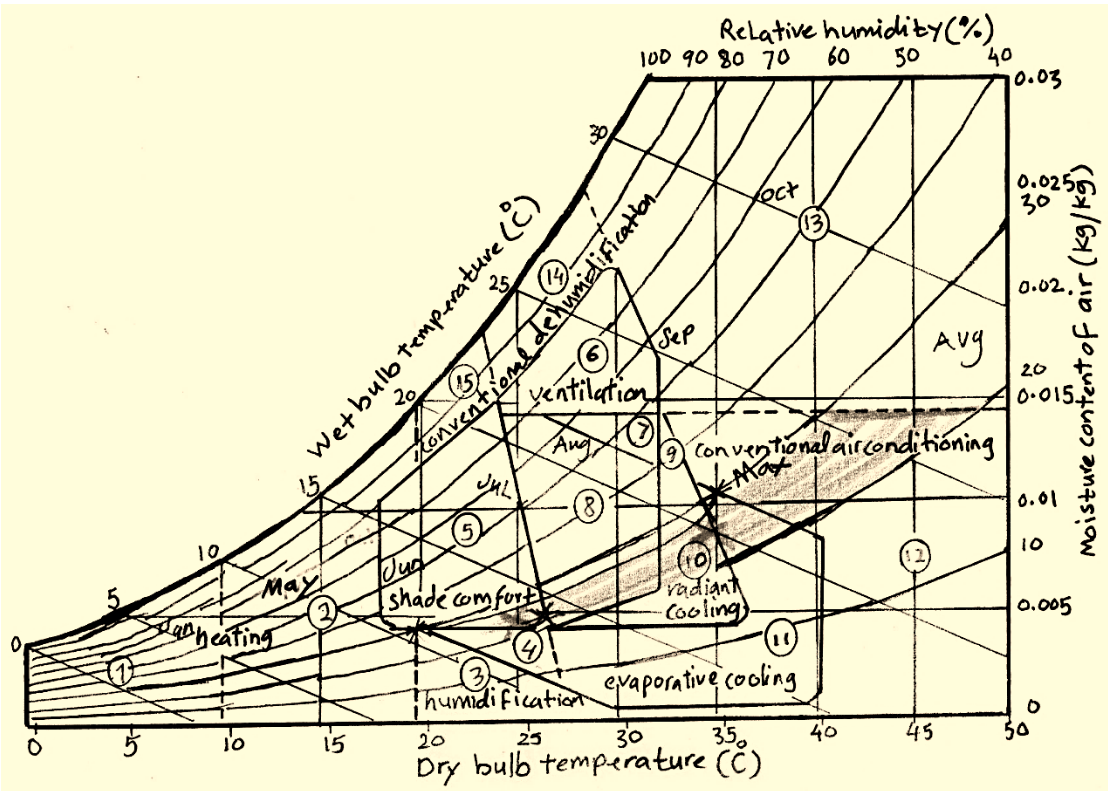


Fig 7.5. Bioclimatic chart of the climate in Baghdad (Achard & Gicquel 1986)

It can be seen from this graph that the following strategies are likely to be appropriate in this climate:

- Heating is required – therefore controllable use of solar gain could be appropriate.
- Shade on the hottest days and at the hottest times of the day.
- In addition – care should be taken to avoid draughts – and therefore construction to avoid air leakage is important.

Table 7.20. Environmental factors strategies

Original Factors	Passive Strategy	Final Strategy
Urban Planning	Enable controlled solar gain Shade Discussed under heating	
Built Form	Compact form	**Built Form and Space**
Seasonal Usage of Spaces	Discussed above	
	Control of ventilation Insulation	**Building Fabric**
	Heat source Solar gain Shade	**Heating**

7.4.6.2.2. ***Built form and space***

Traditional house: As has been discussed earlier, the close proximity of neighbouring houses and the compact form of the neighbourhood in traditional houses makes them protect each other from the sun in summer and from heavy rain storms in winter.

Modern house: The siting of modern houses on a small portion of their plot along wide streets does not provide protection from the sun in summer and from heavy rain in winter.

Discussion

So what has been found from the investigation and literature is the compact form of the traditional houses would be beneficial in optimal design strategies. The closeness between the houses protects them from the sun in summer and from the heavy rain in winter.

Optimal Design Strategy

When designing the ideal house consideration it should be given to the compact form of the house. The researcher suggests the traditional compact form be applied to the optimal design strategies.

7.4.6.2.3. ***Building fabric***

Traditional house: The insulation of the internal walls of the traditional houses keep the heat during the winter and provides the inhabitants of the house with comfortable thermal conditions during the cold days in winter. The insulation in the roof terrace prevents heat gain in summer and retains heat in winter.

Modern house: The insulation of the internal walls of the modern house does not keep the heat during the winter to provide the inhabitants with comfortable thermal conditions during the winter.

Discussion

So what has been found from the investigation and literature is the traditional house has a good building fabric and the insulation in the roof terrace prevents heat gain in summer and keeps the heat in winter.

Optimal Design Strategy

When designing the ideal house the design strategy must ensure air leakage is minimal to prevent draughts. The use of insulation in the roof will assist in preventing heat gain in the summer as well as help to retain heat in the winter. In addition a more compact form will enable more efficient heating of the internal spaces.

7.4.6.2.4. ***Heating***

Both house types need heating to provide comfort, either paraffin or electric heating is used to provide comfort during the winter.

Traditional house: The researcher has found that the traditional house provides comfort to its inhabitants during the winter with just paraffin heating, due to the good response of the house to the climate conditions. It has been found that the inhabitants are happy with their house in terms of thermal comfort.

Modern house: The modern house does provide comfort to its inhabitants during the winter with electric heating; this is due to the house failing to have a good response to the climate conditions. It has been found that the inhabitants of the house are not happy with their house in terms of thermal comfort.

Discussion

It has been found from the investigation and literature that the traditional house provides the inhabitants with thermal comfort using traditional heating (paraffin heaters) and the house has a good response to the climate conditions during the winter. Also the modern house provides thermal comfort to the inhabitants with electric heating due to the house failing to have a good response to the climate conditions in winter.

Optimal Design Strategy

When designing the ideal house consideration should be given to providing an adequate and controllable heating system to provide thermal comfort.

7.4.6.2.5. W*inter thermal environmental considerations*

The researcher recommends that what has been found good about the traditional houses and modern houses should be considered and applied to the optimal design strategies.

