Provision of Urban Thermal Comfort: A Socio-Technical Approach to Climate Responsive Urban Design

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Declaration

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to my mum & dad…

Abstract

This research claims that urban design as a discipline has the potential to catalyse the production of more climate responsive urban living environments. This is now a goal for many governments who are looking for ways to tackle climate change. The research argues that a climate responsive design (CRD) approach, which originated in the field of architecture, can be scaled-up to wider urban scales in order to activate the catalysing power of urban design. Climate responsive urban design (CRUD) can help to reduce energy consumption for the provision of thermal comfort in different layers of urban life. However, its application calls for the integration of `technical knowledge(s)` (i.e. building form, street geometry, density) and `social knowledge(s)` (i.e. lifestyle, socio-cultural values) that are generated through everyday life experiences and socio-cultural relationships of local people.

Adopting a socio-technical approach, the research was conducted in Mardin, Turkey, a city in the south east of the country and a candidate for the UNESCO World Heritage List. Part of the city (the 'Old Town') evidences a mode of urban development that has been developed over thousands of years in response to climatic conditions, people's lifestyles and their socio-ecologic values. The research takes a comparative approach to explore the similarities and differences between the way(s) in which urban thermal comfort is evidenced and provided within the 'Old Town' heritage site and a contemporary ('New Town') development delivered by the Turkish government using a standardized design. Various techniques such as in-depth interviewing, technical measurements (i.e. temperature, humidity), street questionnaires, ethnographic observation, photographing and video-recording were used.

The results present that the current urban development pattern fits neither local requirements nor respond sufficiently to climatic variations of the type seen in Mardin. The research elaborates this mismatch by highlighting the responsive design clues/traces from the vernacular ('Old Town') urban development pattern which offer more responsive environments for the provision of thermal comfort. The research shows that, in order to achieve truly sustainable urban development, there is a need to (re)define climate responsive urban design to better respond to local climatic characteristics and consider local people`s perceptions and comfort requirements under specific climatic conditions.

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ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BCR	Building Coverage Ratio
BIAA	British Institute at Ankara
CIAC	Conservation Implementation Audit Centre
COP21	21st Conference of Parties
CRD	Climate Responsive Design
CRUD	Climate Responsive Urban Design
ETKB	Ministry of Energy and Natural Resources
FAR	Floor Area Ratio
GMM	Greater Municipality of Mardin
IPCC	Intergovernmental Panel on Climate Change
KUDEP	Conservation Implementation Audit Centre
MA	Municipality of Artuklu
MPDUE	Mardin Provincial Directorate of Urbanization and Environment
MUE	Ministry of Urbanization and Environment
NCCAP	National Climate Change Action Plan 2011-2023
OECD	Organization for Economic Cooperation and Development
TMOBB	Union of Chambers of Turkish Engineers And Architects
TOKI	National Housing Development Administration of Turkey
TSI	Turkish Statistical Institute
WCED	World Commission on Environment and Development

CHAPTER 1

INTRODUCTION

Figure 1.1 Protests against populist political rhetoric for climate change

Source: www.elviravaclavik.com (2015)

"TURN OVER A NEW LEAF: It is necessary to achieve changes in production processes in the fields of energy, urbanization and transportation. Unfortunately, countries could not cover a substantial distance since the Kyoto protocol. We are FULL of HOPE for countries to take particular responsibilities, at the 2015 Paris Climate Conference….Turkey declared its target of 21% reduction in greenhouse gas emissions by 2030..." (Fatma Güldemet Sarı, Minister of Environment and Urbanization, Turkey, 2015)

The above press briefing by the Minister of Environment and Urbanization of Turkey and Figure 1.1 exemplify Swyngedouw's (2010) argument regarding climate-associated policies' being sustained by decidedly populist gestures. In the domain of science, it has been known for several decades that the development of urban built environment has serious effects on the natural environment and climate (Smit et al., 2000; Jankovic and Hebbert, 2012; Shashua-Bar et al., 2012). Although decision-makers involved in urban development have started to recognize the severity of this impact, a sufficient level of action (e.g. revisions in urban development legislations, use of low/zero carbon emissions technologies) has yet to be achieved. The failure to act is due to two different challenges. First is the identification of an appropriate approach, mechanisms and methods for climate responsive urban space production. Second is the willingness of urban decisions-makers to initiate a change in the current urban development system; that is to say, support a transition from the current urban development system to a more climate responsive one. The current urban development system, labelled 'conventional' in this research, disregards both climatic variations and socio-cultural diversity in the country, and leads to prototype planning applications highly dependent on expert (e.g. urban planners) decisions (Yazar and Dede, 2012).

1.1 The Research Focus

This research focuses on the two challenges of introducing climate responsive urban space production mentioned above. With this purpose in mind, the research argues firstly for the importance of a climate responsive design (CRD) approach in reducing the impacts derived from urban built environments. Secondly, it investigates the possibility of implementation/application of a CRD approach in urban development practices.

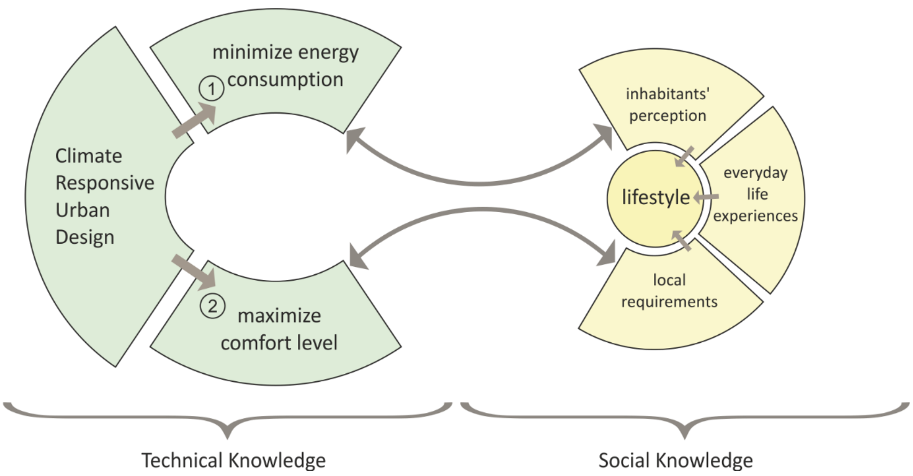
A climate responsive design (CRD) approach, which emerged within the field of architecture, strives to produce inherently comfortable living spaces while consuming minimum energy in order to reduce negative effects (i.e. greenhouse gas emissions) (Energy Design Resources, 2010). The approach assumes that the majority of the greenhouse gas emissions derived from urban areas is caused by energy consumption, particularly energy used for the provision of thermal comfort in urban settings. Thermal comfort here refers to thermal satisfaction of residents within the climatic variables (e.g. temperature, humidity) of living environments. In this sense, the CRD approach calls for designers to make maximum benefit of natural territorial climatic characteristics in order to reduce the use of finite energy sources while seeking a desirable comfort level. Therefore, the CRD approach defines two main goals, (1) the reduction of energy consumption and (2) the provision of comfortable living environments.

This research argues that a climate responsive design approach (CRD) can be scaled-up to wider urban scales from streets to city levels. In so doing, the research claims that 'urban design' as a discipline has the potential to catalyse the production of climate responsive cities. Thus, the research considers climate responsive urban design (CRUD) as a potential mechanism for achieving climate-related targets, such as those declared in the news briefing in the opening of this Chapter (i.e. 21% reduction in greenhouse gas emissions in cities by 2030).

Taking this as a point of departure, the first goal of climate responsive design (CRD) (the reduction of energy consumption), can be achieved through two channels. First is the use of technologicaly innovative solutions that foster the use of less energy and obtain efficient performance in the built environment. The second can be achieved by reducing demand for energy through design that ensures energy is saved by gaining the maximum benefit from the natural climatic characteristics found in specific territories. For this purpose, different professional groups such as environmental scientists, urban planners, architects and engineers seek alternative urban development and design solutions to reduce the negative influence such as greenhouse gas emissions derived from urban areas. These endeavours generate an accumulation of 'technical knowledge' regarding designing cities that are more responsive to climate change. The term 'technical knowledge' in this research refers to design variables such as urban form, street geometry, building form and materials, as well as the advanced technologies for implementation of the proposed solutions for responsive urban development tactics.

However, the second goal of CRD (the provision of comfort in living settings), is not as easy as to achieve as the former. This is primarily due to the context-dependent nature of the term 'comfort'. Attributes of human comfort, as Milne and Givoni (1979) underline, vary from culture to culture. In addition, localities have the capacity to produce their own adaptive strategies and coping mechanisms to provide comfortable living settings responding to local climate (see for instance: Berkes and Ross, 2013 and Hammond et al., 2012). Therefore, the accumulated technical design principles can be helpful but cannot be sufficient due to the lack of integration of the human dimension and understanding of everyday experiences of urban inhabitants. Each context may require different spatial organizations. For instance, proposing transit oriented development and expecting people to live in small houses and use public transportation for their daily commuting needs in an Arabic city like Abu Dhabi may not be the ideal urban development approach because private car ownership is a symbol of prestige in this society. The key message is that each locality has its own unique culture. Therefore, it is essential to combine technical knowledge about climate responsivity (i.e. building form, street geometry, density) and the social / cultural knowledge (i.e. lifestyle, socio-cultural values) that is generated within and by local communities. In other words, the latter goal of CRUD necessitates approaching urban design as a socio-technical process allowing for the integration of local specific values into urban development processes (see Figure 1.2).

Figure 1.2 The cyclical relationship between climate responsive design and lifestyle



Source: Author`s original

The research argues that producing climate responsive urban space calls for an in-depth understanding of the micro-climatic conditions of territorial settings, as well as lifestyles and the ways in which inhabitants make use of urban space. In order to achieve upper level targets such as reducing energy consumption in urbanities, the research argues that the production of climate responsive built environments calls for an **urban design approach that (1) responds to local climatic characteristics, and (2) considers local peoples` perceptions and requirements for the provision of thermal comfort in urban life.** The research aims to develop a socio-technical approach to urban design capable of finding technical design solutions suitable both for local climatic characteristics and the social attributes and thermal comfort requirements of inhabitants/end-users in urban life.

In order to do this, the research uses the explanatory power of case studies and investigates an urban heritage site which exemplifies a reasonable level of sustainability through its capacity to survive for thousands of years. Urban heritage sites stand as open laboratories that can enable us to understand how the physical organization of the urban built environment could be formulated in coherence with local lifestyles while providing thermally comfortable urban living environments (see for instance: Oktay, 2002; Bekleyen and Dalkılıç, 2012; Frey, 2013). As argued in the literature (Fry, 2008; Torus, 2011) many lessons can be learned from the past and interpreted for future urban development. The presence and contemporary usage of urban heritage environments provide an opportunity to design comparative research between the past and the contemporary urban development in cities. This kind of comparison provides an opportunity to see the way(s) in which the formation of built environment provides responsive settings for local requirements both in terms of socio-cultural and climatic variations.

This research is designed based on the province of Mardin a city in South-Eastern Turkey that accommodates an urban heritage site that has developed over thousands of years under extreme climatic variations. The uniqueness of the vernacular development pattern of Mardin - which has led to the city being named a candidate for the World Heritage List by UNESCO - offers the potential to learn lessons from the past that may help urban designers, planners, developers and government actors tackle contemporary challenges associated with climate. The research additionally argues that heritage sites do not only accommodate clues in terms of appropriate design techniques but can also provide visions for living in more climate responsive way with the help of coherent urban space production in wider urban scales from housing to street and city levels.

This research is designed using a comparative approach between the Old (heritage) and New (contemporary) Towns in the province of Mardin in order to explore the clues (socio-physical markers) of an efficient use of natural assets and smart strategies to prevent negative conditions of extreme climate conditions. While the Old Town has been developed over thousands of years, the

New Town began to be shaped after the 1960s to accommodate an increasing urban population triggered by the migration from rural areas. As seen in Figure 1.3, two towns present conspicuously different urban forms.

Figure 1.3 Aerial photo of Mardin

Source: Google Earth, 2015

The comparative study, by revealing the way(s) in which the formation of urban space presents responsivity to both climatic conditions and inhabitants' lifestyle, generates an evidence base to support the main aim regarding the development of a socio-technical approach to climate responsive urban design. In line with the main aim, the research has four inter-related minor research questions:

RQ 1. How is the morphology of the urban built environment (urban 'grammar') in both the Old (heritage) Town and New Town of Mardin formulated?

RQ2. What is the relationship between urban thermal comfort and the urban built environment in Mardin?

RQ3. How do the built environments within in the Old and the New Town vary in response to climatic conditions and local lifestyles?

RQ4. What are the barriers and/or catalysers for the introduction of design principles/solutions to enhance climatic responsiveness in new urban developments?

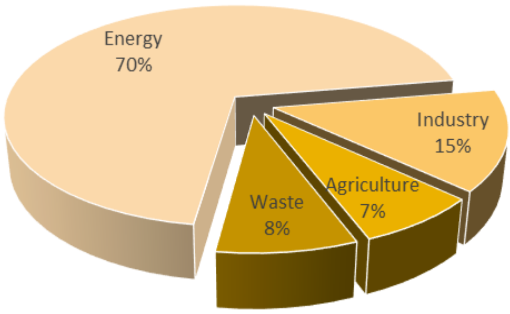
1.2 Rationale for the Study

The pressing challenge of climate change is a growing crisis with economic, health and safety, food production, security, and other implications. Although climate change and its potential future impacts on human and natural life have been discussed for over 40 years, the ambiguities of the phenomena and the unpredictability of its future impacts means it remains an urgent issue for scientists looking to minimise its effects upon the human and natural world. While there is enormous debate about how best to achieve this, what scientists and intergovernmental bodies (e.g. IPCC) agree upon is that climate change is a real fact that needs to be managed in order to prevent possible catastrophic impacts in the future. The most recent agreement signed in COP21 Paris underlines the importance of "rapid emission reductions" to control the irreversible climate change threat to human societies and the planet (COP21 Agreement, Paris, 2015).

1.2.1 Greenhouse Gas Emissions Derived From Cities

Due to its complex nature, climate change has a reciprocal relation with several issues such as sustainable urban development, resource efficiency, food sustainability and many other biotic dimensions. Since the late 1970s, scientists have recognized the contribution of cities, particularly in terms of greenhouse gas emissions, to processes of climate change. Since the 1980s, governments have generated common ground upon which they can collaboratively take precautions in order to control temperature increases and reduce the adverse impacts of climate change. International conglomerations and agreements such as United Nations Framework Convention on Climate Change, Kyoto Protocol and Marshal Protocol approach the issue using sector-based classifications (i.e. contributions from different sectors such as transportation, energy etc.) and point out the significant greenhouse gas emission reductions to be achieved mainly by sustaining energy efficiency in various sectors. With respect to use of energy, the UN Secretary-General's Advisory Group on Energy and Climate Change (2010) declares that the energy system – supply, transformation, delivery and use – is the dominant contributor to climate change, representing around 60% of total current greenhouse gas emissions (p:7). Likewise, the Turkish Statistical Institute (TSI) (2012) presents that the energy sector makes up the greatest portion (70%) in the general distribution of sectors according to emissions (see Figure 1.4). In addition, recent researches (Zhou et al., 2013; Lombard et al., 2007 and Janulis, 2004) highlight the energy consumption volumes of different sectors such as building, transportation, industry, lighting, manufacturing, communication and agriculture. Each sector contributes a certain level of carbon emissions in line with the energy consumption which is determined according to specific requirements.

Figure 1.4 Greenhouse gas emissions by sectors in 2012



Source: TSI, 2012

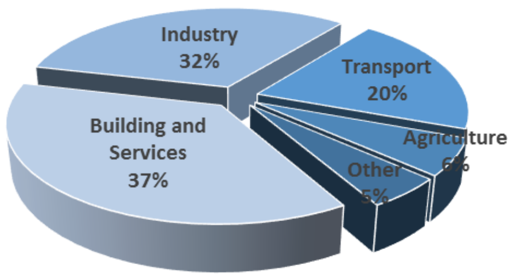
For instance, providing thermal comfort by controlling heating and cooling mechanisms in buildings requires a certain amount of energy consumption which releases greenhouse gases into the atmosphere in return. Likewise, transportation infrastructure, modes, and networks are significant variables in terms of controlling the amount of greenhouse gas emissions. Table 1.1 shows the general contribution of different sectorial groups to climate change in relation to energy use.

Table 1.1 Sectorial distribution of energy consumption inducing to climate change

Sectors	Use of Energy	Output	References
Buildings	Heating and Cooling Thermal comfort	Greenhouse gases	Zhou, Lin, Cui, Qiu and Zhao (2013) Lombard, Ortiz and Pout (2007)
Transportation	Vehicle Fuels Public Transport Network		U.S Environmental Protection Agency (2006)
Industry	From manufacturing to heavy processes of industry		The European Council for an Energy Efficient Economy (2012)
Communication	Visual & audial networks Wireless internet		Feeney, L. M. (2001)
Agriculture	Fuel or electricity for equipment, farm lighting		Janulis, P. (2004)

According to the Ministry of Energy and Natural Resources, based on 2011 statistics, Turkey procures 93% of its primary energy supply from fossil fuels and only 7% from hydraulic and renewable sources (ETKB, 2011). As seen in the Figure 1.5, the largest part of the consumed energy belongs to the building and services sector.

Figure 1.5 Distribution of energy consumption by sectors



Source: ETKB, 2011

1.2.2 Energy Consumption in Urban Space

Cities as multi-sectorial formations have an active contributing role in terms of greenhouse emissions, primarily caused by the consumption of non-renewable energy sources. Therefore, tackling this multi-dimensional problem calls for multi-disciplinary interventions that include various policies and actions from different disciplines. However, a number of research (see for instance: Roggema, 2009; Hammond et al., 2012) claim that the adaptation to climate change is dominantly a spatial problem. Beyond the meaning of physical formation, spatiality also refers to practices of individual and social life continuously (re)produced within the urban space. Considering that sectors such as building and transportation are bound up in space production and shape the way in which the physical environment is organized, it is essential to question the appropriate approach to space production with respect to the climate issue. As presented in Table 1.2, built environment components at various scales can have effects at two critical levels: on the one hand, the urban micro-climate; on the other hand, energy consumption (Bourbia and Boucheriba, 2010; Davies et al., 2008; Hamin and Gurran, 2008; Kleerekoper et al., 2011). The list of urban components shown in Table 1.2 also helps us to identify which features contribute towards energy consumption in the built environment.

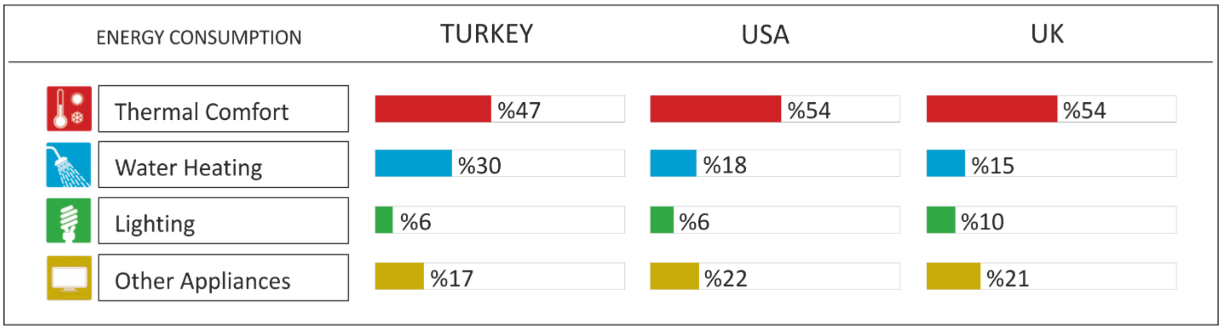
Table 1.2 Urban space indicators

Urban Space Components	Sub-indicators	Effects on	References
Macroform	Density Urban fabric Urban cover	Travelling distances Urban climate Modes of living	Hamin and Gurran (2008) Zhao, Fu, Liu and Fu (2010)
Transportation	Orientation of streets Street geometry Pavements and parking	Local wind velocities Cooling	Davies, Steadman and Oreszczyn (2008)
Buildings	Building forms Orientation of buildings Density and design of blocks Materials	Incidence of radiation on materials that can store heat Wind speed Heat accumulation	Kleerekoper, Esch and Salcedo (2011)
Vegetation	Urban forests (parks) Street trees Private green in garden Green roofs or facedes	Microclimate of the spaces Evaporation and transpiration	Bourbia and Boucheriba (2010) Kleerekoper, Esch and Salcedo (2011) Shashua-Bar, Tsiros, Hoffman (2012)

Urban components such as urban form, buildings masses, vegetation systems, with their capacity of creating atmospheric change, have a significant role in the formation of urban climate (Smith, 2005 and Birkeland, 2002). For example, the design of building units and development patterns affect heat radiation ratios, while urban street patterns influence the formation of wind corridors and utilization of solar energy (Hyde, 2001; Santamouris, 2001 and Smith, 2005). The design of buildings and urban spaces directly affects urban temperature, wind, rain and air quality, whose effects can be seen on human comfort and health (Jankovic and Hebbert, 2012). Therefore, the formation of the built environment affects not only urban microclimates and thermal comfort, but also the energy consumption patterns needed in order to obtain thermal comfort.

Considering the relationship between the formation of urban space and end-use energy consumption for the provision of comfort in urban life, calls for a political change with respect to reducing energy consumption in urban areas. The Turkish National Climate Change Action Plan (NCCAP) identifies “energy efficiency” as the most essential action in terms of reducing energy consumption. As presented in Table 1.2, urban design components such as density, urban fabric, street geometry, building forms and orientations are essential in terms of their capacity to change energy consumption patterns. Energy used in housing facilities and transportation in urban areas has the largest ratio among the other urban-oriented factors changing the urban climate. Most of the energy consumed in housing is used for heating and cooling to provide urban thermal comfort. For instance, materials used in housing units affect the amount of energy required for heating or cooling. Almost half of the domestic energy consumption both in developing and developed countries is used in heating and cooling facilities for the provision of indoor thermal comfort. As seen in Figure 1.6, in Turkey, 47% of total energy consumption by end-users is used to provide thermal comfort, while 30% is used for heating water, 6% for lighting and the rest is for other appliances such as small electronic devices.

Figure 1.6 Domestic energy consumption by end-use

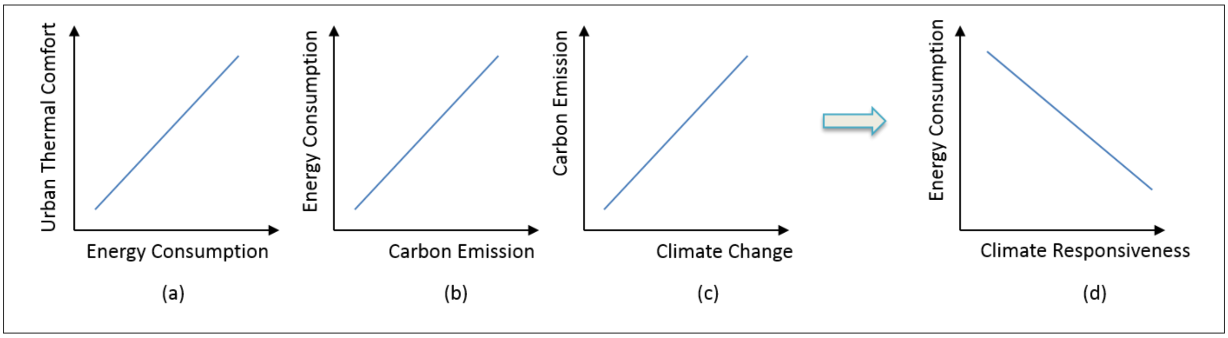


Source: Cakar (2012), USA Department of Energy (2011) and UK Department of Energy and Climate Change (2015), Graphic: Author’s original

This shows that there is the potential to save energy for the provision of thermal comfort at the housing scale. The Energy Efficiency Report published by TMOBB EMO (2012), states that Turkey has the potential to save in energy use at least 35% in building, 15% in industry and 15% in transportation sectors (TMOBB EMO, 2012). The report says that if energy efficiency plans can be translated in actions, Turkey may reduce its total energy consumption by as much as 20%. This amount is 2.5 times more than the amount of energy that can be produced by renewable sources. Therefore, in order to reduce levels of energy consumption in cities, it is essential to design the built environment in such a way to gain maximum benefit from natural climatic characteristics in specific territories.

The provision of urban thermal comfort in cities requires a certain amount of energy consumption in various sectors such as housing, transportation and services. As seen in Figure 1.7, the consumed energy induces a certain amount of carbon emission which is one of the major factors of climate change. Therefore, the study assumed to evidence a reciprocal relationship between designing climate responsive urban settings and the amount of energy consumed for providing urban thermal comfort.

Figure 1.7 Graphical presentation of the relationship between urban thermal comfort and climate responsive design



Source: Author's original

In addition, since each locality presents different characteristics in terms of both climatic and socio-cultural parameters, it is also essential to approach urban design as a context based activity, which understands and internalizes contextual variables and tries to harmonize these values into problem solving processes.

While exploring the contextual variables in terms of climate responsive urban design through the Mardin case, this research approaches urban design from a socio-technical perspective in order to explore the design indicators providing responsivity to climatic conditions and to understand how people use the built environment and adapt and/or avoid certain urban climatic conditions.

1.3 Structure of the Thesis

Chapter 1 presents the research focus and the rationale for the thesis. It includes an introductory discussion of climate responsive design and its requirements regarding the integration of technical knowledge about the production of urban physical space and the social knowledge generated within and by local communities.

Chapter 2 first presents a review of existing approaches to the provision of urban thermal comfort in different layers of the urban built environment, including indoor and outdoor spaces. Then, based on a critical synthesis of the ways in which thermal comfort studies have framed the phenomenon, the chapter develops the argument that a reconceptualization of urban thermal comfort is needed. Following that, the chapter presents reviews of two related bodies of literature on climate responsive design indicators with respect to the provision of thermal comfort in different urban scales and human responses to climatic conditions and climate change.

Chapter 3 first presents the potential of urban design discipline as a catalyser of climate responsive space production. Then, it presents a socio-technical perspective that considers both the measurable/technical dimensions of thermal comfort such as temperature and humidity, and the anthropogenic dimensions such as the human responses and inhabitants` adaptation capacities. Following the socio-technical perspective, the chapter develops a socio-technical approach to urban design for the provision of urban thermal comfort such as the climate responsive design approach aims to achieve.

Chapter 4 presents the research methodology. Initially, the chapter introduces the research themes and questions that underpin the thesis. Later on, the chapter presents the rationale behind the selection of the Mardin case study, and explores wider issues associated with taking a case study approach to climate responsive urban development. Subsequently, the chapter examines the methodological techniques that correspond with the research objectives. The chapter ends with a reflection on the nuances of researching local specificities and the researcher`s experiences of conducting socio-technical research in the selected case city.

Chapter 5 provides an in-depth discussion of the Mardin and wider Turkish urban development context. The chapter starts by introducing the city of Mardin, outlining its geographical, climatic and demographic structure. It then briefly explains the development history of Mardin from ancient times through to the contemporary period. Subsequently, the chapter focuses on the variations between the organic/historic urban pattern and the contemporary development pattern, and presents the sub-component urban elements (i.e. housing typologies, street patterns) forming the spatial pattern in each town. In addition, the chapter presents an overview of urban development systems in Turkey. This includes the spatial planning hierarchy and the planning institutions partaking in decision-making processes.

Chapter 6 presents the research findings relating to the impact of the urban built environment on end-users` perceived thermal comfort levels at different scales of urban life. The findings in this section correspond to the whole sample (i.e. without distinction between the Old and New Towns) used in this research. Results are discussed only in terms of the relationship between the formation of urban forms and the perceived thermal comforts, rather than a comparison between the samples generated from two towns.

The differences between the Old and New Towns are presented in Chapter 7. The chapter presents the way(s) in which the formation of the built environment in the Old and the New Towns respectively influence perceived thermal comfort at housing, street and city scales. In order to do this, the chapter focuses on the differences and similarities between design attributes and their influencing potential on thermal comfort and the amount of energy consumed for the provision of that comfort.

Chapter 8 evaluates the research findings and discusses possible ways to reflect the research findings in urban development practices. Accordingly, the chapter elaborates the political dimension of urban space production and discusses the challenges of producing climate responsive urban environments under the existing socio-political conjecture in Mardin. As part of this discussion, the chapter also focuses on the research findings relevant to the climatic features discussed under different scales and elaborates it from an urban design point of view.

Lastly, Chapter 9 presents the research contributions in relation to the role of urban space on energy consumption levels for the provision of thermal comfort in urban life. The chapter summarizes the findings generated by the comparative analysis of the Old and New Towns in Mardin, and particularly the lessons that can be carried forward into the delivery of future developments/design proposals. Subsequently, the chapter highlights the research`s contributions related to the discussion of the catalysing power of urban design and, more specifically, the need for a socio-technical approach to climate responsive urban design. The chapter ends with the methodological contributions and recommendations for future research agendas and directions.

CHAPTER 2

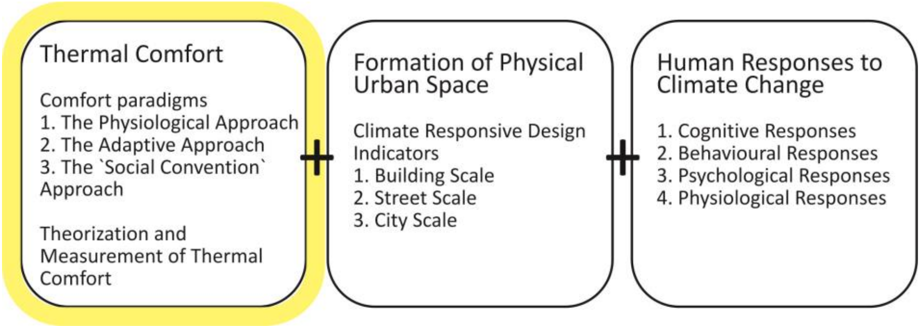
URBAN THERMAL COMFORT IS ACHIEVED WITHIN AND THROUGH THE PRODUCTION OF SPACE

2.1 Introduction

This research argues that the production of climate responsive urban spaces can be achieved by approaching urban design as a socio-technical process which allows for the integration of localy specific knowledge and values into urban development processes. Considering that each locality has its own culture, and lifestyles vary widely from place to place, designing climate responsive urban environment calls for an in-depth analytical approach which enables the exploration of contextual requirements (e.g. local climatic challenges) and the limits of urban development (e.g. construction techniques). Therefore, this research approaches urban design as a process comprising of not only spatial organization and physical adjustments to the built environment but which also integrates human dimensions, including an understanding of social interactions and variations in, and barriers to, climate adaptation.

Within this context, this chapter first reviews the existing approaches to urban thermal comfort in different layers of urban built environment, including indoor and outdoor spaces. Then, based on a critical synthesis of the ways in which thermal comfort studies have approached/framed the phenomenon so far, the chapter proposes there is a need to reconceptualise urban thermal comfort. Reconceptualization here includes equal consideration of the measurable/technical dimensions of thermal comfort such as temperature and humidity, and the anthropogenic dimensions such as the human responses and inhabitants` adaptation capacities. Following this argument, the chapter presents reviews of 3 different bodies of literature as diagrammed in Figure 2.1. These bodies include (1) thermal comfort paradigms including the theorization and measurement techniques, (2) climate responsive design indicators with respect to the provision of thermal comfort at different urban scales and (3) human responses to climatic conditions and climatic change.

Figure 2.1 Three major bodies of literature used in the research



Source: Author's original

2.2 A Deeper Look at Thermal Comfort Paradigms

Despite the lack of an absolute standard definition for thermal comfort, literature presents that there are three different approaches to explaining and understanding thermal comfort, (1) the physiological/ conventional approach, (2) the adaptive approach and (3) the social convention approach (Chappells and Shove, 2004; Djongyang et al., 2010; Liu et al., 2012). Each approach has its own strengths and limitations, therefore, it is useful to understand how the inadequacies of one approach triggered the emergence of the other, rather than looking for a supremacy gradation among the approaches. Table 2.1, based on the study of Chappells and Shove (2004), presents a brief summary of the thermal comfort paradigms, including how each approach defines, determines and (theoretically at least) seeks to achieve, thermal comfort.

Table 2.1 Thermal comfort paradigms

	(1) Physiological	(2) Adaptive	(3) `Social Convention`
Defining Comfort	Biological heat balance	Physiological/Behavioural adaptation	Social/cultural experience
Determining Comfort	Definable universal condition	Definable condition	Matter of cultural/ historical convention
People / End-users	Passive recipients	Active recipients	Active recipients
Stimuli of Thermal Comfort	Physical Space	Physical Space Personal lifestyle	Cultural Issues Socio-economic factors
Comfort Environment	Mostly indoor	Indoor Outdoor	Indoor Outdoor
Assessment Approach	Experimental	Quasi-experimental	Explanatory
Assessment Technique	Laboratory experiments	Field studies	Ethnographic enquiries

Source: Adapted from Chappells and Shove (2004)

As seen from the Table 2.1, the main difference between the three approaches derives from the definition of thermal comfort. While the physiological approach conceptualizes thermal comfort as a definable condition determined by the relation between external environment and the responses of the human body (Fanger, 1970), the adaptive approach defines comfort as an outcome of physiological and behavioural adaptations which can be developed as a response by individuals facing the condition of discomfort (Nicol and Humphreys, 2002). Furthermore, the social convention model appreciates the adaptive capacity of the human body and reinforces the definition of thermal comfort by highlighting the significance of historical and cultural background by which the thermal comfort expectations are (re)produced (Chappells and Shove, 2004). Variations in the definition of thermal comfort inherently create variations in the achievement and assessment of the level of comfort. The following sub-sections present a deeper understanding of the theoretical and empirical aspects involved in each approach.

2.2.1 The Physiological/Conventional Approach: Provision of Heat-Balance

The physiological or 'conventional' approach, which was developed based on human-heat balance[1], mainly focuses on well-controlled environments disregarding the adaptive capacity of individuals (Humphrey and Nicol, 1998; Nicol and Humphrey, 2002; Liu et al., 2012). The approach seeks to explain human responses to the environment in terms of the physics and physiology of heat transfer (Nicol and Humphrey, 2002). An index of thermal comfort, as exemplified in Fanger`s (1970) experiments using a steady-state[2] heat transfer model, is used to express the thermal state of the human body and the thermal environment. The most important variables of thermal comfort are activity levels, the thermal resistance of clothing, air temperature, relative air velocity and the water vapour pressure in ambient air (Fanger, 1970).

In Fanger`s (1970) experiments, participants are dressed in the same clothes and asked to do some pre-defined activities in groups exposed to different thermal conditions. In this 'heat-balance' approach, the experiments aim to monitor how the human body maintains a balance between the heat produced by the body metabolism and the heat lost from the body. Maintaining this heat-balance, as Charles (2003) asserts, is the prior condition of achieving a neutral thermal sensation. Based on serious experimental studies, Fanger (1970) obtained a `comfort equation` which forecasts

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[1] "*Humans burn food for energy and must discard the excess heat. This is accomplished by evaporation coupled with the three modes of sensible heat transfer: conduction, convection, and radiation. For a person to remain healthy, the heat must not be lost too fast or too slowly, and a very narrow range of body temperature must be maintained.*" (Bradshaw, 2006, p.7)

[2] A `steady state` is a situation in which all state variables are constant in spite of ongoing processes that strive to change them.

the conditions in which the participants feel thermally neutral. This comfort equation, as Djongyang et al. (2010) state, was combined with a thermal sensation scale developed by ASHRAE[3] and turned up as `Predicted Mean Vote` (PMV) index. Summarising, the PMV index predicts the mean response of a group of participants according to the ASHRAE thermal sensation scale which runs from cold (-3) to hot (+3). The PMV index was then incorporated into the `Predicted Percentage of Dissatisfied` (PPD) index which is a quantitative measure of the thermal comfort of a group in a particular thermal environment (Djongyang et al., 2010). Literature presents that the PMV-PPD model was used as a common index for indoor thermal comfort studies until the limitations of the model were recognised by scholars (Liu et al., 2012).

The model is mostly used for indoor environments to estimate the mean thermal sensation of a group of participants based on a standard scale which takes into account the four physical attributes (air temperature, air velocity, mean radiant temperature (MRT[4]) and relative humidity) and the two subjective attributes (clothing and activity level) (Yau and Chew, 2012). The model is also called a heat-balance model because the thermal sensation in PMV is interrelated with the thermal load from the mechanisms of the human thermoregulatory system (Fanger and Toftum, 2002). According to the model, thermal comfort can be achieved only if the body is in heat balance, with the average skin temperature and sweat rate within certain limits (Yau and Chew, 2012).

As Schiavon and Melikov (2008) argue, the heat-balance/physiological approach does not provide a comprehensive understanding of thermal comfort since people in everyday life do not act like `static variables` unaffected by external factors. Moreover, laboratory based experiments, as Djongyang et al (2010) assert, are only possible in stable and consistent conditions which is not possible to ensure in `real life` field studies. For instance, a study by Oseland (1995) shows that the predicted mean votes (PMV) obtained by the index, and the actual mean votes (AMV) obtained in fieldwork, present variations. Similarly, field studies conducted in tropical climates (see Nicol, 2004) reveal that the PMV model does not effectively express the thermal comfort situation, especially in buildings without a mechanical heating or cooling system. This shows the requirement of additional dimensions/variables in terms of understanding/assessment of thermal comfort and the need for a reconceptualization of the approach to the thermal comfort.

[3] American Society of Heating, Refrigerating, and Air-Conditioning Engineers

[4] The mean radiant temperature (MRT) is defined as the uniform temperature of an imaginary enclosure in which the radiant heat transfer from the human body is equal to the radiant heat transfer in the actual non-uniform enclosure (ISO 7726, 1998).

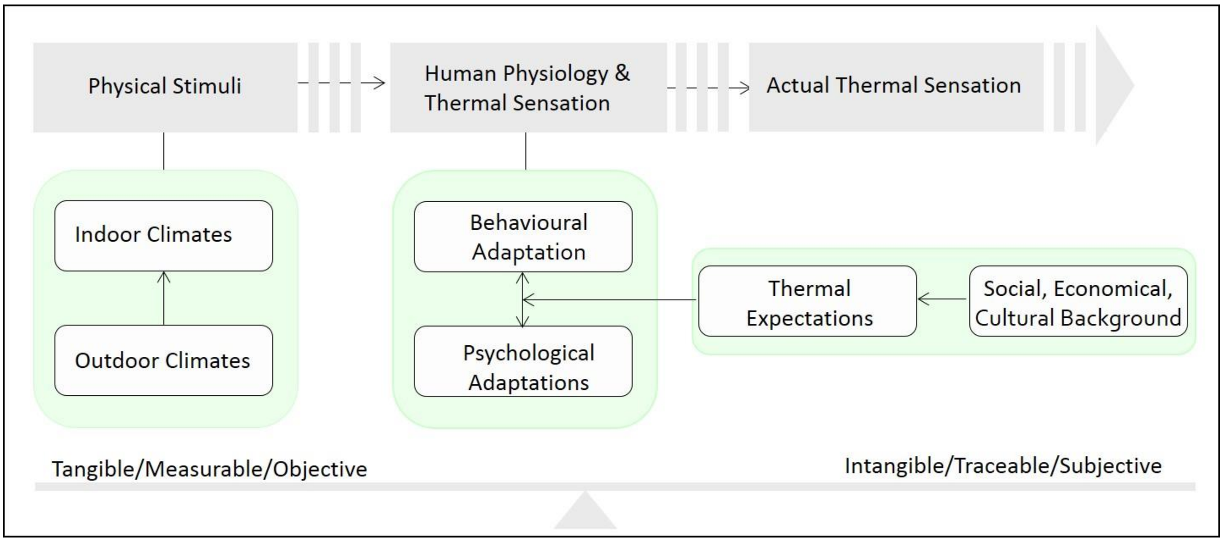
2.2.2 The Adaptive Approach: More than Just a Question of Temperature

In contrast to the conventional approach, the adaptive approach considers people as active, rather than passive recipients in response to ambient physical thermal stimuli (Liu, et al., 2012). The adaptive approach argues that individuals have adjustment skills in terms of their physiology, behaviour and psychology (Brager and de Dear, 1998). Therefore, the adaptive approach, as Liu et al. (2012) state, understands thermal comfort as a combination of stimuli derived from both physical space and factors such as lifestyle, cultural beliefs and values. This is why the adaptive approach to thermal comfort is mostly based on the findings of field work/case studies (Humphreys, 1996; Djongyang et al., 2010). According to Nicol and Humphreys (2002), field studies suggest that `rational indices` are difficult to use in real situations and are poor indicators of comfortable conditions. Therefore, the relationships based on the laboratory experiments (as in the conventional approach) need to be tested in the field, rather than applied as sets of standards for the provision of thermal comfort.

While the physiological approach focuses on the ways in which various components of physical space affect thermal comfort and how this is received by end-users, the adaptive approach goes one step further by considering other external factors which might potentially influence perceived thermal comfort. Studies (see Baker and Standeven, 1995; Fanger and Toftum, 2002) approaching thermal comfort from an adaptive perspective are mostly based on the building scale and individuals using the indoor environments such as office spaces. In this sense, the adaptive capacity is more about the ability of people to open a window, draw a blind or use a fan (Baker and Standeven, 1995) and the clothing choices of individuals (Nicol and Humphreys, 2002). This shows that most of the adaptive opportunities mentioned in the literature allow end-users to change their thermal comfort levels. However, there is a strong relationship between the design of physical space and the adaptive capacity of end-users to provide thermal comfort in buildings. Unless the building gives occupants the chance to adjust the conditions for their ideal thermal comfort level, as Nicol and Humphreys (2002) assert, it is likely to lead to a decrease in their level of comfort.

Some studies which approach thermal comfort from an adaptive perspective (see for instance: de Dear and Brager, 2002; Yao et al., 2009) incorporate an additional dimension; that end-users react in ways to restore their thermal comfort when a change occurs such as to produce discomfort. Thus, people present self-regulatory actions through (1) physiological, (2) psychological and (3) behavioural adjustments (Yao et al., 2009). The physiological process (1) of adaptation, as Yau and Chew (2012) assert, consists of a `genetic adaptation` which has evolved over a long time period and `acclimatization` which is a change in an individual's thermoregulation system in response to the thermal environment. The psychological process of adaptation (2) refers to the alterations in the thermal perception triggered by psychological factors which vary in different subjects (Nikolopoulou and Steemers, 2003). And lastly, the behavioural adaptation process (3) refers, as Yau and Chew (2012) state, to actions that a subject might take to achieve thermal comfort by changing their body`s heat balance. The following diagram, derived from the model of thermal comfort developed by Yao et al. (2009), visualizes the interrelationships between different adaptive capacities and the actual thermal sensation of end-users.

Figure 2.2 An adaptive approach model of thermal comfort



Source: Adapted from Yao et al. (2009)

In this model, actual thermal sensation depends on human physiology and the adaptive capacity of individuals as the active receivers of physical stimuli from physical space. Within the interrelationships shown in Figure 2.2, the physiological adaptation developed by an individual is correlated with behavioural and psychological adaptive capacities. In turn, the relationship between the psychological and behavioural responses are shaped according to the thermal expectation and also previous thermal comfort experiences (Yao et al., 2009). In addition, thermal expectation is a subjective issue which is shaped by intangible values and norms generated by cultural, economic and social factors. To read the adaptive model from a wider frame, the tangible and easily measurable stimuli come from the design of the physical space and the intangible and not so easily measurable but traceable stimuli come from relatively subjective stimuli.

This balance draws attention to the context-dependent nature of the adaptive practice. Considering the variations in contexts, as Nicol and Humphreys (2002) assert, standards and formulas for adaptive thermal comfort might not be valid for different cases. Although defining universal adaptive standards is not easy and realistic, this research follows the argument of Nicol and Humphreys (2002) that standards have the capacity to help designers develop more successful strategies while designing physical space in different circumstances. Strategies here refer to the physical stimuli shaped by indoor and outdoor climates as seen in the left side of the Figure 2.2. In this sense, understanding the relationship between indoor and outdoor climates becomes critical for the production of urban space from a wider perspective including the buildings and the surrounding urban areas. This is because the intangible values mentioned in the model are not only limited by the indoor or outdoor experiences, rather they present existence in every layer of urban life.

2.2.3 The `Social Convention` Approach: Beyond the Biological Limits

The `social convention` approach, as Chappells and Shove (2004) state, advocates that the definition of thermal comfort is ultimately a matter of `social convention`. It highlights the significance of historical and cultural variability and, in this sense, suggests that thermal comfort depends upon the social and political context in which it is defined and structured and in which the comfort expectation are shaped (Chappells and Shove, 2004).

Although there are a relatively few studies focusing on the sociological and anthropological dimensions of thermal comfort compared to those found in the building and the engineering sciences, some studies (see for instance: Lutzenhiser 1992, Kempton and Lutzenhiser 1982, Wilk and Wilhite 1987) suggest that expectations of comfort may vary widely, even in situations where occupants have the same level of income and access to infrastructure services. This calls for the questioning or rethinking of the sufficiency of universal definitions, standards or indexes of thermal comfort.

For instance, Wilhite et al.'s (1996) study of energy usage in Japanese and Norwegian houses underlines the importance of cross-cultural differences in heating and cooling habits. While in the Norwegian case, it was common to heat all rooms creating a thermally consistent environment in which to move around, in the Japanese case it was more common to use traditional ways such as the "kotatsu" – *a small heating unit placed under a table* – designed to heat individual bodies rather than surrounding spaces. In both cases, strategies of heating were related to culturally-specific ideas about thermal comfort, as well as to routine forms of social interaction, with the "kotatsu" also providing a focal point for family life.

Sociological and anthropological variations, as exemplified in Wilhite et al.`s (1996) research, show that the provision of thermal comfort is not an isolated enterprise, cut off from the rest of social life. People do not behave according to what might be considered norms of 'rational' behaviour. In this regard, as Chappells and Shove (2004) argue, many aspects of energy consumption, including practices of heating and cooling, carry social meaning and significance – the intention is not only to meet thermal needs, but also to fulfil cultural norms and collective conventions.

This research appreciates the arguments of the `social convention` approach in the sense of understanding the ethnographic dimensions which have a significant role in provision of thermal comfort in urban daily life. However, the research does not disregard the previous outputs (i.e. index or model of comfort) from the studies derived from the adaptive approach, rather it assumes the comfort models originated from adaptive studies as a scientific basis. In other words, this research takes an adaptive approach *to determining* the thermal comfort on the one hand, and uses a `social convention` approach *to understanding* the perception of thermal comfort within the localities on the other. In this context, the following section presents a deeper look at the ways in which previous studies have theorized and measured urban thermal comfort. This includes a review of different conceptualizations of thermal comfort and the assessment methods and techniques used in the previous adaptive studies. The section highlights how previous studies fall short of capturing the nuances attached to the real life experience of thermal comfort. This is important in drawing out the rationale behind the epistemological assumption of this research, that is to say the emphasis on the lack of integration of the `intangible` values (i.e. cultural factors, local values) which was mentioned theoretically but not applied sufficiently in adaptive studies; at least to the same level as in the `social convention` paradigm.

2.3 Theorization and Measurement of Urban Thermal Comfort

The subjectivity in thermal comfort experiences and the interpretations flowing from a very complex interaction between end-users and the physical environment has been the focus of a significant amount of research. Measuring thermal comfort stands as a challenging task due to the subjective nature of the term `comfort` itself. When it comes to wider urban scales, especially for outdoor physical environments such as streets and open public spaces where `social convention` gains more importance due to the shared usages in physical space, it is preferable to triangulate objective data collected by technical measurements with subjective remarks coming from people, in order to reach `scientific` or statistically significant results. However, most of the studies on outdoor spaces do not give sufficient weight to the intangible values (i.e. social values, cultural background).

For instance, Ng and Cheng (2012) claim that transverse questionnaire surveys are sufficient in order to obtain a general statistical understanding of the outdoor thermal comfort condition. Transverse questionnaire surveys involve interviewing large numbers of subjects in different environmental conditions and involve subjective judgements of comfort. In Ng and Cheng's (2012) study, a thermal comfort survey is composed of two parts: (1) micro-climatic measurements and (2) guided user questionnaire. While the first part contains the technical measurements of climatic variables, the second part includes people's thermal comfort conditions. In the first phase, they measure air temperature, wind speed, relative humidity and solar radiation by using TESTO 3-function probe. Mean radiant temperature is estimated by using a globe temperature model which put into process the values of glove temperature, air velocity and globe diameter. In the second phase, they conduct a public survey to explore people's subjective sensation of the microclimatic conditions at the time of survey. The results of the second part are correlated with the first part to analyse the general thermal comfort conditions in the outdoor spaces. However, sensations are measured via pre-defined ranking scales which do not reveal the aforementioned local values, rather it gives a general picture. An in-depth understanding which could be potentially correlated with statistics is missing.

Similarly, research by Shashua-Bar et al. (2012) focuses on the quantitative estimation of the effect of different urban design scenarios on thermal comfort. While they used physiologically equivalent temperature (PET) index to assess thermal comfort, for microclimatic analysis a model called Green-CTTC is used. The Green-CTTC model is "an analytical model using a cluster thermal time constant for predicting the air temperature variations in the urban canopy layer" (Shashua-Bar et al., 2012, p112). The theory behind the model assumes that the variation of air temperature inside an urban cluster is related to the amount of solar radiation, the net outgoing long-wave radiation exchange, the anthropogenic heat release and the amount of vegetation. Having the values of these main microclimatic parameters as outputs of the Green-CTTC model, they couple the model's microclimatic information with the PET thermal comfort index. Results show that trees have the most significant effect on thermal comfort followed by the deepening aspect (Height:Width ratio) and the walls surface albedo modification. In terms of H/W ratio, the results reveal that higher H/W scenario provides more comfortable conditions compared to lower H/W. Although this study makes useful recommendations in terms of the formation of physical urban space, it also exemplifies how model-based approaches invite criticism regarding the pitfalls of generalization due to the lack of a human dimension.