It is suggested that the future optimal design should have habitable rooms and spaces that do not open to the outside to make the inhabitants feel less cold during the winter and also provide protection from the rain during the winter. Also the traditional compact form should be applied to protect the house from the heat in summer and from the rain in winter; also to ensure air leakage is minimal to prevent draughts. Also the use of insulation in the roof terrace should assist in preventing heat in summer and retaining heat in winter. An adequate heating system is required to provide thermal comfort.

Table7.21. Environmental factors informing winter strategies

Strategy	Source(s) informing strategy		
	Traditional Houses	**Modern Houses**	**Literature**
Built Form & Space	X		X
Building Fabric	X	X	X
Heating	X		X

7.5. CONCLUSION

In order to establish optimal design strategies to enable occupant comfort in a context of reduced energy use and cultural responsiveness, traditional courtyard houses and modern houses in Baghdad have been studied. A series of important factors have been identified and evaluated: socio-cultural, economic, neighbourhood, architectural, services and environmental factors performance in both house types. As a result of this study the researcher has suggested that the advantageous characteristics of both traditional and modern houses should be applied to future optimal design guidance to achieve the future optimal design aim.

The following table provides the themes of proposed design strategies for domestic optimal design in Baghdad, Iraq.

Table 7.22. Findings of factors for traditional and modern houses

	Traditional or Modern	
Socio-Cultural Factors	**Trad**	Privacy from the public realm
	Trad	Entrance
	Trad	Outside Spaces
	Trad	Overlooking
	Trad	Privacy for outside sleeping spaces
	Trad	Internal privacy between genders
Economic Factors	**Trad**	Low land cost
	Trad	Low construction cost
	Mod	Low running cost
Neighbourhood Factors	**Trad**	Compact/walkable
	Mod	Access to services
	Mod	Access for vehicles
Architectural Factors	**Trad**	Adequate spaces
	Trad	Floor to ceiling height
Services Factors	**Mod**	Sanitation services
	Mod	Site drainage services
	Mod	Waste services
	Mod	Water services
	Mod	Other services
ENVIRONMENTAL FACTORS		
Summer Thermal	**Trad**	Self shading at neighbourhood scale

Environmental	**Trad/Mod**	External space design
	Trad	Seasonal usage of spaces
	Trad	Night purge ventilation & thermal mass
Winter Thermal Environmental	**Trad**	Built form & space
	Trad/	Building fabric
	Trad/Mod	Heating

CHAPTER VIII

CONCLUSION & RECOMMENDATION

8.1. INTRODUCTION

It is hoped that the final results and the findings of this research will lead to an understanding of both the advantages and disadvantages of the traditional vernacular and modern architecture in Baghdad, leading to an effective synthesis in terms of both environmental and social factors.

Further, it is the intention that this research might provide the building industry in Iraq with guidance on optimal design strategies in order to resolve some of the existing problems and design challenges associated with new buildings and perhaps inform such development in other countries, where such challenges exist.

It is asserted that this research has achieved its aims and has succeeded in identifying the architectural, environmental and socio-cultural characteristics of the traditional courtyard dwellings and modern homes in Baghdad. Further, that it has evaluated occupant comfort and satisfaction as well as established the thermal performance of the selected case study traditional courtyard and modern houses throughout the year. Further, the work has successfully undertaken qualitative comparison of both the socio-cultural and environmental performance of the case study houses throughout the year in order to inform the optimal design strategies.

This research has contributed new knowledge in architecture by investigating how the advantages of traditional courtyard and modern homes might be synthesised to inform a new domestic vernacular.

The research has explained that, the traditional courtyard houses were designed historically to satisfy the functional needs of their inhabitants regarding the environmental/socio-cultural factors (details in Chapter II).

Architecturally, the research has successfully explained how the design of the traditional house was designed to respond directly to the social-cultural demands of the inhabitants by providing them with privacy when they use the habitable rooms and spaces such as the courtyard for their daily activities, preventing overlooking by passers-by and during their use of the roof terrace as a sleeping area during the summer, where overlooking by neighbours is also prevented.

Also the research has explained how the use of inward-looking habitable rooms and spaces overlooking the courtyard at both ground and first floors levels also helps to provide the inhabitants with necessary privacy.

This research has also explained how the architectural design was a response to the climatic conditions and helps to provide inhabitants with thermal comfort and has satisfied the inhabitants' needs environmentally (details in Chapter II).

The work has established that the inhabitants of the traditional courtyard houses continue to use their houses differently during the four seasons, in line with the original historical design intentions. As this work focused on the summer and winter, this was most explicitly established through observation in these seasons where the inhabitants were found to continue to use habitable rooms and spaces which originally were designed for summer habitation, such as the basement level room (Sirdab), as well as those habitable rooms and spaces which were designed for winter habitation, such as the winter living room (Ursi) at first floor level.

Also the research has identified and evaluated the advantageous and disadvantageous characteristics of the modern houses in Baghdad and such advantages have been integrated into the proposed optimal design strategies.

8.2. CONCLUSION

This section will go on to provide conclusions in response to each of the stated research objectives and finally provide an overarching conclusion to the main aim.

The research has achieved objective 1 which is:

> ***Identify the current understanding of the socio-cultural, economic, environmental, neighbourhood and services factors of traditional courtyard houses and modern houses in Baghdad.***

The research has achieved objective 1 through the literature review as presented in Chapter II. This chapter identified and evaluated the architectural, environmental and socio-cultural characteristics of the traditional houses and modern houses by considering the most important issues, as presented in the literature, for the inhabitants of the two types of houses.

The ***socio-cultural*** characteristics associated with the houses in Baghdad were found to be those related to responsiveness to privacy requirements driven by the inhabitant's need for complete privacy. From the literature it is clear that the traditional homes have evolved to respond to historic socio-cultural needs, while the imported designs of the modern homes are less clearly responsive to these subtle requirements.

In terms of ***economic factors***, traditional houses have been constructed at higher density and with the widespread use of three party or shared walls, design strategies that can contribute to lower land and capital costs, in contrast with the lower density found in modern housing. The form of the traditional buildings with most spaces having just one external wall provides common benefits with the compact built form of modern houses.

Environmentally, the integrated passive design strategies of traditional houses, should, in theory, contribute to lower running costs, in comparison to the reliance on active systems found in modern houses.

Some characteristics of the traditional ***neighbourhood*** were found to be positive, including the compact neighbourhood that provides access to a diverse range of needs, including employment, shopping and social needs. However, the modern neighbourhood characteristics were found to provide for different and perhaps more modern requirements, such as vehicular access and as a result ease of access to public services such as libraries, health services and wider employment opportunities.

Finally**,** from the literature it is clear that expectations regarding ***services*** including Sanitation, Site Drainage, Waste and Water have changed since the traditional houses were designed and constructed, while modern houses are equipped with effective services systems

As presented in chapter IV the research has achieved objective 2:

Establish architectural characteristics of the case study houses to be studied.

This objective was largely achieved through an extensive physical survey of the seven case study traditional houses and seven case study modern homes including, survey measurement, occupant observation and occupant surveys. Together these methods gathered data about design, structure, building materials, insulation, openings, climate and comfort zone, privacy, and passive technologies of heating and cooling including natural ventilation**.**

For the ***traditional houses***: most of these houses consist of two storeys and have a courtyard which is located in the centre of the house, while the habitable rooms and spaces are looking inwards, towards the courtyard. The traditional houses have been built in groups and as a result the closeness between houses enables the inhabitants to develop direct social connections with their neighbours.

For the ***modern houses:*** most of these houses consist of partially single storey and partially two storeys and have been built at apparent random, in detached or semi-detached forms. As a result the inhabitants are not provided with a direct social connection with their neighbours. These houses also have a garden which is the only open space in the house, but this space is not as private as the courtyard**.**

Occupant observation established how the occupants of the traditional and modern houses used their houses during the summer, winter and transition seasons. In particular it was established that the spaces designed to be used in different seasons in the traditional homes, and identified in literature as such, remain in use as intended, responding to the varying climatic environments. In particular, the semi basement level room and the basement level room (Sirdab) continue to provide the inhabitants with comfort in the absence of active servicing during the summer, this despite the presence of air conditioning in some of these houses.

As presented in Chapter IV the research has achieved objective 3:

> ***Establish the socio-cultural, economic, neighbourhood and services performance and responsiveness of traditional and modern case study houses throughout the year.***

This objective has been achieved through both occupant observation together with interpretation of the responses to questionnaires that were administered to the occupants of the fourteen case study houses.

In terms of ***social factors*** the traditional house was found to more effective in responding to current needs than the modern home, with these homes delivering privacy from the public realm in terms of entrance design, outside space, prevention of overlooking of habitable spaces and privacy for outside sleeping spaces; where these latter spaces were found, in particular, to be perceived by occupants to create a sense of security and privacy. Further the traditional houses also provided internal privacy between genders that is responsive to socio-cultural needs.

Table 8.1. Findings for socio-cultural factors in traditional and modern houses

Socio-Cultural	**Traditional or Modern**	
	Trad	Entrance
	Trad	Outside spaces
	Trad	Privacy for outside sleeping spaces
	Trad	Internal privacy between gender

Key: **Completely achieved** **Partially achieved** **Not achieved**

For the ***Economic factors***, the primary research supported the findings from literature that suggested that the traditional house should be considered as an effective model to inform the achievement of lower land costs and lower construction costs, due to density and built form factors already discussed. Further, the researcher established that the energy bills in traditional houses were very low for cooling and heating and were affordable for the inhabitants, while those for the modern houses were relatively expensive but still affordable to occupants.

Table 8.2. Findings for economic factors in traditional and modern houses

Economic	**Trad**	Low land cost
	Trad	Low construction cost
	Trad	Low running cost

***Neighbourhood*:** The inhabitants of both traditional and modern houses were all found to be happy with their neighbourhoods, where advantages and disadvantages to the characteristics of each were identified. In particular, positive factors identified for the traditional houses were compact and walkable access to services, while providing accessibility to vehicles for domestic and emergency use were established as positive factors in the modern neighbourhoods.

Table 8.3. Findings for neighbourhood factors for traditional and modern houses

Neighbourhood	**Trad**	Compact/walkable
	Mod	Access to vehicles/services

Services: As was suggested from the literature, the researcher has found that the modern home provides a good level of services, while the traditional house does not; this is likely due to the changing nature of servicing expectations over the past century.

Table 8.4. Findings for services factors in traditional and modern houses

Services	**Mod**	Sanitation services
	Mod	Site drainage services
	Mod	Waste services
	Mod	Water services
	Mod	Other services/kitchen

As presented in Chapter VI the research has also achieved objective 4:

Establish the occupant comfort, satisfaction and thermal performance of traditional and modern houses throughout the year.

Two case study homes from each typology were monitored environmentally for a fortnight during the summer and winter, with corresponding occupants' diaries that were designed to establish the occupant's comfort and satisfaction**.** Conclusions arising from these monitoring periods are as follows:

SUMMER MEASUREMENT

Traditional houses

The habitable rooms and spaces such as the living rooms, bedrooms of both traditional houses provide the occupants with comfortable thermal conditions and they performed well in the summer

The courtyards of both traditional houses did not perform well during the morning and afternoon; the thermal environmental conditions prevailing in the shade in the courtyard are uncomfortably hot during this period of time, particularly in the first and second peaks in temperature of the day due to floor area of the courtyard receiving direct sunlight during this time of the day. However, the courtyards provided the occupants with comfortable conditions in the evening. They performed adequately.

The roof terraces of both traditional houses provided the occupants with comfortable thermal conditions during the night. They performed well in the night in summer.

Modern houses

The living rooms of both modern houses performed well during the day under the air conditioning systems; the thermal environmental conditions prevailing in the living room of MH1 are very comfortable and comfortable for the MH2 in the morning, lunch and afternoon and very comfortable in the evening.

The bedrooms of both modern houses provide comfortable thermal environmental conditions in the morning and in the afternoon during the afternoon siesta.

The gardens of both modern houses did not perform well in the late morning, lunch and afternoon according to the recorded measurements during this period of time. The thermal environmental conditions prevailing in the shade in the garden are very uncomfortably hot during the lunch and afternoon, particularly during the first and second peaks of the day, but there are comfortable thermal environmental conditions in the early morning and in the evening. The gardens performed adequately.

The roof terraces of both modern houses performed well during the night when the occupants use the roof terrace for sleeping in the night.

Table 8.5. Comparison of findings for traditional and modern houses in summer

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Summer	
Living Room		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	Day	Performs adequately	Performs adequately
	Night	Performs well	Performs well
Roof Terrace	Day	Performs adequately	Performs adequately
	Night	Performs well	Performs well

WINTER MEASUREMENT

Traditional houses

The habitable rooms and spaces which are designated for winter habitation, such as the living rooms (Ursi) and bedrooms performed well. The Ursi rooms in both traditional houses provide the occupants with comfortable thermal conditions during the day and they performed well in winter. The thermal environmental conditions prevailing in the bedroom of TH1 are acceptable in the afternoon and comfortable in the evening and the thermal environmental conditions prevailing in the bedroom of TH2 are acceptable in the morning and comfortable in the afternoon and evening. The bedrooms performed well in winter.