In line with this discussion, Yang et al. (2013) argue that a purely physiological approach in outdoor thermal comfort research is inadequate in order to develop design guidelines since it disregards behaviourial adjustments *(personal, environmental, technological or cultural)*, physiological factors *(genetic adaptation or acclimatization)* and psychological factors *(habituation or expectation)* (p.426). The main objectives of their research was to understand the thermal perceptions and preferences of people using outdoor spaces and to explore the effect of thermal adaptation on human thermal sensations in outdoor spaces. They determined different outdoor spaces representing different microclimatic conditions and used for different activities such as resting, meeting, playing, and having a picnic. The measurement of climatic variables such as air temperature, globe temperature, relative humidity, wind speed and global radiation was done using two tools called Testo 445 and CM6B Pyranometer. Alongside these technical measurements they conducted a public questionnaire aiming to explore people's thermal sensation, thermal preferences and thermal acceptability. Respondents were asked to rank their thermal sensation according to the ASHRAE 7-point scale (-3 cold, -2 cool, -1 slightly cool, 0 neutrality, 1 slightly warm, 2 warm, 3 hot) and rank their thermal preference according to 3-point McIntyre scale (prefer warmer, no change, cooler) and finally to indicate thermal acceptability via direct assessment (i.e. acceptable or not). They correlated the results of the quantitative measurements with subjective judgements made by people in situ in outdoor spaces. Finally, an outdoor thermal comfort map was produced in GIS format by combining a temperature map, wind map and Tmrt[5] Map.

Likewise, Krüger et al. (2011), explore the influence of urban geometry on outdoor thermal comfort, including air quality and air flow in urban canyon by means of on-site monitoring and microclimate simulations. Their study focuses on two streets one representing a pedestrian environement and the other intense traffic flow. They use HOBO[6] Onset weather stations to measure air temperature and humidity, wind speed and direction, solar radiation and globe temperature in both streets, according to ISO 7726. In order to understand the influence of urban geometry on local temperatures and comfort levels, they use Sky View Factor (SVF[7]) as an indicator. In order to determine the SVF, they took fisheye images from each monitoring point and used RayMan[8] tool for calculation. Along with measurements, they conducted a comfort survey with local users. The questionnaire, which was prepared according to recommendations of ISO 10551, explores five different judgements; perceptual, affective evaluation, thermal preference, personal acceptability and personal tolerance. From the gathered data, they formulated a regression formula to express "thermal sensation" as a function of measured climatic conditions. To correlate the calculated thermal sensation value in two streets, they calculated the effect of SVF and being exposed to solar radiation using the RayMan tool.

Similarly, research by Deb and Ramachandraiah (2011), reveals that street orientation and the percentage of green cover are two significant variable that influence urban comfort at the street scale. Their study was conducted in six selected urban locations. At each location, they selected three sample streets with different orientations (S-N, E-W, NE-NW) and monitored the microclimatic

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[5] Mean radiant temperature (MRT) is defined as the uniform temperature of an imaginary enclosure in which the radiant heat transfer from the human body is equal to the radiant heat transfer in the actual non-uniform enclosure. (ISO 7726, 1998)

[6] HOBO is a data logger.

[7] SVF is a an indicator in energy studies and it reflects the amount of visible sky at a given point (Krüger et al, 2011).

[8] RayMan is a tool for research in applied climatology. It refers to "radiation on the human body".

conditions in summer months. The only significant difference between those selected samples was their height to width (H/W) ratio and the ground coverage classification (green cover percentage). For comparison they used PET as the primary thermal comfort index along with the air temperature and globe temperature scales. They computed PET, air temperature and globe temperature for each location and performed an ANOVA single factor test. As a result the research reveals that although H/W ratio has influence on thermal comfort the green cover percentage has more significant affect. For instance, areas with maximum green cover presents the lowest PET value compared to others.

Gao et al. (2012) also argue that the formation of an urban wind environment has an influence on both indoor and outdoor thermal comfort along with the energy consumption in buildings. For this purpose, Gao et al. (2012) investigated the effect of built form (orientation, distance between buildings and group arrangement) on wind formation, airflow distribution and ventilation. Wind speed and directions measurements were collected with a wireless weather-station, at six different spots (representing street canyon, semi-closure, courtyard form) at the University of Reading campus. In addition, they obtained meteorological data at an isolated point on the campus. In the first stage, in order to compare the wind-speed and direction at all measurement points, they prepared a wind-rose[9] diagram. Based on these wind-rose diagrams, they calculated the velocity at all measurement points by using the SPSS correlation analysis method. At the end, in order to identify the meteorological factors and the architectural layout factors of the built form, they used factor analysis.

Unlike the above researches, Turkbeyler et al. (2011) mentioned the challenge of achieving passive cooling/heating system in densely built environments including high-rise buildings due to the obstructions at close proximity and existing orientations of streets. Turkbeyler et al. (2011) investigate the effect of the layout and orientation of buildings on the microclimatic variables. Four streets, presenting different characteristics in terms of width, H/W ratio, building materials and albedo, were selected in a sample district called Elephant & Castle in London. At each measurement location, air temperature, wind speed and direction, air humidity and global solar radiation were measured by an automatic weather station called Davis Wireless Vantage Pro2. Measurements demonstrated that the microclimatic variables change from one place to another due to variation in the layout and orientation of the buildings.

The above reviewed studies presents that urban thermal comfort is mostly explained by a formula or index, following a similar tradition observed in the thermal comfort studies in indoor environments.

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[9] A wind-rose is a graphical tool to give sufficient view of how speed and direction are typically distributed at a particular location.

Correlation-based definitions look to establish a relationship between the dependent variable -thermal comfort- and the independent variables which shape the thermal comfort. Table 2.2 (see next page) presents these variables along with the conceptualization and the measurement techniques of thermal comfort in urban studies.

Literature shows a variety of research using different techniques to analyse the thermal comfort level either for indoor (eg: Coch, 1998 and Manioglu and Yilmaz, 2008) or outdoor spaces (e.g.: Nagara et al. 1996; Nikolopoulou et al. 2001; Nikolopoulou and Steemers 2003; Nikolopoulou and Lykoudis, 2007). While it is relatively easier to follow/understand the arguments of an adaptive approach in indoor studies, it is not as clear how the social dimensions of comfort has been reflected/interpreted in outdoor studies. In most studies, the representation of ethnographic values is limited to investigation by only pre-defined questionnaires and/or multiple choice tests conducted with participants. However, the significance of cultural background, social norms and the local specificities which are emphasized in the `social convention` approach, call for an in-depth understanding of local lifestyles as a combined and natural order of experiences both indoor and outdoor environments. And this in-depth understanding requires a novel methodological quest both to measure and understand the urban thermal comfort in localities.

With this task in mind, this research approaches urban thermal comfort from a joint perspective of indoor and outdoor experiences and handles the issue as a combined matter which is lived/experienced in every layer of urban life (i.e. everyday experiences in living room, outdoor experiences in daily commutes). Therefore, the research aims to understand the way(s) in which the formation of the urban space affects the perceived urban thermal comfort and the energy consumption levels for the provision of thermal comfort in urban daily life. In seeking to achieve this, the research underlines the importance of examining both indoor spaces where an individual's basic life activities take place and the outdoor spaces where individuals start to interact with urban life and use urban facilities. This is important because urban space production is not only about the formation of physical environment for living, it is also about the way(s) in which people develop their adaptive mechanisms within their everyday life experiences including their social interactions, actions and re-actions to urban spaces. Based on this assumption the following section presents the way this research conceptualizes urban thermal comfort, including the dynamic relationship between the urban space production and people`s comfort experiences in urban space.

Table 2.2 Conceptualization and measurement of urban thermal comfort in previous studies

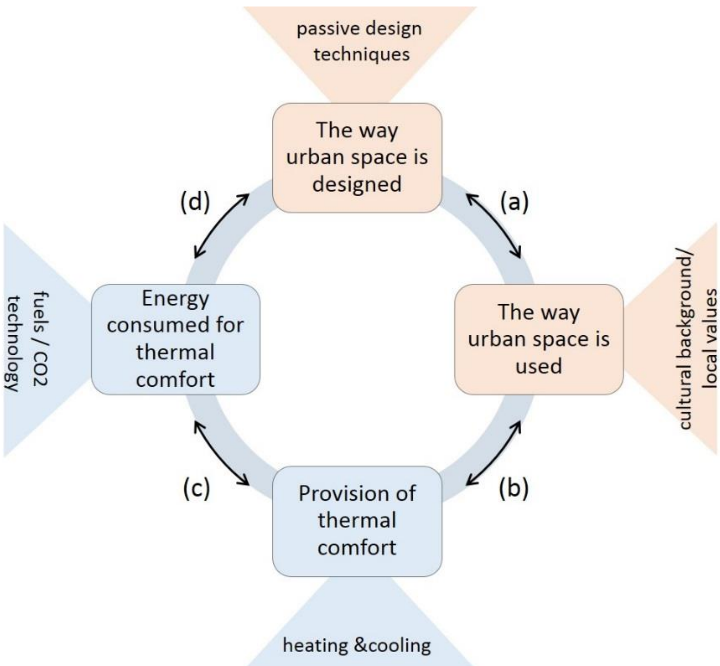
Researchers	Determinants of Thermal Comfort	Measurement Tool	Independent Variables	Thermal Comfort Index	Analysis Tool
Taleghani, Tenpierik, Dobbelsteen and Dear (2013)	hourly weather data solar heat gain daylight	EnergyPlus Simulation engine	surface to volume ratio annual heating and lighting energy demand		DesignBuilder software
Krüger, Minella and Rasia (2011)	air temperature humidity, wind speed solar radiation , globe temperature	HOBO Onset whether stations Fisheye images	sky view factor solar radiation	MRT PET	Rayman
Deb and Ramachandraiah (2011)	air temperature globe temperature relative humidity wind speed	Extech Heat Stresss WBGT Meter (HT30)	orientation height/weight green cover percentage	PET	ANOVA test
Shashua-Bar, Tsiros and Hoffman (2012)	air temperature solar radiation wind speed	meteorological station	height/weight trees canopy coverage area ratio walls surfaces albedo	MRT PET	Green-CTTC model Rayman
Hwang, Lin and Matzarakis (2011)	air temperature relative humidity wind speed global radiation, cloud cover	Portable instrument Fisheye images	Shading Sky view factor	PET MRT	Rayman
Yang, Wong and Jusuf (2013)	air temperature globe temperature relative humidity wind speed, global radiation	Testo 445 CM6B Pyranometer questionnaire survey	thermal comfort perceptions and preferences	MRT	GIS CFD Rayman
Ng and Cheng (2012)	air temperature wind speed relative humidity solar radiation	TESTO 3-function probe.	Thermal comfort perceptions	MRT PET	
Yao et al. (2012)	surface temperatures air temperature solar radiation	UMsim simulation model	solar radiation, daylighting natural ventilation		UMsim simulation model
Türkbeyler, Yao and Day (2011)	air temperature wind speed and direction air humidity global solar radiation	Davis Wireless Vantage Pro2	Street width H/W ratio Building materials Albedo		

2.4 Urban Thermal Comfort is Achieved Within and Through the Production of Space

Based on the review of previous thermal comfort studies, the chapter has so far presented the significance of human adaptive capacities that are developed and occur as a result of human-space interaction(s). Appreciating the significance of adaptive capacities, this research develops the argument that adaptive capacities (i.e. the behavioural adjustments) are enhanced/developed within and by the organization of urban physical space. However, if the physical space constitutes the major part of the environmental stimuli for thermal comfort (as argued in adaptive studies), it also means that the built space has the capacity to limit/control the adaptive mechanisms that can be developed by the users of it, since there is not a linear/cause-effect relationship between two. Therefore, the research assumes that the adaptive mechanisms developed by individuals are not only (re)shaped by the physical environment but are combined with the specific values (i.e. cultural/ traditional ways of heating/cooling) developed locally and simultaneously with the formation of urban space over the course of time. In this sense, the research approaches urban thermal comfort as a phenomenon achieved within and through the production of urban space.

As visualized in Figure 2.3, the provision of thermal comfort in urban built environments has a reciprocal relationship with the (a) formation/design of the urban space and (c) the provision of thermal comfort in the lived space. This relationship can be read as a circular journey which is complemented by the integration of (b) human adaptation (i.e. individual actions taken in the urban space) and the (d) energy consumption for the provision of thermal comfort in urban life (i.e. energy for heating & cooling).

Figure 2.3 The relationship between thermal comfort and urban space design



Source: Author's original

The following paragraphs explains the circular relationship (a,b,c,d) presented in Figure 2.3.

(a) The relationship between the way urban space is designed and the way urban space is used:

The design of urban space, as Knox and Ozolins (2000) assert, gives meaning and identity to the entire range of forces involved in people`s relation to their surroundings. In other words, the urban built environment provides `signs` for all kinds of human behaviours. This is why Knox and Ozolins (2000) uses the analogy of `text` for the city, as it can be `read` as a narrative of `signs`. For instance, it is possible to `read` a city in terms of the `signs` of the transportation elements, to understand the extent to which the physical network (i.e. railway network, walkability, cycling network) enhances the reduction of individual`s carbon footprint in their daily commutes. Citizens are able to change/adjust their behaviours within the limits of urban physical space and the urban services provided by it. The influence of physical space can be `read` or observed in every layer of urban life, including public, semi-public and private spaces from wider scales to single building scale. This statement made by Winston Churchill (1924) expresses the significance of human-space interactions in an assertive way.

> "*There is no doubt whatever about the influence of architecture and structure upon human character and action. We make our buildings and afterwards they make us. They regulate the course of our lives*." (Winston Churchill, speech addressing the English Architectural Association 1924)

Similarly, as Ittelson (1974) asserts, in all buildings at least some form of social activity takes place, stemming from both the initial intended function and the random encounters the buildings may generate. For example, the layout plan including the locations of the rooms, entrances, open spaces and garden space has the power in influencing social conventions and the behavioural approach developed in the physical setting. In addition, the outdoor environment also influences the way people live, which is shaped by anthropogenic factors, the density of urban development and the amount of green space (Klemm, 2007).

On the other hand, Brand (1994) directs attention to the capacity of end-users who use the `designed` space according to their own lifestyles, including cultural habits and behavioural adjustments carried from their historical background:

> *"All buildings are predictions. All predictions are wrong."* (Brand, 1994, p. 178)

Both arguments validate the reciprocal relationship between the production/design of urban space and the way end-users use the produced/designed living settings. More striking examples of human-space interaction and the way people develop responsive acts according to the formation of built environment are visible in the urban heritage sites that have developed down the ages and which still accommodate local people at the present time. Urban heritage sites also accommodate design clues in terms of climate adaptation with `smart solutions` that benefit from the local climatic values; these solutions can help local people to more easily adapt climatic conditions. In addition, heritage sites prove how use of urban space influences the formation of built environment with the socio-ecological values developed within and by the local communities.

(b) The relationship between the way urban space is used and provision of thermal comfort:

The provision of thermal comfort in urban environment, as the literature (Nikolopoulou et al., 2001) stresses, is indeed of prime importance influencing people's use of urban spaces. Thermal comfort, with its capacity to alter the perception and satisfaction of people (Humphrey and Nicol, 1998), has a determinant role in the way people use indoor and outdoor spaces such as open public areas, pedestrian paths and plazas. For instance, the provision of thermal comfort in a public plaza with sufficient level of vegetation, shading and furniture encourages the use of space. Similarly, a pedestrian path without effective and sufficient shading in a hot and arid climate will not be encouraging for pedestrian experiences (Setaih et al., 2013).

In addition, as the adaptive approach to thermal comfort argues, the perceived thermal comfort in urban space is correlated with human movements. End-users can control/modify/balance their thermal comfort, as Brager and de Dear (1998) categorize, in three ways, by making (1) personal adjustments, (2) technological adjustments and (3) cultural adjustments. Personal adjustments can be achieved by simple individual modifications such as changing clothing, activity or moving to another space which delivers greater comfort. Technological adjustments refer to modifications which can be achieved by using external devices such as heaters or coolers that can quickly change the thermal environment. And lastly, cultural adjustments are more commonly accepted/admitted behavioural patterns such as taking a siesta in Spanish culture or the white dress code in Arabic cultures.

These two methods of influence certify a reciprocal relation between thermal comfort and the way people use the urban built environment. In other words, the formation of the physical space is both influenced by and influences the way people use/live in urban settings.

(c) The relationship between the provision of thermal comfort and energy consumption:

It is known that the provision of thermal comfort in every layer of urban space calls for a certain level of energy consumption. Yang et al. (2014) claim that buildings account for about 40% of global energy consumption and a large proportion of this energy is used for the provision of thermal comfort. For example, air conditioners with their huge consumption capacity can increase the total energy consumption in a building and associated carbon emissions by up to 100% (Carbon Trust, 2015). Occupants` use of technical devices for heating and cooling leads to different levels of CO_2 emissions, depending on the used source and technology. Brown and Sovacool (2011) claim that worldwide, nearly 2.4 million people use wood, charcoal and other biomass fuel for cooking and heating. Therefore, reducing the carbon emissions derived from comfort-related consumption requires efficient use of resources.

As Barbhuiya and Barbhuiya (2013) point out, reducing energy consumption in buildings becomes crucial in minimizing post-occupancy energy consumption from the design stage of the buildings and the surrounding urban spaces. Potential lies in the design process of the built environment from building to wider spatial scales. For instance, Chappells and Shove (2004) estimate that 70-90% of energy decisions are made at the 'concept design' stage of a building which goes on to affect end-users` behaviours. Thus, the formation of physical space can be strategically interpreted to gain maximum efficiency in terms of balancing comfort and energy consumption in the use of produced space.

(d) The relationship between the way urban space is designed and energy consumption: The amount of energy consumed in the provision of thermal comfort can be reduced with the appropriate design of urban space. Appropriateness here refers to smart design solutions/ tactics which make maximum benefit of local climatic conditions and turn the climatic inputs into an advantage regarding reduced energy consumption in company with carbon emissions. In line with this target, the climate responsive design (CRD) approach presented in the previous chapter includes elements of design tactics that can be used to facilitate the provision of comfort with less energy. For instance, Baker and Steemers (2000) present that energy consumption in a building is influenced by building design by a factor of 2.5 times, system efficiency by a factor of 2 times, and user behaviour by a factor of 2 times. So, in this case, the design factor stands as the major determinant of energy consumption.

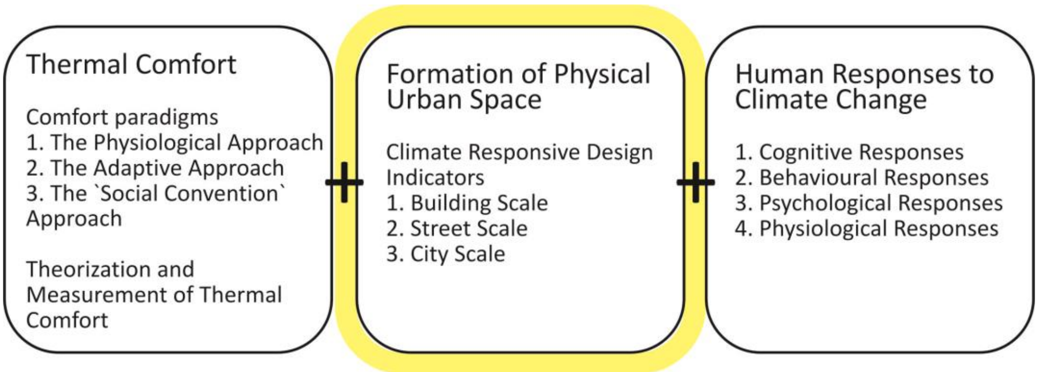
Literature reveals that high levels of outdoor urban comfort can bring savings in energy, improve quality of life and also influence individuals' perceptions of indoor thermal comfort (Deb and Ramachandraiah, 2011). Yao et al. (2012) state that since urban form determines the availability of solar radiation, daylighting and natural ventilation of a building, it has a significant influence on energy consumption in buildings. Moreover, research (see Shashua-Bar et al., 2012 and Krüger et al., 2011) claims that climate responsive urban planning can provide optimal, comfortable, thermal conditions for outdoor spaces while also affecting the requirement of energy use in indoor spaces.

This circular chain (between a, b, c, d) in Figure 2.3, shows that the main goals of climate responsive design (CRD) are directly related to the act of design itself. In other words, the goals highlighted in CRD approach simultaneously constitute the process of design itself. Therefore, it is essential to underline that the thermal comfort and the reduction of energy consumption are not final targets, or the outcomes/products of a climate responsive space production, rather they evolve with space while influencing and being influenced by the ways people use the urban space. Within this context, space production needs to be reconceptualised in line with the entailments/necessities of these two goals.

Studies in the field of climatology provide different data sets related to climate types, reasons for the formation of different climates and their effects on human life. However, in terms of urban design, it is essential to translate this data into a form that provides input into the spatial organization and design of buildings. For instance, variables such as the geometry of streets, building forms, albedo, vegetation and anthropogenic factors can be managed, to varying degrees, by urban designers (Shashua-Bar et al., 2012). However, the literature presents that knowledge of urban climatology is still limited and, additionally, is not solidly integrated into urban design practice (Eliasson, 2000 and Erell et al., 2010).

Within this context, the chapter continues by reviewing of the use of climatic information on the development of physical forms and functions of urban spaces. Section 2.5 presents the pre-defined design strategies in the literature (second column in Figure 2.4), which aim to obtain maximum benefit from the natural climatic assets and reduce the fossil fuel consumption through accurate building and urban layout design.

Figure 2.4 Three major bodies of literature used in the research



Source: Author's original

2.5 Climate Responsive Design Indicators

Climate responsive design calls for maximising the benefits of natural territorial climatic characteristics in order to reduce the use of finite energy sources while seeking a desirable urban comfort level. The following section focuses on the former goal of climate responsive design (i.e. maximizing the benefits), and presents pre-defined design strategies that allow designers to create energy efficient urban layers by taking advantage of different climatic characteristics.

2.5.1 Building Scale

Buildings are one of the largest elements of energy consumption worldwide. The way a building is designed and used directly affects the amount of energy it consumes. As Sarte (2010, p.170) states, factors such as geographic location, orientation, topography and vegetation have great influence on the energy demand for heating, cooling, ventilation, lighting and pumping requirements for water facilities of a building. From an urban design point of view, passive design strategies come to the fore when considering how to benefit from natural energy sources such as sun and wind. Passive design strategies refer to a *series of architectural design strategies used by the designer to develop a building in order to respond adequately to climatic requirements, among other contextual necessities* (Ochoa and Capeluto, 2008, p.1829).

In general, to achieve the best thermal performance of a building, rather than focussing on one or more climate variables, climate components need to be considered in a holistic manner. However, it is essential to bear in mind that these strategies/suggestions should not be perceived as unique, universal solutions that can work everywhere in similar climatic conditions. Each locality may require certain interventions according to specific climatic and cultural characteristics which may not match up with pre-defined strategies in the literature.

2.5.1.1 Orientation

A building`s orientation towards the sun and dominant wind direction has the potential to influence the total amount of energy demand for heating and cooling (Sarte, 2010) as well as human health and the degree of comfort (Golany, 1996). Careful positioning and orientating of buildings can enable the negative effects of sun and wind to be reduced, while taking advantage of natural airflow in a controlled way (Gut and Ackerknecht, 1993). Therefore, it is essential to ascertain the optimum orientation which provides a balanced heat gain and loss according to different seasons. Golany (1996) suggests that designers should synthesize the reciprocal relation among solar radiation, ventilation, landscape and relative humidity which is related to the proximity of a body of water.

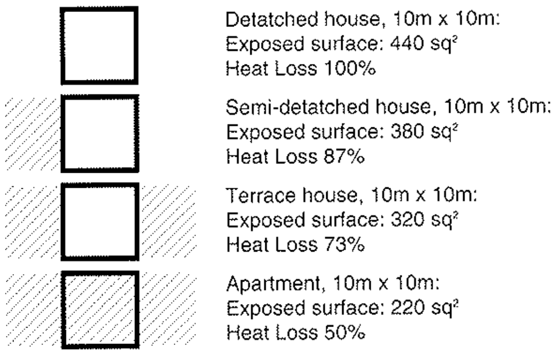
Climatic components such as temperature, precipitation, humidity, sunlight and wind affect the thermal efficiency, indoor air quality and structural integrity of buildings (Wong and Chen, 2009). For instance, in hot and arid territories it is possible to obtain a more healthy thermal performance by orienting buildings in the right direction to reduce solar heat absorption. Both in hot humid climates and hot dry climates where heating is not required in winter, the orientation should exclude the sun year round and maximum exposure to cooling breezes should be provided (Reardon et al., 2010).

According to Holger (1999, cited in (Rodrigues and Landin, 2011), in hot and humid climates, the long axes of a building should be located on an E-W axis in order to minimize the surface which is exposed to solar irradiation. In a temperate climate, buildings` long axis should be orientated in N-S/E-W axis in order to capture winter sun and block summer sun predominates[10]. In all other climate zones, the optimum degree of solar gain and the need to capture cooling breezes should be supported by the passive solar heating and cooling techniques (Reardon et al., 2010). For instance, in climatic zones where cooling in summer and heating in winter is required, Cofaigh et al. (1998) suggest protecting south-facing spaces by external shutters, blinds, overhangs and vegetation. Depending on the species selected, trees can provide shade in summer while not blocking the winter sun (Cofaigh et al., 1998).

2.5.1.2 Building Form

In order to achieve good thermal performance while using low energy, building form should maximize timely solar collection and minimize heat loss or gain as appropriate. Although compact forms usually lose the least heat, Cofaigh et al. (1998) state that for a given floor area, energy consumption levels of different building forms decrease from apartment blocks to detached houses (see Figure 2.5).

Figure 2.5 Building planning and proportion



Source: Cofaigh et al. (1998)

However, that conceptualization does not necessarily mean that in all climatic and cultural contexts detached houses present high-energy consumption levels. The particular built form of a detached house may help to reduce the amount of energy used. For instance, the literature presents that a courtyard form has significant potential to save energy given its cooling and heat storage capacity. The courtyard form, which has been used from distant antiquity to the present day, creates an enclosure for interiorthermal performance as well as providing security and privacy (Cofaigh et al., 1998). The walls of a courtyard are the major shading elements for hot seasons. Besides that, additional elements such as vegetation, fountains and canvas awnings can keep courtyards cooler when compared to outdoor temperatures. Bougdah and Sharples (2010) explain the operation of

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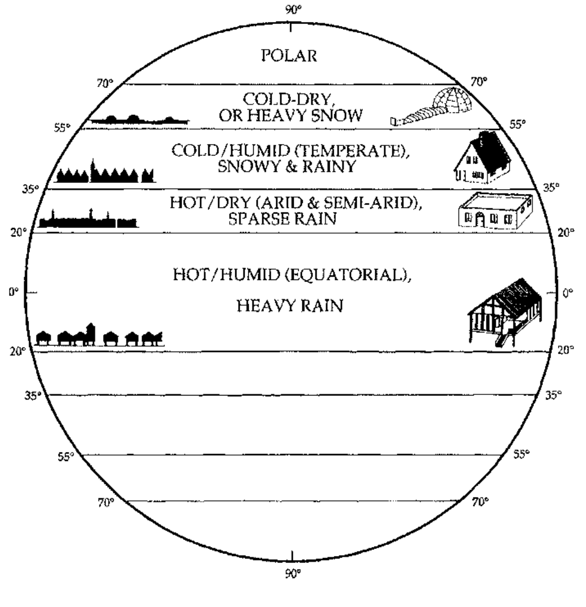
[10] The Western Australian Planning Commission (1997, p.55) determines the optimal range as N20°W to N30°E, or E20°N to E20°S.

courtyard house under three diurnal thermal regimes. In the first phase, during the night, the radiation from external walls to the sky cools the air in the courtyard. The cool air in the courtyard, and the associated cooling effects, proceed until the afternoon of the following day. In the second phase, after the sun rises to the highest point in the sky, the courtyard ground starts to absorb the heat from the sun and warms the air in the courtyard. The warmed air in the courtyard starts to rise and generates a chimney effect which leads to a cooling effect throughout the rest of the house. In the last phase, with the descent of the sun below the western horizon, shading is created in the courtyard. This begins to cool the air prior to the night cycle commencing again (Bougdah and Sharples, 2010).

Beside the buildings` volumetric forms mentioned above, design details such as windows, balconies, and terraces also have a significant role in determining the energy performance of a building. For instance, Sarte (2010) suggests designing large south-facing windows in order to receive solar radiation as appropriate for buildings in northern, colder climates. Conversely, in hot climates, buildings can be shaded using deep overhangs and awnings or by screening and tinting windows to reduce solar gain (Sarte, 2010).

Another design detail in terms of building form is roofing which covers and protects the building from external factors. Figure 2.6 presents traditional roof forms according to different climatic regions. For example, historical human settlements in the Mediterranean, the Middle East and Central Asia present that flat roof structures and the aggregation of similar height buildings which create one large "platform" on the top of the settlement, ease the movement of wind over the built environment in hot-dry climates (Golany, 1996).

Figure 2.6 Roofs of indigenous housing are uniform and their forms are designed to suit their climatic zone conditions

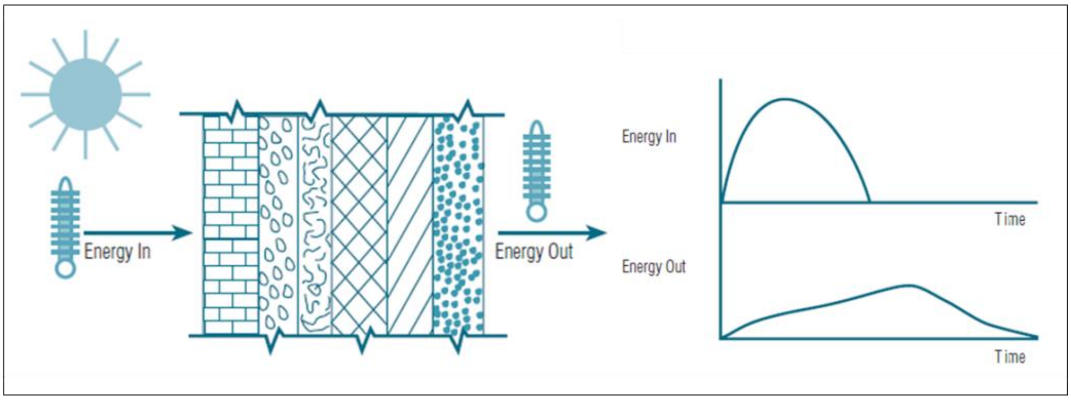


Source: Golany (1996)

2.5.1.3 Materials and Thermal Mass

Along with orientation and form, the use of materials in construction also influences the extent to which a building can take advantage of natural assets and the amount of energy it consumes in order to maintain thermal comfort. The term "thermal mass" refers to the ability of materials to store thermal energy and delay heat transfer through a building component (Energy Design Resources, 2010). Materials have the capacity to absorb energy from outside of the wall and store it in order to maintain inner space at either cool or warm temperatures. As seen in Figure 2.7, when energy enters into a material either thorough solar radiation or air circulation, the alteration of its surface temperature depends upon the combination of its thermal capacity, its thickness and how readily the heat is conducted into its depth (Cofaigh et al., 1998).

Figure 2.7 An example of generic wall cross section



Source: Energy Design Resources (2010)

A building`s thermal mass is determined by its floors, walls and roof. Sarte (2010) claims that use of efficient insulation, sealing and building materials can reduce the amount of energy needed to heat or cool a space from between 20 to 30%. For instance, in hot climatic zones, particularly where the temperature difference between daytime and night-time is considerable, air conditioning becomes a major requirement for daytime while heating may be required during the night. In this case, thermal mass has significant potential to both delay heat gain through the walls and roof during the day and use the heat stored in the building for meeting the requirement for heating during the night. The literature suggests that masonry provides a high thermal mass which decelerates the building`s response to changes in external conditions and reduces fluctuations in internal temperatures (Cofaigh et al., 1998; Milne and Givoni, 1979). Likewise, heavy stone walls have been used throughout history in both hot and cold climates as a way to maintain moderate temperatures inside while outside temperatures fluctuate (Sarte, 2000). This works because heat takes longer to travel through stone and other dense materials like concrete which essentially act like a thick insulation. Moreover, Krope and Goricanec (2009) suggest that wood, straw, reedy plates and clay, from which brick shaped products can be made, are environmentally friendly materials since they have the potential to control humidity and store heat. In addition, massive brick, concrete or silicate brick walls are also appropriate building materials since they have the capacity to retain heat.

The colour of a building envelope is another significant variable in terms of solar gain which directly influences indoor thermal comfort. It is widely known that light colours reflect solar radiation while darker colours enable solar absorption. Therefore, in hot climatic zones, exterior walls should be painted with light colours in order to decrease solar absorptivity (see Figure 2.8). Conversely, in cooler climates, dark colours should be used for increased solar gain.

Figure 2.8 Traditional settlement pattern in the city of Bodrum where the climate is hot and humid

Source: www.emlakjet.com/haber/foto-galeri.php?imaj_id=62358#foto_td (2014)

2.5.2 Street Scale

Urban streets vary in geometry which is usually defined in the literature by height/width ratio, sky view factor or the orientation of streets' long axis (Bourbia and Boucheriba, 2010). The common point of these different definitions is that streets have a significant role in the formation of urban micro-climates. Thus, when designing new urban developments, streets can be configured in such a way to minimize the undesirable effects of dominant climatic characteristics such as extreme hot, strong winds or frequent rain. Existing climate characteristics can also be turned into an advantage through design which includes appropriate street layout, canyons, surface cover and shading.

2.5.2.1 Layout

Street layout has an important role on the alteration of air and ground surface temperatures (Bourbia and Boucheriba, 2010). Gut and Ackerknecht (1993) suggest three basic possibilities in terms of physical street structure in hot and arid climate zones (see Figure 2.9).

Figure 2.9 Examples of designing urban forms in an arid region taking into account solar radiation and wind

Source: Peker (2011)

The grid pattern with its straight streets increases the exposure to radiation. It is possible to break the direct radiation by orienting the grid pattern diagonally to east-west axis which enables the creation of shade among buildings. However, it is also important to consider the forms of buildings and other components such as trees and pavements that define the street layout. Unlike straight streets, winding or zigzagging narrow streets reduce the exposure to radiation as well as decreasing the effects of strong winds (Gut and Ackerknecht, 1993). Gut and Ackerknecht (1993) also mention that non-linear streets generate micro level shaded spaces which provide a cool and comfortable microclimate, while staying relatively warm during nights in cold seasons. In terms of wind ventilation, linear streets provide natural cooling while the negative effects of strong winds can be prevented by blocking the streets (Gut and Ackerknecht, 1993).

Road layout can also have a significant impact on the environmental and energy performance of a neighbourhood. For instance, Littlefair et al. (2000) stress that in passive solar layouts it is possible to design roads in an east-west direction in order to make the main facades of the buildings face 30^0 off due south. In places where the streets have to run in a north-south direction, houses can be oriented towards the south. Figure 2.10 (see next page) presents an example of passive solar layout showing the optimum solar orientation of houses.

In temperate or cold climates, Sarte (2010) suggests orientating residential streets in such a way to allow buildings to have summertime-shaded south facades, maximising solar gain in the winter and reducing cooling requirements in the summer. In temperate or cold climates the ideal street layout should include main corridors perpendicular to dominant winter winds and parallel to cool summer breezes as much as possible. Contrastingly, in hot climates where cooling needs to dominate, orientating corridors parallel to prevailing breezes can provide natural cooling for developed areas (Sarte, 2010).

Figure 2.10 A passive solar layout showing good solar orientation of houses

Source: Littlefair et al. (2000)

2.5.2.2 Height-Width

Streets defined by building blocks can turn into an 'urban canyon' with its own microclimate. According to Oke (1987), the air space above a city can be divided into the 'urban air canopy' and the boundary layer over the city space called 'the urban air dome'. The urban air canopy is the space bounded by the city buildings up to their roofs. The upper boundary of the urban canopy varies from one spot to another because of the different heights of the buildings and the wind speed. The temperature distribution in the urban canopy layer is strongly affected by the city's radiation balance. Most of the solar radiation strikes roofs and the vertical walls of the buildings. Walls, roofs and the ground emit long-wave radiation to the sky. The intensity of the emitted radiation depends on the view factor of the surface to the sky. Urban canyons are characterised by three main parameters namely; H: the mean height of the buildings in the canyon, W: the canyon width and L: the canyon length (Littlefair et al., 2000). The height-width (H/W) ratio has a significant impact on the ventilation and heat trapped in a street.

It is very difficult to offer specific guidance on planning canyons in the urban environment. Littlefair et al. (2000) claim that a small H/W ratio provides good ventilation but weak shading, and the increase in H/W ratio makes air flows more turbulent. They suggest the optimal ratio as H/W=1 which provides enough ventilation with a vortex of air in the street. In terms of street width, in a hot-dry climate zone, wide streets ease the ventilation of the city. However, Golany (1996) stresses that wide streets require more shadowing since they are open to direct solar radiation which creates an obstacle for pedestrian usage. In hot climatic regions, one of the most efficient shading mechanisms in streets is the shadow provided by the height of the buildings. Narrow streets defined by tall buildings provide shadowy outdoor environments. Littlefair et al. (2000) suggest avoiding east-west streets in hot climates since they have significantly higher penetration of sunshine during the year.

2.5.2.3 Shading

Considering the large areas that urban streets cover, streets might have a significant influence on the solar radiation in urban environments. Golany (1996) mentions that asphalt cover on the streets increases solar radiation while stone paving or cement decreases it. Traditional settlements present that stone paving was one of the most frequently used street covers in order to provide comfort, especially in city centres where pedestrians tend to be concentrated. In addition, shading stands as one of the most significant strategies to decrease solar absorption and provide cooling in the street. Due to transpiration, grassed surfaces alongside streets present cooler characteristics than hard surfaces in cooling seasons (Cofaigh et al., 1998). Therefore, streets should be designed as a combination of softscape (e.g. grass) and hardscape (e.g. pavements).

Golany (1996) points out that street trees are powerful elements in terms of absorbing dust or pollution, decreasing noise and reducing solar radiation while providing shadowy walking paths for pedestrians. On the other hand, other vegetation elements such as grass, bushes, single trees or group of trees are potential wind catchers and wind screens (Littlefair et al., 2000). Besides planting there are also structural elements that provide shadowing in streets. Colonnaded streets can provide comfortable, shadowy pedestrian paths for users, particularly in extremely hot regions, and have been used for centuries in Mediterranean civilizations. Littlefair et al. (2000) summarize the benefits of colonnaded streets as providing natural shading capacity in hot seasons, snow and rain protection in winter and visual screening throughout the year.

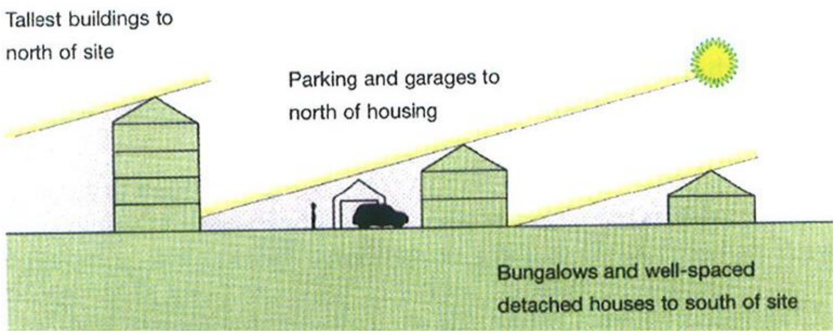
2.5.3 City Scale

One of the best-known effects of urbanization in cities is the formation of urban heat islands. A range of factors such as the thermal properties of materials, the height and spacing of buildings and air pollution levels contribute to urban warming. Although the urban heat island effect is a city-scale problem, modification strategies that can be implemented at neighbourhood and street levels are possible (Davies et al., 2008).

2.5.3.1 Form

Golany (1996, p.459) states that compact settlement forms respond to the thermal requirements of regions located in cold-dry and hot-dry climates. This is because compact forms catalyse the reduction of energy consumption for heating and cooling, infrastructure cost, and also, potentially, time and energy spent commuting. Moreover, compact neighbourhood forms with narrow streets which provide shadow for all buildings are suitable for hot-dry climates (Goulding, Lewis, and Stteemers, 1993). Golany (1996) also refers to clustered form which has the potential to respond favourably to the severe conditions of cold-dry and hot-dry climates. The clustered urban form refers to aggregated formations of certain types of land use in relatively small urban units located in close proximity to each other. However, it is essential to consider that the form of neighbourhoods, which is shaped by the leaguing together of clusters or single units, determines the levels of solar energy or daylight received. For instance, designing tall building forms in the southern part of a neighbourhood could cause the problem of overshadowing on the other properties in northern parts (Littlefair et al., 2000). The following figure shows an example of how to avoid this 'over-shading' problem.

Figure 2.11 An example of one way to avoid the over-shading problem



Source: Littlefair et al. (2000)

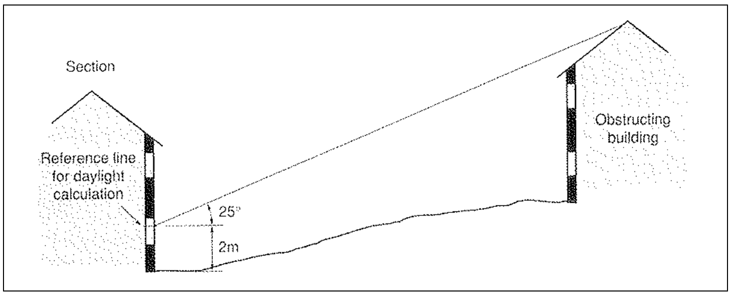
2.5.3.2 Open Space

Open spaces can be defined as breathing spaces in the built environment. Both hardscape and softscape open spaces affect urban micro-climate and thermal comfort levels. According to Golany (1996), in a hot-dry climate, a large open space designed as a hardscape (such as a square covered with asphalt) influences citizens in negative ways since dust and strong hot winds create uncomfortable conditions. Therefore, in hot-dry and cool-dry climate zones, small or medium size green (softspace) open spaces should be provided in order to create breathing spots in the built environment. The dispersion of open public spaces also supports the idea of equal opportunity for all citizens in terms of proximity to green open spaces. Due to their capacity to support ventilation and provide shadowing, large green open spaces are also desirable in hot-humid climate zones. Littlefair et al. (2000) suggest designing wide open spaces that enable sufficient solar access for cool and intermediate climates. However, in hot-dry climates open spaces should be reinforced by cooling and shading elements such as trees, fountains and sun-blinds.

2.5.3.3 Slope

The slope of the site where a neighbourhood is located has significant influence on the daylight, sunlight and solar heat gain that buildings can receive (Littlefair et al., 2000). As seen in Figure 2.12, for slopes of all orientation, facades facing the slope will receive limited daylight. Therefore providing sufficient space between buildings is essential in order to prevent buildings` blocking each other in terms of received daylight.

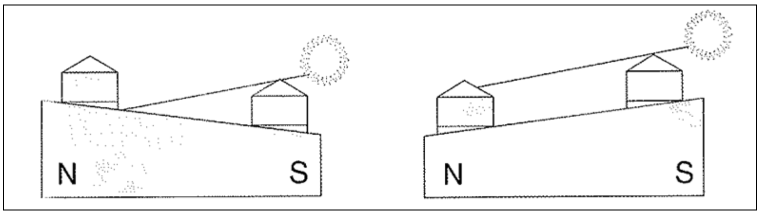
Figure 2.12 To achieve the same obstruction angles and hence daylight access, greater spacing is required on sloping sites



Source: Littlefair et al. (2000)

When it comes to accessing sunlight, while north-facing slopes require greater distance between buildings, south-facing slopes can receive sufficient solar radiation with a reduced space between buildings (see Figure 2.13) (Littlefair et al., 2000).

Figure 2.13 The slope of the site has a significant effect on over-shading



Source: Littlefair et al. (2000)

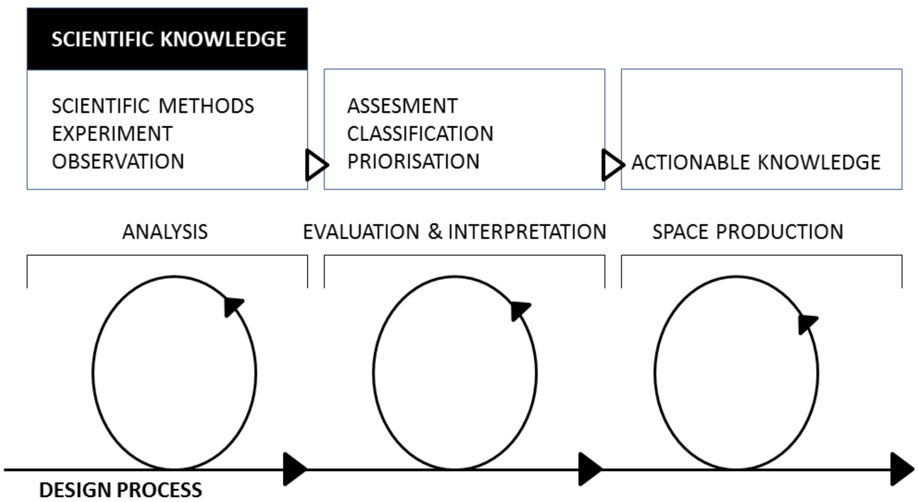
2.5.3.4 Heat Sinks

Heat sinks such as water bodies, public gardens and forests are significant design elements in terms of absorbing solar radiation, particularly in extremely hot temperature zones. Water bodies present little fluctuation in terms of surface level temperature. As Littlefair et al. (2000) explain, the water bodies` capacity to absorb solar radiation and to store absorbed heat provides a low level of heat transfer to its surroundings. On the other hand, water bodies are potential cooling mechanisms not only at the neighbourhood or city level but also at a cluster or even building-level. For instance, in an enclosed courtyard, a pond will have large cooling effect, particularly if it replaces low albedo hard surfaces which would heat up in hot seasons, though the absorption capacity of a pond may vary according to its depth. Beside water bodies, plants, with their capacity to absorb radiation in the leaves and cool the air through evapotranspiration, open green spaces, forests and public parks all have significant cooling effects in hot climatic regions (Littlefair et al., 2000).

The following tables (Table 2.3, Table 2.4 and Table 2.5) present the summaries of the climate responsive design strategies at building, street and city scales. Strategies are classified according to the main climate typologies seen in Turkey (see Chapter 4, Figure 4.1).

Climate responsive design results from selecting strategies appropriate for various climate types. There are a number of design decisions that have to be taken with regard to the modification of climate to microclimate. Although planners have recently became more aware of the use of climatic knowledge, recent research by Eliasson (2000) and Erell et al. (2010), point out the absence of a systematic approach to using climatic knowledge in urban planning practice. As seen in Figure 2.14, it is essential to translate scientific/climatic knowledge from being high-level, abstract concepts to actionable knowledge in a form that can be used to directly foster urban design processes. Pre-defined design strategies are not sufficient by themselves in terms of creating sustainable urban environments since they do not cover the local specific contextual differences.