The courtyards of both traditional houses did not perform well during the day, particularly in the early morning, during which time they provided the occupants with very uncomfortable thermal conditions. However, there are comfortable thermal environmental conditions during the warm and sunny days. They performed adequately.

Modern houses

In general the living rooms in both modern houses provide the occupants with comfortable thermal conditions during the day and they performed well during the winter.

The bedrooms of both modern houses are also providing the occupants with comfortable thermal conditions during the day and night. They also performed well in winter.

The gardens of both modern houses did not perform well during the day, particularly in the early morning. They provide the occupants with very uncomfortable thermal conditions in the morning, but there are comfortable thermal environmental conditions during the warm and sunny days. They performed adequately.

Table 8.6. Comparison of findings for traditional and modern houses in winter

SPACE		TRADITIONAL HOUSE	MODERN HOUSE
		Winter	
Living Room Ursi Room for Traditional House/Winter		Performs well	Performs well
Bedroom		Performs well	Performs well
Courtyard/ (Traditional)/ Garden (Modern)	**Day**	Performs adequately	Performs adequately
	Night	Does not perform well	Does not perform well
Roof Terrace	**Day**	Performs well	Performs well
	Night	Does not perform well	Does not perform well

As a result of the ***winter*** monitoring and occupant surveys it was established that an effective and efficient heating system is required to achieve comfort in both types of houses, while fabric construction can be improved for both types of houses to improve efficiency of comfort

The research has achieved objective 5:

> ***Establish appropriate design strategies that are responsive to the socio-cultural and environmental context, to inform a 'modern vernacular style' for housing in Baghdad.***

The research has identified and evaluated the findings of the socio-cultural, economic, neighbourhood, architectural, services and environmental factors of the traditional and modern houses in Baghdad in order to establish appropriate design strategies for the future ideal house (details in Chapter VII). The researcher has suggested that in order to provide optimal design strategies the advantageous characteristics of both traditional and modern houses should be combined. This will achieve the main aim of this research which is to enable occupant comfort in a context of reduced energy use and cultural responsiveness.

Socio-cultural factors:

Table 8.7. Design strategies relating to socio-cultural factors

Socio-Cultural	Traditional	Modern	Discussion
Entrance			It is suggested the traditional entrance lobby (Mejaz) be applied in optimal design strategies.
Outside Space			It is suggested the concept of the courtyard of the traditional house be applied in optimal design strategies.
Internal Privacy Between Genders			The optimal design should be provided with the habitable rooms and spaces designed particularly to receive adult male visitors.
Privacy for Outside Sleeping Spaces			The parapet wall of the roof terrace of the ideal house should be high enough to prevent overlooking by neighbours. The appropriate height depends on height and proximity of the surrounding buildings.

Key: **Completely achieved** **Partially achieved** **Not achieved**

Economic factors:

Table 8.8. Design strategies relating to economic factors

Economic	Traditional	Modern	Discussion
Low Land Cost			The ideal house should cover the whole plot area and the first floor level should cover the whole ground floor level to make the house economical to build.
Low Construction Cost			The ideal house should be built wholly two storeys rather than single storey to make the house economical to build.
Low Running Cost			**Summer:** Shading the internal environment from the sun would help to reduce the energy usage. Frequent power outage suggests there is a need for houses to function adequately during power cuts. Also the sirdab room and natural ventilation of the traditional house would benefit the house.
Low Running Cost			**Winter:** The adaption of a more compact form for some of the living areas with enclosed transition spaces between the internal and external spaces would make the future ideal house less expensive to achieve comfort in winter.

Neighbourhood factors:

Table 8.9. Design strategies relating to neighbourhood factors

Neighbourhood	Traditional	Modern	Discussion
Compact/ Walkable			With the ideal house it is suggested consideration should be given to the distance between the houses and the other places. Mixed characteristics of the traditional and modern neighbourhood to be applied to the optimal design strategies.
Access to Vehicles/ Services			With the ideal house, car and emergency access to the houses should be easy and direct. It has been suggested that modern neighbourhood characteristics be applied to the optimal design strategies.

Architectural factors:

Table 8.10. Design strategies relating to architectural factors

Architectural	Traditional	Modern	Discussion
Adequate Spaces			The optimal design should have an adequate number of habitable rooms and spaces which satisfy the inhabitants' needs and have habitable rooms and spaces which are designed particularly for summer and winter habitation.
Floor to Ceiling Height			In the ideal house, the floor to ceiling height at the ground floor level should be higher than the floor to ceiling height at the first floor level.

Services factors:

Table 8.11. Design strategies relating to services factors

Services	Traditional	Modern	Discussion
Sanitation Services			It is recommended that the ideal house should incorporate the sanitation system used for modern houses which will not cause a noise for the inhabitants and their neighbours.
Site Drainage Services			The neighbourhood of the optimal design should incorporate paved pavements to avoid problems with dust during the summer and during the heavy rain in winter.
Waste Services			It is recommended that for the optimal design, rubbish should be kept in a waste storage area outside the house.
Water Services			It is recommended the optimal design should incorporate a covered cold water tank for protection from the sun and also the optimal design should have adequate water taps.
Other Services			There should be a high availability of public services such as electricity/telephone and internet. Also the ideal house should have a fitted kitchen to provide the inhabitant with comfort.

Environmental factors:

Summer Thermal Environment

Table 8.12. Design strategies relating to summer environmental factors summer

Environmental	Traditional	Modern	Discussion
Self Shading			It is suggested that the traditional compact layout should be applied to the optimal design strategies.
External Space Design			It is suggested that the concept of fountains and trees of the traditional house be applied to the optimal design strategies.
Seasonal Usage of Spaces			It is suggested the basement level room (Sirdab) be applied to the optimal design strategies to provide inhabitants with natural ventilation and natural daylight.
Night Time Purge Ventilation & Thermal Mass			The internal walls of the ideal house should be thick, providing thermal capacity to provide the interior with comfortable conditions.
Airtightness			It is difficult for the ideal house to be protected from spring/summer dust storms if the courtyard has been applied to the optimal design strategies, so a covered courtyard provides some protection for the inhabitants.

Winter Thermal Environment

Table 8.13. Design strategies relating to winter environmental factors

Environmental	Traditional	Modern	Discussion
Built Form and Space			It is suggested that the traditional compact layout to be applied to the optimal design strategies.
Building Fabric			It is suggested that the use of insulation in the roof will assist in preventing heat gain in summer as well as to retain heat in the winter.
Heating			With the ideal house it is recommended that an adequate and controllable heating system is required to provide thermal comfort.

The research has achieved the main aim which is to:

Identify and evaluate environmental and socio-cultural performance of traditional and modern houses in Iraq, in order to establish optimal design strategies that enable occupant comfort in a context of reduced energy use and socio-cultural responsiveness.

The environmental performance of both traditional and modern houses is affected both by physical properties such as the climate in which it performs as well as its construction. In the summer the traditional and modern houses perform well to provide comfortable conditions under air conditioning/air cooling systems. The modern houses in the summer are considered more comfortable with air conditioning systems, also there is learning to be had from traditional houses as these houses perform reasonably under zero services.

Although from the literature it appears that traditional houses have been designed to respond to socio-cultural factors such as privacy, outside sleeping and gender specific spaces, the residents of Baghdad are findings ways to live in their modern houses while responding to their socio-cultural requirements. However, there is detailed learning to be had from traditional housing, in particular regarding privacy, entrance design, and internal privacy between genders. It has been found to be important to apply these characteristics to the optimal design strategies to satisfy the occupants' requirements in terms of the socio-cultural factors.

8.3. RECOMMENDATION FOR THE FUTURE WORK

In the future the researcher considers the following further work to be a priority in this field:

- This research has proposed strategies to inform the future design of modern housing in Baghdad. It is suggested here that future work would apply these strategies to new housing design, which could then be modelled in order to evaluate their environmental performance, in particular energy requirements to deliver comfort.
- Further, it is suggested that focus group research is required to establish potential occupant interest and feedback in response to optimal design

informed case study homes. In particular this research would focus on the effectiveness of the socio-cultural aspects of the proposed designs.

- Future research should establish the effectiveness of the basement level room (Sirdab); original research proposals for this study had planned to measure the room environmentally to know how this room performed naturally but this was not possible due to objections from the inhabitants.
- It is known that similar issues exist in other countries where traditional housing has been replaced by modern prototypes which have been imported from different climates and cultures. Similar research strategies to those employed here could be applied in these contexts in order to inform the development of context relevant design guidance elsewhere.

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APPENDIX 1

Consent Form - Confidential data

I understand that my participation in this project will involve mainly in architectural and environmental performance of Traditional courtyard houses/Modern houses in Baghdad, Iraq, also I will provide the researcher with the information about social and economic issues. I will complete one questionnaire about the buildings which will require approximately 30 minutes of my time. The researcher will transfer and explain each question in Arabic language.

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason.

I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with **Dr Julie Gwilliam.**

I understand that the information provided by me will be held confidentially, such that only the Principal Investigator and [name(s) of other researchers where applicable] can trace this information back to me individually. The information will be retained for up to 24 months when it will be deleted/ destroyed.

I understand that I can ask for the information I provide to be deleted/destroyed at any time and, in accordance with the Data Protection Act, I can have access to the information at any time.

I, ______________________________ **[PRINT NAME]** consent to participate in the study conducted by **Nagham Salman,** Welsh School of Architecture, Cardiff University with the supervision of **Dr Julie Gwilliam.**

Signed:

Date: 16.12.2013

EC1401·175

WELSH SCHOOL OF ARCHITECTURE
ETHICS APPROVAL FORM FOR STAFF AND PHD/MPHIL PROJECTS

WS

Tick one box:	☐ STAFF	X PHD/MPHIL
Title of project:	The relevance of traditional buildings forms to the design of modern buildings in the Middle-East: A study of environmental performance of traditional courtyard dwellings in Baghdad, IRAQ.	
Name of researcher(s):	Nagham Salman	
Name of principal investigator	Dr Julie Gwilliam (Supervisor)	
Contact e-mail address:	naghamsaluk@yahoo.com SalmanN@cardiff.ac.uk	
Date:	16th Dec. 2013	

Participants		YES	NO	N/A
Does the research involve participants from any of the following groups?	• Children (under 16 years of age)		x	
	• People with learning difficulties		x	
	• Patients (NHS approval is required)		x	
	• People in custody		x	
	• People engaged in illegal activities		x	
	• Vulnerable elderly people		x	
	• Any other vulnerable group not listed here		x	
• When working with children: I have read the Interim Guidance for Researchers Working with Children and Young People (http://www.cardiff.ac.uk/archi/ethics_committee.php)				

Consent Procedure	YES	NO	N/A
• Will you describe the research process to participants in advance, so that they are informed about what to expect?	X		
• Will you tell participants that their participation is voluntary?	X		
• Will you tell participants that they may withdraw from the research at any time and for any reason?	X		
• Will you obtain valid consent from participants? (specify how consent will be obtained in Box A)[1]	X		
• Will you give participants the option of omitting questions they do not want to answer?	X		
• If the research is observational, will you ask participants for their consent to being observed?	X		
• If the research involves photography or other audio-visual recording, will you ask participants for their consent to being photographed / recorded and for its use/publication?	X		

Possible Harm to Participants	YES	NO	N/A
• Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		x	
• Is there any realistic risk of any participants experience a detriment to their interests as a result of participation?		x	

Data Protection		YES	NO	N/A
• Will any non-anonymous and/or personalised data be generated or stored?			x	
• If the research involves non-anonymous and/or personalised data, will you:	• gain written consent from the participants			x
	• allow the participants the option of anonymity for all or part of the information they provide			x

Health and Safety	YES
Does the research meet the requirements of the University's Health & Safety policies? (http://www.cf.ac.uk/osheu/index.html)	X

Research Governance	YES	NO	N/A
Does your study include the use of a drug? You need to contact Research Governance before submission (resgov@cf.ac.uk)		x	
Does the study involve the collection or use of human tissue? You need to contact the Human Tissue Act team before submission (hta@cf.ac.uk)		x	

[1] If any non-anonymous and/or personalised data be generated or stored, *written consent* is required.

If any of the shaded boxes have been ticked, you must explain clearly how the ethical issues are addressed. The list of ethical issues on this form is not exhaustive; if you are aware of any other ethical issues you need to make the SREC aware of them.

Box A **The Project** (provide all the information listed below in a separate attachment)

Please see attached document.