Figure 2.14 Flow diagram of generating actionable knowledge through climatologic knowledge



Source: Peker (2011)

Table 2.3 Climate responsive design strategies at building scale

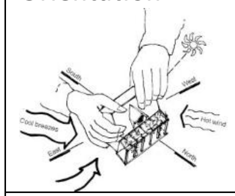
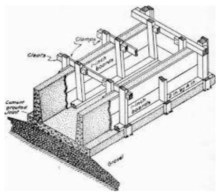
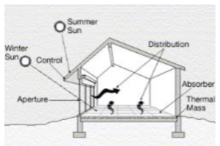
Climate Responsive Design Strategies	**Climate Type 1: Continental (a)** Extremely hot and dry summers, cold winters	**Climate Type 2: Continental (b)** Hot and dry summers, very cold and harsh winters	**Climate Type 3: Continental (c)** Hot and dry summers, cold winters	**Climate Type 4: Continental (d)** Hot and dry summers, cold and wet winters	**Climate Type 5: Marmara** Hot summers, mild and wet winters	**Climate Type 6: Mediterranean** Hot and dry summers, mild and wet winters	**Climate Type 7: Black Sea** Temperate and wet all year long
	Hot and dry				**Temperate**	**Hot and humid**	**Warm and humid**
Building Scale	Avoid large flank walls facing the dominant wind; orientate long axis parallel to the dominant wind.						
Orientation 	Let winter sun in and keep unwanted summer sun out Use shading devices to exclude high angle summer sun and admit low angle winter sun Long axes should be east-west, with flexibility to shift axis 20 C^0				Orient buildings` long axis in N-S/E-W axis in order to capture winter sun and block summer sun predominates	Orientation should exclude the sun year round and max. exposure to cooling breeze should be provided	No specific suggestion The orientation should be supported by the passive solar heating and cooling techniques
Building form 	Shaded courtyards Colonnaded buildings Self-shading buildings Windows facing prevailing breezes in summer for ventilation Windows to admit night time ventilation Minimize area of roof lights				Windows facing south for solar access in winter, facing prevailing breezes in summer for ventilation Avoid windows to the east and west	The main goal is the reduction of direct heat gain by radiation through openings and of the internal surface temperature.	Forms with large surface areas are preferred to compact buildings. This favours ventilation and heat emission at night time. The roof is preferably pitched to allow heavy rains to run off
Thermal Mass 	Mass that is well shaded, light in colour and ground coupled High solar reflectivity and emissivity for long-wave radiation are essential in the roof Use light colours in facades to reduce solar abortion				Adobe and burned clay bricks are the materials with the best properties for trombe wall constructions	High reflectivity and high emissivity are required for keeping the indoor temperature and the inner surface temperature low	Materials non-determinant due to little variation in temperature, lightweight preferred for quick response

Table 2.4 Climate responsive design strategies at street scale

<table>
<tr><td>Climate Responsive Design Indicators</td><td>Climate Type 1: Continental (a)

Extremely hot and dry summers, cold winters</td><td>Climate Type 2: Continental (b)

Hot and dry summers, very cold and harsh winters</td><td>Climate Type 3: Continental (c)

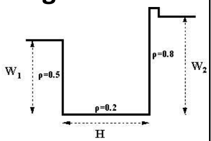
Hot and dry summers, cold winters</td><td>Climate Type 4: Continental (d)

Hot and dry summers, cold and wet winters</td><td>Climate Type 5: Marmara

Hot summers, mild and wet winters</td><td>Climate Type 6: Mediterranean

Hot and dry summers, mild and wet winters</td><td>Climate Type 7: Black Sea

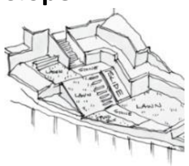
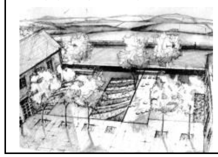
Temperate and wet all year long</td></tr>
<tr><td></td><td colspan="4">Hot and dry</td><td>Temperate</td><td>Hot and humid</td><td>Warm and humid</td></tr>
<tr><td>Street Scale</td><td colspan="7"></td></tr>
<tr><td>Layout
</td><td colspan="4">orienting corridors parallel to prevailing breezes can provide natural cooling

design winding or zigzagging narrow streets reduce the exposure to radiation</td><td>design streets in the direction of summer winds, avoiding the direction of winter winds.</td><td>orienting corridors parallel to prevailing breezes can provide natural cooling</td><td>main corridors perpendicular to dominant winter winds and parallel to cool summer breezes as much as possible</td></tr>
<tr><td>Height-Width
</td><td colspan="4">Narrow streets defined by tall buildings provide shadowy
Avoid east-west streets since they have significantly higher penetration sunshine</td><td></td><td>wide streets ease the ventilation

Avoid east-west streets</td><td>Street spaces should be long and straight to facilitate air movement and lined by high, shade-providing trees.</td></tr>
<tr><td rowspan="2">Shading
</td><td colspan="7">Trees, bushes, walls, fences and ground profiling (such as mounds and banks) can all contribute to shading and wind shelter.</td></tr>
<tr><td colspan="4">Half and full shade protection by arcades, membranes etc., and vegetation (trees) is desirable; exposed paved surfaces should be avoided; pools of water are beneficial.</td><td>Use tree canopy in summer to shade building but allow breeze.

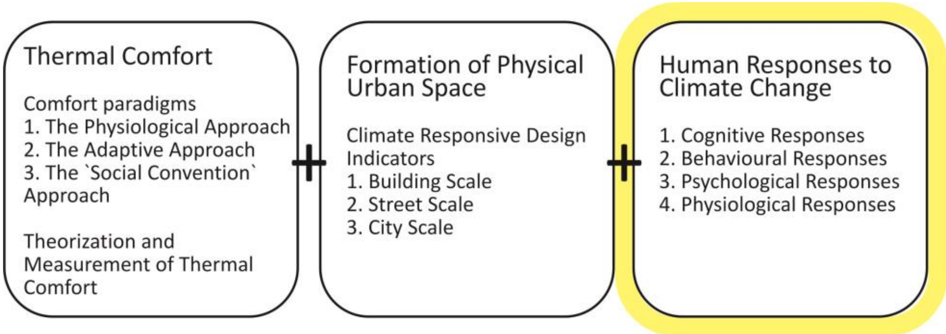
Planting to allow solar access in winter</td><td>Tall shading trees and reduced ground vegetation are important elements.</td><td>Sites should be well-sheltered from prevailing winter winds</td></tr>
</table>

Table 2.5 Climate responsive design strategies at city scale

Climate Responsive Design Indicators	**Climate Type 1: Continental (a)** Extremely hot and dry summers, cold winters	**Climate Type 2: Continental (b)** Hot and dry summers, very cold and harsh winters	**Climate Type 3: Continental (c)** Hot and dry summers, cold winters	**Climate Type 4: Continental (d)** Hot and dry summers, cold and wet winters	**Climate Type 5: Marmara** Hot summers, mild and wet winters	**Climate Type 6: Mediterranean** Hot and dry summers, mild and wet winters	**Climate Type 7: Black Sea** Temperate and wetall year long
	Hot and dry				**Temperate**	**Hot and humid**	**Warm and humid**
City Scale							
Form 	Design compact forms with narrow streets so that all the buildings are shaded to some extent from the sun. Arcades, colonnades, cantilevered buildings or building components, membranes and small enclosed courtyards are traditional responses to the climate				Natural ventilation will be easier if the site can catch prevailing summertime winds	Natural ventilation will be easier if the site can catch prevailing summertime winds	Buildings should be separated with large, free spaces between them for ventilation for cooling and a hygienic environment.
Open space 	Small or medium size green open spaces should be provided in order to create berating spots Walking distance to public spaces should be minimal and the footpaths shaded.				Open squares with groups of trees to provide shade are desirable	Walking distance to public spaces should be minimal and the footpaths shaded.	Open spaces should be wide enough to allow adequate solar access
Slope 	Try to locate neighbourhoods in the most shaded areas by the natural topography High altitudes and locations with evaporative possibilities are advantageous.				Try to orient south-southeast and locate in the middle or the lower middle of a slope		A south-facing slope will be warmer and give better solar access
Heat sinks 	Heat sinks like sea, lakes and forest will be cooler in city scale In smaller scales, fountains and ponds can be effective air-conditioning systems				Water walls and roof ponds could be suitable	Water bodies as cooling systems	

Strategies discussed in this section are defined in an 'ideal world' scenario where there is an optimum fit between climate and building response. However, in practice, the direct application of these strategies is almost impossible due to context-based characteristics which require specific interventions. Therefore, technical design strategies from different scientific disciplines, particularly from urban climatology, should be interpreted, classified and prioritised in a way that maximises their input into urban design processes. The knowledge produced should be more human oriented and harmonized with the traditional contextual values of localities. To do that, it is essential to understand the 'human dimension' of climate responsive design. This includes understanding of the way human beings develop responses to climate change and the way it affects urban daily life activities and thermal comfort experiences. This is important because human responses to climate change are directly related with the way people use/live in urban living environments. This includes the levels of energy consumption for the provision of thermal comfort at housing scale or the choice of transportation mode for the daily commutes at urban scale. The critical point here is to understand the way people develop responses to climate and particularly climate change. This will help us to better harmonize the social dimensions of space production with the technical dimensions of climate responsive space production. With this purpose in mind, the last part of this review chapter focuses on the human responses to climate change (third column in Figure 2.15) with respect to furthering the design of climate responsive urban built environments.

Figure 2.15 Three major bodies of literature used in the research



Source: Author's original

2.6 Understanding Human Responses to Climate Change in Furthering the Design of Climate Responsive Built Environments

A great amount of scientific research refers to a significant human factor on climate change (IPCC, 2001, 2007). The perception of climate change and the consciousness of the related effects directly impacts upon both adaption and mitigation processes. The more people understand their role in climate change, the more likely they are to play an active role in prevention. Thus, precautions and interventions designed to tackle climate change need to go beyond physical planning. A climate responsive production of space should consider end-users' responses which might be positively influenced by formation of the built environment. Having said that, design in and of itself has always had the potential to change preferences with its creative and attractive dimensions. A carefully designed urban living environment has potential to affect and change the way people conceive, feel, and use the built environment. In this regard, designers need to understand the dynamics underlying how individuals 1) conceive of the phenomenon of climate and 2) assign (or ignore) meaning within his/her on going lifestyle and modify/change their actions accordingly.

Within this context, the following section presents a review of different human responses to climate change. The section follows the work of Sheppard (2005), which groups environmental responses into four categories; cognitive, affective, behavioural and physiological. In this categorization, cognitive responses are related to awareness of climate change and understanding of its possible future effects. Affective responses, which are referred as psychological responses in this paper, are related to emotions and the way people feel. Behavioural responses are about changes in behaviour. Physiological responses are related to any biological and physical effects on peoples' bodies.

2.6.1 Cognitive and Behavioural Responses

The way in which people firstly, perceive climate change and secondly, develop cognitive responses according to their experiences, is closely related to the formation of their behavioural responses. The literature presents researches investigating the relationship between cognitive factors and precautions to climate change, address the significance of perception of climate change risks. For example, Grothmann and Patt (2005) indicate two cognitive factors as '*risk perception*' and '*perceived adaptive capacity*'. They argue that the main determinant in motivating adaptation responses to climate change is the relative perception of risk. This is defined as "*the perceived probability of being exposed to climate change impacts and to the appraisal of how harmful these impacts would be to the things an actor values relative to the appraisal of how harmful and urgent other problems or challenges in life are"* (Grothmann and Patt, 2005, p.6). Similarly, Lorenzoni et al. (2007) claim that being aware of climate change is not enough for people to be engaged in adapting their behaviours; they also need to be motivated and able to take action. O'Connor et al. (1999, p: 467) state that: "*perceptions specific to climate change and general environmental beliefs are equally strong predictors of behavioural intentions for voluntarily actions"*. Their research about risk perception reveals that people become more willing to take voluntary action to address environmental problems when they learn the risks of climate change.

The literature presents different tools or methods that might make the public more aware and understand the possible future risks of climate change (Stall-Kleemann et al, 2001). For instance, Sheppard et al. (2011) suggest using visual tools to escalate levels of interest and interaction, accomplish internalization and encourage the engagement of people with the actions proposed in plans and policies. They claim that using life-like three-dimensional visualisation, like future scenario images of local places under threat of climate change can increase the awareness rate. Another alternative is to make contact with community leaders in order to help them work through their local networks to encourage citizens to address climate change contradictions (Stoll-Kleemann et al., 2001). This method enables people to understand their responsibilities and position themselves within the challenge of dealing with climate change. Another tool is the media, which is one of the most significant knowledge transfer mechanism, in terms of climate change awareness (Sampei and Aoyagi-Usui, 2008).

All of these awareness raising methods and tools are also related to the second cognitive factor which is called '*perceived adaptive capacity*' in the literature (Grothmann and Patt, 2005). Adaptive capacity is about understanding the change or possible forthcoming change and taking measures to address possible future risks and threats. Adaptation to climate change necessitates decision-making under conditions of uncertainty. Within this context, the motivation and perception of peoples' ability to decrease the negative impacts of climate change becomes more of an issue. As Sheppard (2005) stated, although the serious risk of climate change is becoming extensively accepted in the scientific and political environment, public awareness still falls behind. Research done by Grothmann and Patt (2005), demonstrates the significance of socio-cognitive variables in terms of developing models of adaptation and adaptive capacity. Research findings reveal that a well-designed model of human decision-making can contribute to increased levels of assessing individual adaptive capacity. In order to reveal the adaptive capacity, a high level of consciousness among the public is necessarily achieved.

Whitmarsh (2009) claims that understanding behavioural response to climate change calls for understanding the intentions of the actors. Her research analyses the actions taken against climate change, grouping these into `*intent-oriented*' and `*impact-oriented*' actions. The findings reveal that there is a significant difference between the mitigation actions proposed by authorities and those taken in line with the public's own accord. Whitmarsh (2009) explains this difference with the argument that `intent-oriented' action is related to moral considerations, while `impact-oriented' action tends to be stimulated by concrete benefits such as saving money and enhancing health. The research also shows that more than two thirds of respondents behave concerning for climate change. However, actions which are easier to carry out, such as recycling and turning off lights, are more likely to be coupled with environmental manner, while actions such as avoiding driving, using public transport are more dependent on conductive conditions (Whitmarsh, 2009).

Research by Lorenzoni et al. (2007) indicates that although many people have personal, social and moral responsibilities to address climate change, they identify reasons for not taking action. They categorised these reasons into two groups, individual and social. Individual barriers include: *"lack of knowledge, uncertainty and scepticism, distrust in information sources, externalising responsibility and blame, reliance on technology, climate change perceived as a distant threat, importance of other priorities, reluctance to change lifestyles, fatalism and helplessness."* (p. 449). Social barriers include: *"lack of action by governments, business and industries, 'free-rider effect', pressure of social norms and expectations, and lack of enabling initiatives"* (p. 449). Lorenzoni et al. (2007) also point out *'social identity'* as an important factor that affects the rate of people's energy use; this emphasizes the challenge of changing consumption behaviour (p. 449). For instance, although reduction in the levels of CO2 emissions released by transportation is one of the common goals determined mostly in upper (policy) level scale agreements and acts, the issue is closely interrelated with individual cognitive processes which can be addressed at smaller (i.e. local / individual) scales. This is where urban design offers possibilities that foster the change in cognitive processes. For instance, the presence of comfortable, accessible pedestrian routes would motivate people to alter their preferences in terms of daily commuting patterns. Transforming vehicle-oriented commuting patterns into pedestrian-oriented models is a radical change and requires a deeper understanding and internalization of the perceived risks of climate change. Having said that, recognizing or being aware of an issue does not necessarily mean a change in what people do. This is where design can take on a *catalysing role* in fostering change in conventional urban development patterns.

2.6.2 Psychological and Physiological Responses

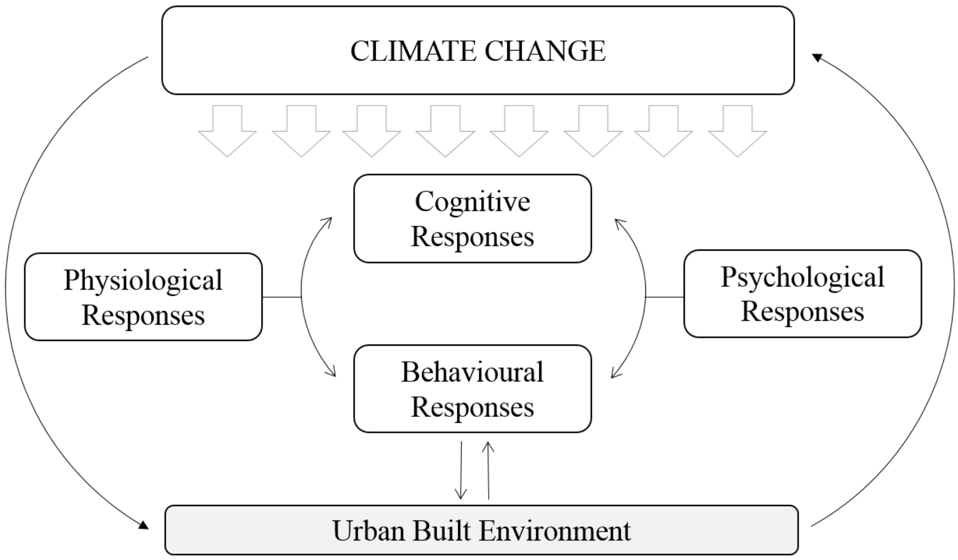
There is a strong connection between cognition, feelings and the ways in which people use the built environment in the context of climate change. Since human being maintains their existence based on natural resources and environmental conditions, both human psychology and physiology are sensitive to any alteration in the environmental balance. Psychology, in general, has a significant role in reducing the inherent impacts of climate change (Gifford, 2008). In particular, environmental psychology examines people's interactions with the environment, their perceptions, attitudes and actions. The risk and environmental psychology literatures also underline the variety of influences, including past behaviour, experience, knowledge, feelings, and social relations, that impact upon individual attitudes towards environmental issues (Lorenzoni et al., 2007). It is possible to say that any experience affecting the psychological or physiological state of people can have a triggering role in developing cognitive responses to climate change and modifying behavioural responses subsequently.

Stoll-Kleemann et al. (2001) state that the application of socio-psychological theories can help to explain why people's attitudes do not present parallels with their behaviours. They point out that people are more likely to accept alterations to their existing behaviours when they feel willing to do so. At this point, design is a potential mediator which facilitates/encourages the change by providing necessary inputs required for the psychological and physiological well-being while searching for climate responsiveness on the one hand. In research on the impact of visual landscapes on psychological well-being, Roger (1979) suggests that the outdoor visual environment has a potential impact on human psychological well-being and thus should be considered by designers and planners. For example, the design of a communal park in a city can provide a visual aesthetic generating psychological relaxation while contributing positively to physiological conditions as a result of its capacity to introduce natural ventilation to the city.

Literature presents that there is a direct relation between climatic conditions and human health and well-being (Kalkstein and Valimont, 1987). Human physiological adaptive responses such as sweating are largely determined by climatic factors (Oliver, 2005). Therefore, creating climatically comfortable urban environments can be a critical step towards providing sustainable urban lifestyles. Moreover, different seasons require different design approaches (Nikolopoulou and Steemers, 2003), especially for open spaces where the majority of social relations are being experienced. In research about the impacts of urban design on human health and well-being, Jackson (2002) summarizes his research findings according to three sections, each representing a spatial hierarchy of human settlement starting from the building scale via the neighbourhood scale, and ending with the city scale. At the building scale, most of the research concentrates on visual and physical access to the outdoors and the most health-friendly architecture exposes individuals to natural light and ventilation, views of vegetation, and closeness to open green space (Jackson, 2002). At the neighbourhood scale, Jackson (2002) emphasizes the issue of social capital, focuses on the influence of interpersonal relationships on peoples' emotional and physical conditions. At the city scale, transportation network design has widespread environmental impacts on people's daily activities. For instance, asthma is one of the most cited human physical health problems that has increased due to high rate of car usage (Jackson, 2002).

As this brief review of different bodies of literature shows, the formation of the urban built environment has various influences on the psychological and physiological status of end-users. In line with the review, Figure 2.16 demonstrates the interrelationships between different human responses to the fact of climate change. It shows that there is a circular relationship between cognitive responses and behavioural responses, since people display a tendency to change their behaviour as they become more aware of the future negative effects of climate change.

Figure 2.16 Network demonstrating interrelationships between different human responses to environment and climate change



Source: Author's original

A consequential change in behavioural patterns also led to a second level cognition which turns this mechanism into a cycle. Scannell and Grouzet (2010) claim that a deeper analysis of cognitions which are built in the face of climate change might help to understand the way people conceptualize the phenomenon. They introduce a new perspective by linking meta-cognition, defined as "*high-level order cognitions in which people attempt to, reflect upon, and sometimes attempt to control primary thoughts"* (Petty et al., 2007: cited in Scannell and Grouzet, 2010) with the climate change-related behaviours. From this perspective, meta-cognitive concepts may foster patterns of climate change cognition and might create new solutions for handling the socio-cognitive barriers to climate change. Additionally, biological and physical effects as well as feelings and emotions have great influence on how people behave and use the built environment in the face of climate change. People feel an emotional need to change their behaviours within a certain cognitive level as such in they behave easily where they physiologically feel comfortable. This network explains why the creation of climate responsive built environments needs to direct attention towards both the physical and emotional dimensions of space production.

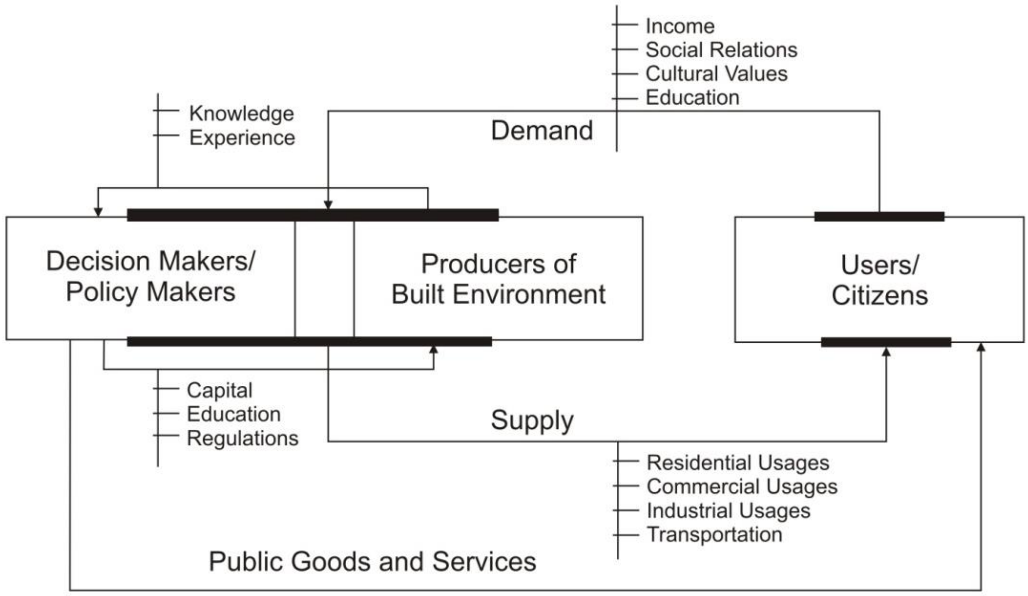
2.7 Conclusion

Urbanists, as creators of living spaces, play a significant role in people's way of life. In the context of creating sustainable built environments, 'designers' do not only have responsibility for considering technical indicators such as energy use, water consumption, and waste reduction but also social indicators such as conviviality, social support and community safety (Hancock et al., 1999). When it comes to the climate responsiveness, indicators become more complex since they also need to include measures of thermal comfort that are related to, and derive from, individual sensations shaped by cultural and local climatic dimensions. It is essential to emphasise that the needs and desires of people change from region to region and culture to culture. Likewise, the way people use the built environment also changes according to lifestyles that have developed in accordance with the climatic conditions of different territories.

In the sense of space production, although citizens as the users of the built environment have a certain level of adaptive capacity, this power is limited. For example, while an individual might modify the configuration of internal or external spaces within the home to maximise thermal comfort, they are unlikely to have the capacity to make radical changes in terms of wider physical conditions in residential units or the ability to modify the master plan of the city that they live in.

Depending on personal circumstances, such as access to financial resources and jobs, some people may have some level of choice over whether they live in a housing development that consumes less energy for heating or cooling, or one that is closer to their place of work (in order to reduce the amount of energy used for commuting). It is worth emphasising that the ability to make such decisions is determined by a range of factors such as income levels, existing social networks and cultural values and preferences, education and level of awareness of climate change, to name just a few. As discussed in the review of human responses to climate change, the capacity to develop cognitive responses to climate change factors is determined by various attributes. In line with this, Figure 2.17 presents the relationship between users (demanders), and decision makers and producers of built environment (suppliers). In this conceptualization, actors located on the ‘supply side’ need to take more proactive role to trigger the cyclic mechanism of cognition and behaviour change in order to address the gaps that may arise as a result of individual variables such as income, social relations and education. Many countries have already introduced awareness raising programmes and community capacity development training to address these issues. However, it is not realistic to expect citizens to develop cognitive responses and change their behavioural patterns in the built environment solely through political or regulatory alterations. Instead, it is necessary to accompany these measures by providing urban built environments in which end-users have the opportunity to use spaces in more climate-responsive ways without necessitating a dramatic change to lifestyles. This also requires experience and knowledge of using climatic variables in space production to provide climate responsive residential, commercial or industrial usages.

Figure 2.17 Conceptual framework for relationship between comfort of living space, users and designers/planners



Source: Author's original

Reducing energy consumption and maximizing comfort levels in a society whilst being sensitive to the wider needs and desires of citizens calls for an understanding of both the formation of the physical environment and the emotional dimensions that are created through the design of the urban built environment. Brown (2011) claims that from the regional scale to the local scale, designers and planners have an essential role to play in decreasing the effects of extreme climatic conditions. For instance, orientating a dwelling to maximise solar energy gains means that the amount of energy consumed to heat facilities in winter should be minimised. Conversely, providing natural cooling components in architectural or street-scaled implementations can reduce the use of external cooling devices in summer. The ways in which planners and designers shape the physical environment is seen as a reflection of people's behaviour and the way they use the environment.

Within the context of climate change, the task for urban designers is to combine technical analysis with observation of user behaviours according to different climatic zones and that is sensitive to cultural preferences and individual behaviours. For instance, the usage level of any public open space is dependent upon the existence of comfortable weather conditions (Westerberg, 1994; Nikolopoulou et al., 2001) and it is known that there are various factors that influence the condition of the plaza. When we consider designing a plaza for extremely hot regions, variables like shadowing, cooling and ventilation become influential in shaping people's experiences of these spaces. In addition to these more technical parameters, there might be hidden parameters that can affect the way people use the built environment. These parameters can only be explored by examining the present lifestyle and cultural dynamics. For instance, Barton (2010) argues that distance is the main factor in determining whether people walk or not. He adds that people have a tendency to walk in attractive, accessible and safe environments. Therefore, providing these indicators while designing urban environment could help to support reduced carbon emissions from motorised transport.

Furthermore, being prepared to change or developing adaptive responses is closely related to emotional variables. These, by virtue of their myriad forms, are not easy to measure and control. Although some scholars (see for example: Nicol and Humphreys, 2002) argue that people have a natural tendency to adapt to changing conditions in their urban environment, people are often sensitive to environmental alterations which directly affect their habits and lifestyles. For instance, from a climate responsive design perspective, human comfort is one of the major determinants for liveability of an urban environment. Outdoor human comfort is a multi-dimensional urban phenomenon that can be affected by different variables namely; air temperature, relative humidity, wind speed, solar radiation, human activity, clothing and age. Studies also show that climatic conditions labelled as either too cold or too hot effect emotional conditions in negative ways which can trigger emergence of aggressive behaviours (Eliasson at el., 2007). While sustaining thermal comfort, the role of conviviality on sustainable urban futures should not be underestimated. Conviviality covers many dimensions such as sense of neighbourhood, family safety and security, social support networks, public services etc. (Hancock et al., 1999). All these linkages highlight the significance of understanding human responses to climate change and experienced climatic conditions in such as way that this understanding could then be applied to urban design practices.

CHAPTER 3

APPROACHING CLIMATE RESPONSIVE URBAN DESIGN FROM A SOCIO-TECHNICAL PERSPECTIVE

3.1 Introduction

Chapter 2 has presented that the production of climate responsive urban space involves both technical dimension (i.e. physical devices, infrastructures, built forms and patterns) and social dimension (i.e. human responses, social values, cultural routines and believes). Due to the co-existence of technical and social dimensions, this research argues that climate responsive space production calls for a joint understanding of both dimensions. Co-existence here refers to the inevitable link between inhabitants and the technologies regarding the provision of climate responsivity in urban settings. The following extract from Bijker (1993) expresses the necessarily integrated structure of technical and the social dimensions.

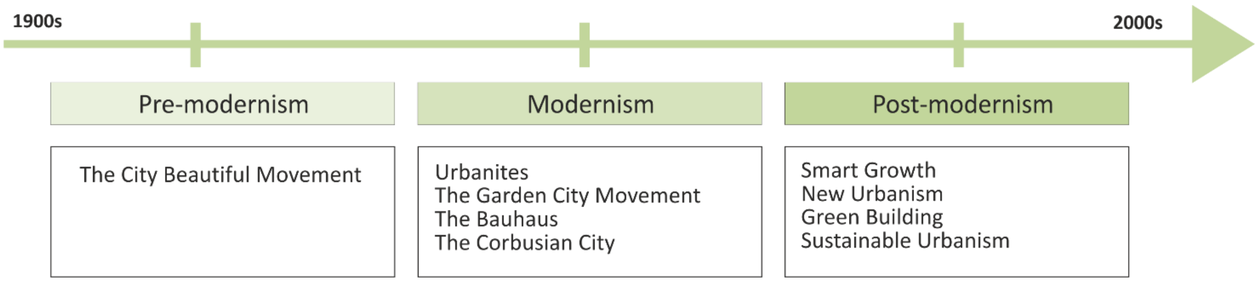
> *"Purely social relations are to be found only in imaginations of sociologists, among baboons, or possible on nudist beaches; and purely technical relations are to be found only in the sophisticated reaches of science fiction. The technical is socially constructed, and the social is technically constructed- all stable ensembles are bound together as much by the technical as by the social. Where there was purity, there is now heterogeneity. Social classes, occupational groups, firms, professions, machines- all are held in place by intimately linked social and technical means… Society is not determined by technology, nor is technology is determined by society. Both emerge as two sides of the sociotechnical coin."* (p. 113)

Within this context, this chapter first argues for the capacity of the urban design discipline to catalyse climate responsive space production. Then, based on this argument, the chapter underlines the requirement of approaching urban design from a socio-technical perspective. This includes the joint understanding of the measurable/technical dimensions such as temperature and humidity, and the anthropogenic dimensions such as the human responses and inhabitants' adaptation capacities. Following this argument, the chapter develops a socio-technical approach to urban design for the provision of urban thermal comfort such in the CRD approach aims to achieve. Finally, the chapter ends with the theorization of Multi Level Perspective (MLP), developed based on socio-technical systems thinking.

3.2 Urban Design as Catalyser for Climate Responsive Space Production

An urban built environment calls for certain types of spaces which accommodate certain types of activities and usages. Therefore space production has a fundamental role in the formation of the built environment and its components such as building blocks, open spaces, street networks and parks. Even before the term 'urban design' was adopted, as Street (2009) says, intervention in built environment through shaping it either for functional or visual concerns was in operation. Urban design as an interdisciplinary affair is shaped by various scholars` thoughts, utopias and proposals that were developed in an attempt to live in 'better' cities over many years (see Figure 3.1).

Figure 3.1 Design movements in different eras



Source: Author`s original

The review of literature reveals that the design movements introduced in the past present variations in terms of focus and design characteristics. As Table 3.1 shows (see next page), each paradigm represents a different perception of the `best` way to overcome urban problems and generate optimal cities according to its ideologies. Although the foci of the movements vary, the common point observed in the purpose of the approaches is `to create a change` in urban development and introduce new/better way(s) of shaping the urban built environment. For example, while the ideology behind the City Beautiful Movement is to solve urban problems through making cities more beautiful (Hopkins, 1989), the ideology behind the Garden City Movement was to change the migration flows towards the centre by using the magnetic attraction of the new garden city (Howard, 1902).

The ways in which the movements suggest to create the desired change in cities can be categorised broadly in two main groups. The first group is composed of the ones (i.e. the rationalists/functionalists) which emphasize the significance of physical environment and focuses more on the technical dimensions such as geometries, order and aesthetics in the city. The second group is comprised of the ones that highlight the significance of `social usage` approach, which puts human into the centre and focuses more on human experience, interaction and place-making capacities.

Table 3.1 Typology of design movements

Era	Approach	Movement	Design Characteristics	Main Focus	Prominent Names
Pre-modernist	**Rationalism**	The City Beautiful Movement	beautiful, spacious, and orderly cities	urban beauty urban aesthetics	Daniel Burnham
Modernist	**Empiricism**	Urbanites The Garden City Movement	organic plans	open space structure details in urban places	Ebenezer Howard Camillo Sitte Jane Jacobs Gordon Cullen
	Rationalism/ Functionalism	The Bauhaus The Corbusian City	rectilinear geometrics	social and physical structure	Tony Garnier Le Corbusier The Bauhaus
Post-Modernist	**Neo-empiricism**	Smart Growth New Urbanism Green Building Sustainable Urbanism	compact forms	urban sprawl population growth energy climate change	Peter Calthorpe Michael Corbett Andres Duany Elizabeth Plater-Zyberk Douglas Farr

Source: Author`s original

Development of a social usage approach to urban design brought the idea of linking the design with the behaviours of the people using the environment and the contextual values including nature and ecology. The increasing destruction of natural environments triggered the integration of socio-ecological concerns in urban design (Wall and Waterman, 2010). From the 1960s onwards, ecology became a key term in urban design theory. Especially after the 1970s, and faced with the environmental problems associated with globalisation and rapid urbanisation, the idea of creating compact cities and communities became popular among the urban planners. Within this context, different movements and development models such as New Urbanism, Smart Growth, and Sustainable Urbanism have been proposed as potential solutions for increasing problems such as urban and environmental pollution, climate change, resource poverty and some others.

Although diverse, a theme of post-modernist approaches is the creation of high-density, mix-used schemes in compact cities to encourage use of public transportation as well as protecting the natural environment from the effects of sprawl. One significant common point of these approaches is the strong attachment to advanced technologies. From modernist times to the post-modernist era, there is a tendency to seek technological solutions (e.g. green roofs/facades, solar panels, green infrastructure) in order to reduce the negative externalities of the urban built environment. With the current environmental challenges such as climate change or reduction in energy sources design, the main concern of design shifts towards innovative technological solutions for the reduction of human-driven damages on the environment.

Although past urban design movements had different concerns in different eras, visions of utopias from the past can still be related to contemporary urban challenges. For example, the municipality of Gaziantep in Turkey has prepared a city level action plan and proposed a new eco-city which will be developed outside the existing city by using the principles of low carbon design. The project aims to generate an environmentally friendly city while reducing the over-population in the core of the existing city. Howard`s garden city ideology can contribute by creating healthy places while controlling demographic change, and also in terms of supporting transition to low-carbon, eco-friendly development. However, since policies and plans are often not translated into action in a proper way, urban environments which ignore their contextual settings, have continuously been developed in Turkey. Translation of plans into action requires utilizing the advanced technologies that potentially respond to the targets (e.g. reduction of energy consumption) of sustainable urban development.

While echoes of previous scholars from the modern and post-modern era are to be seen in the development of contemporary cities, technological developments have started to penetrate into urban design practice. For instance, due to the risk of energy shortages, markets increasingly require more energy efficient and long term solutions (i.e. ensuring energy availability after fussel fuels are unavailable). Innovative design products such as the solar panels of LED solar street lights which absorb energy from the sun and convert it to electrical energy for use at night (see Figure 3.2) and solar shaded parking lots which receives solar energy and transmit it to solar charging stations for plug-in electric vehicles (see Figure 3.3) are examples of products that have emerged in recent years.

Figure 3.2 Zero-carbon footprint city, Masdar, United Arab Emirates

Source: www.yoursolarlink.com (2013)

Figure 3.3 A solar shaded parking structures, at Dell's headquarters in Round Rock, Texas

Source: www.mnn.com (2013)

Technology has also triggered innovation in construction engineering. For example, green roofs are introduced as an energy saving mechanism by keeping buildings warmer with their insulation capacity in winter and cooler by absorbing water and evaporating it in summer. The widespread use of green roofs can also reduce the urban heat island effect by providing shade and evapotranspiration (see Figure 3.4).

Figure 3.4 **School of Art and Design, Singapore**

Source: www.greenroofs.com (2013)

These innovative design implementations are significant steps towards achieving climate responsive urban developments. However, urban design is not only about creating technical design solutions and exploring new innovations for reducing energy consumption or greenhouse gas emissions. That is only one dimension of it. What makes it different from engineering, architecture or industrial approaches is its process generating capacity rather than being a product-oriented discipline. Formulating the design process as a reciprocal learning process can provide more locally specific uniformation for designers to utilize as well as increasing awareness among the citizens in terms of energy use in urban spaces.

As Adhya et al. (2010) argue, conceiving of the urban space in terms of form is neither necessary nor sufficient to achieve the goals ascribed to sustainable development. They emphasize the significance of approaching sustainability not as a target but as a process. Therefore, seeking sustainable solutions through sustainable architecture, advanced construction engineering techniques or complex policies is not enough without social understanding which refers to human experience and actions in relation to sustainability. Jenks and Dempsey (2005) claim that the major focus in the design of future cities should respect citizens` responses by operating at a human scale, creating rich ‘in-place’ social interaction and supporting daily life experiences. They also mention that technological development might be used to solve some of the problems in cities, but they are not a panacea. Citizens should meet their own needs and seek their own solutions; without change at a societal level, the challenges of sustainability cannot be achieved.

This research argues that approaching urban design from a socio-technical perspective can moderate/catalyse production of climate responsive urban space. The `mongrel`[11] structure of the urban design discipline, as expressed by Carmona (2014) draws its legitimizing theories from diverse intellectual roots. This diversity stands as the main strength of the discipline in terms of responding to social and technical nuances, as well as to various actors of space production with respect to climate responsiveness. The diversity gives the discipline the power to draw the comfort-related, technical insights from disciplines such as architecture, planning and landscape, and intellectual richness regarding the social dimensions of space production from disciplines such as anthropology, sociology and psychology. What makes urban design different to other professional practices such as architecture and planning is the capacity of the discipline to draw together the technical and anthropogenic nuances of space production, and to shed light on different scales of urban space. This integrative process is enriched by design thinking, that does not necessarily strictly adhere to technical details.

3.3 Taking a Socio-technical Approach to Climate Responsive Urban Design

The previous chapter has demonstrated that the production of climate responsive cities calls for a change in the undergoing patterns of energy consumption in all levels of urban life. The energy consumption here refers to the consumption related to the provision of thermal comfort; in other words, the energy for achieving urban settings that enable adaptation to local climatic conditions. The targeted change (i.e the change in the patterns of energy consumption in urban life) can be called radical for two reasons. First, existing energy consumption patterns in buildings and surrounding urban areas are shaped as a process of accumulation based on the existing institutions, professional norms and belief system, which are addressed by Brown and Vergragt (2008) as difficult issues to change in the short term. Second, cities as living mechanisms do not function as pre-fictionalized video games whereby cyber inhabitants are controlled by players. Not surprisingly, the professionals and policy-makers shaping the built environment do not have the capacity to fully control the behaviours of people living in it. The limit to which they can intervene in is the system of physical components (i.e. dwelling units, streetscape, urban forms) which creates an urban system referred to as a physical sub-system by Hillier (2009) in the following extract.

> *"Cities as complex systems are made of (at least) two sub-systems: a physical sub-system, made up of buildings linked by streets, roads and infrastructure; and a human sub-system*

---

[11] *"Urban design is in fact a mongrel discipline that draws its legitimizing theories from diverse intellectual roots: sociology, anthropology, psychology, political science, economics, ecological, physical and health sciences, urban geography, and the arts; as well as from the 'professional' theories and practices of: architecture, landscape, planning, law, property, engineering and management."* (Carmona, 2014, p.2)

made up of movement, interaction and activity. As such, cities can be thought of as socio-technical systems." (p. 1)

Hillier`s (2009) definition constitutes the basis of the argument that the creators of the built environment who decide about formation of urban space cannot be conceptualized as isolated from the end-users who produce the `lived space` (Lefebvre, 1991) and consume amounts of energy according to the ways that they developed to adapt climatic conditions. If the space production system targets a change with respect to climate responsivity, the sub-systems described by Hillier (2009) need to be paired with each other. In this reciprocal relationship, development of technologies facilitate the formation of a physical urban sub-system which influence and is influenced by the social/human sub-system. This includes technological enhancement regarding climate responsivity in space production. Urban technologies are shaped through the requirements of current challenges in cities (e.g. carbon reduction) under the current socio-political circumstances. Therefore, it is essential to understand the way urban technologies, particularly for climate responsivity, are produced. This is important to highlight the argument of this research regarding the significance of contextual/local specific values in urban space production. As seen in Table 3.2, Guy and Karvonen (2011) summarize the common perspectives on urban technologies under four titles.

Table 3.2 Four common perspectives on urban technologies

1) Contextuality: *Technological development processes are contextually based. While it is possible to transfer techniques, skills and knowledge between different places, processes of translation and interpretation dictate the success or failure of technologies in particular locale…*
2) Contingency: *Technological development is a contingent process. This refers to the wide variety of actors and contextual factors that shape technologies, and, in the process, create multiple pathways or alternative routes by which technologies are realized...*
3) Obduracy: *Urban technologies are long lived and they are embedded in a complex array of material realities, social habits and institutional standards…*
4) Unevenness: *Process of sociotechnical development are often uneven. Technologies can replicate and exacerbate existing hierarchies and class distinctions, creating interstices and recesses of partial or no service rather than a level playing field for all urban residents.*

Source: Guy and Karvonen (2011, p. 123,124)

Considering that technological development does not emerge within a vacuum, the success of urban technologies may vary according to different social contexts (Guy and Karvonen, 2011). This is not to argue that new technologies fail to successfully respond to different social groups, but to highlight the significance of end-users/inhabitants, as mentioned by Brown and Sovacool (2011), who potentially can be just as important as the technical innovations for the success of new technologies. Technology here has an expansive meaning beyond the artefacts associated with sustainable development (i.e. solar panels, wind generators). As Guy (2010) asserts, technology also refers to the knowledge required to construct and use these artefacts in urban daily life. This understanding of technology evokes Feenberg's (1999) emphasis on the 'meaning' (of technologies) and the way users engage with the sustainable (i.e. new, smart or green) technologies. The question that arises here is whether too excessive an expectation is now placed on sustainable technologies' ability to create the desired change (towards more responsive living settings) at the expense of their relationship with other potential change mechanisms (Cole, 2005). The critical concern here, as Guy (2013) indicates, is that the contingent complexities of sustainability becomes ignored by focusing on superficially universalized systems of measurements as a guide through cultural diversity. Guy's (2013) alert of 'standardization' implicates ignorance of 'forms of local knowledge' and 'particular local conditions'. In addition, technology is not shaped only by scientists, rather it is influenced by various actors including scientists, engineers, policymakers even users. Therefore, in order not to fall fallacy of technological determinism, it becomes essential to adopt a 'co-constructivist' perspective (Guy and Karvonen, 2011) that argues for a mutual shaping between technology and society.

> *"It is mistaken to think of technology and society as separate spheres influencing each other: technology and society are mutually constitutive"* (MacKenzie and Wacjman, 1999, p. 23)

With the assumption of co-constructivism, approaching urban development from a socio-technical perspective means looking beyond the dualism between humans and non-humans. Avoiding this dualism, as Guy and Karvonen (2011) state, requires interpretation of urban space as a socio-technical system in which people and technologies interrelate through the political, cultural and economic realities of the urban daily life. Therefore, production of climate responsive urban space is not only a task for technical experts such as planners, designers and engineers, but also a process of development and management with the influence of 'non-technical' actors including 'ordinary' people. Considering that this research values urban design as a catalysing discipline for climate responsive space production, generation of urban space (as a socio-technical system) necessitates a socio-technical perspective to the discipline. Based on this argument, the following section elaborates the origins of socio-technical system thinking and the capacity of constituting a key concept for approaching urban design as the catalyser/mediator of climate responsive urban space production.

3.3.1 The Crux of Socio-technical Systems (STS) Thinking

Socio-technical systems (STS) thinking, as Trist and Bamforth (1950) claim, dates from the description of the change from a system of coal mining that emphasized autonomous work groups, to a more mechanized system extrapolated from factory procedures. The concept of the socio-technical system was initially established to emphasize the reciprocal and inevitable relationship between `people` and `technical systems` (Ropohl, 1999). As Miner (2006) states, STS theory began with the idea that there must be a joint optimization between the task or technical environment and the social system.

STS theory developed based on an action research field project done by the Tavistock Research Institute of Human Relations in British coal mines after the Wold War II (Trist, 1950). During that time, the expected increase in the mine productivity was not actualized, despite major investments in advanced mechanization, while `labour turnover` and `absenteeism` were on a rapid rise (Trist et al., 1963). The Tavistock researchers argued that technology merely constrains human action, rather than rigidly determining behavioural outcomes (Marshall, 1998). Indeed, for any productive problem, as Marshall (1998) indicates, there is typically a range of technologically equivalent solutions, with differing implications for human relations. By emphasizing the mutual influence of technology and the social systems of the workplace, the Tavistock researchers sought to move away from technological determinism towards greater appreciation within management of the need for consultation, innovation, flexibility, and an open mind in the design of work processes and procedures.

Although STS thinking was first coined within the field of organizational management, and was particularly concerned with the social and the technical variables of working life, it can be considered a key theory that, in essence, suggests that neither technical nor social systems can function efficiently without a joint understanding. One is lost without the other. Socio-technical systems do not function autonomously, but as Geel (2004) states, they are the outcome of the activities of human actors. Human actors are embedded in social groups which share certain characteristics (e.g. certain roles, responsibilities, norms, perceptions) (Geel, 2004). Therefore, STS thinking calls for the consideration of the human actors and their values, contributions and responses to the technical components of the concerned phenomenon.

The concerned phenomenon in this research is the creation of climate responsive urban space. The research uses socio-technical systems thinking as a key concept that provides an umbrella for joint understanding of the technical dimensions of urban space production, including climate responsive technologies and solutions; and social dimensions of urban space usage, including the adaptive capacities and responses (mostly shaped by cultural background, values and lifestyle) developed by inhabitants of localities. With this sense, Table 3.3 presents the reflection of the main principles of STS defined by Tavistock Researchers, in climate responsive urban design.

Table 3.3 Reflection of the main principles of STS (defined by Tavistock Researchers) in CRD

3 Main Principles of STS
1) STS approaches working life as a **socio-technical process**. Therefore, it theorizes working life as an **anthropocentric formation** rather than a mechanical structure. 2) STS highlights the significance of the **requirements and satisfaction of each sub-group** in a working environment. 3) STS attaches importance to **shared values** grown out of experiences over time and **collaborative-decision making**.
Reflection to CRUD
1) Producing climate responsive urban built environment is a social-technical process which requires understanding the anthropogenic values. 2) Preventing the generation of mechanic/prototyped urban built environments calls for fulfilling the requirements of people living in different localities in different climatic conditions. 3) Transition to a more climate responsive urban development model calls for collaborative decision-making and integration of shared values of all stakeholders.

Source: Author`s original

Socio-technical systems, as Geels (2005a) asserts, are actively created, (re)produced and refined by several social groups such as private entrepreneurs, knowledge institutions, public authorities and public interest groups. Therefore, changing the dominant mode of operation in an existing socio-technical system is not a short-term and one-step action. Impulse for the change emerges at one point, gradually grows and turns into a transition of a whole system. In this sense, the transition towards a climate responsive development in cities accompanies innovation and internalization of sustainable actions at different scales by different actors of space production. This calls for a socio-technical perspective which is reinforced by Guy (2013) in the following way:

> *"Rather than searching for a singular optimal technological pathway, socio-technical perspective encourages us to recognize and listen to the number of voices striving to frame the debate, and visions they express of alternative environmental place-making. The search for consensus that has hitherto characterized (and often still does characterize) sustainable design and policy-making must be translated into the search for an enlarged context in which a more heterogeneous coalitions of practices can be developed." (p.138)*

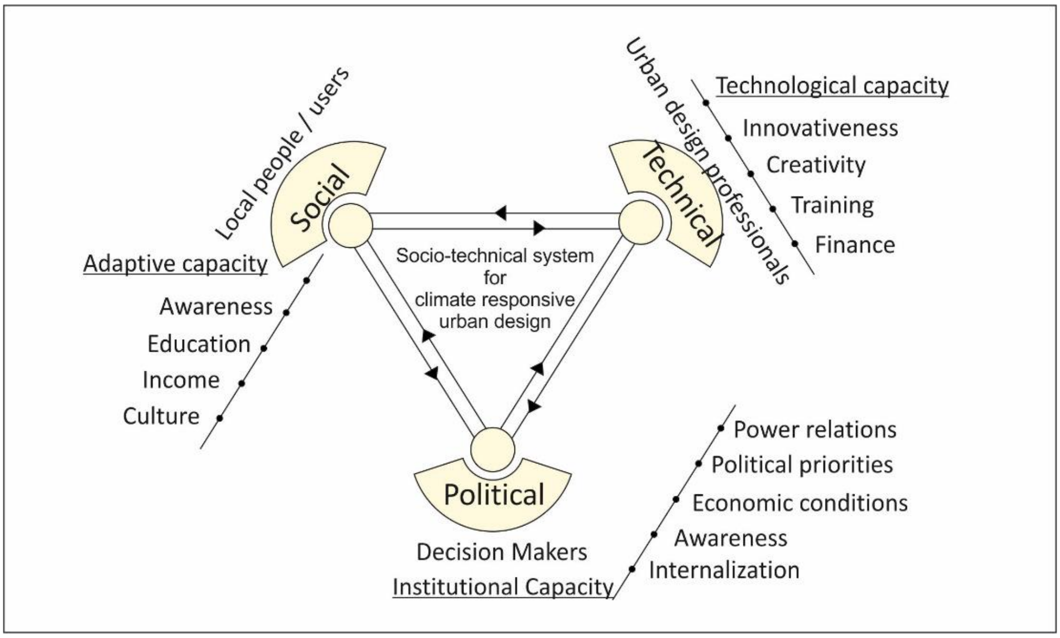
In this regard, rather than viewing climate responsive design as the implementation of a technological innovation/solution as an external solution package, it should be considered as, Long and Long (1992) assert, an on-going transformational process in which different actor interests and struggles are integrated. From this point of view, the following section discusses how a socio-technical perspective can embrace the creation of climate responsive urban settings, particularly in the Turkish context where the case study of this research is conducted.