Researcher's declaration (tick as appropriate)

• I consider this project to have **negligible ethical implications** (*can only be used if none of the grey areas of the checklist have been ticked*).	x
• I consider this project research to have **some ethical implications**.	
• I consider this project to have **significant ethical implications**	

Signature:

Name: **Nagham Salman** **Date** **16.12.13**

Researcher or MPhil/PhD student

Signature **Name** Julie Gwilliam **Date** **07.01.14**

Lead investigator or supervisor

Advice from the School Research Ethics Committee

STATEMENT OF ETHICAL APPROVAL

This project had been considered using agreed Departmental procedures and is now approved

Signature **Name** WOUTER POORTINGA **Date** 22/01/14

Chair, School Research Ethics Committee

QUESTIONNAIRE FOR OCCUPANTS OF SELECTED TRADITIONAL HOUSES IN BAGHDAD

Dear Sir/Madam,

This questionnaire is being undertaken as part of research entitled: **TOWARDS OPTIMAL DESIGN STRATEGIES IN HOT-ARID CLIMATE: A comparative study of environmental and socio-cultural performance of the traditional and modern housing in Baghdad, IRAQ.** Your assistance is being sought in completing this questionnaire for research which will help to develop the building industry in Iraq. Please be assured that you will not be identified as a respondent, and your responses will be confidential with the data only being used for research purposes by university research and will be securely stored. Thank you.

SECTION A

ABOUT YOU AND YOUR HOUSE

1. Are you? **Please tick ONE**

Owner	
Tenants	
Living with family	
Other (give details)	

2. Please indicate how long you have been living in this house. **Please tick ONE**

Under 5 Years	5 -10 Years	11-20 Years	21-25 Years	Over 25 Years

3. Please tell us the ages of all of the residents living in your household.

Adult aged 60 plus		Age 11-18	
Age 19-25 years		Children 5-10	
Adult 25-35 years		Children under 5	
Adult 35-59 years			

ARCHITECTURAL FACTORS

4. Have you had any conservation work to upgrade your house in the last four years?

Yes No

Please briefly describe the work undertaken.

5. To what extent do you consider that, the building work which has been undertaken has improved your living conditions? **Please tick ONE**

To great extent	
To some extent	
Not particularly	
Not at all	
Not the purpose of the works	

6. Do you use the outdoors space in your house for the daily activities?

Please tick ONE

	In Summer	In Winter	In Spring	In Autumn
Always- Every day				
Sometimes 2-3 times a week				
Rarely- Once a month				
Never				

If different, Please describe the activities:

7. How often do you use your outdoor space (courtyard) for your daily activities?

Please tick ONE

	In Summer	In Winter	In Spring	In Autumn
Always Every day				
Sometimes 2-3 times a week				
Rarely- Once a month				
Never				

8. As you are a traditional courtyard house inhabitant, what level of support do you currently receive from the local authority of Baghdad to conserve and protect your house? **Please tick ONE**

Very high support	
High support	
Low support	
Very low support	
No support	
Don't know	

Please state what kind of support did you receive from the local authority?

9. What more support would you like to/do you need to receive?

10. Do you feel secure in your roof terrace?

Very secure	
Fairly secure	
Fairly un-secure	
Not at all	

11. Does the roof terrace provide you with the privacy when you use it as a sleeping area during the summer?

Yes No

12. Does the roof terrace provide you with a comfort zone when you use it as a sleeping area in the summer? **Please tick ONE**

In Summer
Very comfortable
Fairly comfortable
Fairly un-comfortable
Very un-comfortable
Don't know

13. In your opinion, is it important for traditional courtyard house to be equipped by air-conditioning to provide you with a comfort zone?

Very important	
Important	
Least important	
Not important	

14. Is your sitting area in your house is comfortable without air-conditioning?

Yes No

15. Would you consider anyone in your neighbourhood to be a close friend?

Yes No

16. Are you happy with your neighbourhoods? Yes No

17. How long does your journey take? **Please tick ONE**

	30 minutes or less	One hour	One and half hour	Two hours
To work				
To school				
To shops				
To markets				

ENVIRONMENTAL FACTORS

18. Do you think that, your traditional courtyard house is well adapted to the climate?

	In Summer	In winter	In Spring	In Autumn
Strongly agree				
Agree				
Disagree				
Strongly disagree				
Don't know				

19. In your main living room, do you feel comfortable with minimal services in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly un-comfortable				
Very un-comfortable				
Don't know				

20. In your bedroom, do you feel comfortable with minimal services in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly un-comfortable				
Very un-comfortable				
Don't know				

21. In your main living room, do you feel comfortable without minimal services in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly un-comfortable				
Very un-comfortable				
Don't know				

22. In your bedroom, do you feel comfortable without heating and cooling in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly un-comfortable				
Very un-comfortable				
Don't know				

23. In terms of your thermal comfort, are you generally happy with the house you live in? **Please tick ONE**

Very satisfied	
Fairly satisfied	
Fairly unsatisfied	
Very unsatisfied	
Don't know	

If you are not happy, Please state the problems.

What would you like to change in your house?

1.
2.
3.

24. In terms of environment and climate conditions, to what extent do the traditional courtyard houses satisfy your needs? **Please tick ONE**

	In Summer	In Winter	In Spring	In Autumn
Very satisfy				
Fairly satisfy				
Fairly un-satisfy				
Very un-satisfy				
Don't know				

25. How comfortable you are in the basement level room (Sirdab) during the summer?

Please tick ONE

	Day-time?	Night-time?
Cold		
Cool		
Natural		
Slightly warm		
Warm		
Hot		

26. For the family living in Baghdad through the summer months without air-conditioning system, do you feel comfortable around the house? **Please tick ONE**

Very comfortable	
Fairly comfortable	
Fairly uncomfortable	
Very uncomfortable	
Don't know	

27. For the family living in Baghdad through the winter months without heating system, do you feel comfortable around the house? **Please tick ONE**

Very comfortable	
Fairly comfortable	
Fairly uncomfortable	
Very uncomfortable	
Don't know	

28. To what extent, do you think that, the natural ventilation system (Badgir) contributes to comfort within your house through the year?

Please tick ONE

	In Summer	In Winter	In Spring	In Autumn
Very good				
Good				
Fairly good				
Poor				
Don't know				

29. Does the main facade of your house remain protected from the sun throughout the day?

In Summer	In Winter	In Spring	In Autumn

30. Is your house exposed to spring or summer dust-storms?

YES……. NO…….

If yes, what is the impact of this on occupants comfort?

31. Do you have fountains? Yes No

32. Do you have trees? Yes No

33. How important do you think the trees in the open courtyard are in providing comfort during the summer? **Please tick ONE**

Very important	
Important	
Least important	
Not important	

34. How important do you think the fountains in the open courtyard are in providing comfort during the summer? **Please tick ONE**

Very important	
Important	
Least important	
Not important	

SOCIO-CULTURAL FACTORS

35. Does your courtyard provide you with the privacy? **Please tick ONE**

YES……… NO……..

If yes, do you feel comfortable when you use the courtyard for social gathering?

Very comfortable	
Fairly comfortable	
Fairly un-comfortable	
Very un-comfortable	
Don't know	

NEIGHBOURHOOD FACTORS

36. Do you know your neighbours? YES…….. NO……..

37. Do you socialise with them? YES…….. NO……..

38. If yes, how often do you visit them? **Please tick ONE**

Once a week	
Once a month	
Twice a month	
Once every two or three months	

SERVICES FACTORS

39. Are you satisfied with your sanitation system? YES……. NO…

IF NO, Please explain why you are not satisfied?

40. Where do you keep your rubbish? **Please tick ONE**

Courtyard	Alleyway

41. Do you consider this to represent a risk to health? **Please tick ONE**

Strongly agree	
Agree	
Disagree	
Strongly disagree	
Don't know	

42. When it is a heavy rain, do you have problems associated with the surface of the alleyways?

Yes No

If yes please state the problem.

43. A kitchen in an average-size house is usually a medium or small size room overlooking the courtyard but without any fittings, do you think that such a kitchen does provide you with comfort zone? **Please tick ONE**

Strongly agree	
Agree	
Strongly disagree	
Disagree	
Don't know	

44. Generally, the traditional courtyard house incorporates only one tap water which is located in the courtyard; and one in each of the kitchen and bathroom at ground floor and another at first floor. Is this system satisfied your need?

Please tick ONE

Very satisfied	
Fairly satisfied	
Fairly un-satisfied	
Very un-satisfied	
Don't know	

45. If No, do you suffer inconvenience whenever the water supply is cut-off while maintenance work is carried out?

Yes…….. No……..

46. Where is the cold water tank located?

In the courtyard	In the roof terrace

47. Do you think that, it is important to provide each house with cold water tank?

Please tick ONE

Very important	
Important	
Least important	
Not important	

48. Does your house incorporate a hot water system?

Yes……… No…....

ECONOMIC FACTORS

49. Because of the use of small plots results in comparatively less demand on land for houses and alleyways, this leaves more land available for development economically. What would you use this land for?

50. Why were you attracted to the house when you decided to buy/occupy/rent?

51. Would you like to move and live in a modern house? YES…….. NO…….

IF YES, why the modern house was attracted you?

52. Do you consider your energy bills to be: HIGH…… LOW……

53. What does it cost to provide you with comfort?

In Summer	In Winter	In Spring	In Autumn

54. How do you pay your bills?

Monthly	Every three months	Every six months

55. Is it affordable for you? YES………. NO……….

Please state any further information relevant to this research.

Thank you very much for your time and your invaluable contribution to this research.

QUESTIONNAIRE FOR OCCUPANTS OF SELECTED MODERN HOUSES IN BAGHDAD

Dear Sir/Madam,

This questionnaire is being undertaken as part of research entitled: **TOWARDS OPTIMAL DESIGN STRATEGIES IN HOT-ARID CLIMATE: A comparative study of environmental and socio-cultural performance of the traditional and modern housing in Baghdad, IRAQ.** Your assistance is being sought in completing this questionnaire for research which will help to develop the building industry in Iraq. Please be assured that you will not be identified as a respondent, and your responses will be confidential with the data only being used for research purposes by university research and will be securely stored. Thank you.

ABOUT YOU AND YOUR HOUSE

1. Are you? **Please tick ONE**

Owner	
Tenants	
Living with family	
Other (give details)	

2. Please indicate how long you have been living in this house. **Please tick ONE**

Under 5 Years	5 -10 Years	11- 20 Years	21-25 Years	Over 25 Years

3. Please tell us the ages of all of the residents living in your household.

Adult aged 60 plus		Age 11-18	
Age 19-25 years		Children aged 5-10	
Adult 25-35 years		Children under 5	
Adult 35-59 years			

4. In terms of environment and climate conditions, are you generally happy with the house you live in? **Please tick ONE**

Very satisfied	
Fairly satisfied	
Fairly un-satisfied	
Very un-satisfied	
Don't know	

If you are not happy, Please state the problems.

ARCHITECTURAL FACTORS

5. Do you use the outdoor space in your house for daily activities?

   YES ……. NO……

If yes, Please describe what kind of activities?

6. How often do you use the outdoor space (garden) for social gathering?

	In Summer	In Winter	In Spring	In Autumn
Always- Every day				
Sometimes-2 -3 times a week				
Rarely- once a month				
Never				

7. Is it uncomfortably noisy in the main living space in your house?

   YES……. NO…….

If yes, where these noises come from? **Please tick ONE or TWO**

Road	Neighbours

8. Do you feel secure in your roof terrace? **Please tick ONE**

Very secure	
Fairly secure	
Fairly un-secure	
Not at all	

9. When you use it as a sleeping area during the summer, does the roof terrace provide you with the privacy? **Please tick ONE**

YES………. NO………..

10. Does it provide you with a comfort zone when you use it as a sleeping area during the summer? **Please tick ONE**

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly un-comfortable				
Very un-comfortable				
Don't know				

11. Is it important for your home to be air-conditioned at all times to provide you with a comfort zone? **Please tick ONE**

Very important	
Important	
Least important	
Not important	

12. Do you feel comfortable in your living room without air-conditioning?

YES…….. NO……..

NEIGHBOURHOOD FACTORS

13. Are you satisfied with the neighbourhood? **Please tick ONE**

Very satisfied	
Fairly satisfied	
Fairly un-satisfied	
Very un-satisfied	
Don't know	

14. How long does your journey take? **Please tick ONE**

	30 minutes or less	One hour	One and half hour	Two hours
To work				
To school				
To shops				
To markets				

ENVIRONMENTAL FACTORS

15. Do you think that, your modern house has a good response to the climate conditions? YES………. NO…………

16. Do you feel comfortable with (minimal services) in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly uncomfortable				
Very uncomfortable				
Don't know				

17. Do you feel comfortable without (minimal services) in your house?

	In Summer	In Winter	In Spring	In Autumn
Very comfortable				
Fairly comfortable				
Fairly uncomfortable				
Very uncomfortable				
Don't know				

18. With your thermal comfort, are you happy with the house you live in?

YES…… .. NO……..

19. In terms of environment and climate conditions, to what extent does the modern house satisfy your needs?

	In Summer	In Winter	In Spring	In Autumn
Very satisfy				
Fairly satisfy				
Fairly un-satisfy				
Very un-satisfy				
Don't know				

20. To what extent that, your comfort has affected by the lack of natural ventilation system?

21. Is the inside of your home protected from the sun at any time of the day?

In Summer	In Winter	In Spring	In Autumn

22. Is your house exposed to spring or summer dust-storms?

YES……. NO…….