3.3.2 Socio-technical Perspective for Embracing the Challenges of Contemporary Cities and Designing Future Cities

Approaching the production of urban space with sensitivity towards climatic variables, particularly in the Turkish context, is a relatively new approach that occurred after the recognition of the climate crisis in the world. It requires a transition of the modernist urban development pattern which has been implemented since 1980s to compensate for the rapid urbanization triggered by neo-liberal policies. The planning approach adopted since 1980s in Turkey was based on zoning, that is to say, the determination of future images of cities by choosing certain sites for different land uses. Since the 1980s, development of urban built environment in Turkish cities has been done within the frame of a planning system composed of two different plan sets called ***"environmental plans"*** and ***"development plans"***. Although the details of the planning system are explained in Chapter 5, briefly, "Environmental plans" are upper scale strategy and vision plans at the regional or provincial levels. "Developments plans" are prepared by municipalities and comprise a basis for urban design principles and implementation tools. However, Ersoy (2005) argues that the definition of implementation tools in development laws is incapable of dealing with the rapid urbanization associated with the industrial and technological development. He argues that a law with comprehensive and functional targets, which encourages collaboration amongst institutions within a well-developed organisational model, may still be weak due to the lack of a portfolio of implementation tools. Moreover, the main concerns and priorities in urban development have changed particularly after the late 1980s, when the climate change debate came to the fore of many countries` political agendas. Therefore, planning systems need different methodologies and implementation tools in order to adapt/revise themselves according to contemporary problems of the 21st century such as climate change. For instance, taking a climate responsive urban design approach at the municipal level calls for appropriate design methods and tools that enable us to benefit from climatological knowledge and to explore tacit knowledge produced by local people.

Moreover, today future visions of cities should emerge as the form of human relations rather than urban forms as in the modernist era. Transition to a climate responsive form of development calls for the implementation of collectively generated knowledge. Therefore, urban design should be perceived as a process comprising not only spatial organization and physical adjustments but also the human dimension, social interaction and harmony with nature. As Geels (2005a) suggests, these kinds of transitions are multi-actor processes that involve interactions between different groups. Therefore, considering the challenge of creating a transition in a deep-seated urban development system, a climate responsive design approach requires a holistic framework including innovation and alteration in relation to ***political, technical*** and ***social*** systems (see Figure 3.5 and Figure 3.6).

Figure 3.5 Socio-technical system for climate responsive urban design



Source: Author's original

Figure 3.6 Alternative diagram for the holistic framework

Source: Author's original

Integrating climate sensitivity into planning and design practice calls for the generation of common ground among different actors. In this conceptual framework, the ***political dimension*** mainly refers to decision-making authorities who are largely politicians responsible for identifying strategies and objectives for taking action against climate change. The political dimension is one of the strongest challenges in making the transition to new socio-technical systems due to the variations in political priorities, power relations and economic conditions. Transition, in this research, refers to the change of existing principle-led and form-oriented design approach to a more sustainable design approach that allows the integration of social and contextual dimensions as well as human experience into the production of the built environment. Those in positions of political power may be resistant to change since transition requires certain reforms in institutions, financial and human resources within time constraints. For instance, transition from a top-down planning approach to bottom-up planning approach at the municipal level will certainly entail various amendments such as creating supplementary budget and training municipal staff on the use of more participatory methods and techniques. Considering the political authorities are elected for 4-5 years in Turkey, this relatively short time interval for providing the mentioned amendments explains the legitimacy of resistance to change.

The ***technical dimension*** refers to technological advances and design solutions developed principally by engineers, urban planners and designers. Climate responsive design calls for a certain level of training, technical and climatological knowledge, creativity and adequate financial support. Political and technical actors should set a collaborative working environment to obtain efficient information and input for their own responsibilities. Along with this mutual mechanism, the integration of the social dimension into this framework is crucial to sustain climate responsiveness in every layer of urban life. The ***social dimension*** refers to individual and social/societal responses to climate change and the internalization capacity/potency of local people to generate adaptive, innovative solutions within their contextual setting. The emergence of organic agriculture stands as an example of how a small innovation in one locality triggers the idea of producing organic, healthy and sustainable products in agricultural systems. As Fischer and Herrmann (2011) stated, the relationship between social and technical should be read as contingent rather than deterministic. For instance, developing a railway system in a small-scale city does not deterministically change citizens but only influences the evolution of their social structures. Here, transportation designers can be reflective with respect to the impact of a railway system on its social context, and they can make their assumptions about the expected evolution of the social system but they cannot control the societal change. Moreover, Fischer and Herrmann (2011) stress that technical improvement is not only represented by artefacts but by methods and procedures that are connected with these artefacts. For instance, transition from a general waste collection system to a re-cycling system in a municipality does not represent a socio-technical transition unless it is supported by additional support systems such as training and awareness raising at the societal, even individual level.

3.3.3 Making the transition/change happen: Multi-Level Perspective (MLP)

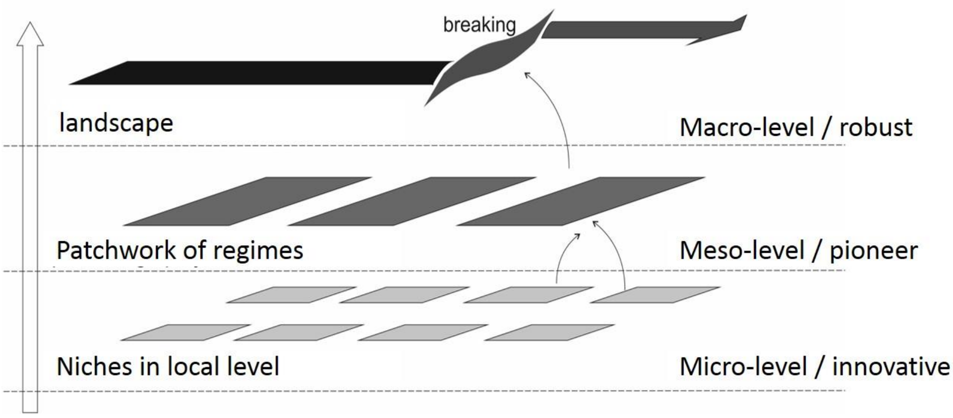
Since the beginning of the 1990s, Turkey has been oriented towards sustainable development, conservation and environmental protection through participation and collaboration by many agreements and international reports. Examples include the report of the World Commission on

Environment and Development, *Our Common Future*, linking cities to sustainability for the first time (WCED, 1987); the European Union`s *Green Paper*, on the urban environment; and the Organization for Economic cooperation and Development`s (OECD) *Environmental Policies for Cities in the 1990`s* (OECD, 1990). All fields of the Turkish national system certainly have taken their share from these notions affecting the global discourse. Planning policies have quickly embraced the notion of sustainability through participation; however, only a few authorities have tailored it in practice.

The current urban development system in Turkey represents a mechanical system mostly based on technical determinism (i.e. planning based on zoning) that underestimates the significance of the variations (i.e. climatic factors) in different localities across the country. As argued so far, changing the existing trend is possible via activating the urban design discipline in the space production processes. To create a change/transition in the socio-technical systems, the multi-level perspective (MLP), as a middle range-framework, provides a useful theorization of the process of a transition (Schot et al., 1994; Geels, 2004). Although MLP has not been illustrated in urban design studies before, it has been used in various urban cases such as transition from industrialized agriculture to integrated production (Belz, 2004), transition from sailing ships to steamships (Geels, 2005c) and transition from horse-drawn carriages to automobiles in passenger transport (Geels, 2005a). The MLP aims to integrate findings from different literatures as an `appreciative theory` (Nelson and Winter, 1982) which accords with the `mongrel` nature of the urban design discipline.

The conceptual structure of MLP consists of three levels and transition can occur when these levels become linked (see Figure 3.7).

Figure 3.7 Multi-level framework for transition to climate responsive urban development



Source: Adapted from Geels (2002)

The first level consists of niches, *'the locus for radical innovations'* (Geels, 2005b). Niches are essential elements since they provide locations for learning processes like learning by doing, learning by using and learning by interacting (Geels, 2005). The strength of a niche comes from its attachment to the real world experience. Niches originate from a requirement or as a reaction or a solution to a specific life experiment. However, niches that emerge from daily life experiences may not be easily accepted and internalized by all actors identified in the three-dimensional framework. This reflects the various roles of different actors in the production, adoption and adaptation of socio-technical systems. For instance, road construction and car regulations are controlled, designed and maintained by the ministry of transport. Designers and engineers produce cars with the technological knowledge. The cultural and symbolic meanings attached to cars and car use are produced in and through different societal groups. Geels (2002) claims that the activities of these different groups are aligned to each other and co-ordinated in an 'ideal' (i.e. fully functioning) socio-technical system. To understand this relationship, Geels (2002) uses the term 'socio-technical regimes' to refer to the semi-coherent set of rules carried by different actor groups. The accumulation of resolved regimes leads to change at the landscape level. MLP conceptualizes the accumulation of different regimes as a 'landscape' at the macro-level. The term 'landscape' is used to emphasize the literal connotation of relative 'hardness' of change and to mention material aspects of society such as city structures, transportation infrastructures and electricity grids (Geels, 2005b). Effecting change at the landscape level is complex and requires action over an extended period of time.

In MLP theory, niche innovations in the early phases have difficulty in attracting attention and funding due to the stable structure of existing regime (Geels, 2005a). This argument is evident in relation to the inflexible structure of the Turkish urban development system. The existing urban development system stands as a robust landscape which is not open to radical changes in short run. This calls for revisions in policies or modifications in construction system. In other words, it requires changes in the meso-level socio-technical systems which potentially can be triggered by the niches in localities. Looking from the perspective of thermal comfort and the energy consumption, creating changes in the consumption pattern calls for understanding the niches which correspond to the hidden values, cultural norms, beliefs highlighted in the `social convention` approach to thermal comfort. Transition to low-energy or energy-efficient forms of comfort provision need an approach derived from the micro-level which potentially accommodates innovative solutions derived from everyday life experiences.

Although the existing urban development system disregards the variations among localities and underestimates the capacity of local niches, the recent effort of national authorities to include climate change related articles in the rules of regulations for different sectorial bodies is promising for changes in the meso-level socio-technical systems. For instance, The Turkish National Climate Change Action Plan published in 2011 presents a road map which covers different sectors such as energy, industry, transportation, agriculture, waste and forestry. This can have the effect of loosening the 'blocked' nature of a stable regime. This can be turned into an advantage in drawing niche innovations out of their hidden localities and carrying them to the upper level regimes. As Geels (2005a) mentions, the breakthrough from niche to regime level does not take place at once but through a series of steps. Niches in this study refer to the clues of climate responsive urban design which potentially can be used for the future development proposals and can instil the design-oriented development approach in the long run.

3.4 Conclusion

This chapter has demonstrated that urban design, including the recent sustainable developments in urban technologies, stands as a potential discipline for climate responsive space production. In order to activate this potential, it is essential to understand the unified nature of the technical dimensions and social dimensions of space production as argued by socio-technical scholars. Therefore, this research values the investigation of ethnographic values which are highlighted in the `social convention` approach (presented in Chapter 2) coined by Chappells and Shove (2004). This is important because, as Milne and Givoni (1979) mention, the parameters of human comfort vary from culture to culture. Therefore the second goal of CRD -providing a comfortable living environment- might be achieved by approaching urban design as a socio-technical process which allows for integration of local specific values and knowledge into space production.

The chapter has shown that the integration of social knowledge generated within and by local communities is possible through approaching urban design as a socio-technical process. Therefore, the chapter emphasized the requirement of activation of the urban design discipline in the urban development processes. Activation here refers to making room for the discipline to catalyse/mediate the integration of technical dimensions and the social dimensions of climate responsive space production. This is not to undervalue the disciplines such as planning and architecture, rather to argue the potential of urban design to draw a structural frame of urban space production rather than just constituting a bridge between other disciplines.

The chapter has also shed light on the robustness of the existing development trends and challenges of creating a change/transition towards producing climate responsive urban built environments. This is conceptualized through a multi-level perspective (MLP) which theorise the transition under three levels originated from the local level niches to macro level, robust urban development system. This research explores these niches through the case study of a heritage site which accommodates urban design traces developed responding to extreme climatic conditions in a Mediterranean context. This calls for a novel socio-technical method to understand how people use the built environment and adopt and/or avoid urban certain climatic conditions within their living settings. The following chapter explores the methodological issues associated with this type of research, and outlines in more detail, the research questions and research design adopted in the thesis.

CHAPTER 4

CONDUCTING SOCIO-TECHNICAL RESEARCH

4.1 Introduction

This research explores the ways in which the formation of the built environment affects thermal comfort in urban space and, more specifically, the amount of energy consumed for the provision of thermal comfort in different layers of urban daily life. The research was conducted between 2012-2015, during summer seasons in which the city of Mardin faces the challenge of cooling under extreme climatic conditions. As previous chapters have shown, there is a trilateral relationship between the design of urban space, the way thermal comfort is provided and the amount of energy consumed for the provision of thermal comfort in urban daily life. Based on two different development patterns in the city of Mardin, this research explores how this trilateral relation varies according to the responsivity of the built environment to local climatic challenges and requirements. The aim of this chapter is to reflect upon the research methods used to shed empirical light on the production of urban space in the city of Mardin.

The research has attached importance to two main issues. Firstly, the multi-dimensional nature of "climate responsivity" calls for an understanding of different dimensions such as individual housing units and the way end-users provide thermal comfort at their homes; street patterns and the way citizens mobilize in the city; and urban form and the way it affects the urban climate in the city. Thus, analysing these different dimensions requires a multi-scaled approach which considers the nuances of development in each scale from housing to street and the city. In this sense, the research is conducted based on a 'staged' methodology which underlines the significance of 'scale' and explore the reflective relations between different scales of urban space.

Secondly, researching "climate responsivity" in urban built environment is neither solely a technical, nor a social exercise in of itself. As discussed in previous chapters, urban climatic concerns call for a certain level of technical knowledge regarding urban development strategies, construction techniques and / or innovative engineering solutions for local climatic conditions. Further to that, since the term 'responsivity' evokes the feeling of interaction -*a reciprocal action & reaction*- it also requires integration of social knowledge which is generated within and by the users of the urban built environment. Therefore a socio-technical approach is adopted to explore and understand the local requirements and needs to be considered for the production of climate responsive urban spaces.

The chapter is divided into four sections based on the methods literature and the researcher's personal experiences of conducting this research. Section 4.2 introduces the research themes and questions that underpin the thesis. Section 4.3 discusses the selection of the Mardin case study, and explores wider issues associated with taking a case study approach to climate responsive urban development. Section 4.4 examines the methodological techniques that correspond to the research objectives. Section 4.5 is concerned more specifically with internalization and researching local specificities and reflects upon the researcher`s experiences of conducting ethnographic research in the selected case city.

4.2 The Research Focus: Research Questions and Aims

This research argues that the formation of urban built environments affects the experienced thermal comfort in urban life and the amount of energy consumed for the provision of thermal comfort in everyday life. Acknowledging the context-dependent nature of the term thermal comfort, the research claims that in order to create climate responsive living settings, along with using design principles aiming to reduce the amount of energy consumption, it is also essential to understand local people`s perceptions of thermal comfort and their requirements and responses to climatic conditions. Peoples' perceptions vary depending on the way they use the built environment, that is to say, their lifestyles. In this respect, the research aims **to develop a climate responsive urban design approach that (1) responds to local climatic characteristics, and (2) considers local people`s perceptions and requirements for the provision of thermal comfort in urban life.** Considering the importance of energy consumption in urban areas in the face of climate change, this is an important yet underexplored area of study. Further to that, existing urban development patterns in developing countries (i.e. Turkey) underestimate the significance of aforesaid issues. Within this context, the main research question of this study is:

Can "climate responsive urban design" be (re)defined in such a way to respond to local climatic characteristics and inhabitant`s requirements for the provision of thermal comfort in urban daily life?

The research has four inter-related minor research questions:

RQ 1. How is the morphology of the urban built environment (urban grammar) in both the Old (heritage) Town and New Town of Mardin formulated?

Aim: To understand the urban grammar (building, street, city scales)

RQ2. What is the relationship between urban thermal comfort and the urban built environment in Mardin?

Aim: To understand the relationship between the physical environment and comfort (building, street, city scales)

RQ3. How do the built environments within in the Old and the New Town vary in response to climatic conditions and local lifestyles?

Aim: To understand differences and similarities between the Old and New Towns (building, street, city scales)

RQ4. What are the barriers and/or catalysers for the introduction of design principles/solutions to enhance climatic responsiveness in new urban developments?

Aim: To discuss the possibility of redefining urban design in such a way to integrate local people`s values in order to minimize energy consumption for the provision of thermal comfort.

4.3 Context Matters: Taking a Case Study Approach

In order to find the answers for the above listed minor research questions, a case study approach was conducted to investigate specified issues in an empirical way (Smith, 1978). In line with the focus of this research, the city of Mardin in Turkey was selected as a case city in which the presence of the Old and the New Town areas allows a comparison in terms of urban development patterns in a hot and arid climatic zone. This section aims to explain the significance of a context-based approach for this research. It also briefly introduces the city of Mardin, outlining its local characteristics, and describing the dualistic urban development patterns in the Old and the New Towns.

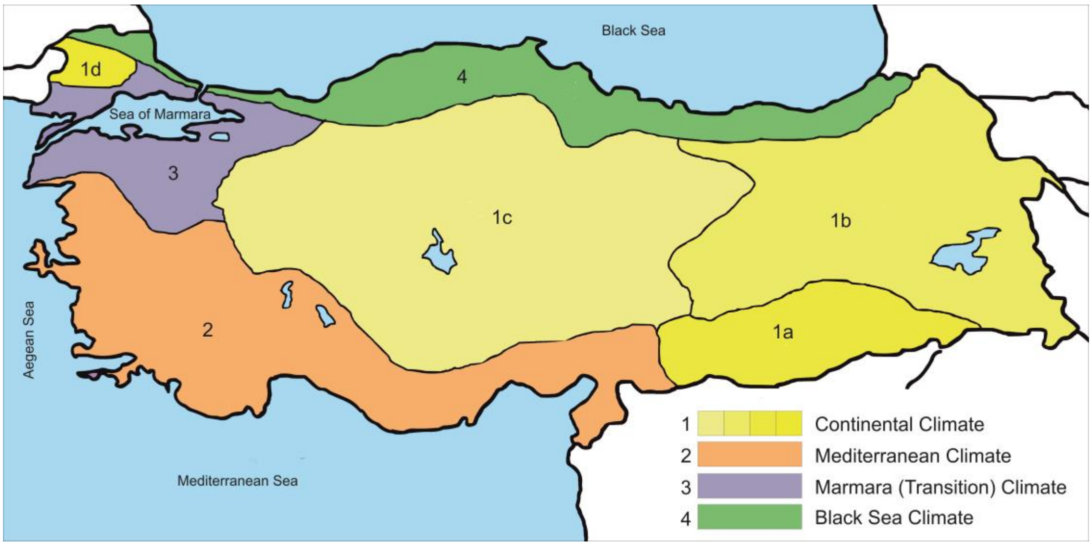
4.3.1 Context-based Approach to Climate Responsive Development

According to global climate classifications, much of Turkey is characterised by a Mediterranean geography, where climatic conditions are quite temperate. However, due to sharp landforms, the alignment and direction of mountains, and being surrounded by seas on three sides, the country experiences various climatic conditions which is illustrated in Figure 4.1 (see next page).

There are four major climate types in Turkey, namely: Continental, Marmara, Mediterranean and the Black Sea. The Continental climate is characterized by significant temperature differences between summer and winter seasons. In Continental zones, summers are typically hot and dry, while winters are usually cold and raw. The Continental climate type has four sub-types according to temperature and precipitation characteristics. The first sub-type (1a) is characterised by extremely high temperatures (up to 50 ^{o}C) and low relative humidity which induces severe drought in summers. The second sub-type (1b) is distinguished by extreme cold and heavy snow in winters. The third sub-type

(1c) of continental climate demonstrates hot summer seasons and cold winters, usually with frost. The last sub-type (1d) is distinguished by its high rainful capacity when compared to other types.

Figure 4.1 Climatic regions of Turkey



Source: Atalay (1997)

The second major climatic type in Turkey is Mediterranean Sea climate (2) which presents warm to hot, moderately dry summers and cool to cold, wet winters. The third major climatic zone in Turkey is Marmara climate (3), also known as a ‘transition climate’ since it represents a transition between the Black Sea and Mediterranean Sea climates. The last climate type is the Black Sea climate (4) which is characterised as oceanic, with high and evenly-distributed rainfall all year round. In recent years, many cities in the Black Sea climate zone have suffered from severe damage caused by frequent floods and landslides due to extreme precipitation. As seen in Figure 4.2, the most extreme precipitation event[12] of all time in the city of Rize resulted in a flood and landslide which damaged approximately 400 houses in 2011. Figure 4.2 also shows some other extreme climatic events experienced in other cities from different climatic regions.

Figure 4.2 Extreme climatic events experienced in different cities from different climatic regions

City of Rize (4) Excessive precipitation caused flood and landslide.	**City of Gaziantep (1a)** Extreme summer temperatures (up to 50 °C) conduced toward melt of asphalt	**City of Hakkari (1b)** Extreme snowfall blocked both pedestrian and vehicle transportation

[12] 226.6 litres per m^2/24hrs, Source: http://www.mgm.gov.tr/veridegerlendirme

As mentioned above, each climatic region generates its own context which requires specific interventions with respect to different dimensions such as building construction, transportation infrastructure and agricultural precautions. Therefore, this research approaches urban design as a context based phenomenon, which understands and internalizes contextual variables and tries to harmonize these values into production of space in the face of contemporary challenges such as climate change. Appreciating the variations in different contexts, the research explores the traces of climate responsive urban development in the Continental climatic context.

4.3.2 Urban Development in Mediterranean Climate: The Case of Mardin

This research is designed based on province of Mardin, a city in South-Eastern Turkey that accommodates an urban heritage site developed under extreme climatic variations (see Figure 4.3). The uniqueness of the vernacular development pattern of Mardin - which led to the city being named a candidate for the World Heritage List by UNESCO - offers the potential to learn lessons from the past that may help urban designers, planners, developers and government actors tackle contemporary challenges associated with climate.

Figure 4.3 City of Mardin, Turkey

Source: www.doguforum.com (2014)

The Mediterranean climate is broadly characterised by hot summers and relatively mild winters. However, different regions within the Mediterranean climate category may present different winter and summer temperatures according to local specific geographical features. The study was conducted in the city of Mardin, Turkey, located at 37° 19' 3 N 40° 42' 55 E, which represents a Continental climate with hot-dry summers and cold-wet winters. Statistics present that Mardin faces high temperatures especially in the months of July and August. The city is surrounded by a desert climate to the south and high mountains to the north which block the cooling northern winds. As a result, the city developed on the lowland faces extreme hot days in summers.

The city of Mardin is composed of two different settlements, one of which was developed more than a thousand years ago (Old Town); the other was developed from early 1960s onwards (New Town). As seen in Figure 4.4, the two towns represent quite distinct urban development patterns/forms. While the Old Town (urban heritage site) presents a horizontal style of development mainly based on a terraced housing system located on the south facing-slope of a hill with an altitude of 800m, the New Town has been developing predominantly in a vertical direction comprising apartment blocks (5-15 storeys) located on the Mediterranean plain starting from the foothills of the slope.

Figure 4.4 Urban development patterns in the Old and the New Mardin

Source: Author's Original

In line with the objective of exploring the differences between two towns, the research adopts a comparative case study approach to assess the role of the formation of the built environment on the provision of thermal comfort in the Old and the New Towns of Mardin. The Mardin case offers valuable insights into the provision of thermal comfort via the production of climate responsive urban spaces in a hot and arid climatic zone in the Mediterranean region. Although the presence of the historical town in Mardin stands as an `extraordinary` case, it provides an open laboratory which allows for the exploration of climate responsivity via a comparison between the two settlements. Two distinct development patterns in the city also provide a basis for understanding the dynamics behind today`s development trends, requirements and challenges in terms of climate.

4.3.3 Conducting a Case Study: Much-debated Issues

This research aims to illustrate, through the Mardin case, key issues in climate responsive urban design and how end-users` perceptions and experiences matter in the provision of urban thermal comfort in the face of extreme climatic conditions. The study uses the explanatory power of the case study and aims to make inferences that can potentially speak to broader development practices under different climatic and / or socio-political contexts. Although climatic characteristics vary in different regions, the principles of conducting socio-technical research can be valid for different cases. In other words, the research approach used in the thesis can speak to wider cases. This brings the discussion of `generalizability`, which is the most common external objection voiced against case study approach.

Some scholars (see for instance: Bolgar, 1965; Shaughnessy and Zechmeister, 1985) argue that `generalizability` is a major weakness of the case study approach in social science. This argument is based upon the perceived limitations of a single case study in providing a wider contribution to the scientific world. However, as Donmoyer (1990) asserts, the `so- called` limitations appear to be as an outcome of approaching social sciences case studies in a similar way to the way in which physical scientists might. This `conventional` view seeks regulatory, lawful explanations between causes and effects, thus the generalization defined here presents what Donmoyer (1990, p.46) terms a `restricted conception`. In this sense, one must consider the situation from the perspective of the reader/user of the generalization and re-think the notion of generalization according to the following argument:

> "*case studies will often be the preferred method of research because they may be epistemologically in harmony with the reader`s experience and thus for that person a natural basis for generalization."* (Stake, 1978, p. 19)

The above statement highlights the importance of how one conceptualizes the term `generalization` in social science. Based on Stake`s (1978) argument, Lincoln and Guba (1979) assert two kinds of generalization. One is referred to as `rationalistic generalization`, this is rigid and adheres to `*research-laws*`. The other is referred to as `naturalistic generalization`, this is more `*intuitive, empirical, based on personal direct and vicarious experience*` (p. 36). Based on the former definition, one can say that a singular case study may not be able to speak to broader urban development processes. However, as Lincoln and Guba (1979) state, there are some weaknesses with the `conventional` concept of generalizability in the social science literature (p:29-34) (see Table 4.1).

Table 4.1 Some of the weaknesses with the `conventional` understanding of generalizability

Weakness 1: Dependence on the assumption of determinism
Weakness 2: Dependence on inductive logic
Weakness 3: Dependence on the assumption of freedom from time and context
Weakness 4: Entrapment in a reductionist fallacy

Lincoln and Guba (1979) do not argue that ‘naturalistic generalization’ should replace the ‘rationalistic generalization’, rather it shows how different scholars conceptualize the norm of generalizability with each reading having its own applicability.

Assuming that different cases represent different contexts, Lincoln and Guba (1985) re-conceptualise the notion of generalization and introduces the term `*transferability*` which, in a sense, questions whether the hypothesis of research conducted on the basis of a single context might be applicable to another context.

> *“The degree of transferability is a direct function of the similarity between two contexts, what we shall call `fittingness`. Fittingness is defined as the degree of congruence between sending and receiving contexts. If Context A and Context B are `sufficiently` congruent, then working hypothesis from the sending originating context may be applicable in the receiving context.”* (p:124)

Although the term `transferability` goes one step beyond the `conventional` view of generalizability and adds value to case studies to some extent, it still assert the pre-condition of `fittingness` which stands as a reason of being influenced by the conventional view. As a reaction to the conventional influence, Donmoyer (1990) mentions one of the reasons why social scientists often insist on using `outdated notions` is the lack of an `alternative language` to use for social research. As Donmoyer (1990) expresses in the statement –*“what we cannot say, we often cannot see”*– the lack of an `alternative language` blocks one`s capacity to re-think the concept of generalizability and concomitantly appreciating the value of single case studies.

Flyvbjerg (2006), one of the advocates of a case study approach, uses the analogy of the `*black swan*`, to ironically express the way some scholars `misunderstand` issues in case study research, including underestimating the power of case studies in the generation of context-specific knowledge. For example, one common misunderstanding highlighted by Flyvbjerg (2006, p.66) is that: *“One cannot generalize on the basis of an individual case; therefore, the study cannot contribute to scientific development”*. Indeed, the argument here again is about what one expects from the social science as an outcome.

As Kvale and Brinkmann (2008) state, qualitative studies cannot, like quantitative studies, demonstrate generalizability statistically but must employ some form of analytic generalization which rests on theoretical understanding of the subject matter. The way this research approaches the development of a more climate responsive urban built environment constitutes a theoretical understanding. This understanding can shed light on the urban development processes according to a specific concern (of climate). Its aim is not to create a generalizable sample, but rather to illustrate, through the Mardin example, key issues in the development of climate responsive urban spaces, design parameters facilitating the provision of thermal comfort in houses and surrounding urban areas and the lessons that can be drawn out from the past.

4.4 Research Design

Acknowledging the explanatory power of case studies, this research is designed in such a way to explore the socio-technical dynamics behind the production of climate responsive urban space in a hot and arid climatic territory. As Chapters 2 and 3 have shown, issues related to climate responsivity and thermal comfort in urban daily life are linked to different social, technical and political variables with respect to urban development. To respond to these dimensions, and explore the richness of these multi-layered phenomena, different qualitative and quantitative research techniques are applied according to the nature of the minor research questions and the objectives of the research.

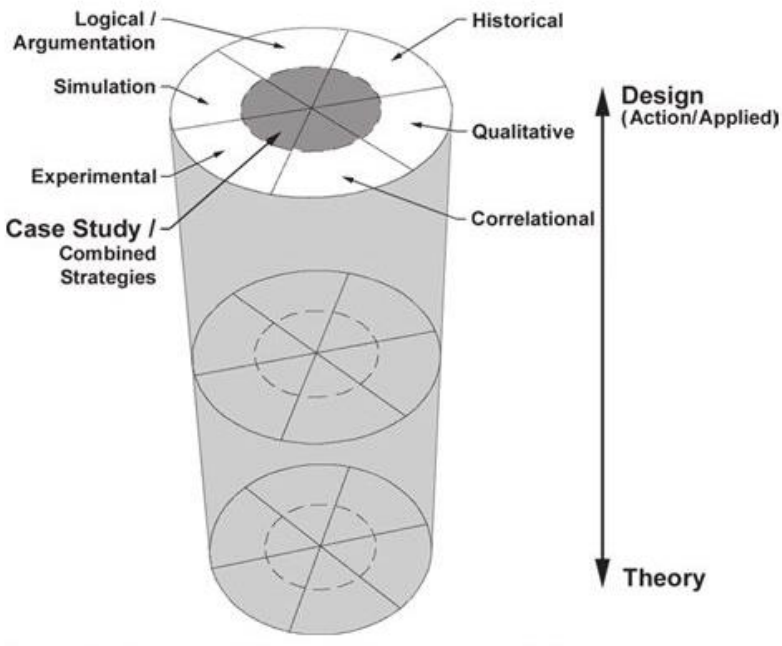
A review of literature on research methods presents that different methods have various strengths and weaknesses (Gillham, 2000; Gerring; 2007; Simons, 2014). As a result, the use of multiple methods, known as triangulation (Gillham, 2000) in the literature, provides a logical combination of different methods which complement each other while producing a stronger justification of the entire methodology used in the research. The following analogy, written by Plano Clark (2005), presents the significance of integrating different methods for an enhanced understanding of a research problem.

> *"The story of the three blind men is that one blind man is holding the tail of an elephant, and says "OK, if this is an elephant, an elephant is long, skinny and it has wispy hairs on the end." And another one has leg of elephant, and he sticks his arms around and holds it, and says, "Well, an elephant is something like a tree with a large solid trunk, very strong and sturdy." An than you have the third blind man who has a different part of the elephant, and says "Well an elephant is something that's long and broad like a wall and flat." And so if you had only any one of those views from the three blind men then you would say an elephant is either something long and wispy, or something like the trunk on the tree or you might say that an elephant is something broad and long like a wall. But if you were able to have all three of those put in together and integrate them, then you might indeed come up with a better description of what an elephant is. (Plano Clark, 2005, p: 151, in Hesse-Biber, 2008, p.10)*

As told in the story of the blind men and the elephant, the added value of using mixed methods in this research arises in different ways. As the literature review chapters in this thesis have demonstrated, studies of thermal comfort in urban settings have both technical and social dimensions. The technical dimension brings discussion about various issues from the formation of built environment, street patterns and greening strategies, to housing typologies, forms and construction materials in buildings. Each of these dimensions calls for a different research technique in order to understand the deep, context-dependent knowledge attached to each of the listed variables in urban development. Bearing in mind these sensitivities, this research is designed following the theoretical argument (see Chapter 3) of a socio-technical approach to urban development (i.e. theory-driven in nature) and involving various research techniques in a way to respond to the research objectives.

The following diagram exemplifies a conceptual model that originates from the architectural research field. It is used to explain the relationship between different research approaches combined under a case study. As seen in Figure 4.5, contiguous research approaches in the diagram share similarities. For instance, experimentation is mostly dependent on quantitative data but requires the manipulation of the researcher to find a logical correlation among the variables. Correlational research, on the other hand, calls for the integration of a qualitative dimension which brings the understanding of the nature behind the explored relationships among the analysed variables.

Figure 4.5 A conceptual framework of research design

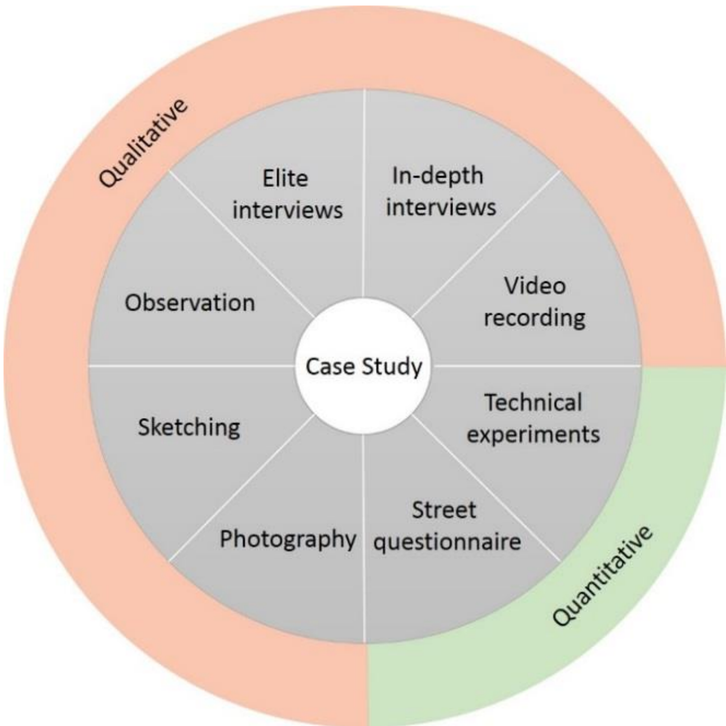


Groat and Wang (2002, p.15)

Groat and Wang (2002) explain that the central positioning of the case study in the diagram does not mean that it has more value than other methods, rather it is a way to show how a case study could be designed in order to interrelate with different methods. In addition, the cylindrical shape of the diagram represents the outcome – the final message of the research – and the column in the right presents the dimension of practice to theory. In some cases an outcome which can serve for practice might originate from a theoretical structure while in other cases a deeper theoretical outcome can be developed derived from the analysis of applied processes. The methods used in this research were selected based on the 'Social Convention' approach to thermal comfort. Epistemologically, putting the researcher and the Mardin case to be interactively linked, methods are combined in a way that the 'findings' are literally created as the research/investigation process.

The researcher takes up the model introduced by Groat and Wang (2002), and combines relevant qualitative and quantitative research techniques in a case study as a meta-method. The following diagram presents how this research has re-designed the pie-shaped wedges in the research model. Further to that, Table 4.2 gives more details about the research design including the research approach, data collection and data analysis techniques used for each minor research question.

Figure 4.6 Qualitative and quantitative research techniques embedded in the case study



Source: Author's original

Table 4.2 Research Design

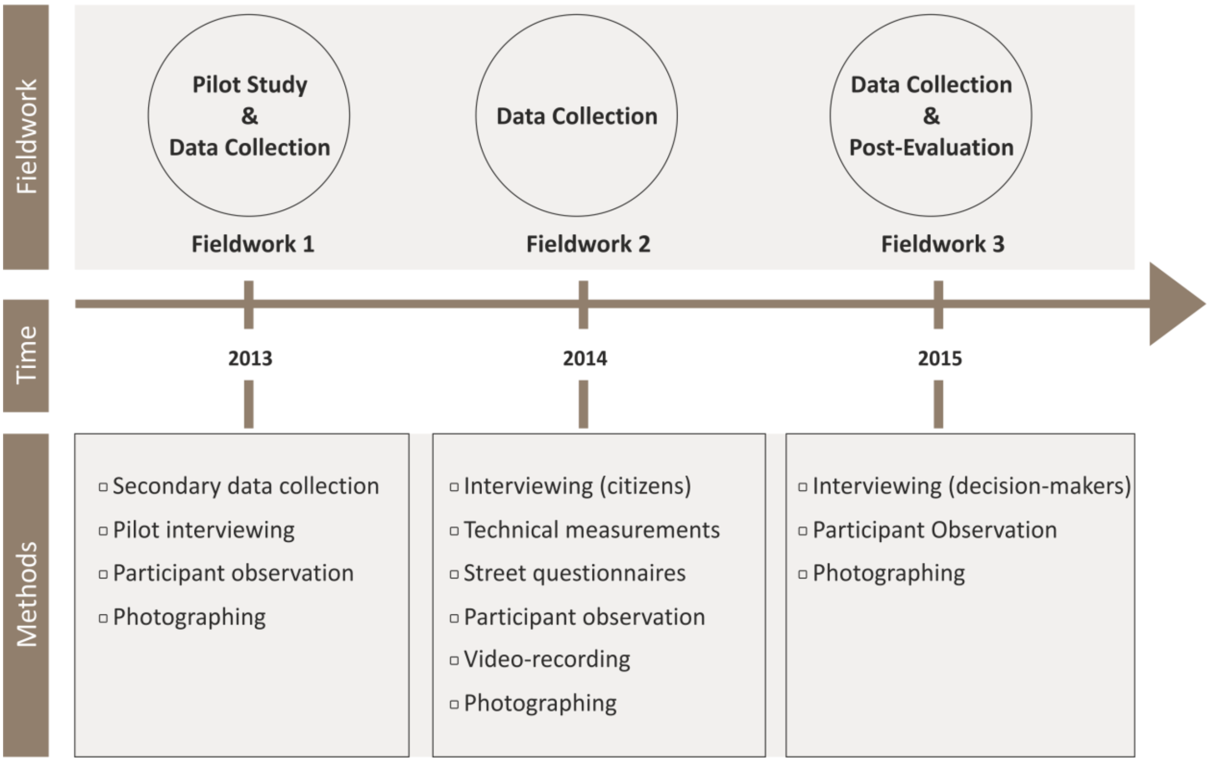
Minor Research Questions	*Research Approach*	*Data Collection*		*Data Analysis*	
		Technique(s)	***Tool(s)***	***Technique(s)***	***Tool(s)***
How is the morphology of the urban built environment (urban grammar) in the Old (heritage) Town and New Town of Mardin formulated?	Exploratory	Sketching Fisheye Photography	Maps Plan Layouts Camera	Morphological Analysis	Corel Draw
What is the relationship between urban thermal comfort and the urban built environment in Mardin?	Quasi-Experimental	Technical Measurements Street Questionnaire	Testo 174H Thermometer	Multiple Regression Analysis	SPSS
How does the built environment in the Old and the New Town vary in response to climatic conditions and local lifestyles?	Exploratory	In-depth Interviews with Local People Participant Observation Video-recording	Voice-recorder Video camera	Content Analysis Multiple Regression Analysis Discriminant Analysis	NVivo SPSS
What are the barriers and/or catalysers for the introduction of design principles -extracted from the heritage town of Mardin- into new urban development sites	Exploratory	Elite Interviews with Decision-makers	Voice-recorder	Content Analysis	NVivo

Source: Author`s original

4.4.1 Data Collection

Figure 4.7 presents the fieldwork design for data collection, including the aim of fieldwork, timing and the methods used in each field visit. The first round of fieldwork undertaken in 2013 took the form of a pilot study in order to test if Mardin was a suitable case for responding to the main aim of the research. The second round of fieldwork was designed to collect both technical microclimatic data and social data generated by local residents. As seen in Figure 4.7, in-depth interviews were conducted by visiting the local residents in the second phase of fieldwork. In addition, technical measurements both at the architectural and street scales were conducted to measure microclimatic variations. Simultaneously, an on-street questionnaire was conducted in order to understand the variations in the perceived outdoor thermal comfort in both towns. The last round of fieldwork was designed to evaluate the research findings from the first and second phases of fieldwork, and to collect data with respect to the politics of implementing climate responsive development in Mardin.

Figure 4.7 Fieldwork design for data collection



Source: Author`s original

4.4.1.1 Interviewing

Interviewing is one of the key means of data collection, it offers researchers valuable social (context-based) knowledge that responds to the 3rd and 4th minor questions of this research. An in-depth interviewing technique was used to understand how the built environment in the Old and New Towns vary in response to climatic conditions and local lifestyles. This included visits to local residents` houses in order to share in some of their daily life experiences as well as generating a dialogue-based interviewing setting. In addition, `elite` interviewing techniques were used to explore the barriers and/or catalysers for the introduction of design principles -extracted from the heritage town of Mardin- into new urban development sites. The following sections present the theoretical arguments attached to the interviewing techniques and offer some reflection on the application of these techniques in the fieldwork.

4.4.1.1.1 In-depth Interviewing

As the name of the technique implies, in depth-interviewing seeks 'deep' information and understanding, which usually involves a certain style of social and interpersonal interaction (Johnson, 2001). This information usually concerns matters such as participants' lived experience or values, cultural knowledge or local perspectives. As Johnson (2001) emphasizes, more commonly in-depth techniques gain more meaning when harmonized with the lived experience of the researcher as a participant in what is being studied. Considering the aim of achieving the same deep level of knowledge (as much as possible) and understanding as the participants, the researcher needs to explore and experience the contextual uniqueness and develop a shared/common ground with participants within the contextual boundaries of his/her own experiences or perceptions. This is the point at which in-depth interviewing techniques deviate from conventional interviewing techniques based on structured questions and answers. This does not necessarily mean that the researcher does *not* use structured questions during the interview, rather that he or she orients the key questions based on when they feel the right time in the conservation flow is. This is very much related to the atmosphere of the dialogue. In some cases, deep discussion and understanding of the key issues can emerge very soon after the initial introduction, while in other cases a series of icebreaking questions and/or transition questions explaining the purpose of the research may be required.

As Simons (2014) points out, entirely unstructured interviewing has three main advantages. First, it helps engage participants via listening to their stories; second, it makes the research process educative for participants by reflecting on specific issues, and third, it creates an informal dialogue between the researcher and participants which can reduce the `stress` of the interviewing setting (2014, p: 462). However, there are also disadvantages to conducting unstructured interviews. For instance, the variety of responses (including irrelevant issues) collected from unstructured interviews can complicate the analysis process. In addition, the time spent on each interview may double or triple due to the trajectory of dialogue. However, these disadvantages can be tackled by using organizational tactics. Thus a balanced approach which involves the use of semi-structured questions as a conversation 'guide' while fostering the emergence of a more spontaneous dialogue between the researcher and participants better suits the nature of in-depth interviewing. The critical point here, as Johnson (2001) underlines, is that the information exchange created by construction of a dialogue helps the researcher to build a stock of knowledge after a few interviews and this knowledge feeds some of this information back to the participants in subsequent interviews. Thus, data collection and verification become unintentionally interlocked in most in-depth interviews.

In this research, the aim of semi-structured in-depth interviewing was to understand the way people perceive thermal comfort in urban daily life and whether (and in which way) the formation of the urban built environment influences users' comfort level and daily activities, as well as the energy consumption levels for provision of thermal comfort both indoor and outdoor spaces. With this purpose in mind, in total 60 houses were visited and in-depth interviews were conducted with 153 participants from 10th August to 22nd August 2014. In order to experience living both in vernacular and contemporary urban patterns, the researcher was accommodated both in a vernacular pension in the Old Town and a contemporary hotel in the New Town for the duration of the fieldwork. This facilitated the practice of observation in the actual setting. Participants for the in-depth-interviews were selected by knocking on doors in the neighbourhoods. A female student assistant supported the researcher in order to smooth the way for communicating with local people. The presence of the female assistant was planned due to the fact that mostly women were at home during the day and the researcher (as a `gate-crasher`) was not sure whether he would be welcomed by the local residents. This aspect is described by Lincoln and Denzin (2003) as follows:

> *"The ethnographer an uninvited stranger who depends upon the patient courtesies and openhanded hospitality of the community, is compelled by the laws of reciprocity and human decency to intervene, if he can."* (p.399)

Conducting the first in-depth interview in a research project, as Johnson (2001) mentions, was tinged with anxiety mixed with the feeling of excitement about the collection of the first data related to the theoretical framework of the research. One extract from a research diary, included below, exemplifies the stressful moments of researching in a different local context for the first time:

> *…Before entering the first house in the traditional settlement, I was nervous about the reaction that I might get from the residents. Two strangers standing outside of a house surrounded by stone walls! Fortunately, the presence of my female research assistant facilitated a smooth and warm beginning for the conversation that I wanted to hold… Having passed over the door and proceeded to the courtyard, I clearly understood how the courtyard stands as a semi-private space for people…We spent almost an hour in the shadowy part of the courtyard with very kind hospitality. Now I felt more confident for the rest of the interviewing process. At least for the Old Town…We haven't seen the reactions in the New Town yet!..*

As the above extract demonstrates, the place where the interview is conducted has a significant influence on the atmosphere of the interview. Elwood and Martin (2000) argue that the interview place itself embodies and constitutes spatial relations and meaning, which construct the power and positionality of participants in relation to the people, places, and interactions discussed in the interview. Interviews were conducted in a proper and convenient place provided by the householder. In the Old Town, semi-private open spaces in the vernacular houses provided a more comfortable place both in terms of serving as a shadowy and relatively cooler space for thermal comfort and also a secure place for householders to hosting two 'strangers' knocking their door. Thus, the researcher did not face any difficulties approaching residents in the Old Town. Figure 4.8 demonstrates some examples of courtyards in which the interviews were conducted in the vernacular houses.

Figure 4.8 Courtyard as a semi-public transition zone which provides comfortable setting while protection of privacy

Source: Author's original

On the other hand, approaching residents in the New Town was not as easy. Most often, the physical boundaries (i.e. lack of a semi-public, transitionary space in the apartment flats) were the main reasons. Therefore, the researcher used a snowball sampling technique and reached most of the participants from New Town based on referrals from people whom he had interviewed in the Old Town before.

> *"……we visited the new apartment flat of the sister of XXXXX (a lady of 60 years old who helped a lot during the entire fieldwork) whom we had interviewed in the first day in the Old Town…. It was obvious that her sister was prepared to host us since we went to her sisters' flat with an appointment. We had to stay about one hour, since she served tea and cookies that she had prepared for us (that is a part of Mardin hospitality.) Although it takes more time to start the actual interviewing process, it helped in creating a more informal/friendly interview atmosphere (research diary, 19.08.2014)"*

The above extract illustrates how the referral sampling influenced the time intervals allocated for each in-depth interviews. The extract also shows how the emotions surrounding the interview process, such as sensing the right signal from respondents about being ready to contribute the main purpose of your research influences the interview. As seen from this example, even though the semi-structured interviews set out the key topics and the questions regarding the research, the flow of the dialogue may continue in a different direction. The decision about whether to interrupt and/or redirect participants towards the main focus depends on the atmosphere which can only be felt by the researcher at that moment of the dialogue.

Interviews were recorded using a digital voice recorder and filmed (in some cases) by a handy camera, having obtained the prior permission of the interviewee (see Appendix B for consent form). As suggested by Gillham (2000), transcription was carried out as soon as possible after the actual interviews since the researcher's memory helps in hearing what was on the tape and recalling the written notes. Transcribed interviews files were upload in NVivo, a tool for organizing the unstructured data. A more detailed discussion about data organisation, management and analysis (including the use of NVivo) is presented in section 4.5.2.

4.4.1.1.2 'Elite' Interviewing

Although the term 'elite' has an in-egalitarian connotation, it is still used as a label for the interviewing technique in which the researcher interviews someone in a position of authority related to the subject of the research (Gillham, 2000). `Elite` interviews in this research refer to the interviews with key actors taking a part in the process of urban development in Mardin, such as directors in governmental bodies.

The difficulty of interviewing `elites`, as Mikecz (2012) asserts, often begins with accessing respondents and can get more difficult through gaining their trust and building rapport with them. Due to common difficulties in gaining access to `elites`, Burnham et al. (2008) suggest that random sampling for the interviews with decision makers is not appropriate. This is not only because all actors are not willing to participate, but also because they do not have equal weight in urban decision-making processes. A more appropriate technique, as described by Burnham et al. (2008), is 'snowball' or 'referral' in which the researcher starts out with a few key participants identified according to the research framework and a preliminary investigation. The researcher than asks them to name other key staff who might potentially contribute to the research. The 'snowball' grows larger as new names are included in the interviewing list. Here the main concern is when to stop interviewing more individuals. Although there is not a simple answer to this question, literature (Johnson, 2001 and Burnham et al., 2008) presents that it depends on the researcher's subjective evaluation, in line with the maturity of responses with respect to the research aims and objectives.

In this research, one of the biggest challenges of conducting elite interviews was that key contacts were very busy. This was compounded by the existing political agenda mainly shaped by the on-going events in the region. Being close to the Syrian boundary and working under the pressure of terrorist attacks in the South-Eastern part of Turkey, inevitably changed the agenda in all departments. Thus the main objective of this research is not one of the priority concerns in the region. In order to access key actors, prior to the commencement of fieldwork the researcher mapped out the institutional urban development system in the Mardin (and Turkish) context and determined (1) the key institutions which have a role in urban development, (2) the main departments related to the aim(s) of the research and (3) the primary individuals who have directorship roles in these departments. Using the snowball sampling method, 15 interviews were conducted with governmental department directors and technical staff such as planners, architects and engineers.

Although the snowball sampling method often accelerates access to decision-makers, Mikecz (2012) underlines the risk of collecting information from one directed channel (i.e. a group of people who share the same ideology or beliefs). Actors in senior positions may present the tendency to avoid possible criticism or speculative reflections on their department or work and may guide the technical staff working under his/her direction. In other words, as Mikecz (2012) says `elite` actors may find a way to manipulate the actual information. The following extract exemplifies the possibility of `elite` actors hiding reality or giving information in a way they perceive the researcher wants to hear it:

> *"My first visit in the Greater Municipality of Mardin lasted only a few minutes... The principal clerk has requested to see my interview questions and invited me the next day with a commitment of referring me to the `best` employees who can give me the `satisfactory` responses to my research questions. At that moment, I felt myself like a journalist rather than a researcher…"* (Research diary, 12.08.2015)

Mikecz (2012) defines this attitude as the protection of `back stages` where the negotiations and critical decision-making processes go on. Regardless of the attitude of senior actors, the critical factor in gaining `insider` information is to gain the trust of respondents. In this research, the researcher did not introduce himself as an `outsider` conducting an inspection, rather he expressed his intention to collaborate with the planning department in terms of overcoming the climatic challenges in the city. In addition, in order not to receive 'journalistic' answers, the `recalibrating` tactic suggested by Thomas (1995) was used to rephrase the question in a way to triangulate the received verbal information. For instance, after learning the focus of this research, the principle clerk in the Municipality emphasized and repeated several times the 'ecological' statement in their development vision. She positioned herself in a defensive situation, in a way promoting an ecological vision and waiting confirmation from the research. However, 'what has been done' or 'what is planned to be done' with respect to ecological concerns was not the subject of the dialogue. The researcher raised these questions and the contradictory issues (e.g. lack of green spaces) that he has observed in the city and the principle clerk wanted to 'brand'.

Hunter (1995) claims that `elites` are `relatively unstudied` because of their ability to protect themselves from criticism by using their power. In addition, elites can present the tendency to underestimate the importance of research or being involved in the research within their current `super busy` agenda. The following extract from research diary exemplifies that attitude.

> *"I was invited for an interview with the director of one of the key departments that I had planned to visit. The interview was set for 10am and I arrived the department around 9.50. The secretary, in some way, was surprised to see me (apparently, she was not aware of the meeting and she also didn't know where the director was). She kindly offered me a seat on one of the chairs in front of her desk. The office was designed in an open way, so all desks, including the secretary`s, were attached to each other in a U-shape. The technical staff were working in their usual routine…*
>
> *…I have been waiting for 20minutes and the director is still not around. It seems like the principle clerk did not arranged a meeting time although her secretary informed me in that way. This is quite annoying! …Meanwhile, I had to chat with two young and curious interns who were trying to act like they knew all the answers…*
>
> *After a few calls, the secretary informed me that the director had to attend a senate meeting and referred one of the planners in the department to interview with. Any apology?! Oh Thanks!*
>
> *…Since the office was designed in an open way, now everyone is looking at me (judging eyes!) and trying to understand who I am. It`s time to introduce myself and turn this into an advantage, at least all of the other staff look interested now..."* (Research diary, 13.08.2015)

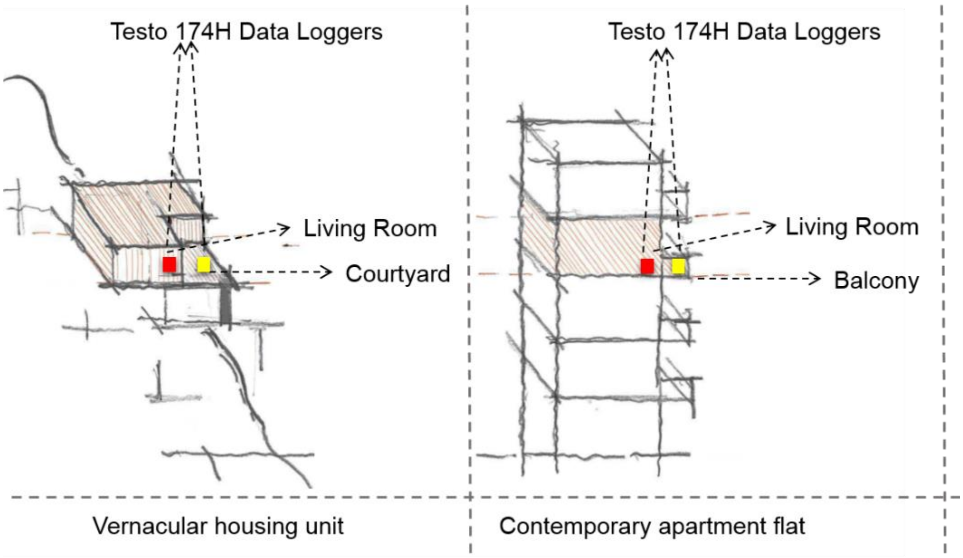
The above extract also illustrates how the interview environment affects the researcher`s mood with the emerging issues such as the director not showing up (disappointment), being exposed to judging eyes (stress) or being directed to endless questions by interns (irritability). The key task for the researcher is not to lose motivation in the face of unexpected conditions. This is only possible, as Laurila suggests (1997), by making prior preparations for this kind of situation and developing strategic tactics to tackle them. For instance, in order to eliminate the 'judging eyes', the researcher introduced himself and the research with a warm tone rather than waiting to be asked. The tone and the expression used in the introduction was important in order to gain the trust and give the right message to technical staff in respect to their valuable knowledge about the research focus.

4.4.1.2 Technical Measurements

The third method of data collection used in the research was a series of technical measurements made in order to compare urban climatic variables such as temperature and humidity, and assess the influence of these variables on the perceived thermal comfort in urban daily life. Technical measurements provided evidence to understand the way in which the formation of the built environment in the Old and New Towns creates changes in the urban climate. In order to do this, quasi-experimental measurement work was planned with respect to the scales of housing and streets, following the conceptualization of the built environment presented in the morphological analysis (see Chapter 5).

For the first stage, following the variations that will be explained further in Chapter 5, an indoor thermal comfort comparison was conducted between a typical vernacular house and a typical contemporary apartment flat as the dominant typology for each settlement. Since the dominant orientation of houses in the historical town was designed to face South, for a fair comparison it is essential to ensure that the sample apartment block is also facing the South. The same criteria (i.e. south facing) was also valid for the rooms where the measurement was conducted. Measurements of air temperature and the humidity were recorded continuously for 48 hours in order to see the difference in the nighttime as well. Climatic values were recorded simultaneously using Testo 174H Data Loggers. Two separate measurement instruments were set in the balcony (New Town) and courtyard (Old Town) in order to measure the outside temperature and humidity conditions at the two different settlements. In the end, four measurement instruments (2 indoor, 2 outdoor) simultaneously recorded the climatic values over 2 days (see Figure 4.9). Measurement tools record and store the data on an internal disk, so no periodical check is required.

Figure 4.9 Placement of data loggers in both sample housing units



Source: Author's original

In the second stage, a street scale thermal comfort comparison was carried out between two sample streets representing the same characteristics from each town. A quasi-experimental method was employed which included measurements of climatic variables via technical equipment and the exploration of thermal sensation of users via an on-street survey.

Since there is only one street which accommodates both vehicle traffic and pedestrian flow in the Old Town, accordingly a street which presents similar characteristics was selected from the New Town. Land use characteristics were taken into account with the assumption made that this influences the ways and frequency of people use the street (i.e. a variety of shops might encourage walking). The Sky-View Factor (SVF) of each street was calculated using fisheye photos. As seen in Table 4.3, while the selected streets present very close SVF values, they have different alignments which determine the occurrence of shading in line with the movement of the sun. In addition, the Old Street (the first of the two maps shown in Table 4.3) is surrounded by low-rise, 1-3 storey buildings while the New Street (the second) is defined by high-rise 6-7 storey apartment blocks.

Table 4.3 Sample Streets from Old and New Town

Sample Street	Fisheye Photo	SVF	Height	Width	H/W	Orientation
		0.51 ψs	7m	8m	0.87	W-E
		0.62 ψs	18m	25m	0.72	NW-SE

Source: Author`s original

Measurements were carried out over two consecutive days with clear sky conditions on 20th and 21st August 2014 between the hours of 10:30 to 17:30 at sample points in Old and New Towns,. Testo 174 H Data Loggers were affixed at a level of average human height in order to record the variables closest to human sensation. Temperature and humidity values were recorded every 15 seconds for a total of 7 hours per day.

4.4.1.3 Street Questionnaire

As Bulmer (2004) states, the questionnaire occupies an important position in social science research and is used to collect information on participants' standards of behaviour and reasons of action with respect to the phenomena under investigation. This study uses the questionnaire technique in order to understand the relationship between measured data and people`s self-reported thermal sensation under the high temperatures experienced during summer months. The street surveys were carried out on the same days and at the same time intervals at which technical measurements were conducted. Respondents were selected randomly from people passing by the on street. As recommended in ASHRAE Standard 55 (2014), the first criteria for taking a part in the survey was spending at least 15 minutes in outdoor space before taking part in the survey. Therefore, people who had been in an air-conditioned place such as a supermarket, private car or bus within last 15 minutes were not included in the survey. In total, 600 street questionnaires - half of which were completed by users of the Old Town and the other half by users of the New Town - were completed. Table 4.4 presents the summary of the respondents including gender and age distributions.

Table 4.4 Summary of the sample participating in street survey

	Old Town		**New Town**	
Age	**Male**	**Female**	**Male**	**Female**
15-18	16	5	20	21
19-29	54	29	79	42
30-39	38	23	40	16
40-49	30	16	25	12
50-59	25	8	19	4
60+	42	14	15	7
	(%68) **205**	(%32) **95**	(%66) **198**	(%34) **102**
TOTAL	**300**		**300**	

Questions were designed in a closed format (i.e. using the Likert Scale), allowing participants to rate their sensations of temperature, humidity, sun, wind and overall thermal comfort on the streets (see Appendix C). Closed questions facilitated the progress of interviewing and allowed participation of 600 individuals in a shorter time than was expected. In addition, as Sarantakos (2005) mentions, closed questions are relatively easy to digitize, code and analyse. The codification and digitization of collected data facilitated the production of comparative graphics and charts which explained the experimental, technical measurements presented in the previous section.

Conducting a street questionnaire in a different or `unfamiliar` context, as was the case when conducting in-depth interviews, raises some challenging issues in terms of accessing the general public. For example, reactions from people may vary depending on the way the researcher approaches the participants. Since in this research setting there is less time to explain the purpose of the research, a smart and simple way of transferring necessary information is required. In addition, the posture, communication style and even the clothing of the researcher has an influence on the process of engaging with the public. For instance, this extract from a research diary illustrates how clothing influences the attitudes of participants from the streets:

"…It was the right decision to wear a colourful t-shirt and shorts with a red cap on my head. I probably looked younger than I was. Most people tried to be helpful (and somehow show care) assuming that I was a student trying to prepare homework. Indeed, [this perception] was not wrong to some extent, but I am a bit older than they thought, I am afraid…" (research diary, 20.08.2014)"

Figure 4.10 Clothing of the researcher, while surveying on the streets

Source: Author's original

4.4.1.4 Participant Observation

Unlike a laboratory setting in the natural sciences[13], most social research, particularly ethnographic research, is conducted within a contextual setting which the researcher does not control, modify or design (as is in an experimental laboratory environment). Rather, ethnographic research calls for the discovery of the social setting, human experiences and interaction in the particular context selected as the sample for the research. Such a discovery can be characterized as an `informal` or not pre-planned accumulation of experiences and observation which happen within the natural flow of the research. Angrosino (2007) defines this accumulation as *"the act of perceiving the activities and interrelationships of people in the field setting through the five senses of the researcher"* (p.37). In this research, sensing the research setting and the way participants' use urban spaces under specific

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[13] *"There is at least one important difference between the laboratory of the physical scientist and that of the social scientist. In chemistry, physics, and even biology the subjects of the study can be brought into the laboratory and studied under controlled conditions. This as yet, except on a small scale as with institutes of child research, is not generally possible in the social sciences. The object of social science research - persons, groups and institutions - must be studied, if at all, in the 'laboratory' of community life. Yet it is just as necessary in the social as in the physical sciences to make observations and comparisons of behaviour under controlled conditions."* (Burgess, 1929, p:47)

climatic conditions becomes crucial for bridging the research data collected via relatively `technical` data collection techniques discussed above. The practice of observation allowed the researcher to build upon technical data in a way that generated insights into the use of urban space that he could not generate in any other way.

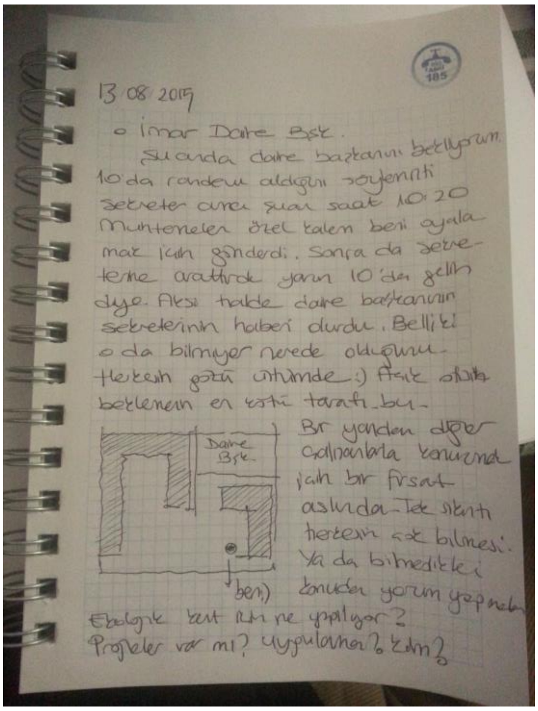
This is important because this research focuses on the way people use the urban built environment and, in turn, understanding how this provides thermal comfort in urban daily life. To this end, perceiving the urban setting as a laboratory in which the researcher observes the movements and end-users' interaction with the urban environment was not sufficient; rather he aimed to internalize the setting and explore the thermal comfort experience in urban setting *together* with the local people. Indeed, what the researcher 'sees' might not have been the reality. Thus, observation in this research was based on participation, experience and engaging in the activities of urban daily life together with end-users. Erlandson et al. (1993) call this process a `*prolonged engagement*` which is a key task to establish trustworthiness in an ethnographic research. The argument here is that if the researcher spends enough time in the field and tries to position himself as a local resident, he might potentially get a `better` understanding of the local specificities and the associated issues related to the topic investigated. In this sense, multiple visits in consecutive years provided an opportunity for the researcher to go one step further in his observations, helping him to internalize the dynamic relationships between the residents, urban built environment, daily lifestyles and the extreme climatic conditions in the context of Mardin.

While participant observation calls for a level of spontaneity and 'living in the moment' on the one hand, it is also essential for the researcher to prepare and focus on the main aim of the research, to ensure that he is not distracted by limitless stuff that *could* be observed in an urban setting. On the other hand, too much concentration on the pre-framed aims or assumptions may lead to a failure to notice the details which may bring/reveal unexpected findings from the field. In order to find a balance between these two edges, as Angrosino (2007) suggests, ethnographic observation requires some degree of structure and the habit of taking well-organized field notes. This is to familiarize the researcher with the issues that might potentially be supportive for the rest of the field research. In this research, the researcher noted down the answers to the following questions following the recommendations of Angrosino (2007).

- *How do people use/behave/move in the built environment?*
- *How do they talk about, characterize and perceive climatic conditions?*
- *Do certain conditions influence their behaviours?*
- *What are the unexpected nuances that researcher did not anticipate seeing?*
- *How was the researcher's experience of being in that hot and arid climate for the first time?*
- *How did the researcher `get closer` to local people?*
- *What was the reaction of local people when they heard the theme of the research?*

Considering the amount and density of observation typically carried out during fieldwork, taking structured and organized notes often becomes difficult, especially when the researcher is focusing on the methods and the techniques that will be used in the field. The analogy drawn by Hammersley and Atkinson (1996) is that inadequate note taking in a well-designed research is like `*using an expensive camera with poor-quality film*` (p.176). Thus not to end up with a `foggy picture`, the nuances of the fieldwork process were recorded with as much care and consciousness as possible. In order to prevent notes from becoming disorganized, the researcher made sure that every note was headed by the date, time and the place where the observed event/thing/phenomena had occurred. Since the researcher did not find time (e.g. not to interrupt the flow of the dialogue) to write his experiences in the research diary (see Figure 4.11) at all times in the field, some notes were taken on the interview sheets or in the sketchbook where the housing plans were drawn. The key task here was to organize the notes daily, almost immediately after returning back from the field, without losing the sequence and the references of the observed points.

Figure 4.11 Research Diary



Source: Author's original

Diarizing the fieldwork in sequence not only provides a reminder of what was happening at a particular time (Emerson, 1995), but also helps the researcher to understand and interpret the data gathered from in-depth interviews. For example, small notes entered in the research notebook can be used as a signal of the impressions and/or feelings of the participant; this might help the researcher to see how things collected in interviews `fit together` in a logical sense to construct an outcome (Emerson, 1995).

In this research the presence of a research assistant during the visits of houses provided more space for the researcher to observe and take notes, as he was able to concentrate more on the dialogue and the participants` responses and reactions while the research assistant was caring for the technical tasks such as organization of interview sheets, distribution of consent forms and collection of signatures.

4.4.1.5 Video-recording

The last data collection technique used in this research was video-recording which involved the collection of naturally occurring data during the fieldwork. As a supportive technique of participatory observation, video-recording provides concrete files of `memories/moments` from the field work in a quick way. Further to that, as Bloor and Wood (2006) claim, video-recording is more reliable than observation and field notes because videos allow repeated examination and the data in a video is not limited to the resercher's selective attention. It allows the researcher to replay and recapture the details of the recorded moment, event or the dialogue from the fieldwork. However, video-recording may create some challenges in social research. The following table presents the potentials and constraints of using video-recording as a social science method.

Table 4.5 Some potentials and constraints of video data

Potentials	Constraints
• *Video can support an exploratory research design and extended data discovery* • *It can be 're-opened' for later analysis and capture things not noticed at the time of being present* • *It can be used effectively to support empirical comparison of strategies, style, and interaction across a data set* • *Video enables researchers to re-visit a moment 'not as past but formerly present'* • *It can re-awaken the memories and experiences of a researcher or participant*	•*Video data is limited and shaped by decisions in the field* • *Video data is partial: it includes and excludes elements* • *Video is primarily focused on the material external expression* • *It usually provides one perspective on an event* • *It generally records interaction over short periods of time* • *Video takes time to watch and review and can be difficult to meaningfully summarized*

Source: Jewitt (2012, p.8)

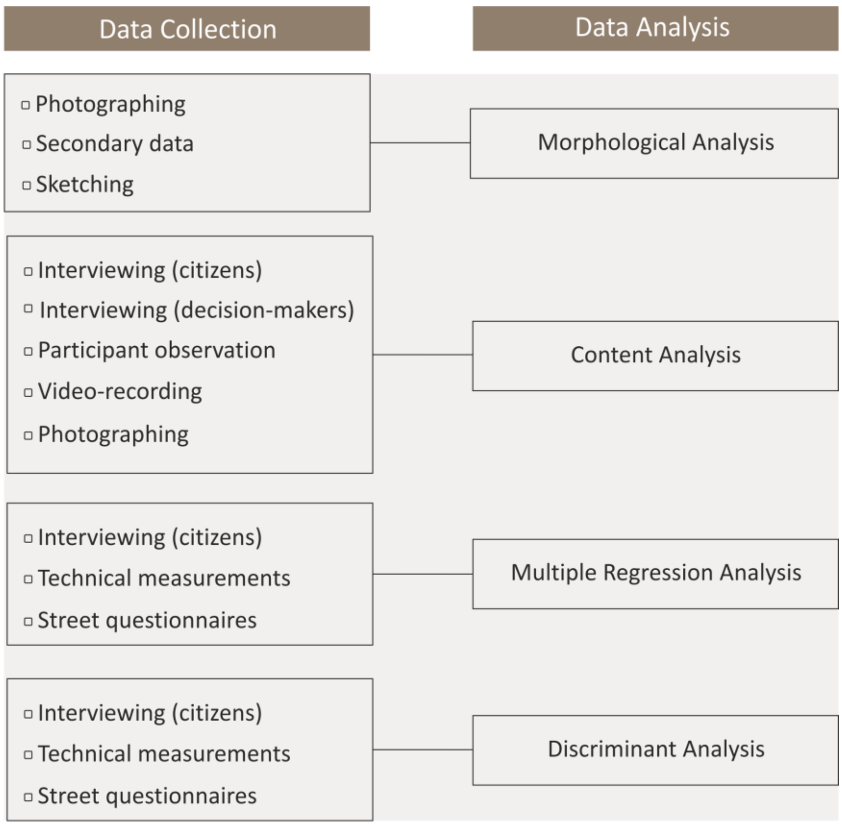
In this research, the video data was used for two main purposes. First, the videos from the interviewing settings provided the opportunity for the researcher to review the entire fieldwork process upon leaving the fieldwork setting. Thus, it provided a reference point to memories which helped the researcher to recall the order of the tasks completed in the field and link together the identified/explored research outputs without losing the logic/flow of the field story. Second, the video-recordings in outdoor urban areas were used to analyse the physical formation of the urban built environment, in a way as an animation/visualisation of the two dimensional morphological data, such as maps and plans.

Furthermore, in order to share the deeper understanding of citizens' lifestyles and the way urban space in Mardin is shaped according to climatic conditions with a broader audience, a short documentary is planned after the finalization of this research. The recorded videos will be used as supplementary sections for the planned urban documentary. The documentary will not be simply about watching people's everyday life experiences through a final finished product. It will be used as a tool for empowering and engaging the Mardin community in issues around climate change, thermal comfort and local responsiveness in urban design by bringing their story to a wider audience. The main aim of the filmmaking is to create an inclusive filmmaking process based on a process of reciprocal learning that engages both with the voices of local people, their community and the places they live in. The interactive documentary will combine film with a range of other media including photography, maps, soundscapes and data visualisations to create an immersive experience for decision makers and the wider public.

4.4.2 Data Analysis

Figure 4.12 presents a summary of the data analysis techniques used in the research.

Figure 4.12 Data analysis techniques used in the research



Source: Author`s original

First, in order to understand the variation in the urban morphology of the Old and New Towns, the researcher conducted a morphological analysis. Second, to understand how variations in the physical formation of built environment influence the perceived thermal comfort in urban life, a set of multiple regression analysis were conducted at different urban scales. Multiple regression results were triangulated with the technical measurements conducted at the housing and street scales. Subsequently, in order to better understand the regression results and measured climatic variations, a content analysis was conducted with the data collected through in-depth interviews. Lastly, to explore whether significant variables derived from multiple regressions vary between the Old and New Towns, a set of discriminant analysis was conducted.

4.4.2.1 Morphological Analysis

Urban morphology, the study of the city as human habitat (Moudon, 1997), has been used as a method in the analysis of physical urban space since the first half of the 20th century (Whitehand, 1986). Urban morphology focuses on the physical components such as buildings, streets, green spaces and open spaces. Thus the aim of morphological analysis is to understand the urban grammar, or the set of structural rules governing the composition of the urban built environment. In other words, urban morphology is about how one \`reads\` the city. Therefore \`reading\` the city calls for understanding the \`sentences\`, the \`phrases\` and \`words\` forming the meaningful composition of the urbanity. With this in mind, the literature presents different principles on how to analyse the urban morphology. Moudon (1997) summarizes three common principles in morphological analysis as follows.

Table 4.6 Three common principles in morphological analysis

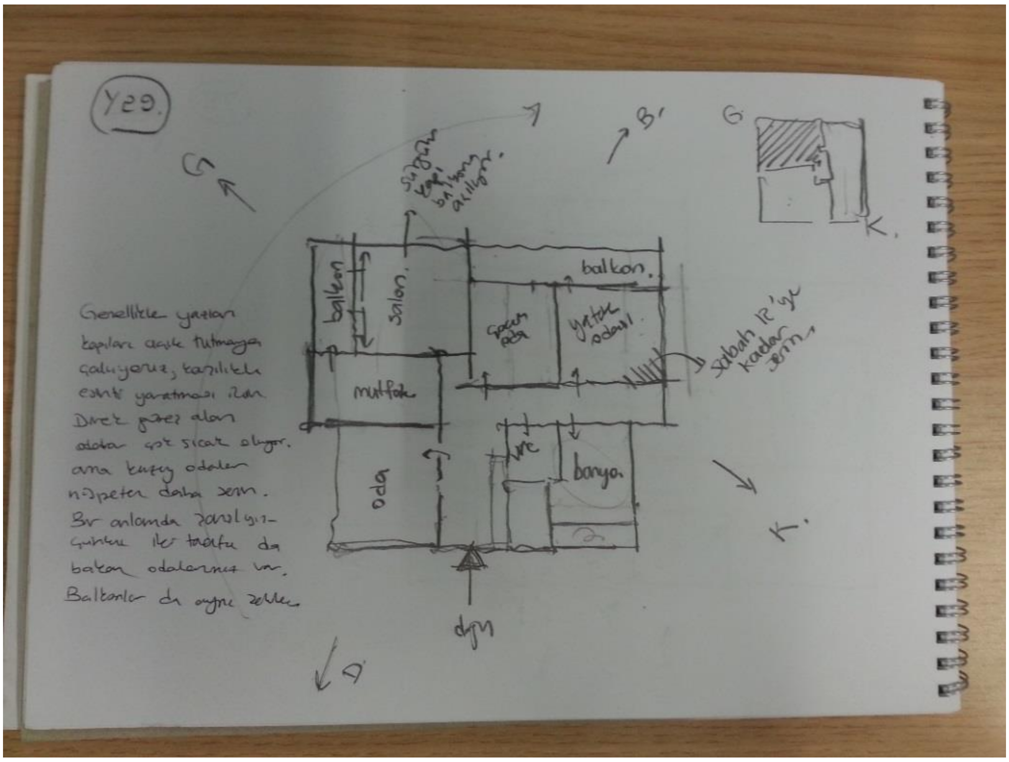
1. Urban form is defined by three fundamental physical elements: buildings and their related open spaces, plots or lots, and streets.
2. Urban form can be understood at different levels of resolution. Commonly, four are recognized, corresponding to the building/lot, the street/block, the city and the region.
3. Urban form can only be understood historically since the elements of which it is comprised undergo continuous transformation and replacement

Source: (Moudon, 1997, p. 7)

Morphological analysis in this research was to understand the grammar of the urban space in the Old and New Towns in Mardin. This analysis was vital in order to understand the variations between the two towns; this was used as a baseline to analyse the differences with respect to climate responsivity. Following Moudon\`s (1997) summary, this research approaches urban space production on the assumption that urban life starts at urban housing units, and the articulation of building units defines the streets which in turn provide accessibility within clustered groups of buildings called neighbourhoods. And lastly, the entire city is developed via the articulation of neighbourhoods.

Based on the above assumptions, a comparative analysis was conducted at different scales. In the housing scale, the aim was to understand the variation in the orientation, construction material and the design of the units in the vernacular and the contemporary units. To do that, a plan layout of each housing unit visited during the fieldwork was drawn in a sketchbook (see Figure 4.13), and the thermal comfort experiences of residents were noted down with the supporting information such as the facades, orientation, and the intra-day movement of the sun.

Figure 4.13 Extract from research sketchbook

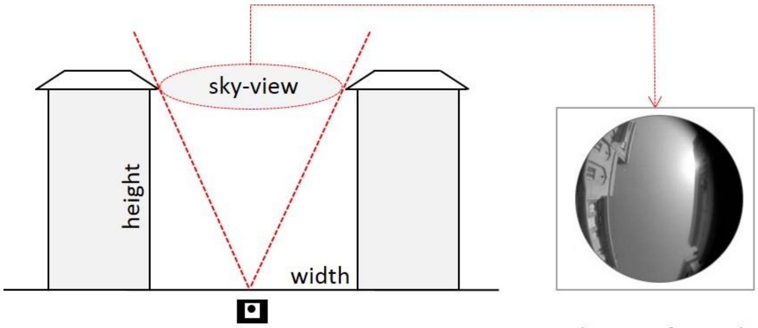


Source: Author`s original

Layouts were used to identify the common design principles for dominant housing typology in each town. Common principles were used to correlate with the indoor comfort ratings of residents.

In the street scale, the aim was to understand the variations of the streets in terms of the height, width, sky-view factor, construction material and the pavement characteristics. To do that, site visits were conducted that involved photographing and sketching supported by fish-eye photographic techniques. Fish-eye photos were used to calculate the sky view factor (SVF) at a given point in the streets. The SVF[14] expresses the ratio between the radiation received by planar surface and that from the entire hemispheric radiating environment (Watson and Johnson, 1987). Figure 4.14 presents the use of photography to analyse sky view in the streets.

Figure 4.14 fish-eye photography for calculation of sky-view factor



Source: Author`s original

4.4.2.2 Content Analysis

Content analysis was the main qualitative analysis technique used in this research. Hsieh and Shannon (2005) summarise three different use of content analysis as 'conventional', 'directed' and 'summative'. Whatever the approach is, the main idea behind this form of analysis is to interpret meaning from the collected data which is most often in text format (i.e. transcriptions of interviews). Hsieh and Shannon (2005) differentiate these three categories according to coding schemes, origins of codes, and threats to trustworthiness. While 'conventional' content analysis categorizes codes directly derived from the data, 'directed' content analysis starts with a theory or a research idea for initial codes. A 'summative' content analysis involves counting and comparisons, usually of keywords or content, followed by the interpretation of the underlying context. This research uses both 'directed' and 'summative' content analysis techniques.

In order to explore the perceived attributes of thermal comfort at housing, street and city scales, 'directed' (i.e. theory driven) content analysis is performed with the data collected via in-depth interviews. The text data is coded with a focus on thermal comfort and energy consumption themes. Results of the analysis serves for understanding variations in the Old and New Towns and provides input for the regression analysis explained in the following section. In addition, the research uses

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[14] *The SVF is a measure of the openness of the sky to radiative transport in relation to a specific location, where a value of 0 means that all outgoing radiation will be intercepted by obstacles and a value of 1 means that all radiation will propagate freely to the sky* (Brown and Grimmond, 2001).

‘summative’ content analysis to compare the most frequently mentioned keywords/contents listed by the participants from two towns.

4.4.2.3 Multiple Regression Analysis

Multiple regression analysis is a statistical technique that analyses the causal relationship between a single dependent variable and more than two independent variables. The objective of multiple regression analysis is to predict how the changes in independent variables affect the depended variable. In other words, this analysis investigates the effects of (X) and (Y) on a dependent variable (Z) which is shown in equation of “$Z= b_1X+ b_2Y+b_0$” (Aiken and Stephen, 1991). The test of the b_1 and b_2 coefficients are easily accomplished and inform the researcher whether the variables X and Y have a non-zero linear relationship to dependant variable Z. The b_0 coefficient represents the regression constant.

This research uses multiple regression analysis to understand which variables explain differences in thermal comfort at various scales. At the housing scale, multiple regression analysis is performed between different variable groups (i.e. housing design attributes, content groups) and perceived comfort ratings in the vernacular and contemporary houses. At the street scale, the perceived values rated by respondents are assumed as an independent variable which defines urban thermal comfort in streets. Thus, multiple regression analysis is performed between perceived climatic variables and the thermal comfort ratings on the street.

4.5 Practising Socio-technical Research: Some Important Highlights

This research aims to bring together the technical aspects of designing climate responsive urban settings and the social aspects of living in harmony with the climate, both in terms of adaptation to climatic conditions and mitigation to change in urban climate. In this sense, the research is designed primarily using an exploratory approach to understand the relationships between the physical space, climatic variations and the urban life practices. While understanding the relationship between the physical space and climatic variations presents a quasi-experimental character, the exploratory side of the research displays an ethnographic nature, with its commitment to understanding the local specificities and the way in which people use the built environment under certain climatic conditions.

As Atkinson and Hammersley (1994) state, ethnographic research represents a `humanistic, interpretive` approach, rather than a `positivist` position. Conducting this research in the setting (both in the Old and the New Towns) in which people actually live adds value to the research making it (i.e. the thesis) both an `ethnographic product and a process of research` (Agar, 1996). That includes enabling (to a limited extent) the researcher to `live in the participants` world` which, in turn, provides them with an internalization of the culture or context, going one step further than the other methods such as conventional and positivist (Atkinson and Hammersley, 1994). However, one should consider that terms such as `culture`, `society` or `community` used to express various assets of the field, carry a certain level of `abstraction` which allows the researcher to communicate his findings to a broader audience (Flick, 2007, p.14).

According to Flick`s (2007) expression, the `*multi-factorial structure*` of this research involves the use of different data collection techniques requiring a day to day, face to face interaction with the people associated in the research (p.15). The following sub-sections discuss issues relating to the multi-factorial structure and practising the socio-technical research in exploring matters of climate responsive urban development.

4.5.1 Pilot Study

Exploratory research embodying ethnographic characteristics generally requires fieldwork to be conducted over an extended period of time, demanding significant sums of money and a great amount of effort on the researcher's part. For this reason, a pilot study, defined as "*mini version of a full-scale study as well as the specific pre-testing of a particular research instrument"* (Teijlingen and Hundley, 2001, p:1), has the potential to improve the likely success of the eventual 'full' study. '*Pre-testing*' here, as Babbie (1990) states, refers to a '*miniaturized*' trial of the entire research design, rather than a testing of one or two aspects of the research design.

Table 4.7 Reasons for conducting pilot studies

- *Developing and testing adequacy of research instruments*
- *Assessing the feasibility of a (full-scale) study/survey*
- *Establishing whether the sampling frame and technique are effective*
- *Assessing the likely success of proposed recruitment approaches*
- *Identifying logistical problems which might occur using proposed methods*
- *Collecting preliminary data*
- *Determining what resources (finance, staff) are needed for a planned study*
- *Developing a research question and research plan*
- *Convincing funding bodies that the main study is feasible and worth funding*

Source: Teijlingen and Hundley (2001, p:2)

In light of this information, a pilot study was conducted from 14th to 19th June 2013 with the purpose of establishing whether or not Mardin was a suitable case study through which to respond to the main aims of the research. The pilot study corresponded with most of the above-mentioned reasons. First of all, the researcher had not been to Mardin prior to embarking on the research. Although Mardin was nominated as a candidate for a World Heritage Site due to its unique vernacular settlement, and there were initial sources presenting the climatic conditions and the way vernacular housing was designed accordingly (see Chapter 5), witnessing these features in person was still deemed crucial in order to assess the validity of the research design.

Secondly, although the city of Mardin is located within the boundaries of the Turkish Republic, the city presents a multi-cultural demographic structure which includes different ethnic groups (mainly composed of Kurdish and Arabian). Thus the researcher needed to test his ability to approach and access research participants in this setting. Ensuring this was feasible was critical in minimising the risk of the researcher being labelled an `outsider`, something which would undermine the effectiveness of the research, and particularly the ethnographic dimension.

Thirdly, the pilot study guided the design of the research timeline, including estimates of the time needed for data collection. For instance, the first in-depth interview in a local residents` home lasted 45 minutes which indicated that the house-to-house visits would last at least 10 days in total. Thus the fieldwork phases were planned in light of the experiences gained in the pilot study.

And finally, the preliminary outcomes from the pilot study provided input for the preparation of proposals used in the application for additional funding sources. Two separate research funding applications were granted by the British Institute at Ankara to support the fieldwork. In other words, the pilot study conducted in the early stages of the thesis ensured funding which facilitated the completion of the remaining of the research.

4.5.2 Organizing the data

As discussed in the literature, qualitative research usually provides large amounts of textual data in the form of transcripts and field notes which call for a systematic approach that leads to a time and labour-efficient analysis process (Zamawe, 2015). While a systematic approach to data organisation is important, Richards (1999) also outlines the risk of losing the richness of collected data, particularly in qualitative researches. The richness here, as Lofland and Lofland (1984, p. 11) state, refers to:

> …*ideally, a wide and diverse range of information collected over a relatively prolonged period of time. And for the naturalist, that collection is achieved, again ideally, through direct, face-to-face contact with, and prolonged immersion in, some social location or circumstance. You wish, that is, to earn "intimate familiarity" with that sector of social life which has "tickled" your interest.*

The 'richness discussion' brings to the fore some of the ways in which ethnographic data can be managed and prepared in the most efficient way before starting analysis. However, the collection of data through different channels or data triangulation itself does not guarantee this richness, as Richard (1999, p. 416) expresses in the following paragraph:

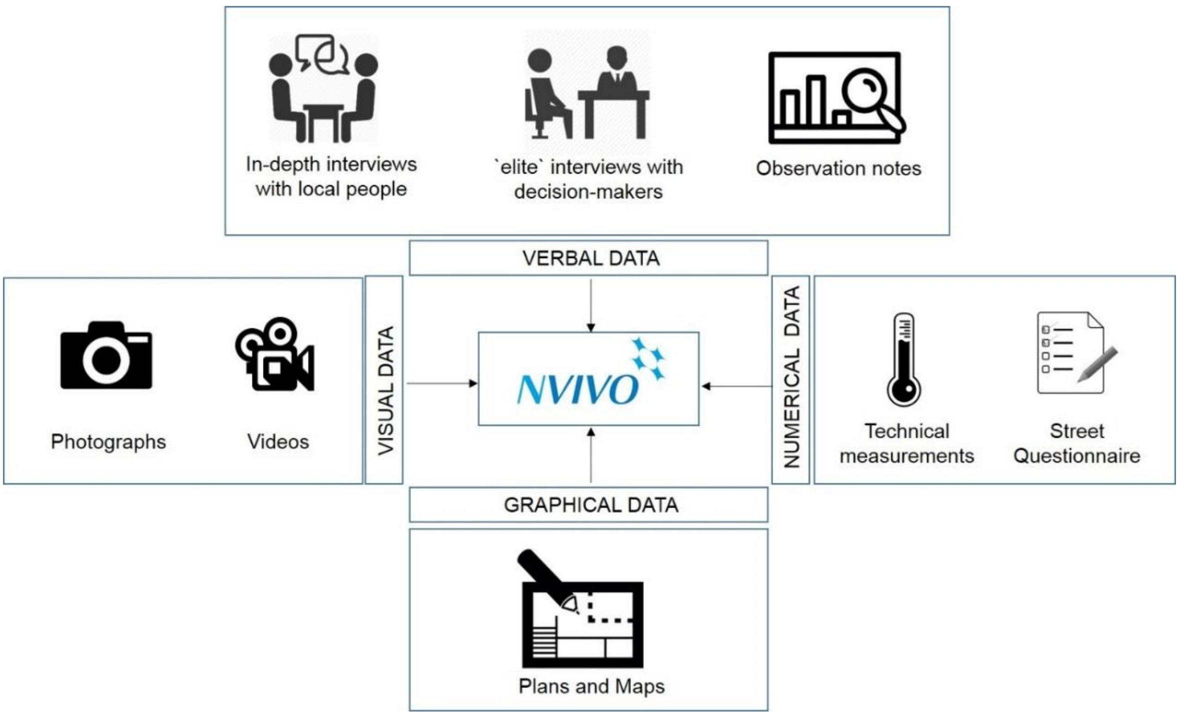
> *Rich projects should be able to hold mysteries, tentative formulations of what is going on, and explorations of different interpretations. Coding and retrieving leave no room for mystery and*

tentativeness; we need other ways to hold those and explore them until the whole becomes clear, elegant, and sensible. This requires dynamic documentation and many different types of links, alerting researchers to what was glimpsed here or discovered by comparison with this.

As Richard (1999) points out, \`coding\` and \`retrieving\` the collective data might lead to over-simplified outcomes which do not reflect the contextual details through which the research gains more significance and creates an impact. At this point, creating linkages between different data sets comes to the fore in order to create a deeper understanding and analysis of a big data set.

In consideration of these discussions, in this research, software called NVivo was used as a data organization tool. As seen in Figure 4.15, different types of data were uploaded to the software in which the relevant data sets can be linked via a structured coding system. For instance, NVivo can link a photograph or a section of video recording with any quotation selected from Word files including interview transcripts. A segment of a video recording may evoke the moment of interview, including the atmosphere in the interweaving setting, which might encourage the researcher to interpret the research findings remaining faithful to the specificities of the research. In brief, NVivo does not directly provide a data analysis function but instead provides a way to organize a data set which facilitates a researcher's steps from analysis through to the framing of research findings. By means of this, the software helps minimize the risk of losing the richness of the data collected through various techniques.

Figure 4.15 Types of data uploaded and organized in NVivo



Source: Author's Original

Data organization was managed with the creation of a project in NVivo. 75 Word files containing interview transcriptions, 53 photographs, 12 video files, 60 housing plans, and 4 Excel files including the technical measurements were uploaded into the project. After all necessary files were transferred to Nvivo, the process of `coding`, which can be defined as a process of putting together relevant data extractions across different types of data files, into pre-defined categories (by the researcher) called `nodes`, could begin. The nodes were created in line with the main objective of each research question. Rather than following a linear structure, the coding process is designed to work in a holistic nature which allows the mobility of any type of data back and forth, aiming to reach the most meaningful sets of nodes.

4.5.3 Ethical Issues: Anonymity and Confidentiality

Social sciences research can involve different types of people who could potentially be affected by the research or the outcomes. Those involved may be participants, colleagues, research assistants, sponsoring bodies and the wider public. In this sense, ethical considerations become as crucial as other theoretical and empirical issues in the research process. Vaus (2002) conceptualizes two broad approaches in designing ethical research. The first is to define a `set of rules or guidelines and follow them without considering the outcome of the research' (Vaus, 2002). The second approach is to follow a set of ethical guidelines but with a certain level of 'personal judgement' far more than the first rule-based approach. Although the latter approach seems more realistic and practical, Vaus (2002) underlines the possibility of emergence of short-term harm to participants or the residents who happen to be living in the research environment. This research followed the former approach. Conducting ethnographic research raises significant ethical issues, and thus concepts of `anonymity` and `confidentiality` gain importance in promoting values such as trust, accountability, mutual respect, and fairness.

The exploratory nature of ethnographic research and open-ended data gathering techniques such as in-depth interviewing with local people, raise questions about whether truly informed consent for such research can be obtained (Fisher and Anushko, 2008). In this research, a consent form (see Appendix B) was prepared and made available to all participants. This contains details of the project and contact details for the principal researcher, advises subjects that their privacy will be protected, that their participation is voluntary and that they may withdraw from the research at any time and without giving a reason. In addition, households who had residents with learning difficulties or where whoever answered the door was aged under 18 years old were not included in the in-depth interview sample. In-depth interviews with householders were conducted in a proper and convenient place of the choosing of the householder who expressed an interest in participating in the research.

In addition, interviews were cancelled when the researcher felt any harm to participants may occur as exemplified in the following extract.

> *Today I intended to interview a woman who has 6 children one of whom was disabled and confined to bed. As usual, the conservation started with getting to know each other but when I started to ask questions regarding the family members, education status, economic conditions; the woman started to share the difficulties that she has been facing for years. She was ready to cry when she was complaining about financial problems such as paying the hospital costs, paying the bills, cost of education for 5 children, even sometimes the challenge of finding a budget for food. At that moment I felt my research theme was not even remotely close to her life and the challenges that she had been facing, and I decided not to conduct the interview. Talking about thermal comfort, climate or the design of the house had no meaning for that moment. In the end, we left the house after listening her troubles which didn't contribute much to my research but at least I can help them by sending some stuff for the children… (Research diary, 18.08.2014)*

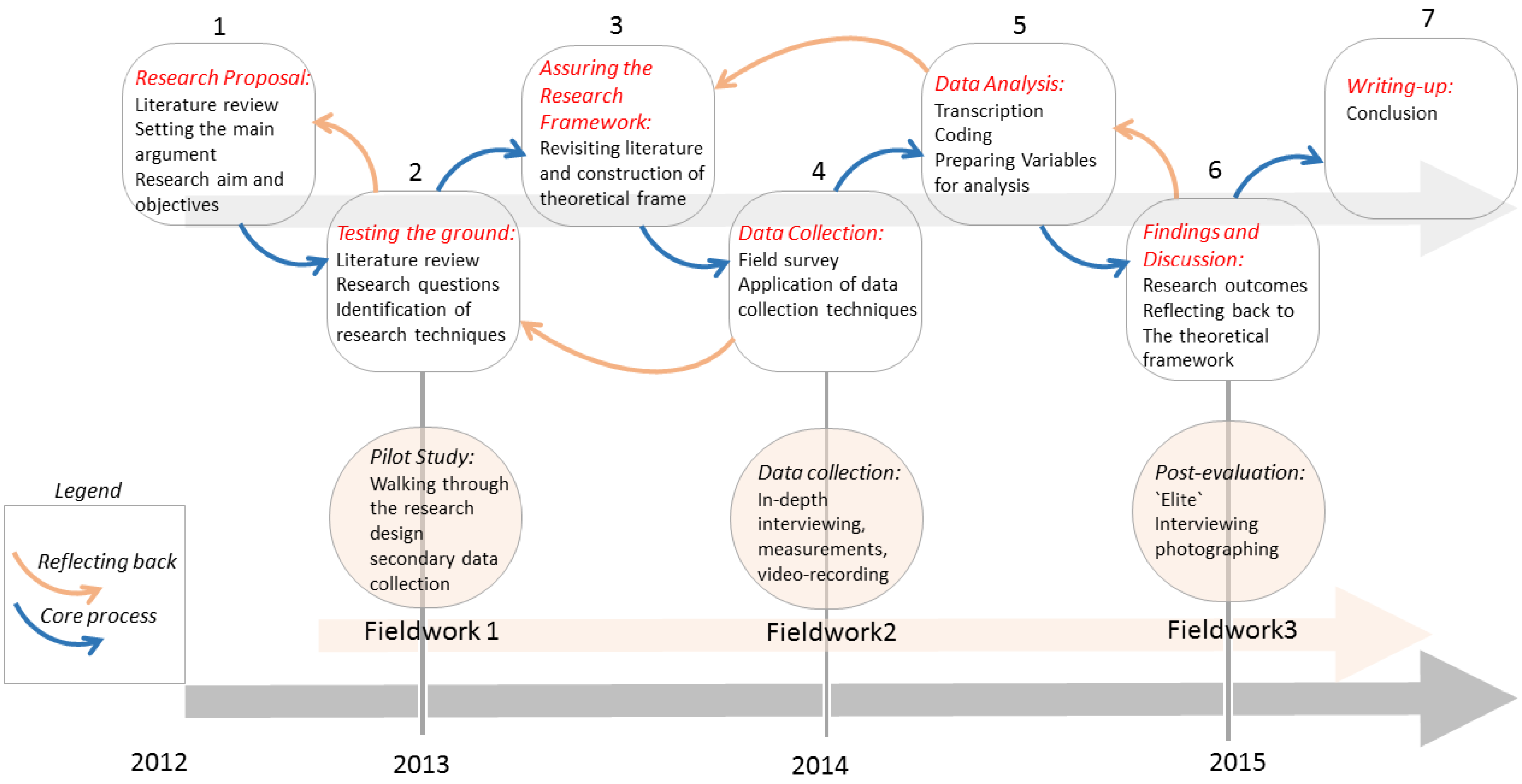
Before each interview, residents were informed about the purpose of the video recording and the camera was not used unless the participant expressed his/her willingness to take a part in the visual product coming out from the research. Any visual data which can reveal the participant's identity was not used without their permission. In order to protect the anonymity of the participants who did not give permission for recording or photographing, quotations from the verbal data was used with a basic description such as `Old Town, Male, 35`, in order not to reveal the identity of participants. Similarly, interview extracts from the decision-makers are used without providing information about the names and affiliations of the participants.

Another ethical point that was considered in the research were the rights of the different stakeholders of the research. As Vaus (2002) points out, interests of different research stakeholders can create conflicts in the formulation of the ethical framework for social research projects. With this in mind, before conducting the research, all research methods and techniques (i.e. in-depth interview questions, street questionnaires and interview guides) were reviewed against the policies and criteria noted in the University of Reading Research Ethics Committee Notes for Guidance and the Research Ethics Framework of British Institute at Ankara (BIAA), the sponsoring body of the fieldwork element of this research. BIAA also approved the research according to these guidelines.

4.5.4 Process Design, Timing and Budget

Figure 4.16 presents the reflexive research design process which promotes self-reflection and re-configuration throughout the process. Although the research was conducted according to the presented research design, the nature of the research topic itself calls for a level of `judgement` of the researcher (Hammersley and Atkinson, 1983, p.23). The `judgement` refers to the ability of the research themes to be re-configured according the flow of the research process in the research field.

Figure 4.16 Process design and research timeline



Source: Author`s original

Thus, the reflecting mechanism in the process stands as the key contribution of this socio-technical research which moderates the rigid boundaries of conventional research approaches and introduces a more circular, open and self-renewing research process.

In a reflexive research process, effective timing has a great importance since some steps of the research may require reflecting back to the previous stage; this might necessitate more time for revision of the research process (Ellen, 1984). In addition, the ethnographic character of the research may create timing conflicts since it calls for more interaction in the field itself. However, what is important here is not the length of time spent in the field *per se* rather, as Beach (2007) asserts, it is how the time is used, in order to be familiarized with the context. This is why staying both in the Old and in New Towns was important in order to feel the sense of the ground during the fieldworks.

Furthermore, as Ellen (1984) remarks, designing the research process also promotes the effective conduct of the research while meeting the demands of funding and administrative bodies. Effective conduct refers to both time management and the effective use of data collection techniques. Data collection in this research was divided into two fieldwork phases since the research findings of the former round provided input for the latter phase. In addition, all logistic costs and technical measurement equipment was funded by British Institute of Ankara, in exchange for a publication of a research report in the annual Journal of Heritage Turkey.

4.5.5 Safety

As Akeroyd (1984) notes, fieldwork is a \`difficult\` and \`taxing\` activity, especially if it is conducted in countries or cross-cultural groups other than the researcher\`s own. The personal safety of the researcher and safety of the participants needs to be safeguarded to eliminate a potential conflict that might occur during the research process.