If yes, what is the impact of this on occupants comfort?

23. Is your house is not protected from the sun in summer because the wide street is exposed to the weather variations? **Please tick ONE**

Strongly agree	
Agree	
Disagree	
Strongly disagree	
Don't know	

24. In your neighbourhood, the pedestrian movement is restricted to pavements without any protection from vehicles or climate conditions? **Please tick ONE**

Strongly agree	
Agree	
Disagree	
Strongly disagree	
Don't know	

SOCIO-CULTURAL

25. Does your garden, provide you with the privacy? **Please tick ONE**

YES……… NO……..

If yes, do you feel comfortable when you use the garden for social gathering?

Very comfortable	
Fairly comfortable	
Fairly un-comfortable	
Very un-comfortable	
Don't know	

26. Do you know your neighbours? YES…….. NO……..

27. Do you socialise with them? YES……. NO……..

If yes, how often do you visit them? **Please tick ONE**

Once a week	
Once a month	
Twice a month	
Once every two or three months	

SERVICES FACTORS

28. Are you satisfied with your sanitation system? YES……. NO…….

IF NO, Please explain why you are not satisfied?

29. Where do you keep your rubbish?

Rear garden	Road

30. Do you consider this to represent a risk to health? **Please tick ONE**

Strongly agree	
Agree	
Disagree	
Strongly disagree	
Don't know	

31. Do you have problems associated with the surface of the pavements?

Yes…….. No………

If yes, please state the problem.

32, A kitchen in an average-size house is a medium-size room incorporated in the plan of the house, with full fittings, and in some houses overlooking the garden. Do you think that, such a kitchen does provide you comfort zone? **Please tick ONE**

Strongly agree	
Agree	
Strongly disagree	
Disagree	
Don’t know	

32. Does your house incorporate cold water tanks?

Yes……… No………

If yes, do you think that, it is important to provide each house with cold water tank?

Please tick ONE

Very important	
Important	
Least important	
Not important	

If No, do you suffer inconvenience whenever the water supply is cut-off while maintenance work is carried out?

Yes…….. No……..

33. Where is the cold water tank located?

In the garden	In the roof terrace

34. As the cold water tank is left exposed on the roof terrace, the water in it is heated by solar radiation during the day in summer, do think that, is very inconvenient?

Please tick ONE

Strongly agree	
Agree	
Strongly disagree	
Disagree	
Don’t know	

35. As the cold water tank is left exposed on the roof terrace, the water in the rising main and the distribution down-pipe sometimes freezes in winter, causing the lack of water supply in the morning, how often this affects them and to what extent this is a hardship?

Please tick ONE

To great extent	
To some extent	
No particularly	
Not at all	
Not the purpose of the works	

ECONOMIC FACTORS

36. The modern house is usually designed to cover only part of the site: the rest is left as a garden at the front, rear or along one or two sides. What do you use this space for?

37. What would you look for in outdoors space?

38. What do you use it for?

39. Why were you attracted to the house when you decided to buy/occupy/rent?

40. How much energy do you spend in your house? HIGH……. LOW…….

41. What does it cost to provide you with comfort?

42. Do you have an experience of traditional courtyard houses? YES…… NO……

IF YES, What is your experience of these houses are?

43. Why you purchased/rent the modern house you do?

44. How much does it cost you for: Heating in winter……………

Cooling in summer…………...

45. How do you pay your bills?

Monthly	Every three months	Every six months

46. Is it affordable for you? YES………. NO……….

Please state any further information relevant to this research.

Thank you very much for your time and your invaluable contribution to this research.

APPENDIX 2:

OCCUPANTS DIARIES FOR THE SELECTED TRADITIONAL AND MODERN HOUSES FOR THE SUMMER MEASUREMENT 20/09 to 04/10/2014

Please indicate the thermal comfort zone with a tick one box. The thermal sensation you felt during these periods of time.

Living Room	Morning (7:00-12:00)						Lunch (12:00 – 14.00)						Afternoon (14:00-18:00)						Evening/ Night (18:00-22:00/22:00-7:00)					
	Very Hot	Hot	Warm	Slightly warm	Neutral	Cool	Very Hot	Hot	Warm	Slightly warm	Neutral	Cool	Very Hot	Hot	Warm	Slightly warm	Neutral	Cool	Very Hot	Hot	Warm	Slightly warm	Neutral	Cool
20 Sep																								
21 Sep																								
22 Sep																								
23 Sep																								
24 Sep																								
25 Sep																								
26 Sep																								

Living Room	**Morning (7:00-12:00)**						**Lunch (12:00 – 14.00)**						**Afternoon (14:00-18:00)**						**Evening/Night (18:00-22:00) (22:00-7:00)**					
	Very Hot	**Hot**	**Warm**	**Slightly warm**	**Neutral**	**Cool**	**Very Hot**	**Hot**	**Warm**	**Slightly warm**	**Neutral**	**Cool**	**Very Hot**	**Hot**	**Warm**	**Slightly warm**	**Neutral**	**Cool**	**Very Hot**	**Hot**	**Warm**	**Slightly warm**	**Neutral**	**Cool**
27 Sep																								
28 Sep																								
29 Sep																								
30 Sep																								
01 Oct																								
02 Oct																								
03 Oct																								
04 Oct																								

OCCUPANTS DIARIES FOR THE SELECTED TRADITIONAL AND MODERN HOUSES FOR THE WINTER MEASUREMENT 14-28/02/2015

Please indicate the thermal comfort zone with a tick one box. The thermal sensation you felt during these periods of time.

Living Room /Ursi	Morning (7:00-12:00)						Lunch (12:00 – 14.00)						Afternoon (14:00-18:00)						Evening/ Night (18:00-22:00/22:00-7:00)					
	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold
14 Feb																								
15 Feb																								
16 Feb																								
17 Feb																								
18 Feb																								
19 Feb																								
20 Feb																								

Living Room /Ursi	Morning (7:00-12:00)						Lunch (12:00 – 14.00)						Afternoon (14:00-18:00)						Evening/Night (18:00-22:00) (22:00-7:00)					
	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold	Very Hot	Hot	Warm	Slightly warm	Neutral	Cold
21 Feb																								
22 Feb																								
23 Feb																								
24 Feb																								
25 Feb																								
26 Feb																								
27 Feb																								
28 Feb																								