In this respect, before starting the fieldwork, the Greater Municipality of Mardin and the Security Directorate of Mardin were notified about the research plans for each instance of the fieldwork. In addition, during the fieldwork, local student(s) were assisting the researcher the vast majority of the time. Where there were instances when the researcher was working alone (e.g. interviewing in participants' homes), a time and meeting place for after the interview was arranged to 'check-in' with the researcher. The researcher and the assistant(s) were also in mobile telephone communication at all times.

During the second phase of fieldwork, the only safety risk that emerged was the uprising that started in the refugee camp of Syrian immigrants. Since the boutique hotel in which the researcher and the assistant had been staying in the Old Town was the main accommodation centre of the representatives of the United Nations who came to manage the riot, the research team had been kindly asked to check out. However, neither the researcher nor research assistant were faced with any security problems since they were moved to another hotel in the New Town of Mardin.

During the third round of the fieldwork (in summer 2015), the socio-political atmosphere in the Mardin was radically different than during the previous visits. This was mainly caused by the unexpected war that emerged in the Syrian border area of the city and the rising conflicts between the illegal forces of the Kurdistan Worker`s Party and the national force of the Turkish Republic. The researcher did not know the reality until he arrived in the field. Therefore, he informed the Security Directorate of Mardin to ensure the safety of researchers' visits to public buildings mentioned in the section 4.4.1.1.2. This was mainly because these forces had focussed their attacks on public buildings such as Security Directorates or the Office of the Governor in other neighbouring cities.

4.6 Conclusion

This chapter has set out the research design adopted in the study, and sought to contribute to some key areas of methodological discussion, specifically, the selection of the case study approach, conducting socio-technical research and the issues related to the ethnographic characteristics of the research. The chapter shows that researching in the field of urban design with a climatic perspective calls for the consideration of different social, technical and political dimensions, requiring various research techniques to be adopted. While the richness of these techniques drives the evolution/generation of this research to a large extent, it also shows the challenges of urban development (in practice) due to the multi-dimensional nature of the phenomenon.

`Climate responsivity` is a bilateral term which refers to meeting the requirements of the local climatic conditions on the one hand, and being sensitive in order to avoid making changes to the climate on the other. Therefore, this research is designed in a way to shed light on the significant points of climate responsive development at different scales of urban space production starting from the household scale and connecting to street, neighbourhood and the city scales. While doing this, the research introduces a novel method in addressing connections between space production, climate sensitivity and the lived experiences of local residents which can be the basis for an alternative design approach that integrates the desires and requirements of end-users as well was embodying the technical dimensions of climate responsive design.

The following chapter introduces the city of Mardin in greater detail. It presents the urban development patterns in the Old and New Towns and provides a deeper understanding of the urban daily life under extreme climatic conditions of the region. It also sets out the urban planning and the local-level decision making mechanisms in the urban development processes and introduces the key institutions and the key departments having a role in the process of creating climate responsive urban development.

CHAPTER 5

PAST, PRESENT AND FUTURE: URBAN DEVELOPMENT IN MARDIN, TURKEY

5.1 Introduction

This research approaches the design of the urban built environment as an on-going process comprising of not only spatial organization and physical adjustments to the built environment but which also integrates human dimensions, including an understanding of social interactions and variations in, and barriers to, climate adaptation. In this respect, before exploring how social and cultural lifestyles relate to the spatial organization of particular climatic territories, this chapter examines both the vernacular urban setting in the city of Mardin which has developed throughout history harmonically with climatic conditions, and the contemporary urban setting which has been developing since the 1960s, as part of the wider rapid urbanization seen across Turkey.

The chapter argues that the development pattern in Mardin can be understood as the grammar of an urban language, that is, distinct but interlinked layers of urban space, through which the level of climate responsiveness of the local place has emerged. Urban grammar here refers to the constituents of the physical space including the indoor living environments and the outdoor urban spaces. Thus, the grammar involves various variables such as form, size, orientation, dimension, material, density and other technical dimensions. The aim of `grammatical resolution` is to provide a basis for the comparison of climate responsiveness within the `lived space` (Lefebvre, 1992) of the Old and New Towns. Following the methodological assumption regarding the significance of scale in this research, the analysis presented in this chapter follows the conceptualization of urban space production at housing, street and city scales. The chapter aims to resolve the sub-components of urban space before exploring the human-space interaction in the Mardin context. The resolutions presented in this chapter are used as independent variables which influence the climate responsiveness levels within urban daily life. In other words, the components of physical urban space provide the evidence base for the following chapters which argue for the significance of human experience and social dimensions in providing effective climate-responsive living environments.

The remainder of the chapter is divided into five sections. Section 5.2 introduces the city of Mardin and provides an overview of its geographical, climatic and demographic structure. Section 5.3 then briefly explains the development history of Mardin from ancient history through to the contemporary period. While there was little formalized planning for the city until the 1960s, organic urban development emerged during the 12th century that helped to shape the urban space in accordance with local climatic conditions. Section 5.4 focuses on the variations between in the organic/historic urban pattern and the contemporary development pattern and presents the sub-component urban elements forming the `grammar` in each town. Following that, in order to evaluate the urban space production within the political and institutional context in which the space is produced, section 5.5 presents an overview of the urban development system in Turkey. This includes the spatial planning hierarchy and the planning institutions partaking in urban development decision-making processes. Lastly, the chapter ends by drawing together the distinct patterns of development seen in two towns, and highlights how the production of urban space potentially influences the relationship between the provision of thermal comfort and the energy consumption in urban daily life.

5.2 Background Information on Mardin: Geography, Climate, Demography

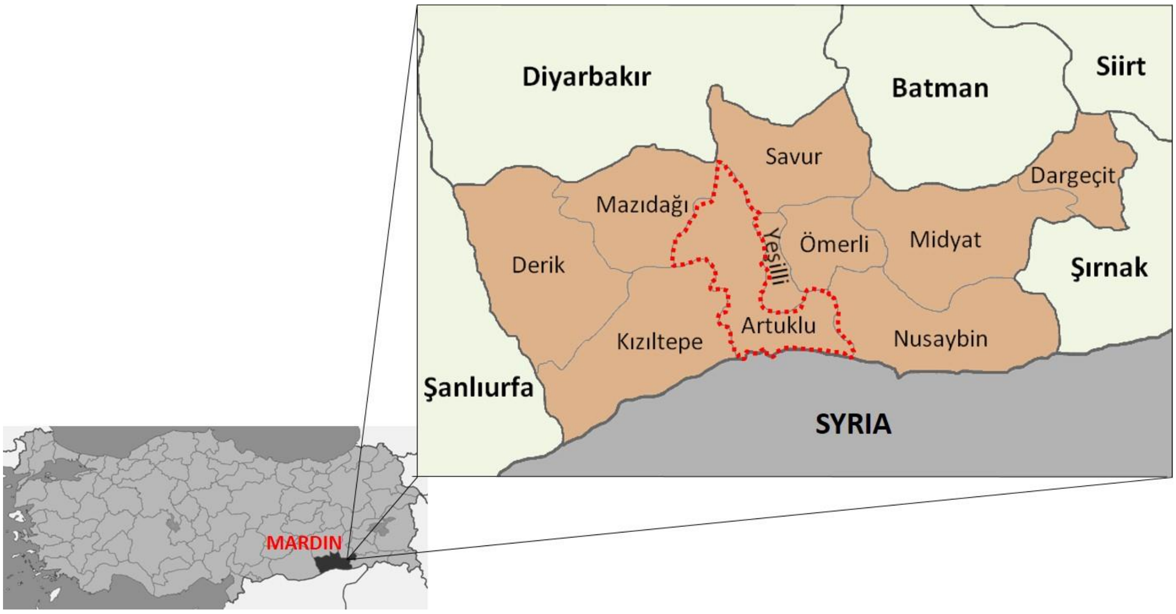
With its strategic location between the intersection of Mesopotamia and the Arab Peninsula, Mardin presents explicit geographical and climatic characteristics which taken together, as this chapter will demonstrate, make it a good candidate for achieving the objectives of this research. Since before the Christian era, the territory has accommodated various civilizations which left some spatial traces throughout history. The historical settlement which was announced as an urban heritage site in 1979, stands as the most concrete, visible trace from past civilizations and represents a characteristic development pattern that is appropriate for the city's unique geography. The following sub-sections introduce the geographical and climatic characteristics of the territory and elaborate the demographic structure both in the heritage site and the entire city of Mardin.

5.2.1 Geographical Location

The city of Mardin is located at 37° 19' 3 N 40° 42' 55 E, in the South Eastern Anatolia in Turkey. The city is surrounded by cities of Diyarbakir and Siirt (in the north), Hakkari (in the east), Sanliurfa (in the west) and Syria (in the south) (see Figure 5.1).

The city`s location between the drainage basins of the Tigris and Euphrates provides a variety of land forms. The northern part of the city is surrounded by the Mazi Mountains (1000-1500m.) which prevents the permeability of the wave of cold air from the north. The southern part of Mardin is seen as an extension of the Tigris Valley which provides fertile agricultural plains as well as allowing the wave of hot air from the Syrian plains in the north.

Figure 5.1 City of Mardin with its neighbouring cities and provincial divisions



Source: Author's original

As seen in the Figure 5.1, the city of Mardin embodies 10 districts. The fieldwork for this research was conducted in the central district, Artuklu (showed with red dots), which embodies both the heritage site (Old Town) and the contemporary site (New Town). Each of these 10 administrative divisions has its own local municipality; the wider 'city of Mardin' is governed by one Greater Municipality that has overall responsibility for the 10 districts. Details of the roles and the responsibilities of local level municipalities and the planning mechanisms are presented in section 5 of this chapter.

5.2.2 Climatic Characteristics

The city is surrounded by a desert climate to the south and high mountains to the north which block the cooling northern winds. With the influence of the desert climate from the Arab Peninsula in the south, climatic conditions in Mardin become extremely harsh, especially in summers. As seen in Table 5.1, daily mean temperature values are above 25 °C from June to September. While the highest average values go up to 35 °C in the moths of July and August, the highest temperature recorded so far was 42.5 °C in July 2000.

Table 5.1 Climatic data for Mardin (1950-2014)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum °C	19.4	18.4	27.5	33.6	35.4	40.0	42.5	42.0	38.8	35.6	26.1	24.1
Average high °C	5.7	7.2	11.6	17.4	23.8	30.4	34.9	34.6	29.9	22.7	14.2	8.0
Daily mean °C	3.0	4.1	8.0	13.5	19.4	25.6	29.9	29.6	25.1	18.3	10.6	5.2
Average low °C	0.5	1.2	4.6	9.7	14.8	20.0	24.3	24.5	20.5	14.5	7.7	2.7

Source: Turkish State Meteorological Service (2015)

Statistics also presents that daily insolation time is at least 4 hours in the winter and it increases up to 12 hours in the summer months (see Table 5.2). While the capacity of insolation stands as a challenge for cooling from one hand, it also offers the potential for the population to benefit from the use of renewable energy technologies such as solar panels on the other. In addition, as seen in Table 5.2, Mardin experiences extremely dry summers with an average number of 0.5 rainy days in July and only 0.2 in August. Low precipitation causes aridity and can create an uncomfortable experience for occupants in the summer months.

Table 5.2 Insulation and precipitation data for Mardin (1950-2014)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average insolation (h)	4.2	5.1	5.6	7.2	9.4	12.1	12.2	11.3	10.1	7.4	5.5	4.2
Average number of days when rain falls	11.5	10.6	11.5	10.5	7.4	1.6	0.5	0.2	0.8	5.2	7.6	10.8

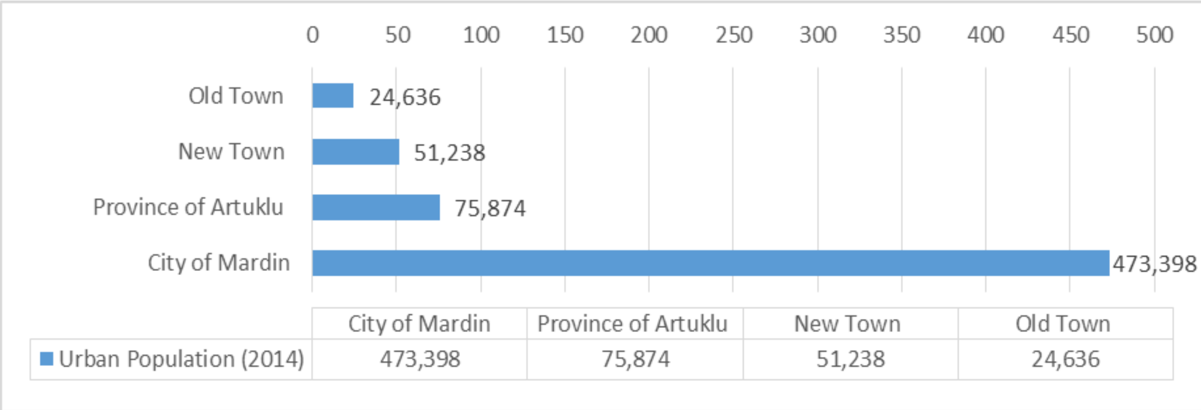
Source: Turkish State Meteorological Service (2015)

Hot climatic conditions in Mardin mean there is a high demand for cooling at the city-wide scale. In this respect, the way the urban form is shaped in Mardin stands as a principle determinant of the urban microclimate which has a significant influence on the provision of thermal comfort in urban areas. As discussed in the literature, the way in which cities are developed has an influence on the provision of thermal comfort as well as affecting the energy consumption patterns in the provision of thermal comfort in urban life.

5.2.3 Demographic Structure

As seen in Figure 5.2, according to the 2014 population census, 473,398 people live in the urban areas within the province of Mardin. This includes all urban areas in the 10 districts within the boundaries of Greater Municipality of Mardin. When it comes to the district of Artuklu, where the Old and New Towns are located, the latest recorded urban population is 75,874 (TSI, 2014). Of this total, 24,636 people live in the heritage (Old Town) site and 51,238 people live in the (New Town) contemporary site developed since the 1960s.

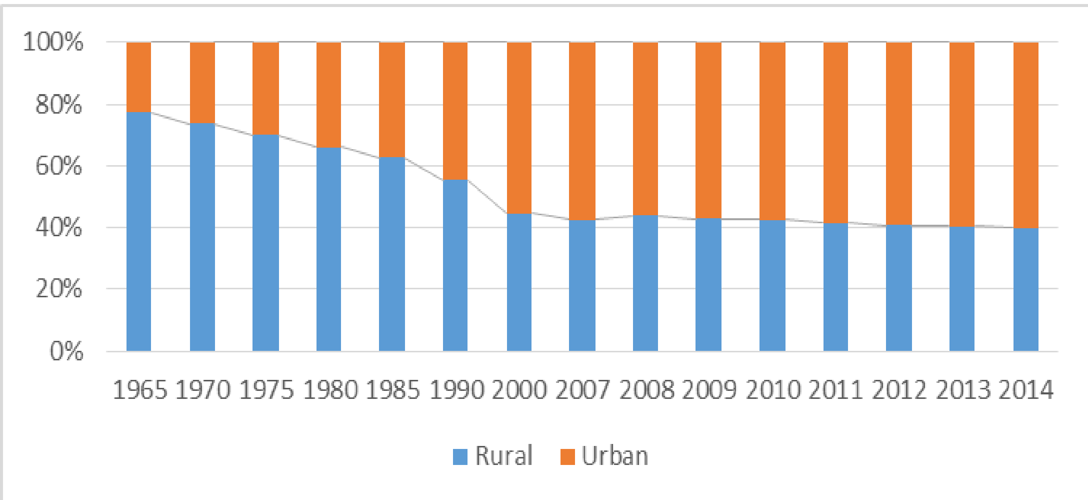
Figure 5.2 Urban population in Mardin – 2014



Source: Turkish Statistical Institute (TSI) (2014)

As seen in Figure 5.3, from the 1965s to 2000s there was a rapid increase in the urban population mainly triggered by the migration from rural to urban areas. These dates coincide with the development of the New Town, the first plan for which was prepared in the 1960s. Although the increase in the urban population slowed after 2000, it is still possible to observe a continuous trend of population movement from rural to urban areas. This trend indicates that more urban development is likely to continue to be required in the future. Unless further development is planned and executed in a controlled and sensitive way, it is likely to lead to various environmental hazards such as the loss of fertile agricultural lands, the increase in the air pollution or the increase in the carbon emissions in urban areas.

Figure 5.3 Variations in the rural–urban population in Mardin



Source: Turkish Statistical Institute (TSI) (2014)

When it comes to the focus of this research, the increase in the population of urban areas can give rise to uncontrolled densification in terms of both building and population. In Turkey, urban population growth has tended to lead to the construction of high-rise developments to accommodate more people per hectare. This type of development can trigger the alteration of the urban climate (i.e. increase in the surface temperature) which, in turn, may adversely affect urban thermal comfort in daily life. It is important to underline that an unplanned/uncontrolled densification may lead to the emergence of an unsustainable city. Population trends need to be considered in order to determine how to configure the urban form with respect to climate responsivity. In order to understand the population trends and increasing tendency in living urban areas, a review of historical development is required.

5.3 Development History of Mardin

There is a lack of archived information regarding the early history of development in Mardin. However, in her book about development of Mardin, Agaoglu (2000) presents a synthesis of the legends about the city and syllogise a conjectural image for the early history of Mardin. According to one legend, the first settlement in Mardin was created after the Persian Prince, Ardesir, located one of his tribes in the territory of what is today the city of Mardin. Another legend says that, in the belief that the Mardin climate had curative powers the Persian Prince brought his son, who was suffering from a severe illness, to the top of the hill where the heritage town exists today. Despite being unscientific sources, legends still give clues of an approximate date for the emergence of first settlements. The lack of information from antiquity stand as a barrier to understanding the emergence of settlement in the area. However, historical literature says that the Persians were in command of Anatolia between BC 543-333. Depending on the legends, it might be assumed that the first settlement was developed sometime between those years.

The first written source about the history of Mardin is from the 4th century. Byzantine historian Ammianus Marcellinus and Palestinian historian Prokopious put down on paper their experiences in the territories of today`s Mardin (Agaoglu, 2000). However there is not much written information about the physical space organization or settlement characteristics of those days. As Agaoglu (2000) indicates, the early historical architectural elements (i.e. monasteries) belonging to the Syriac Christians provide some evidence of how the physical space (mainly at the building scale) of that time was configured. For instance, Figure 5.4 presents the Monastery of Deyrulzafaran which was built in the 5th century and the Figure 5.5 shows the Monastery of Deyrulhammara built in the 4th century. Similarly, the Mar Mikhail Church (495), the Surp Kevork Church (429) and the Mar Hurmudz Church (430) were some of the historical buildings that give partial information about the urban pattern before the Islamic Period in Mardin (Agaoglu, 2000).

Figure 5.4 Monastery of Deyrulzafaran

Source: www.fotokritik.com (2015)

Figure 5.5 Monastery of Deyrulhammara

Source: www.panoramio.com (2015)

In 636, after the Byzantines lost the war against the Arabs, Mesopotamia and the adjacent regions were invaded by the Arabs (Shahid, 1984). No scientific sources about the urban development practices during the domination of Islamic states survive. However, compositions of historical geographers of the era embody some descriptive lines (i.e. the city on top of the hill with a crowded bazaar) about the general layout of the city (Agaoglu, 2000). Although there is not any documented evidence about building characteristics and development details about the Islamic era, the descriptive lines in different texts give the clues of urban development operations.

Agaoglu (2000) claims that the traditional urban pattern we can see today started to be developed from 1108, after the Artuqids entered in the area. This form of development was continued by the Aqqoyunlu Empire and Ottoman Empire. The first differentiation in the settlement's development, in other words an intervention made to the traditional settlement, was seen after 1915 in the Republic Era. From the 1950s, the traditional settlement (the heritage town) started to sprawl wider with public buildings and social housing in the east and irregular housing development in the west and south.

Table 5.3 presents a brief list of the periods under which the city of Mardin was dominated by different empires. The table also gives information about the settlement development in Mardin within the limits of the literature and the archival documentations.

According to Table 5.3, one can say that from the emergence of the first settlement to today's urban development in the city, there are some physical traces which belong to different periods in the history. This research focuses on the traditional urban pattern which started to be generated in 12th century and continued to be developed until the 20th century by the Ottoman Empire. The research is constructed using a comparative approach between the traditional urban pattern, which continues to house local people and the contemporary urban development which was introduced after the foundation of the Turkish Republic. Therefore the following section analyses the development patterns in the Old (traditional) and the New Town (contemporary) with respect to physical space organization.

Table 5.3 History of settlement development in Mardin

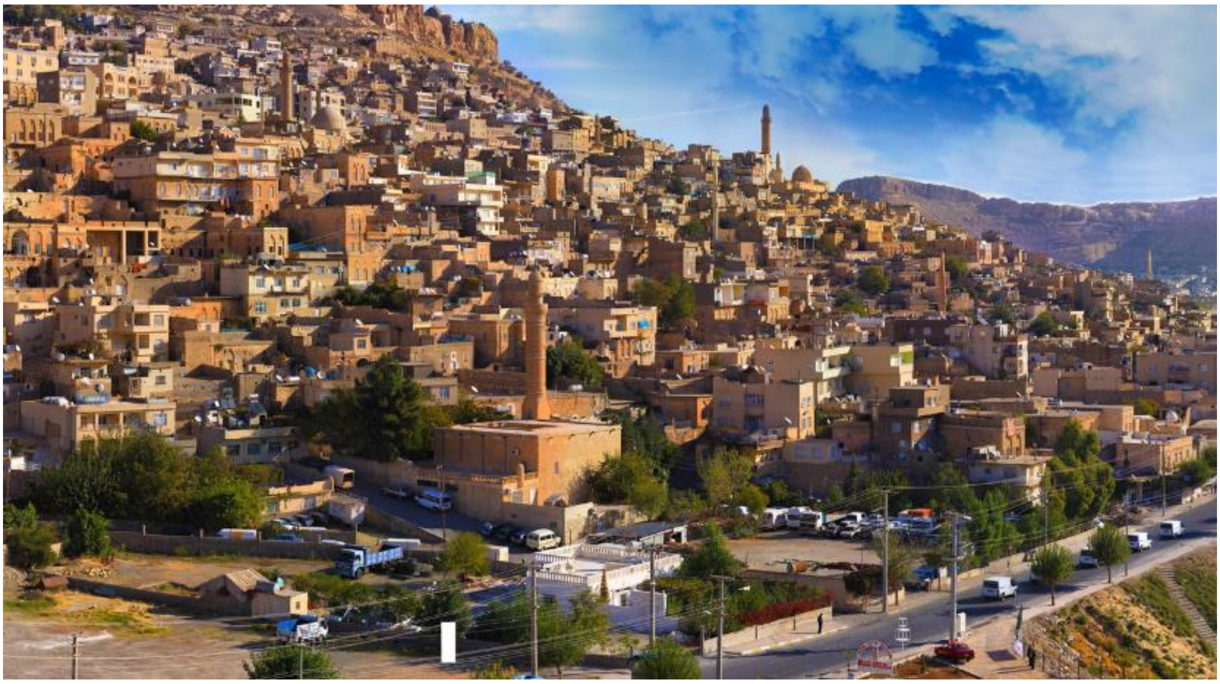
Year	Century	Authority	Settlement Development in Mardin
543 BC-333 BC	6th BC - 4th BC	Persian Empire	- Lack of literature - Some lines in the legends give the clues of first settlement in the area
333 BC-323 BC	4th BC	Macedonian Empire	
323 BC-65 BC	4th BC - 1st BC	Seleucid Empire	
27 BC -330	1st BC - 4th	Roman Empire	- Limited information about the physical space organization - Construction of castle indicates the presence of a neighbourhood around it - Architectural landmarks such as monasteries and churches
330-636	4th - 7th	Byzantine Empire	
636-890	7th - 9th	Arabs	- Development of a settlement on top of the hill - A big bazaar for trade - Limited information about the physical space organization
890-990	9th -10th	Hamdanid Dynasty	
990-1085	10th-11th	Merwanids	
1085-1102	11th-12th	Turkmens	
1102-1409	12th - 15th	Aqqoyunlu Empire	- Emergence of the traditional urban pattern which stands as a heritage town today
1409-1923	15th - 20th	Ottoman Empire	
1923-	20th - 21st	Republic of Turkey	- 1st Masterplan for the contemporary town (1965) - 2nd Masterplan 2007 - Plan amendments

Source: Author`s original

5.4 Formation of the Urban Built Environment in the Old and New Towns

As noted in Chapter 4, the two settlements represent quite distinct urban development patterns which embody different urban components including housing typologies, street spaces and the macroform of the city. The Old Town, presented in Figure 5.6, represents a horizontal and compact development located on the slope of a hill. With a terracing system harmonized with the natural pattern of topography, building units are mostly constructed as 1-3 storey large stone units facing to the south.

Figure 5.6 Urban pattern in the Heritage Town



Source: www.detaypan.com/mardin/bati (2015)

The settlement is developed with a pedestrian oriented inner-city which minimizes the number of vehicular roads required for urban services. Narrow streets defined by the walls of court-yarded housing units provide comfortable and shadowy paths for pedestrians. The main arterial road which passes through the middle of the town provides service facilities for the main commercial centre which is clustered beside the main road. Public services such as education, health and security units are provided within a walkable distance of each neighbourhood.

Disparately, the New Town has been developing in a predominantly vertical direction comprising high-rise apartment blocks. As seen from Figure 5.7, the New Town has been developing on the flat/ plain part of the topography due to the lack of vacant land in the slopes of the hills. Although the topographical difference stands as one of the major factors affecting the variations in the urban development in both towns, it should also be appreciated that the urban spaces in two towns are not created as a product of the same planning approach. The New Town began to be shaped in 1965 to accommodate increasing urban population triggered by the migration from rural areas. Thus the political, economic and demographic conditions were vastly different from the ancient times in which the historical urban pattern was created.

Figure 5.7 Urban pattern in the Contemporary Town

Source: Author's original

Based on the different development patterns, this section focuses on the detail of how the built environment was formed in these different eras. This is important because a review of literature presents that the urban built environment has a considerable level of influence on urban microclimatic conditions (Erell et. al, 2010; Gut and Ackerknecht, 1993; Oke, 1987). Variations in the urban microclimate influence the experienced thermal comfort and the energy consumed for the provision of thermal comfort in urban daily life. In other words, urban thermal comfort and the energy consumption for the provision of thermal comfort are correlated with space production.

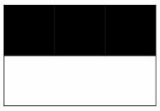
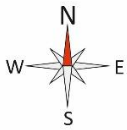
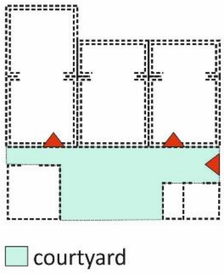
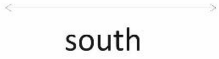
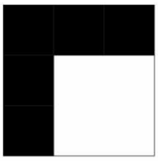
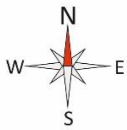
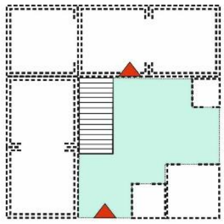
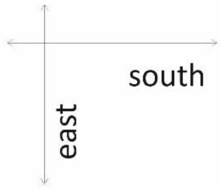
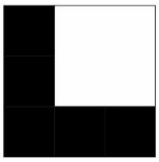
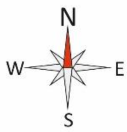
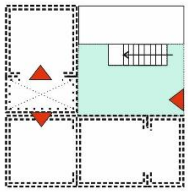
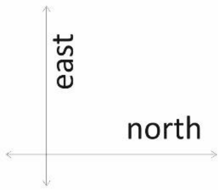
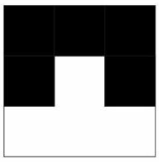
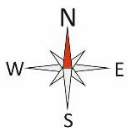
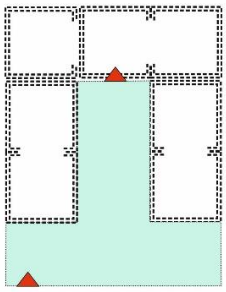
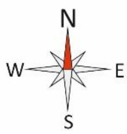
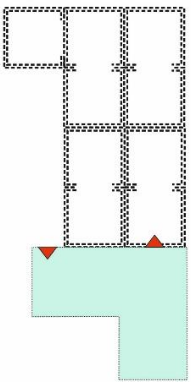
It is argued that (see for instance: Shashua-Bar et al., 2012 and Krüger et al., 2011) climate responsive urban planning can provide optimal, comfortable, thermal conditions for outdoor spaces while affecting the requirement of energy use in indoor spaces. As Yao and Luo (2012) state, urban form determines the availability of solar radiation, daylighting and natural ventilation of a building and thus it has a significant influence on energy consumption in buildings. Similarly, previous studies have examined the influence of street canyon geometry, solar access and shading on thermal comfort by using certain thermal comfort indexes (Andreou, 2013; Krüger et al., 2011 and Hwang et al., 2011). Existing research shows that, in order to understand the relationship between the formation of built environment and urban thermal comfort, it is necessary to understand the grammar of urban space production starting from the architectural through to the street and the city scales.

5.4.1 Variations in the Housing Provision

Building units can be abstracted as the smallest scale sub-component of the urban living environment where individuals` urban live experiences take place. Thus the provision of comfort at the building scale requires certain levels of energy consumption to sustain the everyday life requirements of people. Literature presents that “orientation”, “building form” and “materials and thermal mass” are three major variables that affects the level of energy consumed for provision of thermal comfort in building (Sarte, 2010; Golany, 1996; Gut and Ackerknecht, 1993). In the Mardin context, while the Old Town presents a clear strategy in terms of orientation with housing units facing to the south, it is not possible to observe a clear strategy for orienting the apartments in the New Town. That difference affects the way(s) in which housing units either draw or avoid heat from the sun and subsequently the amount of energy consumed for the provision of indoor thermal comfort. Figure 5.8 presents an analysis of the housing orientations and arrangements of the sub-units/rooms within the floor plans. It is observed that 93% of the houses are oriented towards the South, in such a way as to have at least one room facing the North and at least one room or a courtyard facing the South. This strategy provides benefits from the natural heating power of the solar radiation in the winter and helps protect against over-heating when needed in hot seasons.

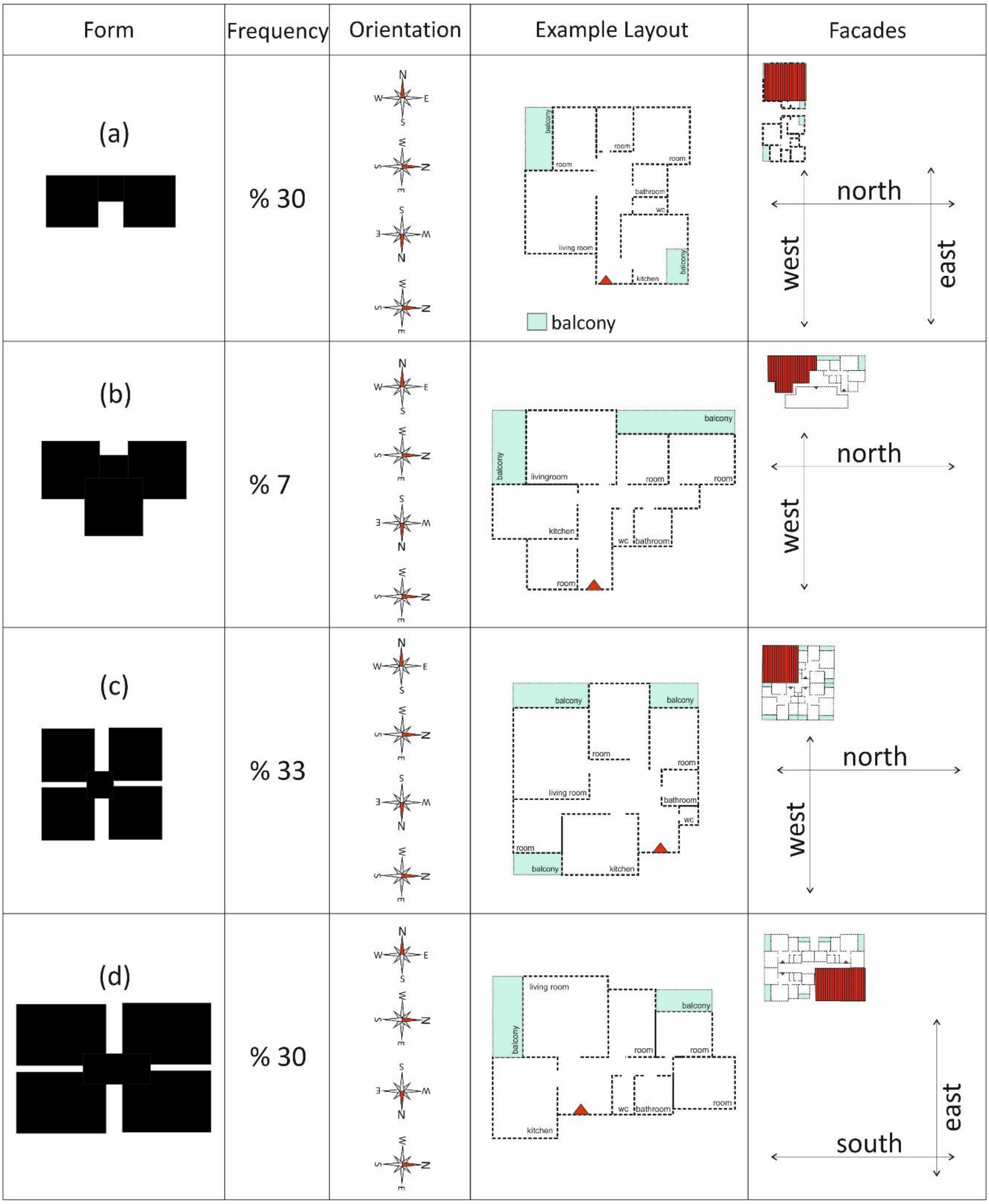
On the other hand, the orientation of the houses in the New Town presents variations which cannot easily be categorized under a clear strategy. This is mainly caused by the use of prototype floor plans which embody 2-4 flat units in one storey. Even though the entire apartment block orients in a specific direction, it still embodies 1 or 2 flats which face in a different direction. Sample layouts presented in Figure 5.9 exemplify the variations in the orientation of houses. The common layout observed in Mardin is a single apartment block which accommodates four flats in one floor and a service area (i.e. staircase and lift) located in the middle of the four units. This provides unequal levels of utilization from natural energy sources such as solar radiation and the wind.

Figure 5.8 Vernacular housing typologies

Form	Frequency	Orientation	Example Layout	Facades
(a) 	% 20			
(b) 	% 30			
(c) 	% 7			
(d) 	% 13			
(e) 	% 30			

Source: Author's original

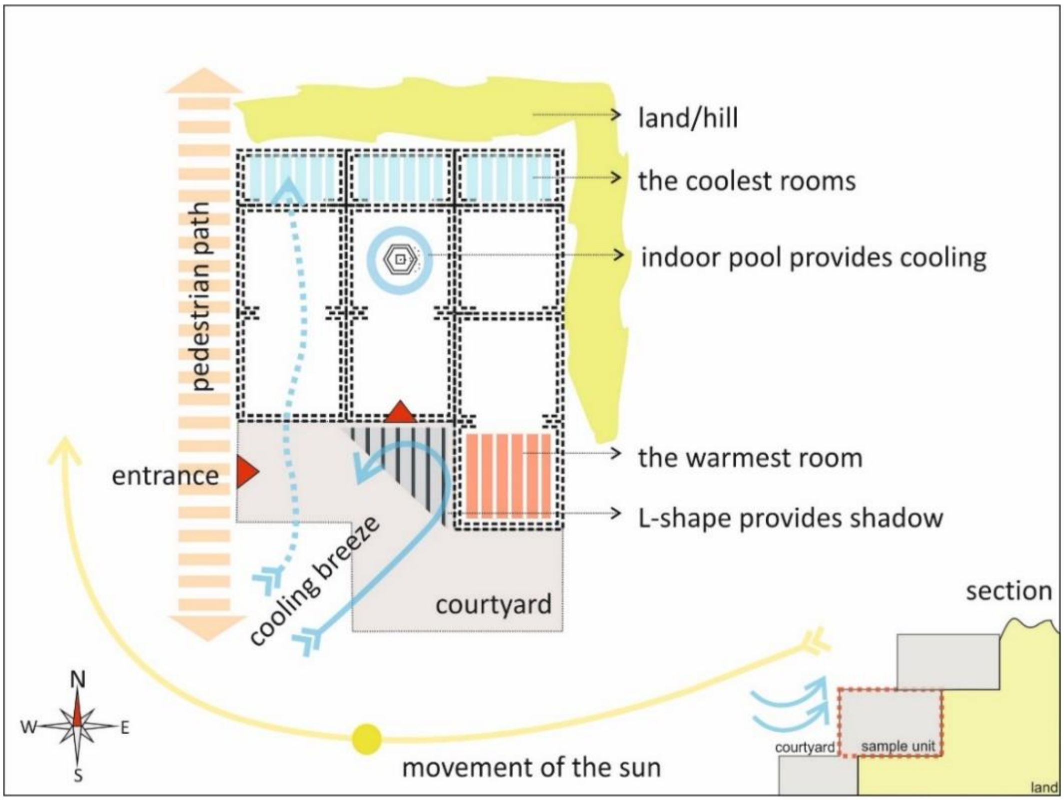
Figure 5.9 Contemporary Housing Typologies



Source: Author's original

In line with the attribute of orientation, in order to achieve a reasonable level of thermal performance with use of less energy, building form should maximize timely solar collection and minimize heat loss or gain as appropriate. Literature presents that the courtyard form has the potential to save energy with its cooling and heat storage capacity (Taleghani et al., 2014). The courtyard form has been used from distant antiquity to the present and creates an enclosure for interior thermal performance as well as providing security and privacy (Cofaigh et al., 1998). The walls of a courtyard are the major shading elements for hot seasons. Besides that, additional elements such as vegetation, fountain and canvas awnings keep courtyards cooler compared to the outdoor temperature. As seen in Figure 5.8 , no matter what the building form is, most of the houses in the Old Town present courtyard forms which allow the above-mentioned advantages for users. The most common form is the L-shape (b + c, %37) which creates an open space in between the two sides of the building block. Another common type is the I-shape (e) which is mostly aligned towards N-S directions. In this form, northern units are mostly used as bedrooms and storage rooms which require a certain level of coolness and southern units are attached to a courtyard which provides the open space requirement. In all forms, interconnectedness of the rooms stand as a common design criterion. Interconnectedness here refers to free and easy airflow among different units of the house. The less connected rooms, the less air flow from one room to another. Therefore, the rooms which have limited connection with other part of the house holds more stable air which leads to faster warming. In comparison, rooms that have multi-connections with other volumes in the house facilitate expansion of air accumulated in the room. As exemplified in Figure 5.10, a cooling breeze coming from the window of a room can easily flow from one room to other of the since the rooms are designed to be interconnected.

Figure 5.10 An example of vernacular housing unit

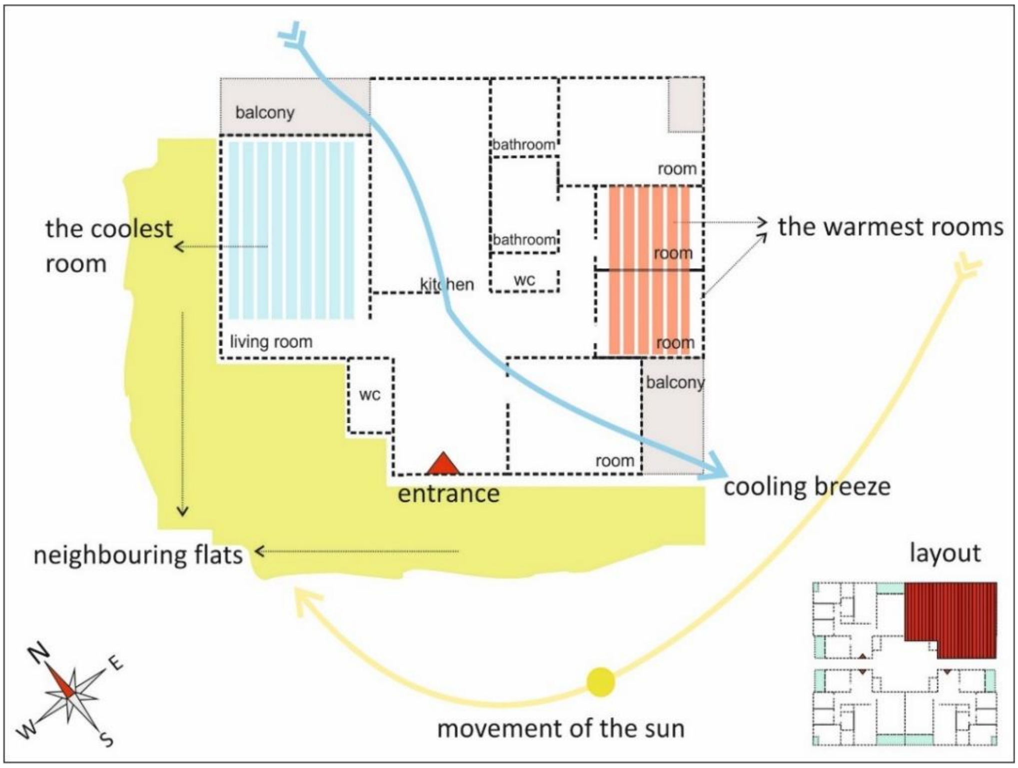


Source: Author’s original

With the help of a cooling breeze mostly caused by the topography (see the cross-section in Figure 5.10), the courtyard is commonly used as a living space in the evenings. Although the form of courtyards varies in different housing units, the L-shape in this sample provides a shady zone especially in the afternoons (see Appendix F for the analysis of entire sample units used in the research). The movement of the sun has a great influence on experienced thermal comfort both in courtyard and the indoor areas. In line with the movement of the sun from East to West, the courtyard is exposed to solar radiation in the morning. So, until the courtyard becomes shady, the northern rooms provide comfortable places to prevent the overheating effect of the sun. In the afternoon, the sun moves behind the hill and the height of the buildings provide shadow on the courtyard. Thus, the courtyard serves as an open air living space towards the afternoon, especially after the indoor temperature increases with the release of absorbed heat by the stone walls.

The open space requirement is replaced with balconies in the contemporary apartment flats. The placement, orientation and number of the balconies are defined by the form of the apartment block. As presented in the Figure 5.9, the most common typology (%63) is the quadrangle form (c and d) which accommodates four flat units within the same floor. In this form, the placement and orientation of the balconies is limited with two facades which totally varies from flat to flat within the same floor. Figure 5.11 exemplifies one of the common layout plans in the New Town.

Figure 5.11 An example of contemporary apartment flat



Source: Author's original

As seen from the Figure 5.11, the sample flat has facades towards the North-East and the South-East. The rooms in the South-Eastern part of house get direct solar radiation from the early morning until the afternoon, and thus the indoor thermal comfort in those rooms become intolerable. In contrast, the living room in the west of the house is seen as the coolest space with its balcony facing the north and the facade totally blocked with the neighbouring flat. Accordingly, solar radiation and indoor thermal comfort varies within the four flats shown in the layout scheme in the left bottom corner of the Figure 5.11.

The level of ventilation and the flow of the air in the house also depend on the layout plan and the locations of the open spaces (i.e. balconies) in the flats. In the example (Figure 5.11), there are two balconies facing opposite directions which provide a certain level of air flow from North to South. The flow is supported by the location of the entrance-hall with a rectangular shape allowing the transmission of air for the other rooms. But the level of interconnectedness between the rooms and the shape of the units within the flats varies (see Appendix F for the analysis of entire sample units).

Housing provisions in the Old and New Towns present variations in terms of utilization of the benefits and prevention of the negative effects of natural energy sources. This is mainly caused by the typology and the form of the houses. When the sub-units forming the layout plans are examined, there is a different level of open and closed space balance between the vernacular and the contemporary housing units. Table 5.4 presents the 5 sub-components namely; (1) open units, (2) semi-open units, (3) closed units, (4) service units and (5) other units.

Table 5.4 Classifications of sub-components of vernacular and the contemporary units

Sub-Components	Vernacular House	Contemporary Flat
Open Units	Courtyard Terrace, “Dam”	Balcony
Semi-Open Units	Iwan Portico	-
Closed Units	Living Unit Aralik	Rooms
Service Units	Kitchen Bathroom/WC	Kitchen Bathroom/WC
Other Units	Cellar	Entrance hall Cellar

Source: Author’s original

Plan layouts present that almost 40% of the vernacular houses are composed of open and semi-open units such as courtyard, terrace, iwan and portico. Contrastingly, the open space ratio in the contemporary units is 10%. The main sub-components that create the characteristic differences in the vernacular design can be listed as follows.

Figure 5.12 An example of a courtyard

Source: Author's original

Courtyard: The courtyard is one of the most essential components of a traditional housing unit. In most cases, it constitutes the heart of the whole house plan. It functions as a linking element which provides the connection/ passages between different spatial components on the house. Courtyards can also be labelled as an open-air room which is usually used for different purposes such as living, sleeping and dining.

Figure 5.13 An example of a terrace

Source: Author's original

Terrace: A terrace is a flat platform which is created by drawing back the floor space boundary of the ground floor contrariwise the slope of the topography. Terraces substitute courtyard for the 1st and/or 2nd floors of the house. Similar to courtyards, terraces are an open space extension, and one of the most essential component of a traditional housing unit for hot and arid climates.

Figure 5.14 An example of a "dam"

Source: Author's original

Dam (Housetop): Technically, a "dam" is the top surface of the housing unit which provides an entirely open-top space for users. Since it is relatively less accessible compared to courtyards and terraces, it is usually used for activities such as dry food production which require long intervals of sun exposure.

Figure 5.15 An example of an iwan

Source: Author's original

Iwan: An iwan is a vaulted semi-open space walled on three sides with one end entirely open. It stands as a transition space between entirely closed rooms. Compared to courtyards or terraces, iwans provide more shade while allowing natural cooling from the entirely open side at the same time. In large houses, the iwan is designed with a water element which provides extra cooling for the house.

Figure 5.16 An example of portico

Source: Author's original

Portico: A portico is a walkway with a roof structure over, supported by columns or enclosed by walls. Porticos are found on the ground floor and provide shadowy and cool transition areas to spaces such as cellars, barns or storerooms on the ground floor.

The listed open and semi-open spaces in the houses influence the experienced thermal comfort at the housing scale. Each physical component stands as a niche (as in MLP theory) that facilitates the adaptation to local climatic conditions naturally.

Alongside the orientation and the form of a building, materials and the thermal mass of the houses in the Old and New Towns also vary. This variation also has a potential role in the experienced thermal comfort. While the dominant construction material in the Old Town is stone, apartment flats in the New Town present a concrete structure made of bricks (see Figure 5.17). The use of materials in construction influence how a building takes advantage of natural assets and the amount of energy it consumes for maintaining thermal comfort. The term 'thermal mass' refers to the ability of materials to store thermal energy and delay heat transfer through a building component (Energy Design Resources, 2010). Materials such as stone have the capacity to absorb energy from outside of the wall and store it to maintain internal cool or warmth. As seen in Figure 5.17, while the thickness of the stones used in the vernacular units goes up to 100cm, the brick units in the apartment blocks are almost one fifth of the thickness of the stone walls. Thus, it is likely variations in the thermal mass and the capacity of energy storage will be observed.

Figure 5.17 Sample housing units and construction materials representing the vernacular (a, b) and contemporary (c, d) houses

(a) A sample of vernacular housing unit with courtyard | (b) Stone wall (thickness: 100 cm) | (c) A sample of contemporary apartment | (d) Brick wall (thickness: 19 cm

Source: Author's original

In summary, housing typologies in the Old and New Towns present variations in terms of the three prominent climate responsive design parameters called (1) orientation, (2) form and (3) materials. These variations are used to assess the extent which the physical components affect experienced indoor thermal comfort in Chapters 6 and 7.

5.4.2 Variations in the Streetscapes

Streets provide the backbones for strings of building units and foster circulation across the entire urban built environment. Two urban patterns in Mardin are formulated with different street networks displaying their own characteristics. While the Old Town accommodates predominantly pedestrianized streets, the New Town presents more car-oriented mobilization in the city. While the streets in the New Town can be classified under four groups in order of (1) main arterials, (2) distributors, (3) peripherals and (4) `pseudo`-streets (see Table 5.5), the streets of the Old Town can be grouped under five categories in order of (1) main arterials, (2) (vertical connectors), (3) horizontal distributors), (4) arcaded passages and (5) `abbara` (see Table 5.6).

It is not possible to define a clear hierarchy of streets either in the Old or New Town due to their unique development types. It is observed that the first site developed in the 1960s in the New Town presents a relatively clearer street hierarchy than the development sites that followed later in the peripheries and the fragmented parts of the city. As seen in Table 5.5, the most visible division between vehicles and pedestrians is seen in the main arterials. Beside that the distributor and the peripheral streets do not embody sidewalks for pedestrians. The lack of sidewalks stands as a physical barrier for walkability in the city. It also influences the perceived thermal comfort since it leaves citizens no choice but to walk in the vehicle routes which are usually exposed to high solar radiation (see Type 3 in Table 5.5). The development in the New Town also creates another type of linear path referred to as `pseudo`-streets in this research. `Pseudo streets` refers to vacant land which creates a narrow canyon between the rows of apartment blocks (see Type 4 in Table 5.5). Although they are not used for circulation, there is a potential to convert these areas for pedestrian usage with appropriate landscape design.

As seen from the Table 5.6, the Old Town embodies only one single vehicular street which serves as the main arterial route. The rest of the typologies are pedestrian streets which are designed according to the natural pattern of the topography. Vertical connectors are mostly designed with staircases since they connect the horizontal streets aligning parallel to the slope of the hill (see Type 2 in Table 5.6). Horizontal distributors are mainly defined by the walls of the private housing units which provides a shaded and relatively more comfortable walking experience (see Type 3 in Table 5.6).

In addition, the two unique street typologies seen in the Old Town are arcaded streets and `abbaras`. Arcaded streets provide shelter for pedestrians especially in the warm and wet climates. In the Mardin context, it is mostly used for the prevention of the negative effects of solar radiation. Similarly, `abbara` is a special passage which provides sun-protected and totally shaded transition paths from the low level distributors to the upper lower distributors on the hillside. This `tunnel` style transition allows for comfortable public mobility even under the conditions of private ownership.

Table 5.5 Street typologies in the New Town

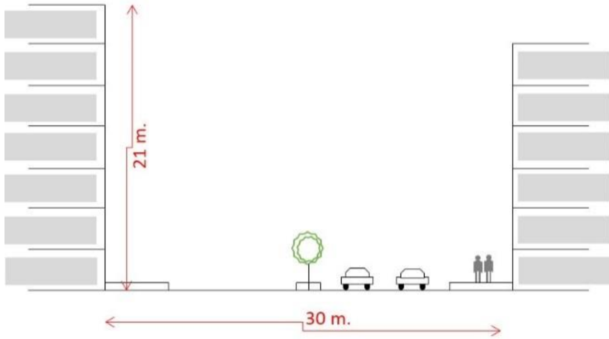
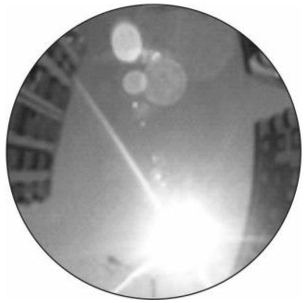
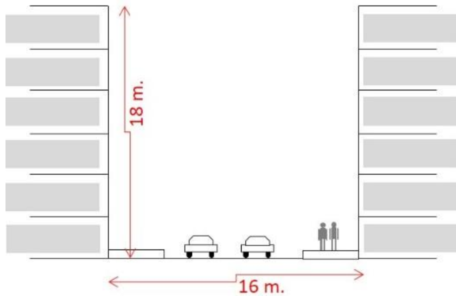
	Sample Street	Street Section View	Fish Eye Photo	Sky View Factor	Width	Height	H/W	Material	Transportation
Type 1 **Main Arterials**				0.55 ψs	30 m.	21 m.	0.87	Cobblestone	Vehicle + Pedestrian
Type 2 **Distributors**				0.30 ψs	16 m.	18 m.	1.12	Cobblestone	Vehicle + Pedestrian

Table 5.5 Continues

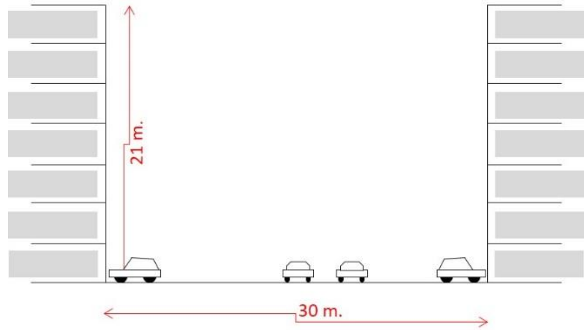
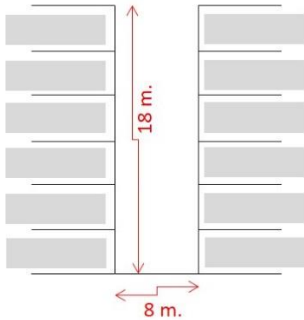
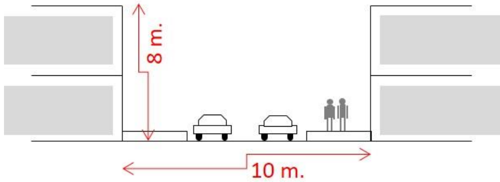
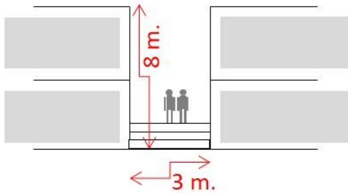
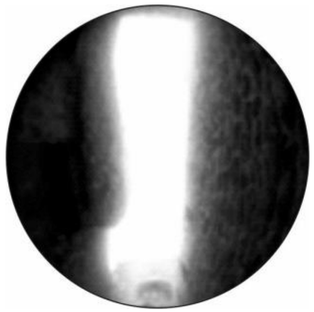
	Sample Street	Street Section View	Fish Eye Photo	Sky View Factor	Width	Height	H/W	Material	Transportation
Type 3 Peripheral Streets				0.51 ψs	30 m.	21 m.	0.70	Cobblestone	Vehicle + Pedestrian
Type 4 \`Pseudo\` Streets				0.21 ψs	8 m.	18 m.	2.25	Soil	Not Applicable

Table 5.6 Street typologies in the Old Town

	Sample Street	Street Section View	Fish Eye Photo	Sky View Factor	Width	Height	H/W	Material	Transportation
Type 1 **Main Arterials**				0.40 ψs	10 m.	8 m.	0.80	Cobblestone	Vehicle + Pedestrian
Type 2 **Vertical Connectors**				0.22 ψs	3 m.	8 m.	2.66	Cobblestone	Pedestrian

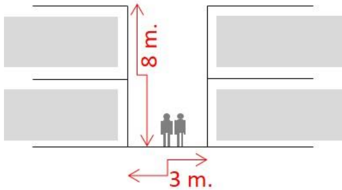
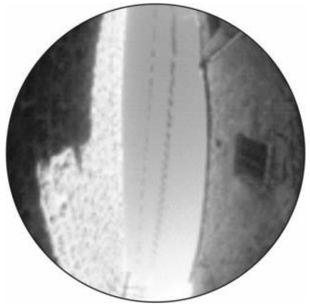
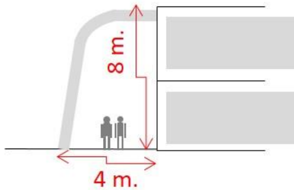
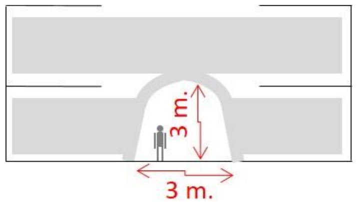
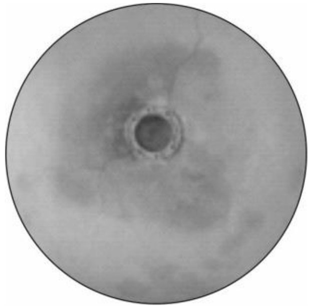
	Sample Street	Street Section View	Fish Eye Photo	Sky View Factor	Width	Height	H/W	Material	Transportation
Type 3 **Horizontal Distributers**				0.23 ψs	3 m.	8 m.	2.66	Cobblestone	Pedestrian
Type 4 **Arcaded passages**				0.26 ψs	4 m.	8 m.	2.00	Cobblestone	Pedestrian

Table 5.6 Continues

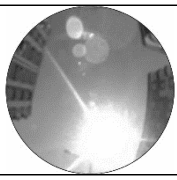
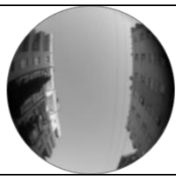
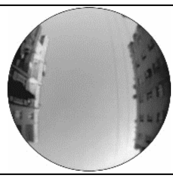
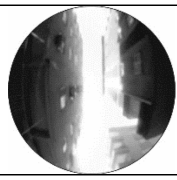
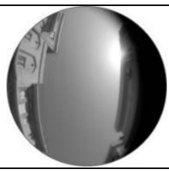
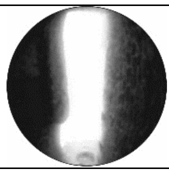
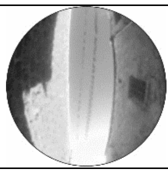
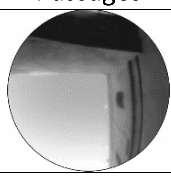
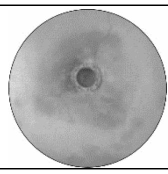
	Sample Street	Street Section View	Fish Eye Photo	Sky View Factor	Width	Height	H/W	Material	Transportation
Type 5 Abbara				0.00 ψs	3 m.	3 m.	1.00	Cobblestone	Pedestrian

Reflecting the focus of this research, literature presents that “street alignment”, “street geometry” and “shading” are three major variables that affect the thermal comfort in street level experiences. Street alignment, which considers the sun and dominant wind direction, has significant potential to influence the air temperature and the ground surface temperature (Bourbia and Boucheriba, 2010). Gut and Ackerknecht (1993) underline the significant role of street alignment in creating different outcomes such as increasing the exposure to radiation or creating shading among buildings, and increasing or decreasing the effect of wind ventilation. Although an apparent development principle in terms of street alignment is not observed in the New Town, the majority of arterial streets are aligned towards the direction of NW-SE. On the other hand, it is possible to observe an obvious street design principle which suggests development in the direction of E-W in the Old Town.

Urban streets vary in geometry which is usually defined in the literature by height/width ratio or sky view factor (Bourbia and Boucheriba, 2010). The common point of these different definitions is that streets have a significant role in the formation of urban micro-climates. Therefore, while designing new urban developments, streets can be designed in order to minimize the undesirable effects of dominant climatic characteristics such as extreme hot, strong winds or frequent rains. Existing climate characteristics can also be turned into advantage through design which includes street layout, street canyon, surface cover and shading.

The sky-view factor (SVF), described as the proportion of visible local sky not obstructed by buildings (Oke, 1981), has the potential to create urban microclimatic alterations. In the Mardin case, although streets in the New Town present various SVF values, most of the pedestrian streets in the Old Town have relatively small SVF which provides more shading for pedestrians.

Table 5.7 Average sky view factors in different street typologies

New Town		Main Arterials	Distributors	Peripherals	Pseudo Streets	
	Fish Eye Photo					
	SVF	0.55 ψs	0.45 ψs	0.51 ψs	0.21 ψs	
Old Town		Main Arterials	Vertical Connectors	Horizontal Distributers	Arcaded Passages	\`Abbara\`
	Fish Eye Photo					
	SVF	0.40 ψs	0.22 ψs	0.23 ψs	0.29 ψs	0.55 ψs

Source: Author’s original

As seen from the Table 5.7, SVF of the pedestrian streets in the Old Town varies from 0.22 ψs to 023 ψs. This variation reduces the hours of solar radiation and provides longer shaded duration in the streets. On average, the SVF values in the Old Town are relatively smaller than the values in the New Town. This is related to the transportation mode and the variations in the width and heights of the street canyons. For instance, the main arterial street which is designed for transportation in the Old Town presents the closest SVF value to the streets of the New Town. This underpins the rationale of selecting these two streets for the comparative analysis presented in the following chapter.

Due to the lack of trees in the two town settings, fish eye photographs were not influenced by the coverage of trees. On the one hand, this helps to understand the actual impact of the built environment on the sky visibility, but on the other hand, it presents a position in which physical spaces (i.e. building forms) are the single determinant of shading in the streets. Considering that shading is the most prominent attribute of comfort in the streets (Emmanuel et al., 2007), the lack of shading creates a significant difference in experienced urban thermal comfort in the two towns.

Considering the form of the streets, the height-width (H/W) ratio has a significant impact upon the ventilation and the heat trapped in a street. Buildings defining a street turn into an `urban canyon` with its own microclimate. Urban canyons are characterised by three main parameters namely; H: the mean height of the buildings in the canyon, W: the canyon width and L: the canyon length (Littlefair et al., 2000). It is very difficult to offer specific guidance on planning canyons in the urban environment. However, Littlefair et al. (2000) claim that a small H/W ratio provides good ventilation but weak shading, and the increase in H/W ratio makes air flows more turbulent. They suggest the optimal ratio as H/W=1 which provides enough ventilation with a vortex of air in the street. As presented in the Table 5.8, the H/W ration in the Old Town varies from 0.80 to 2.66 and most of the typologies (except the one single arterial) present an H/W value larger than 1.

Table 5.8 Average height-width ratios in different street typologies

	Street Typology	Height	Width	Height/Width
New Town	Main Arterials	30m.	21m.	0.87
	Distributors	18m.	16m.	1.12
	Peripherals	21m.	30m.	0.70
	Pseudo	18m.	8m.	2.25
Old Town	Main Arterials	8m.	10m.	0.80
	Vertical Connectors	8m.	3m.	2.66
	Horizontal Distributers	8m.	3m.	2.66
	Arcaded Passages	8m.	4m.	2.00
	Abbara	3m.	3m.	1.00

Source: Author’s original

Since most of the typologies present an H/W value larger than 1, one would expect to observe strong shadow and stronger ventilation in those streets. In the Mardin case, strong ventilation cannot be labelled as turbulent due to the low average wind speeds in summer. On the other hand, the H/W ratio of the streets in the New Town varies from 0.70 to 1.12. This variation conceives the difference of shading and ventilation in contemporary streets. It should be noted that the shading and ventilation mentioned here is only related to the building structure defining the street, it does not include other features such as trees which also influence the speed of wind and the level of shading in the streets.

Shading stands as one of the most significant strategies decreasing solar absorption and providing cooling in the street. Due to transpiration, grassed surfaces alongside the streets present cooler characteristics than hard surfaces in cooling seasons (Cofaigh et al., 1998). Considering the areas that urban streets cover, streets might have a significant influence on the solar radiation in the urban environment. Golany (1996) mentions that asphalt cover on the streets increases the solar radiation while stone paving or cement decreases it. Traditional settlements present that stone paving was one of the most frequently used street covers in order to provide comfort, especially in city centres where pedestrians are typically concentrated.

The variables reviewed in this section are used to examine the technical/physical urban development of the selected case study area. The research aims to explore to what degree these components influence the way people provide their urban thermal comfort in everyday life experiences.

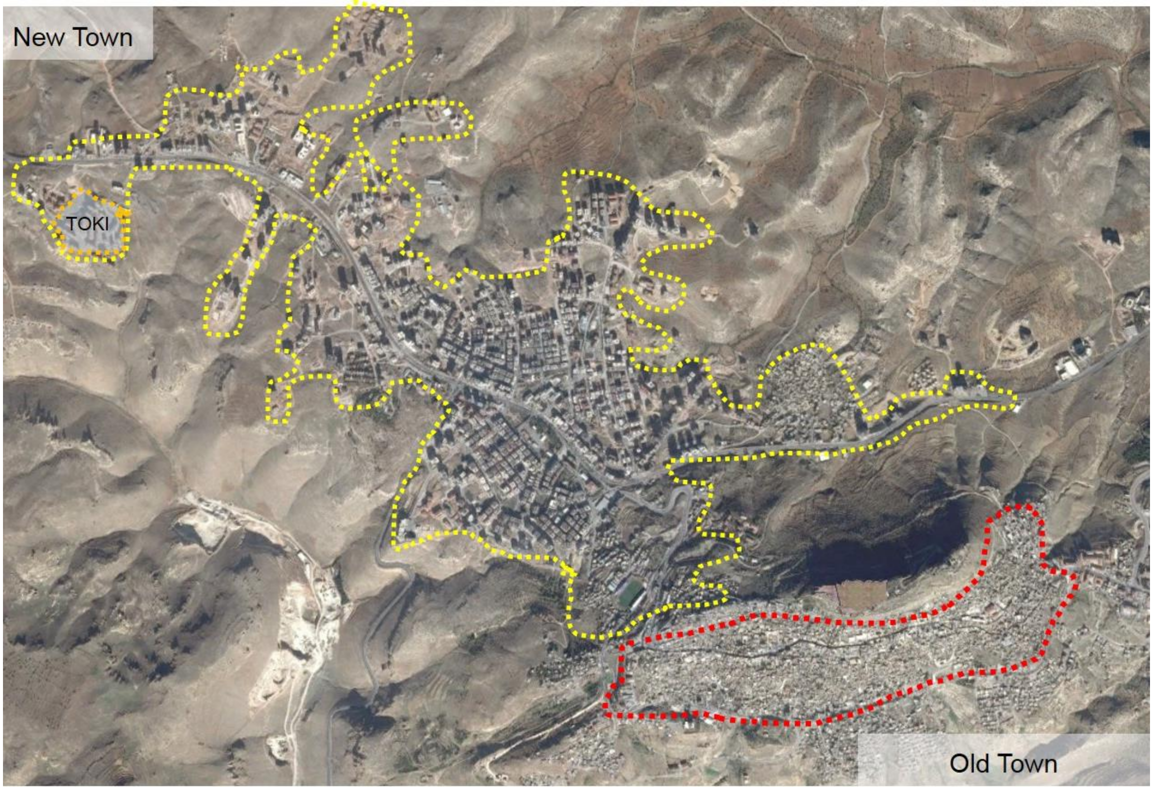
5.4.3 Variations in the Macroform

When it comes to city scale, in line with the political and socio-economical conjecture of the period of development, a clear differentiation in urban development approaches is visible in the Old and New Town. The origin of the Old Town goes back to a period in which different empires established settlements from scratch in order to meet the basic requirements of a settled life with relatively limited[15] technological and engineering skills. Therefore, the production of urban space had to adjust itself to the conditions, skills and resources at those time periods. The sub-components (i.e. vernacular houses and streetscapes) of the urban grammar in the Old Town present that urban space is produced organically but with guidance from a `high level design notion` which generated an un-institutionalized `control` over the macro form of the built space. This is readable from the compact macroform of the vernacular town. As seen in Figure 5.18, the hillside location was one of the definers of the urban form. The form was guided in terms of adapting to local climatic conditions and

[15] `Limited` refers to the absence of technological and engineering innovations that we utilize today to create adoptive design solutions.

this guidance shed light on the details of the different scales of space production presented in the initial sections of this chapter. On the other hand the form was limited with the south facing side of the hill.

Figure 5.18 Aerial photo of the Old and the New Town in Mardin



Source: Google Earth, 2015

Since the 1960s, the New Town has been developed as a part of a relatively more institutionalized planning system that follows conventional planning regimes appreciating the physical plans based on zoning of urban land. Although the zoning approach facilitates decision-making about urban land and accelerates the speed of space production to a certain degree, the quality of the built environment and the responsivity to environmental concerns such as natural resources, energy consumption and climatic impacts are still questionable. For instance, a review of literature presents that spatial planning and land uses are highly correlated with urban heat islands that present significantly warmer temperatures than the actual atmospheric temperature (Souch and Grimmond, 2006; Hidalgo et al, 2008). Moreover, as Seto and Shepherd (2009) claim, the impact of spatial planning on the climate extends beyond affecting urban heat islands since most human activities are related with urban land use (i.e. transportation, energy use). Reflecting back to the climate responsivity focus of this research, the following section discusses the way in which the spatial formation of the Old and New Town directs and/or responds to everyday life requirements with respect to local climatic conditions.

5.4.3.1 Compactness vs. Sprawl

As well as variations in the housing and the street scales, the two development approaches also produce different urban macroforms. As seen from the aerial photo in Figure 5.18, while the Old Town presents a compact macroform with intertwined units of housing and the surrounding urban spaces, the contemporary development in Mardin presents a serious level of urban sprawl which makes it hard to define and/or control the boundaries of the city. If the stadium is taken as a point of reference between the condition in 2004 and 2013, sprawl is observed towards the northern and the North-Western part of the city.

Although the sprawl cannot be explained by one single factor, the site selection strategy of the National Housing Development Administration[16] (TOKI) exemplifies one of the 'piecemeal' development actions that has contributed to this process of sprawl. The housing clusters on the outermost west of the city represent the apartment blocks provided by the TOKI. Although the western corridor is identified as the preferred direction for development plans, TOKI has the power to select the site and to plan the construction process with the housing program, populations, layouts and finance mechanisms. In other words, the integration of TOKI houses with the local development plans is under the initiation of TOKI. And this initiation stands as a threat in terms of the creation of 'piecemeal' physical space which calls for additionally an 'unintegrated' infrastructure. As seen from the Figure 5.19, a TOKI housing development site is planned and constructed only within the boundaries of the building block, but the area surrounding the building block is not planned. Thus it can be lacking in spatial integration.

Figure 5.19 Views of TOKI housing development site

Source: Author's original

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[16] *"TOKİ is a non-profit government administration. It has a non-profit business model which avoids many of the common pitfalls of institutionalized bureaucracy. TOKİ reports directly to the Prime Minister's Office rather than being part of the general administrative bureaucracy."* (TOKI, https://toki.gov.tr, 2015)

The radical change in the macroform seen between 2004 and 2013 (Figure 5.20) gives clues of a lack of comprehensive design vision for creating urban spaces responding to local climatic conditions. The urban sprawl shows that the development happened in a 'piecemeal' way over the last 10 years. 'Piecemeal' development leads to the creation of an unbalanced solid-void distribution with lack of designed open spaces and green areas in the city.

On the other hand, the compact form in the Old Town is formulated by repeating similar housing clusters and the surrounding areas in a rhythmical order. As seen from Figure 5.21, due to the lack of vacant land on the hillside and the declaration of the entire Old Town as an urban archaeological site in in 1979, the urban pattern was conserved without a radical change in the last decades. However, the Old Town is under threat from illegal housing construction which could damage the historical pattern. In order to prevent the emergence of illegal housing stock and to preserve the traditional pattern in the Old Town, a separate body called Conservation Implementation Audit Centre (CIAC) was founded under the Municipality. CIAC does not work for new development, rather it works on the clearance of the illegal housing units in the heritage site.

Figure 5.20 Urban development in the New Town from 2004 to 2013

2004 2013

Source: Google Earth, 2015

Figure 5.21 Urban development in the Old Town from 2004 to 2013

2004

2013

Source: Google Earth, 2015

5.5 Current Urban Planning and Development System in Mardin / Turkey

The last section in this chapter explains the current urban planning system in Turkey which will facilitate understanding of the space production processes and factors leading to the creation of the existing urban landscape in Mardin. Assessment of the institutional system and plan hierarchies is fundamental in order to understand and to explain the variations in different layers of the urban built environment in the Old and New Town.

5.5.1 Planning Hierarchy in Turkey

There are currently two levels of development plans in Turkey which create significant conflicts and challenges for creating more climate responsive living spaces. The first level is that of 'Environmental Plans' which are prepared at the regional or provincial scales and serve as the upper-scale strategy and vision plans. The second level is that of 'Development Plans' which focus on the city level development strategies and planning actions. Table 5.9 presents the development plan types in Turkey, along with the scales and responsible bodies in charge of their preparation.

Table 5.9 Development plan hierarchy in Turkey

Plans	Authorities	Scales
(1) Environmental Plans	Ministry of Environment and Urbanization Provincial Special Administrations Greater Municipalities	1/100.000 1/50.000 1/25.000 1/5.000
(2) Development Plans	Municipalities	1/5.000[17] 1/1.000

Source: Author's original

As the upper level spatial plans, 'Environmental Plans' are prepared at the scales of 1/100.000, 1/50.000 and 1/25.000 depending on the size of the territory. The authorities responsible for preparing general spatial plans are the Ministry of Environment and Urbanization, Provincial Special Administrations and Greater Municipalities. While the Ministry of Environment and Urbanisation prepare the `Environment Plan` for the regions, the Provincial Special Administrations and the Greater Municipalities are in charge of preparing `Provincial Environmental Plans`. Plans at these scales, which Akkar et al. (2011) call 'structure plans', include the main strategic lines for spatial development. Environmental Plans determine different sectorial decisions such as for housing, industry, tourism, agriculture and transportation in line with the national development plans and strategies.

When it comes to the local level, 'Environmental Plans' are prepared at the scales of 1/5000 in accordance with the upper level plans (i.e. 1/50.000 Environmental Plan). These lower level plans can be called `strategic land-use plans` or `master plans` which provide guidance for the preparation of

[17] Any Greater Municipality has the authority to prepare 1/5000 scale development plans. However, in the medium and small sized cities which are not governed by a greater municipality, those plans are done by the local municipality.

the 1/1000 scale implementation plans. A Development Plan is distinguished from an Environmental Plans by its `language` and the `legend` (Akkar et al., 2011). Master plans give guidance on the way(s) cities will be developed by showing the details of urban form, development and population densities, and coordinates for the development of land parcels.

Figure 5.22 exemplifies the spatial distribution of the planning hierarchy based on the case study of Mardin. The Ministry of Environment and Urbanism prepares the `Environmental Plan` for the South-Eastern Anatolian Region composed of 9 provinces (including Mardin). In line with the guidance of this `Environmental Plan`, the Greater Municipality of Mardin[18] is in charge of preparing the `development plans` for the entire province of Mardin (shown in yellow). Within the boundaries of Mardin, the Municipality of Artuklu is responsible for preparing `development plans` for the district of Artuklu (shown in red), where the old and new urban development patterns exist.

Figure 5.22 Spatial schema of planning hierarchy in Turkey

Source: Base map: www.lafsozluk.com, Graphic: Author's original

From the mid-2000s, the planning hierarchy in Turkey represents a move towards the centralization of power with regard to development of cities. The current planning system creates conflicts in practice mainly due to the lack of harmony between the upper level planning decisions and the local level planning decisions. The conflicts and the challenges of translating climatic knowledge into

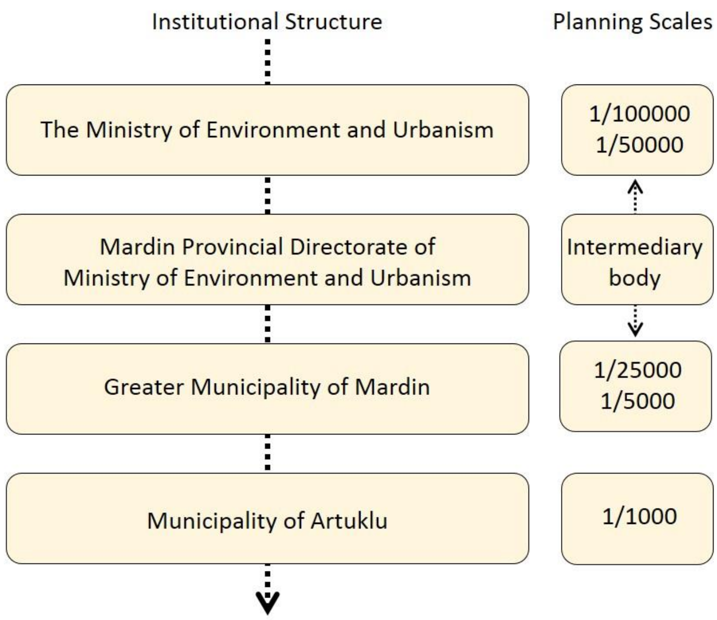
[18] The Law of Greater Municipality states that the Greater Municipalities are authorized for the preparation of 1/25.000 and 1/5.000 scaled plans within the provincial boundaries. However, since Mardin was awarded the status of Greater Municipality in 2012 and the local authority changed with the local elections held in 2014, currently there is no plan prepared at the scale of 1/25.000 . Thus, the only upper scale plan is the `Environmental Plan` which is prepared in the scale of 1/50.000 by the Ministry of Environment and Urbanization.

planning practice and the challenges of creating more climate responsive cities will be discussed in Chapter 7. Before this, the following section presents the institutional planning structure including the bodies, the roles, the missions and the sub-directorates partaking in decision-making processes regarding the urban development in Mardin.

5.5.2 Institutional Planning Structure in the Province of Mardin

The institutional structure is composed of two groups of bodies that can be categorized under the national level and the local level authorities. Although many other institutions are involved with consultancy or collaborating according to the content of the plans, Figure 5.23 shows the main structure of the planning system.

Figure 5.23 Institutional structure of urban planning in Mardin



Source: Author`s original

5.5.2.1 The Ministry of Environment and Urbanism

According to the Decree Law 644, Decree Law 648 and Law 6306, the major duties of the Ministry of Environment and Urbanism can be summarized as the following:

1. To prepare the regulations regarding the urbanisation, environment and building construction as well as monitoring and inspection of the implementation projects.

2. To define the strategies and programs for prevention of environmental pollution and climate change alongside promoting the education and research on environment sensitivity.

3. To prepare the Spatial Strategic Plans (Environmental Plans) in collaboration with the relevant institutions and to control the compatibility of the decisions made in the local plans.

4. To construct the `building inspection system` and to manage, monitor and inspect the compatibility of construction materials and the energy efficiency in the buildings.

The Ministry has many other duties which are not listed here as they have relatively less relevance for the creation of climate responsive urban settings. The list represents the themes which are directly related to the main focus of this research. The duties listed above present a highly centralized form of power which is likely to create practical challenges in development practice. The laws introduce the Provincial Directorate of Ministry of Environment and Urbanization for each city. This aims to construct a bridge between the Ministry and the local Municipalities, in a way to `decentralize` the central power regarding the urban development in local territories. At present, each of the 81 cities in Turkey has one provincial directorate.

The Ministry of Environment and Urbanism declares its mission as "*to fulfil the works and services regarding planning, construction, transformation and environment management in order to supply cities having high quality of life and sustainable environment with regulatory, supervisory, participatory and solution-oriented perceptions*" (The Programme of 61. Government, 2011).

In addition, the Ministry`s 2023 vision is stated as "transforming our cities, our fundamental living space, into "*brand cities*" to develop our country, to increase the welfare of our citizens and to prepare our country for global competition." While doing that the main target is stated as the provision of "*comfortable transportation system, fresh air and nature, high level aesthetics, effective and transparent administration, strong economy and peaceful and happy citizens*" (The Programme of 61. Government, 2011).

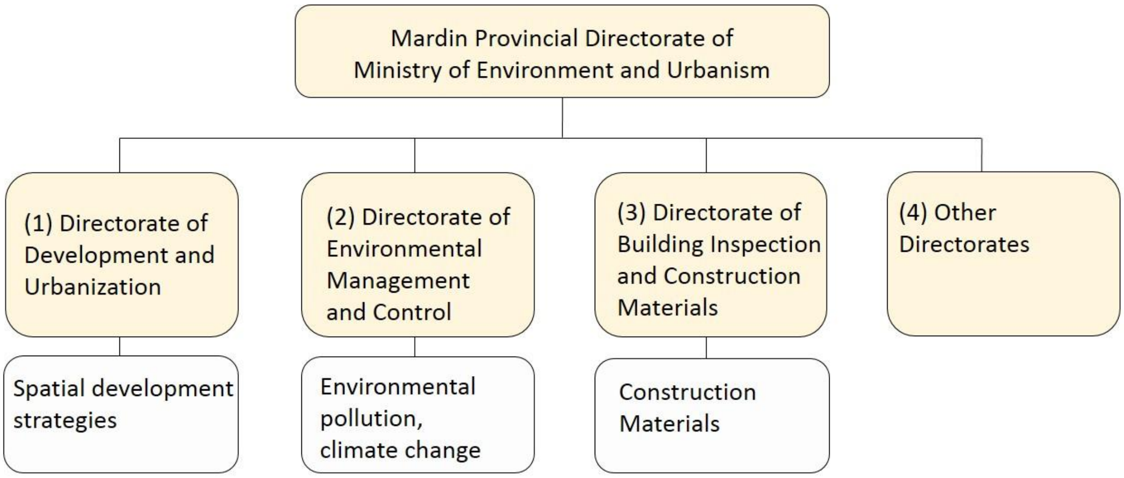
5.5.2.2 Mardin Provincial Directorate of Ministry of Environment and Urbanism

The Provincial Directorate of the Ministry of Environment and Urbanisation is the local representative body of the Ministry which facilitates the relationship between the local authorities (i.e. The Greater Municipality of Mardin) and the Ministry. The Provincial Directorate is structured with different sub-directorates according to different development themes such as urbanization, infrastructure, environment, urban transformation, technical and human resources. In line with the focus of creating climate responsive urban spaces, three of these sub-directorates have significant roles with respect to the urban development in Mardin (see Figure 5.24).

Firstly, the Directorate of Development and Urbanization is in charge of monitoring and controlling the plan implementations and monitoring the compatibility with the spatial development strategies developed by the Ministry. The directorate also controls the development plans (in the scales of

1/5000 and 1/1000) prepared by the municipality and confirms the plan decisions are in accordance with the procedure laid down in the Environmental Plans, before submitting them for the approval of the Ministry.

Figure 5.24 Institutional structure of Mardin Provincial Directorate of Ministry of Environment and Urbanism



Source: Author`s original

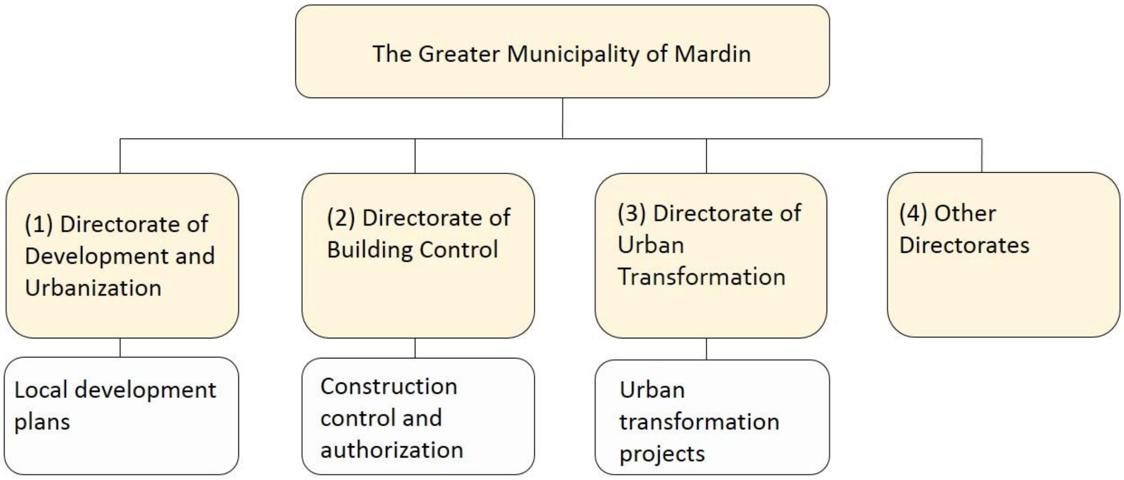
Secondly, the Directorate of Environmental Management and Control is in charge of coordination and the implementation of the strategies and the programmes regarding the prevention of environmental pollution set by the Ministry. Environmental pollution concerns include the way(s) in which the local municipality reflects the Climate Change Action Plan in local level development plans. Thirdly, the Directorate of Building Inspection and Construction Materials is responsible for inspection of the implementation projects and controlling the compatibility with the `Framework of Construction Materials`. In addition, the directorate is in charge of advising the producers, distributors and the other stakeholders related to construction materials.

In brief, the sub-directorates within the Mardin Provincial Directorate of Ministry of Environment and Urbanism act as a monitoring and inspection body which makes the procedural review for the preparation of local level development plans. Although the definition of the role of the Provincial Directorate of Ministry of Environment and Urbanism includes `collaboration with relevant local institutions` in the process of planning, approval, implementation and monitoring; the directorate performs the duties of monitoring more than other tasks.

5.5.2.3 The Greater Municipality of Mardin

The Greater Municipality of Mardin is the main local authority responsible for the local scale development plans (1/5000 to 1/25.000) including plan-making, approval and implementation. In addition, the Greater Municipality approves the plans produced by the district municipalities. This includes the implementation plans, parcelling plans and the partial plan amendments. In addition, the transportation plans and the infrastructure services within the provincial territory of Mardin is also managed and controlled by the Greater Municipality. The multiple duties related to the urban government calls for sub-specialist sections within the municipality`s body. Thus, the institutional structure of the Municipality presents similarities with the structure of Provincial Directorate. Figure 5.25 presents the prominent sub-directorates that have direct influence on the urban development in the province of Mardin.

Figure 5.25 Institutional structure of Greater Municipality of Mardin



Source: Author`s original

The Greater Municipality of Mardin declares its mission as "to create a liveable city with a self-governance approach promoting ecologic development, democracy and gender equality." The stress on the "ecologic development" corresponds with the "sustainability" concerns of the Ministry of Environment and Urbanisation.

5.5.2.4 The Municipality of Artuklu

The Municipality of Artuklu is the district level authority which is in charge of administration of urban management facilities and the common requirements of citizens such as water and electricity supply, lightening and cleaning. The district municipalities have the power to make 1/1000 scaled implementation plans in accordance with the 1/5000 scaled development plans. The Municipality of Artuklu has to collaborate with the Greater Municipality for any amendments that need to be done in the development plans. It is important to note that all levels of municipalities may contract out the plan preparation to a private company, especially when there is a lack of technical and/or human resources. This is also valid in the case of Mardin.

In the Mardin case, the Municipality of Artuklu does not have an influential role in the current planning of the Mardin city, mainly because the institutional structure of the government has recently changed. Mardin was turned into a Greater Municipality in 2014. Therefore, most of the technical staff (i.e. urban planners, architects) who worked in the Mardin Municipality until 2014, were assigned to the Greater Municipality of Mardin. Today, the Greater Municipality of Mardin takes responsibility for preparing the city plans at the scales of 1/25.000 (which has not been prepared before), 1/5000 and 1/1000. In the current condition, the collaboration or the `joint work` between the Municipality of Artuklu and the Greater Municipality of Mardin is in full flow in so far as both municipalities are governed by the same political party[19].

5.6 Conclusion

This chapter has demonstrated how the urban grammar of built environment in Old (heritage) and the New Towns of Mardin is formulated. It has demonstrated the variations in different layers of urban space with potential variations in responsiveness to climatic concerns. The vernacular urban pattern seen in the Old Town embodies specific housing design variables, streetscape characteristics and a city form that is formulated according to an 'integrated design vision' that considers the natural adaptation to the local climatic conditions. A dissimilar urban pattern originated with a comprehensive planning approach in the New Town. This introduces a relatively different urban space experience which is seen as an outcome of stereotyped urban development typically seen in any other contemporary city in Turkey. In other words, it does not produce unique settings responding to the local specificities and climatic priorities.

Having explored the variations in the way urban physical space is formulated in the Old and New Towns, the next chapter considers how this variation influences the perceived thermal comfort in urban daily life. As Chapter 2 and 3 demonstrated, much of the literature that deals with the climate responsive design is characterized by lack of social/ethnographic details regarding what the local specificities and experiences of inhabitants are. While, as this chapter indicates, urban space is produced with different planning and/or design approaches under different socio-economic and political contexts, a question mark remains over how local specific requirements and inhabitants` everyday life experiences are considered in the space production process. How do the two distinct characteristics of the Old and New urban pattern respond to the local requirements and inhabitant`s local lifestyle? Does the formation of urban space influence the way inhabitants perceive the local

[19] The People`s Democratic Party (HDP) was founded as a left-wing political party in 2012. The party is in alliance with the Kurdish Democratic Party, often described as the HDP`s fraternal party.

climatic variables and the way people adapt to severe climatic variations (i.e. the energy consumption patterns for the provision of cooling)?

In addressing these questions, the next chapter critically addresses the influence of physical space on the urban thermal comfort in Mardin as part of the thesis` aim to explore the relationship between the climate responsive urban space production and the provision of thermal comfort in different layers of urban life. Then, Chapter 7 centres upon the ways in which the variations in the urban physical space respond to climatic conditions and local lifestyles. Subsequently, Chapter 8 focuses on the urban development practice/process with a particular discussion about the `backstage` reasons which are conducive to these variations in the physical space.

CHAPTER 6

THE RELATIONSHIP BETWEEN THE PHYSICAL ATTRIBUTES OF THE URBAN BUILT ENVIRONMENT AND PERCEIVED URBAN THERMAL COMFORT

6.1 Introduction

This chapter explores how the physical organization of the urban built environment affects end-users` thermal comfort perceptions in everyday life experiences. The chapter starts with an exploration of the domestic comfort experiences in the houses, continues with a discussion of the provision of outdoor thermal comfort in the streetscape and ends by examining overall urban thermal comfort in the city of Mardin.

Findings are presented according to three scales (housing, street and city) reflecting the different design attributes associated with these scales. The chapter firstly reveals how building design attributes affect end-users` perceived thermal comfort levels at the housing scale. It continues with the relationship between street design and the perceived thermal comfort on the streets. Finally, the chapter ends with the city scale design attributes influencing the perceived urban thermal comfort. The findings in this section corresponds to the whole sample (i.e. results generated from both the New and Old Town samples combined); accordingly, results are discussed in terms of the relationship between the formation of urban form and the perceived thermal comforts with the differences between the Old and New Towns presented in Chapter 7.

6.2 Housing Design and Provision of Indoor Thermal Comfort

Within the urban environment, housing is the major source of shelter and protection from meteorological factors such as rain, wind and sun. The housing unit can be viewed as a tool to be used by an individual to ensure his / her thermal comfort in everyday life. The provision of thermal comfort in a house is correlated with (1) the design of the house itself, (2) the external equipment/factors and (3) the users` own adaptive capacity.

This research uses four different attribute groups to analyse these correlations at the housing scale. Table 6.1 presents the categories of attributes and the source from which the data is extracted.

Table 6.1 Categories of attributes used in analysis in the housing scale

<table>
<tr><th>Attribute Categories</th><th>Source of Data</th><th colspan="2">Attributes</th></tr>
<tr><td>Housing design attributes</td><td>Housing Plans
Housing Visits</td><td colspan="2">(1) typology
(2) material
(3) size
(4) orientation
(5) floor
(6) number of rooms
(7) number open space extensions
(8) location of service zones</td></tr>
<tr><td>Cooling and heating devices</td><td>Questionnaire</td><td>Cooling
(1) air conditioner
(2) electric fan
(3) ceiling</td><td>Heating
(1) stove
(2) radiator
(3) electric heater
(4) kombi boiler</td></tr>
<tr><td>Perceived thermal comfort</td><td>Questionnaire</td><td colspan="2">(1) cold
(2) cool
(3) slightly cool
(4) neutral
(5) slightly warm
(6) warm
(7) hot</td></tr>
<tr><td>Perceived attributes of thermal comfort</td><td>In-depth Interviews</td><td colspan="2">(1) open space extensions
(2) walling
(3) external cooling devices
(4) housing typology
(5) accessibility
(6) others</td></tr>
</table>

Source: Author’s original

Firstly, ‘housing design attributes’ refers to the physical components that are mainly related to the morphological design of a single housing unit. ‘Housing design attributes’, as defined in this research, are (1) typology, (2) material, (3) size, (4) orientation, (5) floor, (6) number of rooms, (7) open space extensions and (8) location of service zones. These attributes are used as independent variables that vary according to the design of selected sample housing units.

Secondly, ‘cooling and heating devices’ refer to additional technical equipment to provide cooling and heating in a housing unit. Technical devices for cooling are (1) air conditioners, (2) electric fans and (3) ceiling fans. Technical devices for heating are (1) stoves, (2) radiators (central heating), (3) electric heaters and (4) combi boilers. Both cooling and heating devices are used as independent variables since they represent external devices/factors which are not pre-defined/foreseen by the design/plan of the houses. It is assumed that having a cooling or heating device is an individual choice shaped by personal thermal sensations and income.

Thirdly, ‘perceived thermal comfort’ refers to the comfort values identified by individual perceptions of the users` of houses both for summer and winter seasons. Comfort values vary from 1 to 7 according to interviewees` subjective judgements. Comfort values are assumed as dependent values influenced by 'Built environment attributes' and 'Cooling and heating devices'.

Lastly, 'perceived attributes of thermal comfort' refers to spatial components related to thermal comfort which are identified by users` during the in-depth interviews. Perceived attribute groups of thermal comfort are (1) open space extensions, (2) walling, (3) external cooling devices, (3) housing typology, (5) accessibility and (6) others. Sub-attributes under these groups are explained in the following sections in which the results of content analysis are also presented.

6.2.1 The Relationship between the Design of a House and Perceived Thermal Comfort

The perceived thermal comfort in houses is analysed according to participants` ranking scores for their summer and winter comfort perceptions. Firstly, in order to understand the extent to which built environment attributes explain the variance in the summer thermal comfort, a multiple regression analysis is performed between 'built environment attributes' and 'perceived thermal comfort' in summer. Thermal comfort is assumed as the dependent variable which is influenced by design variables of a house.

Before running the regression, the multicollinearity between attributes is analysed. Table 6.2 shows correlations between variables of the model.

Table 6.2 Person correlation of built environment attributes

	DV	IV1	IV2	IV3	IV4	IV5	IV6	IV7	IV8
DV: Comfort in summer	1.000								
IV1: Typology	.650	1.000							
IV2: Material	.769	.728	1.000						
IV3: Size	-.028	-.047	-.153	1.000					
IV4: Orientation	-.307	-.449	-.546	.106	1.000				
IV5: Floor	-.464	-.570	-.657	.074	.189	1.000			
IV6: Number of rooms	-.264	-.263	-.491	.714	.308	.292	1.000		
IV7: Number of open space	-.369	-.353	-.524	.105	.380	.308	.196	1.000	
IV8: Location of service zones	.366	.311	.454	-.038	-.248	-.354	-.208	-.340	1.000

Source: Output of SPSS analysis

The strongest correlation observed in the model is between 'material' and 'typology' (r's < 0.75). This correlation is mainly caused by the fact that 95% of sample housing units from the same typology, also presents similar construction material. This was mainly caused by the fact that both Towns have a dominant type of house typology and construction materials. While samples from the Old Town present courtyard and stone houses, samples from the New Town represent concrete apartment flats. In other words, `typology` and `material` varies together. Therefore 'typology' and 'material' are included in the model as substitute variables. Similarly, since sample units from the Old Town are composed of only 1 or 2 storey houses, `floor` is correlated to typology and material. Therefore, `floor` is excluded from the model. Lastly, it is observed that since there is a strong correlation between `size` and `number of rooms`, these variables are included as one single variable. In the end, eight variables are reformulated and defined under five variables. As seen in Table 6.3, there are low to moderate correlations between the variables of the model. This shows that multicollinearity does not constitute significant problem in this model.

Table 6.3 Pearson correlation of built environment attributes

	DV	IV1	IV2	IV3	IV4	IV5
DV: Comfort in summer	1.000					
IV1: Orientation	-.307	1.000				
IV2: Size / number of rooms	-.028	.106	1.000			
IV3: Number of open space	-.369	.380	.105	1.000		
IV4: Location of service zones	.366	-.248	-.038	-.340	1.000	
IV5: Material / Typology	.769	-.546	-.153	-.524	.454	1.000

Source: Output of SPSS analysis

Within this distribution, Table 6.4 shows the model of thermal comfort (Adjusted R^2: 0.60, F= 6.94, p<0.01). In the model, two of the five attributes made a significant contribution to explaining the variance in perceived thermal comfort in summer. These attributes include ‘material/typology’ and ‘orientation` of the house. Two attributes explain the variance in thermal comfort by 61 %. The ‘material/typology` made the most contribution to explaining the variance in comfort by 59 % (see Appendix G.1 for more results of this analysis).

Table 6.4 Results of the regression analysis of built environment attributes and perceived thermal comfort in summer

VARIABLES	*R^2*	*R^2 Change*	*b*	*t*	*p*
(1) Material / Typology	.592	.592	3.351	14.077	.000
(2) Orientation	.610	.018	.178	2.636	.009
(constant)			-1.348	-2.585	.000

Standard Error: 1.28
Adjusted R^2: 0.60
df1= 1 ,df2= 150
For Model: F= 6.949, p<0.01

Source: Output of SPSS analysis

In line with previous research findings (Milne and Givoni, 1979; Edwards et al., 2006; Krope and Goricanec, 2009), regression results present that material/typology of a housing unit has a significant impact on the perceived thermal comfort in houses. It is known that the courtyard type becomes a generic typology in hot and arid climatic regions, especially in Islamic settlements (Ozkan, 2006).

However, the significance of apartment typology and to what extent it substitutes the traditional typologies (i.e. courtyard) is, as yet, underexplored. Apart from technical or climatic significance proved in the regression model, this research argues that this significance can not be understood solely as a technical variation, rather it needs to be handled with the capacity of fulfilling the cultural and collective conventions as argued in the 'social convention' approach (Chappells and Shove, 2004) to thermal comfort. In order to understand which material and/or typology affects thermal comfort in which way, and how these significant variables influence or are influenced by the way people use the built environment, the following chapter will focus on the differences between the Old and New Town.

Secondly, in order to understand the extent to which built environment attributes explain the variance in the winter thermal comfort, a multiple regression analysis was performed between built environment attributes and perceived comfort levels in winter. As seen in Table 6.5, there are low to moderate correlations between the variables of the model. This shows that multicollinearity does not constitute a significant problem in this model.

Table 6.5 Pearson correlation of built environment attributes

	DV	IV1	IV2	IV3	IV4	IV5
DV: Comfort in winter	1.000					
IV1: Material/ Typology	-.271	1.000				
IV2: Size (# of rooms)	-.053	-.153	1.000			
IV3: Orientation	.124	-.446	.106	1.000		
IV4: # of open space	.340	-.424	.105	.380	1.000	
IV5: Location of service	-.523	.454	-.038	-.248	-.340	1.000

Source: Output of SPSS analysis

Table 6.6 shows the model of thermal comfort (Adjusted R^2: 0.29, F= 6.38, p<0.05). In the model, one of the five attributes made a significant contribution to explaining the variance in perceived thermal comfort in winter. This attribute is 'location of service zones' in the house. The attribute explains the variance in thermal comfort by 27 percent. (see Appendix G.2 for more results of this analysis).

Table 6.6 Results of the regression analysis of built environment attributes and perceived thermal comfort in winter

VARIABLES	*R2*	*R2 Change*	*b*	*t*	*p*
(1) Location of Service Zones	.273	.273	-2.661	-7.539	.000
(constant)			7.915	18.131	
	Standard Error: 1.66 Adjusted R2: 0.29 df1= 1 ,df2= 151 For Model: F= 56.839, p<0.01				

Source: Output of SPSS analysis

This study s hows that houses in which the service zones such as kitchen or bathroom are located outside of the main housing unit, passage from indoor living spaces to kitchen and/or bathroom, causes an uncomfortable experience, especially in the cold days of winter.

In summary, both of the regression analyses conducted for summer and winter reveal that some physical design attributes of houses explain the variance in the perceived thermal comfort in Mardin. While the attributes of material/typology and orientation contribute to the variance in summer comfort, the location of service zones contributes to the variance in the winter comfort in houses. However, this outcome does not necessarily mean that other attributes do not contribute to the explanation of variance in the comfort levels. Hidden attributes which might not appear significant in the regression model will be explored more deeply in the following sections where the analysis of in-depth interviews is presented.

6.2.2 The Role of Cooling and Heating Devices on the Perceived Thermal Comfort at the Housing Scale

As mentioned in Chapter 5, additional cooling and heating devices are supportive sources commonly used in the provision of thermal comfort in houses. Firstly, in order to understand the extent to which cooling and heating devices explain the variance in summer thermal comfort, a multiple regression analysis is performed between \`cooling and heating devices\` and \`perceived comfort levels\`. Before conducting regression, a multicollinearity between three external cooling devices was analysed. As seen in Table 6.7, there are low correlations between the variables of the model. This shows that multicollinearity does not constitute a significant problem in this model.

Table 6.7 Pearson correlation of external cooling devices

	DV	IV1	IV2	IV3
DV: Comfort in summer	1.000			
IV1: electric fan	-.384	1.000		
IV2: air-conditioner	-.555	.360	1.000	
IV3: ceiling fan	.321	-.392	-.336	1.000

Source: Output of SPSS analysis

Table 6.8 shows the model of thermal comfort (Adjusted R^2: 0.33, F= 8.98, $p<0.05$). In the model, two of the three external cooling devices explain the variance in perceived thermal comfort in the summer by 34 percent. \`Air-conditioners\` made the most contribution to explaining the variance in comfort by 30 percent (see Appendix G.3 for more results of this analysis).

Table 6.8 Results of the Regression Analysis of Cooling Devices and Perceived Thermal comfort in summer

VARIABLES	R^2	R^2 *Change*	*b*	*t*	*p*
(1) air-conditioner	.308	.308	-1.078	-6.765	.000
(2) electric fan	.347	.039	-.658	-2.995	.003
(constant)			5.745	27.755	

Standard Error: 1.65
Adjusted R^2: 0.33
df1= 1 ,df2= 151
For Model: F= 8.972, $p<0.01$

Source: Output of SPSS analysis

The result shows that some participants are not able to provide indoor thermal comfort without using an additional cooling device such as an air-conditioner and electric fan in their houses. This finding corresponds with the outcomes of in-depth interviews. Many participants expressed the significant impact of cooling devices on their everyday life experiences. In some cases, this dependency was defined at the level of a necessity.

Secondly, in order to understand the extent to which cooling and heating devices explain the variance in winter thermal comfort, a multiple regression analysis was performed between `heating devices` and `perceived comfort levels`. The result of the regression does not present any significant variable that directly explains the perceived comfort in winter. That shows there is not a statistically significant correlation between the heating devices and thermal comfort in winter. However, there might be cases in which the winter thermal comfort is influenced by the use of additional heating devices. These details will be explored more deeply in the next section where the analysis of in-depth interviews is presented. As discussed in Chapter 4, statistical analysis dependent on pre-defined attributes may (or not) give solely accurate results itself, but it is essential for triangulation of the data.

6.2.3 Perceived Attributes of Thermal Comfort in a Housing Unit

After analysing the physical attributes and additional devices influencing the perceived thermal comfort in housing units, this section contributes to a deeper understanding of the way which people define the attributes of thermal comfort in their domestic experiences.

In order to explore the perceived attributes of thermal comfort in a house, a content analysis was performed with data collected via in-depth interviews. Table 6.9 presents the content groups composed of pre-defined attributes extracted from the interview transcripts.

Table 6.9 Content groups of perceived attributes that enhance thermal comfort in a house

Content Groups	Sub-groups	Frequency of mention	Percentage
Open space extensions	Courtyard Terrace Garden Balcony	450	39 %
Walling	Wall thickness Wall material Insulation	228	20 %
External cooling devices	Air-conditioner Electric fan Ceiling fan	192	17 %
Housing typology	Building form Ceiling structure	148	13 %
Accessibility to service zones	Accessibility to kitchen Accessibility to bathroom	78	7 %
Others	Interconnectedness between rooms Diversity of rooms Renewable Energy	50	4%
TOTAL		**1156**	**100 %**

Source: Author`s original

As seen from the table, with a ratio of 39%, `open space extensions` was the most frequently mentioned attribute that was judged to enhance thermal comfort in a housing unit. Open space extensions refer to spaces which provide direct access to fresh air and a sky view. The most frequently mentioned open space extensions were courtyard, terrace, balcony and garden. Subsequently, with a ratio of 20%, `walling` came forward as the second most mentioned attribute. Walling includes thickness, material and the presence of insulation on the surrounding surfaces of the house. Distribution ratios indicate that the top two most frequently mentioned content groups that enhance thermal comfort constitute more than a half (59 %) of all perceived attributes and they are directly related to the physical design of the house.

Afterwards, `external cooling devices` (17 %) come as the most frequently mentioned attributes for the provision of thermal comfort in the house. That shows us that among the whole sample size (60 houses, 153 interviewees) external cooling devices are not the major source of thermal comfort for a reasonable part of the sample. Thereafter, `housing typology` constitutes 13 % of the total frequency of design attributes mentioned. Typology includes responses related to the physical structure of the house such as building form and the shape or the height of the ceiling. Finally, the last (i.e. least frequently cited) content groups include the `diversity of rooms` and `interconnectedness between rooms` and use of `renewable energy` for heating and/or cooling.

Open space extensions in a housing unit are major `breathing points` for citizens especially at times when houses are getting overheated and indoor air temperatures become intolerable. Due to the extreme climatic conditions in summer, the boundaries of a house in Mardin are not generally perceived as a closed structure composed of different volumes. On the contrary, people perceive the house as a place which serves for shelter (when necessary) as well as a space which provides opportunity to interact in open space that allows presence of open air, sky view and natural freshness. Concordantly, people's perception of thermal comfort is related to the presence of open space extensions in the houses. The quotation below from one of the interview respondents gives a better understanding of the way the presence of open spaces in the household setting influences occupants` lifestyles.

"This is an open-air room for us (interviewee points the courtyard). As you see, we have moved our sofas and TV here. You may find it unusual, but isn't it more comfortable? No need to feel suffocated in the house, when we have this opportunity here. My children usually sleep here in the summers." (Female, 30)

The courtyard is the most commonly mentioned space allowing for different activities such as sitting, sleeping, cooking and washing to be conducted in a comfortable open setting. Not surprisingly, all open space units do not serve for the same activities and they provide different levels of thermal comfort experiences. These differences are discussed in the next chapter where the comparison between the Old and New Town is presented. However, overall, any type of open space extension to houses is pointed out as a positive attribute that enhances thermal comfort.

The outcome of the content analysis presented that end-users' are also aware of the role of construction material in the thermal comfort experienced in their houses. Although they may not be aware of the technical role that walling plays, the most frequently mentioned attributes show that more than a half of the participants nonetheless drew a conclusion via a comparison of their experiences in different houses. This could be a house made of a different construction material, with thicker walls or a house with exterior wall insulation. For instance, the extract included below shows the awareness of the owner of one sample house, representing a detached duplex housing typology.

“I devoted a significant amount of budget for the exterior wall insulation of my house. Most of my neighbours speculated about the way which I had made a disinvestment. Today, when I calculate the amount that I saved in cooling and heating costs, it was really worth paying for the insulation. I own this house, which means either myself or my son will stay in this house for many years. Thinking about the long term, rather than paying for the cost of annual heating and cooling each year, I decided to solve the problem in a lump” (Male, 45)

While some respondents try to find permanent solutions (as in the above case), others used external cooling devices such as air-conditioners, electric fans or a ceiling fan. Using a cooling device is the most practical and easiest temporary solution for the provision of cooling in the summer. Interviews present that people uses cooling devices for the provision of comfort over a short time period. The extract below provides insight into the extent to which the use of air-conditioners affects people`s everyday life experiences.

“I am aware of the amount of electricity that air-conditioners consume. Indeed, it also costs too much, but we have to use it during the summer months. Otherwise it is not possible to enter our house. Both I and my husband are working during the day, and when we are back at home after work (around 6), our home becomes like a sauna since the windows are closed all day long. Sometimes we spend time to do some activities like shopping before going back to home, in a way to reduce the time that we spend in the house in the evenings.” (Female, 32)

Exploring the content groups mentioned during the in-depth interviews a little further, participants also appreciate the role that typology plays in the experienced thermal comfort in their houses. Here, typology refers to the physical attributes related to the form and volume of the house. For example, a detached house with a garden may positively influence the experienced/perceived thermal comfort in a house, an apartment flat in a high-rise building might influence this negatively. The formal components of the house are also clustered under these categories, since they are related to the shape/form of the house itself and the formation of the volumes within the house. The extract below presents an example of how a user’s perception of thermal comfort is influenced by the form of the ceiling of his house.

"The ceiling height in this house is more than 4 metres. As you see the ceiling is formed like a dome. That shape accumulates the warm air. As you know the air rises as it gets warmer. I believe it affects the cooling of room in summer. Also in winter, when we open the door the room does not cool down immediately because the warm air protected in the dome balances the temperature right after the cold air flows in the room." (Male, 28)

Beside the structural components of various volumes in a house, participants also raised the significance of the positioning of these volumes within the plan layout. In this respect, the location of service zones such as kitchen and toilets was pointed out as a cause of discomfort, especially in the winter. This shows the significance of positioning the open space extensions in such a way as to provide balanced thermal comfort in different seasons. As seen in the extract below, even though open space extensions like the courtyard are one of the most 'irreplaceable' (i.e. in the way defined by participants) space for local people in Mardin the `inaccurate`[20] positioning of the kitchen leads to face of difficulties in some cases.

"Since the kitchen was located in the courtyard, it was really hard for me to use the kitchen in winter. Especially in the rainy and snowy days, transitioning from the living room to the kitchen was getting more difficult. As you see, my husband constructed an additional wall to create a closure and combine the kitchen with the rest of the house." (Female, 28)

Lastly, some participants also mentioned attributes such as interconnectedness between rooms, diversity of rooms, and use of renewable energy in the provision of thermal comfort. Interconnectedness refers to free and easy airflow among different units of the house. The less

[20] As mentioned in Chapter 5, the lack of a decent infrastructure system when the Old Town was developed has lead to the separation of services zones from the living spaces in the same house.

connected the room, the less air flowed from one room to another. Therefore, rooms which have limited connection to other parts of the house hold more stable air, leading to faster warming. In contrast, rooms that have multiple connections to other volumes in the house facilitate the expansion of air accumulated in the room. Slightly related to the interconnectedness of the rooms, the diversity of rooms was one of the other attributes mentioned as a determinant of comfort. Diversity refers to variance in the number, size and/or direction of the rooms. For instance, rooms facing different directions in a house provide more opportunity for adapting to different climatic conditions. Rooms facing south get the benefits of solar heat which contributes the heating in the winter, while the rooms facing north provide relatively cooler conditions in the summer.

This section has presented the content groups which include the perceived attributes of thermal comfort extracted from the transcriptions of in-depth interviews conducted with local people. It shows the broad picture of the way in which attributes influence the way that people perceive comfort levels in their houses. The next section establishes whether there is a statistical correlation between the content groups defined by participants and their thermal comfort ranking values.

6.2.4 The Relationship Between Perceived Attributes of Thermal Comfort and Perceived Thermal Comfort

Having explored the perceived attributes of thermal comfort in the house, in order to understand to extent which content groups explain the variance in summer thermal comfort, a multiple regression analysis is performed between \`content groups\` and \`perceived comfort ratings\`. First, a multicolleniarity between content groups is controlled. As seen in Table 6.10, there are low correlations between the variables of the model. This shows that multicollinearity does not constitute a significant problem in this model.

Table 6.10 Pearson correlation of perceived thermal comfort variables

	DV	IV1	IV2	IV3	IV4	IV5	IV6
DV: Annual Thermal Comfort	1.000						
IV1: Others	.103	1.000					
IV2: Walling	-.342	.025	1.000				
IV3: Open space extensions	.098	-.029	-.168	1.000			
IV4: Typology	.040	.048	-.022	.217	1.000		
IV5: External cooling devices	-.483	-.064	.412	-.181	-.073	1.000	
IV6: Accessibility	.338	.142	-.165	-.153	.039	-.242	1.000

Source: Output of SPSS analysis

Table 6.11 shows the model of thermal comfort (Adjusted R^2: 0.29, F= 4.20, p<0.05). In the model, three of the six content groups made a significant contribution to explaining the variance in annual perceived thermal comfort. These attributes include ‘external cooling devices’, ‘accessibility to service zones’ and `walling` of the house. Three attributes explain the variance in thermal comfort by 30 %. The ‘external devices’ made the most contribution to explaining the variance in comfort by 23 % (see Appendix G.4 for more results of this analysis).

Table 6.11 Results of regression analysis of perceived thermal comfort attributes and perceived annual thermal comfort

VARIABLES	R^2	R^2 *Change*	*b*	*t*	*p*
(1) External cooling devices	.233	.233	-.505	-4.783	.000
(2) Accessibility to service zones	.285	.052	.475	3.175	.001
(3) Walling	.305	.020	-.145	-2.052	.042
(constant)			5.039	23.027	
	Standard Error: 1,71 Adjusted R^2: 0.29 df1= 1 ,df2= 149 For Model: F= 4.209, p<0.05				

Source: Output of SPSS analysis

These results present a consistent outcome with the statistical correlations observed at the beginning of the chapter. ‘External cooling devices’ have the biggest share in the explanation of the variance in thermal comfort. This shows that cooling devices are a part of their everyday life experiences for a large group of the total sample. Quotations in Table 6.12 give some hints about the significance of using cooling devices for the provision of indoor thermal comfort. However, reflecting back to the outcome of the content analysis, cooling devices were not the most frequently mentioned attribute within the general attribute groups extracted from interviews. That means some other attributes have more meaning for a large number of the total participants in the research. The variance within the total sample size will be more clearly observed in the comparative chapter (Chapter 7).

Table 6.12 Sample quotations for `cooling devices`

“We can`t sleep without air conditioner. Even if we turn it off for an hour, the bedroom gets very hot and uncomfortable” (Female, 35) *“In case of a power cut, I use an ice bottle. Seriously, I am not joking, you don’t have any other option when you are unable to use the air conditioner.”* (Male, 19) *“To be honest, I would consider affixing a single air conditioner for each room if I could afford the electricity cost.”* (Male, 42)

Similarly, accessibility to service zones such as the kitchen and bathroom was one of the significant attributes emerging from the regression model of thermal comfort in the house. Results here consolidate the argument and highlight the negative influence of the location of service zones in the house. As seen in Table 6.13, most participants mention the challenges that they face, particularly in the winter season.

Table 6.13 Sample quotations for `accessibility to service zones`

"Since the bathroom and toilet are in the courtyard, as soon as we open the door, the room becomes cooler in the winter." (Female, 27) *"I remember the days that I used an umbrella to take my children to the toilet." (Female, 33)* *"It would be nice to have an upper deck above the transition area between kitchen and the living room." (Female, 38)*

Lastly and not surprisingly, walling stands as a contributing factor in the explanation of variance in thermal comfort. It was the second most frequently mentioned attribute during the interviews, and the regression model also displays the statistical significance of that factor. Table 6.14 supports the argument that most people feel/experience the influential role of construction material and/or structure of the external walls of a house.

Table 6.14 Sample quotations for `walling`

"Since the walls are made of thick and massive stones, we can easily heat our room with a single stove and it lasts for hours." (Male, 50) *"Insulation should be done during the construction of building, not after the construction."* (Male, 35)

This section has presented the relationship between the housing design attributes and the perceived thermal comfort at the housing level. The next section continues with an exploration of whether there is a similar type of relationship present at the street scale. In other words, the next section looks for a relationship in the outdoor context.

6.3 Formation of Street Scape and Provision of Urban Thermal Comfort

Streets are vessels of a city, if the city is to be likened to a living organism. As healthy blood circulation is an absolute must for heathy tissues, a comfortable human circulation within the network of streets is fundamental for the provision of urban thermal comfort in cities. In this respect, this section explores the factors that influence the perceived thermal comfort on the streets. To do that, three different attribute groups are used in the analysis. Table 6.15 presents the categories of attributes and the source from which the data are extracted.

Table 6.15 Categories of attributes used in analysis in the street scale

Attribute Categories	Source of Data	Attributes
Perceived climatic attributes	Street Questionnaire	(1) felt temperature (2) felt sun (3) felt wind (4) felt humidity
Perceived thermal comfort	Street Questionnaire	(1) cold (2) cool (3) neutral (5) warm (5) hot
Perceived attributes of thermal comfort	In-depth Interviews	(1) arcaded passages (2) breeze (3) landscaping (4) pavement (5) shading (6) urban furniture (7) water elements (8) separated walk way

Source: Author`s original

Firstly, `Perceived climatic attributes` refer to felt climatic attributes which are mainly related to local weather conditions. Climatic attributes defined in this research are (1) felt temperature, (2) felt sun, (3) felt wind and (4) felt humidity. These attributes are used as independent variables that affect thermal comfort as experienced in a street.

Secondly, `Perceived thermal comfort` refers to comfort values identified by the individual perceptions of those who participated in the street questionnaires. Comfort values vary from 1 to 5 according to interviewees` subjective judgements. Overall thermal comfort values are assumed as dependent variables influenced by climatic attributes and the physical design of streets.

Lastly, `Perceived attributes of thermal comfort` refer to the spatial components enhancing thermal comfort. These are identified by users during the in-depth interviews. Perceived attributes of thermal comfort identified by interviewees are (1) arcaded passages, (2) breeze, (3) landscaping, (4) pavement, (5) shading, (6) urban furniture, (7) water elements and (8) separated walk way. It is important to underline that the perceived attributes of thermal comfort are defined by respondents interviewed at their home. Therefore these attributes will not be analysed in correlation with the thermal comfort rankings received from the questionnaires conducted on the streets. Beside, these attributes will be used to present the outcome of the content analysis of the in-depth interviews.

6.3.1 The Relationship between Perceived Climatic Attributes and Perceived Thermal Comfort

In order to understand the extent to which climatic attributes explain the variance in the overall thermal comfort in the street, a multiple regression analysis was performed between `perceived climatic attributes` (temperature, sun, wind, humidity) and `perceived thermal comfort levels`. As seen in Table 6.16, there are low correlations between the variables of the model. This shows that multicollinearity does not constitute a significant problem in this model.

Table 6.16 Person correlation of perceived climatic attributes

	DV	IV1	IV2	IV3	IV4
DV: Perceived overall thermal comfort	1,000				
IV1: Felt Temperature	,469	1,000			
IV2: Felt Sun	,391	,326	1,000		
IV3: Felt Wind	,163	,219	,226	1,000	
IV4: Felt Humidity	,029	,072	,026	-,058	1,000

Source: Output of SPSS analysis

Table 6.17 shows the model of overall thermal comfort (Adjusted R^2: 0.28, F= 53.029, p<0.01). In the model, two of the four climatic attributes explain the variance in overall perceived thermal comfort in the street by 28 percent. `Felt temperature` made the most contribution to explaining the variance in comfort (by 22 percent) (see Appendix G.5 for more results of this analysis).

Table 6.17 Results of the regression analysis of perceived climatic attributes and overall thermal comfort level

VARIABLES	*R^2*	*R^2 Change*	*b*	*t*	*p*
(1) Felt Temperature	.220	.220	.460	10.422	.000
(2) Felt Sun	.284	.064	.542	7.282	.000
(constant)			1.256	9.191	

Standard Error: 0,86
Adjusted R^2: 0.28
df1= 1 ,df2= 597
For Model: F= 53.029, p<0.01

Source: Output of SPSS analysis

6.3.2 Variance in the Perceived Climatic Attributes and Overall Thermal Comfort in Different Time Intervals

In order to explore whether perceived climatic attributes and perceived thermal comfort values vary at different times of day a discriminant analysis was performed. Time intervals in which the interviews were taken place have been classified under three groups namely: (1) morning (10:00-12:00), (2) noon (12:00-14:00) and (3) afternoon (14:00-18:00).

In the discriminant analysis, the possibility of groups to be distinguished is explored when the perceived climatic attributes of thermal comfort are used as discriminating variables. Then, the nature of the differences are analysed. In order to interpret and determine the nature of the discriminant function, the structure matrix[21] is examined to detect the correlations between discriminating variables and discriminating scores. This matrix indicates how closely a discriminating variable and a discriminant function are related.

Table 6.18 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 6.18 presents that `Felt Temperature` is highly correlated with the discriminant score. That means the predictor variable most strongly associated with discriminant function 1 -which distinguished between survey respondents in different time intervals- is `felt temperature` (r=1000) (see Appendix G.6 for more results of this analysis).

Table 6.18 Structure matrix of perceived climatic variables and overall thermal comfort levels in the street

Perceived Climatic Attributes	*Function*
	1
Felt Temperature	1.000
Perceived overall thermal comfort (a)	.463
Felt Sun (a)	.322
Felt Wind (a)	.227
Felt Humidity (a)	.067

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.
(a) This variable was not used in the analysis

Table 6.19 shows the standardized canonical discriminant function that indicated how much each variable contributed (and in which direction) to the variation between different time intervals. The larger the magnitude of the coefficient, the greater that discriminating variable's contribution is. According to Table 6.19, `Felt Temperature` is the most influential discriminating variable amongst all of the general attribute groups of integration. This means `Felt Temperature` makes the largest contribution to the differentiation between time intervals in which interviews are conducted.

[21] When the magnitude of the structure coefficient is large (near to 1.00 or -1.00), the discriminating function is carrying nearly the same information as the discriminating variable. When the coefficients are close to 0, there is very little common information between discriminating function and variables.

Table 6.19 Standardized canonical discriminant function coefficients matrix

Perceived Climatic Attributes	*Function*
	1
Felt Temperature	1.000

Source: Output of SPSS analysis

Table 6.20 displays the results of testing significant differences for the three time intervals. The results of discriminant analysis indicate that the group means are significantly different to the discriminant scores and the group mean of `Morning` (.131) scored different than the other time intervals (`Noon`=.017; `Afternoon`=-.122). In other words, Function 1 separates respondents who have been interviewed in the morning (+ 0.131) from respondents who have been interweaved in the noon and afternoon.

Table 6.20 Functions at group centroids

Time intervals	*Function*
	1
morning	.131
noon	.017
afternoon	-.122

Source: Output of SPSS analysis

Discriminant analysis presents that the `felt temperature` in the street varies for different groups of people interviewed at different time intervals. This points to the possibility of variance in urban temperature in the streets during the day; this variance might be influenced by the formation of the built environment. For instance, the amount of sun exposure has influence on alterations in the urban temperature and it is possible to avoid or get benefit (depending on the context) from the sun with the help of appropriate design solutions. Beside the perceived climatic attributes, the following section focuses on the other attributes which are not predefined by the researcher but were mentioned by participants.

6.3.3 Perceived Attributes of Thermal Comfort on a Street

The housing section of this chapter demonstrated that most of the attributes of thermal comfort in domestic life were closely related to the physical form of the house. When it comes to thermal comfort in streets, external factors vary due to the fact that movement/activities of people changes from indoor to outdoor spaces. In line with the main argument of this research, street scale experiences narrowed down to commuting patterns of local people and variations in the preferences of transportation modes correspondingly to the perceived outdoor thermal comfort.

In order to explore the perceived attributes of thermal comfort on a street, a content analysis was performed with the data collected by in-depth interviews. Table 6.21 presents the content groups that make streets walkable enough to reduce the use of vehicles for daily commutes.

Table 6.21 Content groups of perceived attributes that enhance thermal comfort in a street

Attributes	Frequency of mention	Percentage
Shading	266	36 %
Vegetation	196	26 %
Water elements	62	8 %
Arcaded passages	58	8 %
Separated walk way	50	7 %
Pavement	48	7 %
Breeze	32	4 %
Urban furniture	32	4 %
TOTAL	**744**	**100 %**

Source: Author`s original

The perceived attributes of thermal comfort identified by interviewees are (1) shading, (2) landscaping, (3) water elements, (4) arcaded passages, (5) separated walk way, (7) breeze and (8) urban furniture. As Table 6.21 demonstrates, `shading` is the most frequently mentioned design attribute with the ratio of 36 %. Subsequently, with a ratio of 26 %, `vegetation` comes forward as the second most-mentioned attribute. `Water elements` and `arcaded passages` present the same ratio of 8 %; and ` separated walk way` and `pavement share the same ratio of 7 %. The least mentioned design attributes are `breeze` and `urban furniture`, each of which represent 4 % of the total frequency of mentions.

In line with previous research findings (Givoni et al., 2003 and Lin et al., 2010), content analysis presents that `shading` is the most influential attribute at street scale thermal comfort. It is the most mentioned attribute in the Mardin context, mostly due to hot climatic conditions and long hours of sun exposure. It does not necessarily mean that shading is the most significant attribute for a street to provide a comfortable walking experience. In a different context, another attribute can be mentioned more. However, the content analysis shows that a lack of shading in Mardin stands as a critical problem since it affects citizens' everyday commuting moods during the summer. People inevitably present a tendency to vehicle-oriented commuting moods, even if they have a desire to walk. Quotations in Table 6.22 evidence the view that there is lack of shading, especially in the New Town. Extracts show that a shading requirement in the Old Town was provided in some other way(s). As discussed in Chapter 4, in order not to fall into the error of over-simplification during `coding` it is important to look at how shading is differentiated in the Old and New Towns. The comparison of the experiences and the varying attributes at street scale will be presented in the following Chapter.

Table 6.22 Sample quotations for `Shading`

"I prefer to take the minibus rather than walking under sun." (25, M, New Town)
"It is better not to go out before 6pm, otherwise you have to walk under sun." (33, F, New Town)
"I don't go out in day time unless I have an urgent requirement. Here you can find small slots for hiding from the sun." (44, F, New Town)
"Even the streets in the side streets have stairs, I still prefer side streets since they provide more shadow." (38, M, Old Town)
"I am not originally from Mardin, so I am not used to living under that hot climatic conditions. Sometimes I have a nosebleed when I walk under sun." (27, F, New Town)

Relevant to the lack of shading, vegetation was one of the most desired attributes of thermal comfort in streets. Table 6.23 presents some extracts which underline the lack of or insufficiency of vegetation in Mardin. The positive influence of vegetation was mentioned as a physical attribute in the literature with its capacity to create shading (Lin, et al., 2008). In this research, vegetation was coded as a separate group to shading, since shading stands as an upper category which includes any other components that provide shadow in the streets, while vegetation includes elements relevant to plantation such as trees, bushes, or flowers. This research shows that vegetation could foster comfort not only in a physical sense such as the provision of shadow via trees but also in a psychological way, such as the presence of grassy areas with plants and flowers.

Table 6.23 Sample quotations for `Vegetation`

"*It would be more attractive and comfortable to walk in green streets with trees and flowers*"
"*Tiny trees don't provide any shadow, we need wider trees.*"
"*We need trees between the buildings, look at these concrete junctions!*"
"*There is a serious amount of dust in the new town, sometimes we are not able to open our windows. In order to prevent emergence of dust, vacant lands should be planted.*

Related to psychological effects, `water elements` come to the fore as a catalyser of thermal comfort in urban areas. As seen in Table 6.24, respondents define water elements as a source of relaxation and cooling for the hot and arid climatic seasons. It was observed that the use of water elements either at the street or city scales was not very common provincial-wide (i.e. across Mardin). Nontheless it appears as a desired attribute in the interviews.

Table 6.24 Sample quotations for `Water elements`

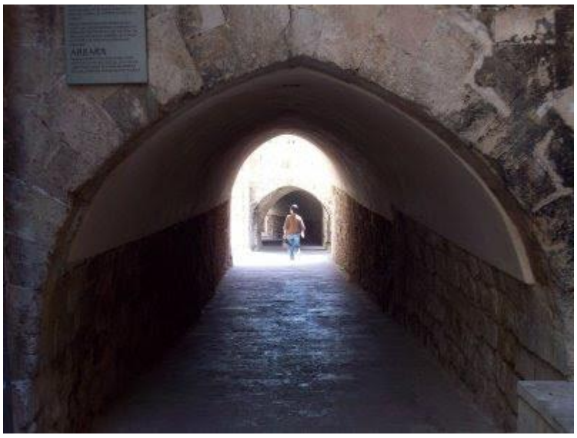
"Fountains alongside the streets would provide an attractive street as well as giving the cooling effect with the water particles splashing in your face" (M, 21, Old Town) *"My children love playing in the artificial pool in the entrance way of the governorship building. Sometimes they get totally wet while they are playing, but this is actually not a problem when the temperature is around 40 degrees." (F, 34, New Town)*

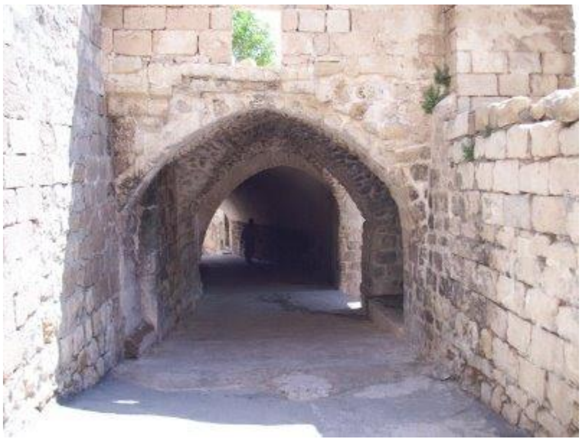
Arcaded passages are one of the street design attributes commonly seen in the heritage town in Mardin. As seen in Figure 6.1, the `abbara` with its curve-linear ceiling structure, prevents a direct solar beam and provides a highly comfortable walking path for pedestrians. Similarly, Table 6.25 present some extracts which support the argument for the potential contribution of arcaded passages in the perceived thermal comfort in street level everyday life experiences.

Table 6.25 Sample quotations for `Arcaded passages`

"[The] Abbara provides very comfortable walking experience, it protects from the sun. I wish all streets were designed in a similar way" (M,37, Old Town) *"Protection from sun is the only way of providing comfort in the streets. A canopy style structure which allows passages under it would be more comfortable" (M, 26, New Town)* *"I prefer shopping in the Ravza Street, because almost all shops along the street have tarpaulins which provides a relatively comfortable walking experience." (F, 33, New Town)*

Figure 6.1 Typical samples of Abbara from the Old Town





Source: Author`s original

The presence of `abbara` style structures mostly depends upon the presence of separated walkways in Mardin. The separation of pedestrian streets from traffic provides a supply of narrow streets which allows the construction of an entire or part-coverage on top of the streets. Table 6.26 exemplifies some of the positive effects of separation which fosters the provision of street level thermal comfort.

Table 6.26 Sample quotations for `Separated walk way`

"In the main street, it is not easy to find a continuous shadowy sidewalk since some people park their cars on the sidewalks. It is already hot, you need to control the traffic, the crowd. I usually prefer back streets, even if sometimes it takes more time to walk." (M,37, Old Town) *"It is more comfortable to take the bus rather than walking, I don't like walking in the crowded streets in summer. I don't have tolerance for the hot. People, cars, noise, all make me feel more uncomfortable, this chaos weighs me down."* (F, 47, New Town)

The presence of breeze in the streets was also mentioned as a positive factor that enhanced urban thermal comfort. Due to the nature of climatic conditions in Mardin, it is not common to experience breezy days during the summers. Therefore, a breeze stands as a desired attribute of comfort in the streets.

Table 6.27 Sample quotations for `Breeze`

"As you can feel, Mardin is like hell in the summer. We give thanks to God when there is a slight breeze." (M,22, Old Town) *"I am from Izmir originally, we have also really hot summer seasons but at least Izmir has some breezy days which you can rarely find in Mardin".* (F, 55, New Town) *"The tunnel under the `abbara` provides a slight breeze that I can feel in my face".* (M, 25, Old Town)

The final two most frequently mentioned attributes at the street scale are `pavements` and `urban furniture` which might seem small details but can still have an influence on participants' perceptions. Table 6.28 and 6.29 present example quotations related to each defined attribute.

Table 6.28 Sample quotations for `Pavement`

"We have witnessed that the asphalt on the main arterial road melted due to the extreme temperatures last summer. Many people suffered from the sticky and fluidic asphalt." (M,23, New Town) *"In the heritage town, all pedestrian streets are paved with stones. When the municipality waters the streets for cleaning purposes (after garbage collection), it also helps cooling during the evaporation of the sprinkled water on the hot stone."* (F, 45, New Town)

Table 6.29 Sample quotations for `Urban Furniture`

"I think more shadowy sidewalls can be created via construction of a continuous structure like a wooden pergola. It can be wreathed with creeper which might support both aesthetic and comfort quality. " (F,33, New Town) *"Sunshades in front of the shops in Ravza Street provide shadow for most of time. But this shopping street is a special case, we are exposed to the sun in the rest of the city "* (F,40, New Town)

In summary, participants declared various design attributes that potentially influence the thermal comfort at the street level. Content groups derived from in-depth interviews reveal that some attributes are related to micro-details (i.e. pavement, furniture) at the street scale while others are relevant to the physical form (i.e. arcaded passages, shading) of the streets. Linked to the physical form of the streets, the next section presents an analysis at the city scale of the key determinants of outdoor thermal comfort.

6.4 City Planning and Provision of Urban Thermal Comfort

City planning is the process of decision making related to urban infrastructure, transportation networks, land use, construction typologies, construction densities, population densities, vegetation ratios and many other urban dimensions. All of these dimensions have an influential role on the provision of thermal comfort in a city, as well as in determining the level of energy consumed in providing everyday life comfort from residential purposes to commuting requirements.

Therefore, approaching city planning from a climate responsive point of view comes to fore as an upper scale strategy for provision of thermal comfort and has the potential to reduce the amount of energy consumed in urban areas.

Since this research focuses on urban thermal comfort and the energy consumed for the provision of that comfort, this section explores only the factors influencing the perceived thermal comfort at the city level.

6.4.1 Perceived Attributes of Thermal Comfort in a City

In order to explore the perceived attributes of thermal comfort in a city, a content analysis was performed with the data collected via in-depth interviews.

Table 6.30 Content groups of perceived attributes that enhance thermal comfort in a city

Attributes	**Frequency of mention**	**Percentage**
Green spaces/breathing points	296	42 %
Building density	150	21 %
Accessibility without sun exposure	136	19 %
Accessibility to urban services	78	11 %
Children and elderly-friendliness	46	7 %
TOTAL	**706**	**100 %**

Source: Author`s original

As Table 6.30 presents, with the ratio of 42 % `green space` is the most mentioned design attribute of thermal comfort in Mardin. Subsequently, with ratio of 21 %, `building density` comes forward as the second most mentioned attribute. Afterwards, `accessibility without sun exposure` constitutes 19 % and `accessibility to urban service` comprises 11 %. Lastly, 'children and elderly-friendliness' stands as the least-mentioned attribute with a ratio of 7%.

Beside the aesthetic beauty of green spaces, respondents mentioned the cooling and relieving effect of green spaces within the dense urban areas where the climatic conditions can reach intolerable levels. Green spaces are defined as `*fire assembly points*` for the summer days in which the felt temperature in urban areas can rise up to 50 degrees. Especially during the summer evenings, most families prefer to spend time in green spaces to get the benefit of natural cooling as well as using that opportunity for socializing. As mentioned in the housing section, the use of open space is an essential part of life in Mardin. It was observed that although not many green space exist in Mardin, community parks were full of people from different age groups from children to elderly people.

Closely related to the presence of green spaces, the second most mentioned attribute at the city scale was building density. Building density includes the ratio of constructed land to the open land, distances between buildings and the uncomfortable environment created surrounding high-rise apartment blocks. Respondents complained about the negative impact of construction density on perceived thermal comfort in Mardin. The density of construction creates a catastrophic atmosphere with less fresh air and more heat in the surface level.

In line with the research findings at the street level, accessibility without sun exposure is a significant indicator of urban thermal comfort in the city. Preferences in daily commuting modes depend on different factors such as the distance to final destination, travel time and/or cost and comfort of the journey. In Mardin, sun exposure is a significant factor influencing the way(s) citizens move within the city. Extreme summer temperatures and the risk of being exposed to sun might potentially push people to use private transportation modes even for relatively shorter distances convenient for walking under usual conditions.

Participants also underlined the importance that accessibility to urban services such as hospital, school and working had on the overall level of thermal comfort in the city. Accessibility here is correlated with the presence of a comfortable walking path that allows pedestrian movement with a significant level of thermal comfort. The more services are within walkable distances, the less transportation demand (and energy consumption) there is.

In relation to the walkability dimension, the last content group mentioned by the participants was children and age friendliness of the city. In terms of thermal comfort under extreme climatic conditions, participants defined children and elderly people as relatively more vulnerable groups in urban areas. This category has parallels with the street furniture attribute which was defined as one factor influencing comfort at the street level. For instance, elderly people may desire urban furniture which serves as a shadowy stop for breaking/resting during walking experiences in the hot season.

6.5 Conclusion

This chapter has outlined the physical design attributes that have an influential role on the perceived thermal comfort in different layers of the city of Mardin. It has suggested that, while uniquely analysed in the particular context of Mardin, the relationship between physical space and the perceived thermal comfort draws attention a number of important issues in relation to climate responsive design.

As the chapter has shown, the thermal comfort concept which originated in the architecture discipline also has an outdoor dimension which calls for an understanding of dynamics set within a wider urban context. This research approaches urban space production with a conceptualization of gradual formation of the cities through articulation of different scales (from building to street, neighbourhood and city). The research highlights the importance of scale due to two main reasons. First, a great variety of urban alteration/interventions mainly introduced by the planning authorities in related planning institutions do not incorporate enough specific requirements for each layer of urban formation, particularly in Turkey. Second, the conventional approach to planning cities with a linear process of space production lacks consideration/integration of essential particularities that might potentially be the key for sustainability.

The chapter has also highlighted the significance of “human perception” in determining the direction of thermal comfort in urban areas. Exploration of perceived thermal comfort in different layers of urban life and linking the variance of perceptions with the design attributes of the urban environments, demonstrated a strong correlation between the way(s) physical space is shaped and the way(s) thermal comfort is perceived. The next chapter explores how this was dependent upon the design of the urban built environment. It develops the argument that the way urban components constitute a living environment in the Old Town provides a different vision compared to the formation of the built environment in the New Town. Thus, this difference fosters the variation(s) of perceived thermal comfort as well as the difference in energy consumption profiles for the provision of thermal comfort in the Old and the New Town.

CHAPTER 7

COMPARISON OF OLD & NEW TOWNS: Variations in Perceived Urban Thermal Comfort and Energy Consumption for the Provision of Thermal Comfort

7.1 Introduction

As chapter 5 has demonstrated, the way(s) the built environment has been shaped in the city of Mardin varies between the Old and the New Town. While this differentiation significantly affects the perceived thermal comfort in urban areas, the level of energy consumed for the provision of thermal comfort is also shaped by the physical organization of the urban settings.

This chapter presents the way(s) in which the formation of the built environment in the Old and New Town influence the perceived thermal comfort at housing, street and city scale experiences. To do this, the chapter follows the same structure of scales but introduces a discussion of the differences and similarities between design attributes and their influencing potential on thermal comfort and the amount of energy consumed for the provision of that comfort.

7.2 Housing Design Makes a Difference to Thermal Comfort and Energy Consumption

This section investigates the extent to which the formation of the built environment explains the variance in the perceived thermal comfort and energy consumption levels in the traditional and contemporary housing samples represented in this research by the New and Old Town settlements respectively. Following the structure of Chapter 6, four different attributes were used in the analysis for thermal comfort comparison. These attribute groups are \`Housing design attributes\`, \`Cooling and heating devices\`, \`Perceived thermal comfort\` and \`Perceived attributes of thermal comfort\`. Additionally, two more attribute groups entitled \`Microclimatic data\` and \`Energy consumption attributes\` are added to the analysis. \`Microclimatic data\` refers to the technical measurements of temperature and humidity values taken in sample houses and streets (see Chapter 4). \`Energy consumption attributes\` refers to the attributes which cause environmental damage either by carbon emission or the consumption of natural resources. Energy consumption attributes defined in the housing scale of this research are (1) heating costs, (2) cooling costs, (3) electric costs and (4) water costs. Table 7.1 presents the attribute groups used in the comparative analysis at the housing scale.

Table 7.1 Categories of attributes used in comparative analysis at the housing scale

Attribute Categories	Source of Data	Attributes
Housing design attributes	Housing Plans Housing Visits	(1) typology (2) material (3) size (4) orientation (5) floor (6) number of rooms (7) number of open space extensions (8) location of service zones
Cooling and heating devices	Questionnaire	Cooling (1) air conditioner (2) electric fan (3) ceiling Heating (1) stove (2) radiator (3) electric heater (4) combi boiler
Microclimatic data	Technical Measurement	(1) temperature (2) humidity
Perceived thermal comfort	Questionnaire	(1) hot (2) warm (3) slightly warm (4) neutral (5) slightly cool (6) cool (7) cold
Perceived attributes of thermal comfort	In-depth Interviews	(1) open space extensions (2) walling (3) external cooling devices (4) housing typology (5) accessibility (6) others
Energy consumption attributes	Questionnaire	(1) heating cost (2) cooling cost (3) electric cost (4) water cost

Source: Author`s original

7.2.1 The Relationship between the Design of a House and Differences in the Perceived Thermal Comfort in Old and New Town

Chapter 6 demonstrated that some design attributes significantly explain the variance in the perceived thermal comfort in houses. In order to understand the extent to which housing design attributes explain the difference between the Old Town and New Towns, a discriminant analysis was performed. Taking the results of the regression analysis presented Chapter 6 as an evidence base, in this analysis it is assumed that the housing design attributes explain the perceived thermal comfort to some extent. Based on this assumption, a discriminant analysis of Old and New Towns was performed in which the researcher examined the possibility that (attribute) groups were distinguished when the housing design attributes of thermal comfort are used as discriminating variables and analysed the nature of the differences.

Table 7.2 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 7.2 presents that `Material/Typology` (.748), `Orientation` (-.460), `Number of Open Space Extensions` (-.434) and `Location of Service Zones` (.359) are correlated the discriminant score.

Table 7.2 Structure matrix of built environment variables of thermal comfort

Built Environment Variables	**Function**
	1
Material / Typology	.748
Orientation	-.460
Number of Open Space Extensions	-.434
Location of Service Zones	.359
Size (a)	.062

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.
a. This variable not used in the analysis.

Table 7.3 shows the standardized canonical discriminant function that indicated how much each variable contributes, and in which direction, to the differentiation between results for the Old and New Towns. The larger the magnitude of the coefficient, the greater is that discriminating variable's contribution. According to Table 7.3 `Material/Typology` is the most influential discriminating variable among all general attribute groups of thermal comfort. This means `Material/Typology` has the largest contribution to the differentiation between Old and New Towns.

Table 7.3 Standardized canonical discriminant function coefficients matrix

Built Environment Variables	**Function**
	1
Orientation	-.343
Number of Open Space Extensions	-.380
Location of Kitchen and Bathroom	.332
Material/Typology	.746

Source: Output of SPSS analysis

Table 7.4 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicates that the group means are significantly different on the discriminant scores and the group mean of Old Town (1.381) scored significantly different than the New Town (-.1436).

Table 7.4 Functions at group centroids

Town	Function
	1
Old Town	1.381
New Town	-1.436

Source: Output of SPSS analysis

The result of the discriminant analysis shows that housing design attributes of vernacular architecture and contemporary apartment flats present a significant discrimination which leads to variance in comfort sensations. In order to understand which attributes influence the variance in the thermal comfort in each town, two separate multiple regression analyses were conducted between design attributes and the perceived thermal comfort levels in the Old and New Towns.

First the analysis was performed for the design attributes and thermal comfort evaluations conducted by users living in vernacular architecture (located in the Old Town). Table 7.5 presents the multicollinearity test between the attributes. Since all of the houses in the sample group face towards the South and construction materials do not vary within the group of housing samples from the Old Town, these two variables were excluded from the model. Moreover, since the `number of the rooms` is highly correlated with the size of house, only the number of rooms was included in the analysis.

Table 7.5 Pearson correlation of housing design attributes for Old Town

	DV	IV1	IV2	IV3	IV4	IV5	IV6	IV7	IV8
DV: Comfort in summer	1.000								
IV1: Typology	-.171	1.000							
IV2: Material	.	.	1.000						
IV3: Size	.192	.042	.	1.000					
IV4: Orientation	.	.	.	.	1.000				
IV5: Floor	-.088	-.118	.	.054	.	1.000			
IV6: Number of rooms	.273	.120	.	.756	.	-.002	1.000		
IV7: Number of open space	.273	.250	.	-.187	.	-.075	-.285	1.000	
IV8: Location of service zones	.060	-.118	.	.037	.	-.303	.020	-.224	1.000

Source: Output of SPSS analysis

In the end, five (typology, floor, number of open space, number of rooms and location of service zones) of eight attributes were included in the regression analysis; Table 7.6 shows the model of thermal comfort (Adjusted R^2: 0.77, F= 11.75, p<0.05). In the model, three of the five attributes made a contribution to explaining the variance in perceived thermal comfort in summer. These attributes include the 'number of rooms', 'number of open space extensions' and 'typology` of the house. Three attributes explain the variance in thermal comfort by 31 % (cumulating).

Table 7.6 Results of the regression analysis of housing design attributes and perceived thermal comfort in vernacular architecture in summer

VARIABLES	R^2	R^2 *Change*	*b*	*T*	*p*
(1) Number of rooms	.074	.074	.332	4.429	.016
(2) Number of open space	.208	.134	.824	4.654	.001
(3) Typology	.317	.108	-2.006	-3.427	.001
(constant)			8.043	7.106	
	Standard Error: 0.77 Adjusted R^2: 0.29 df1= 1 ,df2= 74 For Model: F= 11.746, p<0.05				

Source: Output of SPSS analysis

The most influential attribute in the model is the `number of open space extensions` which are the courtyards, terraces and housetops of the vernacular housing samples. Furthermore, court-yarded houses provide a more comfortable setting when compared to non-court yarded traditional housing sample. Moreover, even with very little contribution (0.74), the number of rooms in the vernacular housing units positively affect the variance in occupants' perceptions of comfort.

Second, the same regression analysis was performed for the design attributes and thermal comfort evaluations conducted by users living in the contemporary apartment flats. Table 7.6 presents the results of the multicollinearity test carried out comparing the attributes. Like the sample group in the Old Town, construction material, is excluded from the model as it does not vary within the group of samples from the New Town. However, unlike the Old Town, the orientation of the houses varies in the New Town, therefore `orientation` is included in the regression. Moreover, a high correlation between the size and `number of rooms` and `number of open space extensions` is observed. The correlation between `number of open space extensions` and `size` is not surprising, because the only open space extension in apartment flats is the balcony, and there is a linear relation between size/number of balcony and the size of the house. Therefore, the `size` attribute is excluded, assuming that it is also represented by `number of the rooms` in the model. Finally, since the location of service zones does not vary in the housing sample from the New Town, that attribute also excluded from the regression.

Table 7.7 Pearson correlation of housing design attributes for New Town

	DV	IV1	IV2	IV3	IV4	IV5	IV6	IV7	IV8
DV: Comfort in summer	1.000								
IV1: Typology	.276	1.000							
IV2: Material	.	.	1.000						
IV3: Size	.239	.362	.	1.000					
IV4: Orientation	.243	-.093	.	.111	1.000				
IV5: Floor	.118	-.182	.	-.216	-.279	1.000			
IV6: Number of rooms	.276	.430	.	.603	.178	-.157	1.000		
IV7: Number of open space	-.028	.011	.	.717	.165	-.057	.325	1.000	
IV8: Location of Service Zones	.	.	.	.	.	.	.	.	1.000

Source: Output of SPSS analysis

Five (typology, floor, # of open space, # of rooms and orientation) of eight attributes were included in the regression analysis; Table 7.8 shows the resulting model of thermal comfort (Adjusted R^2: 0.63, F= 6.006, $p<0.05$). In the model, only one attribute made a contribution to explaining the variance in perceived thermal comfort in summer. The 'number of rooms' attribute explains the variance in thermal comfort by 7 percent. That shows the formation of the houses in the New Town does not contribute much to the perceived thermal comfort levels.

Table 7.8 Results of the regression analysis of housing design attributes and perceived thermal comfort in contemporary apartment flats in summer

VARIABLES	*R^2*	*R^2 Change*	*b*	*T*	*p*
(1) Number of rooms	.076	.076	1.074	-.878	.017
(constant)			-1.598	2.451	
	Standard Error: 1.55 Adjusted R^2: 0.63 df1= 1 ,df2= 73 For Model: F= 6.006, $p<0.05$				

Source: Output of SPSS analysis

A comparison of perceived thermal comfort values in summer displays that the housing design attributes do not directly explain the variance in comfort levels in the contemporary apartment flats. However, the presence of open space extensions and the typology of the house itself positively influences the thermal sensation in the vernacular houses. During in-depth interviews (a finding now reinforced by the regression model above), participants frequently mentioned how balconies in the apartment flats failed to satisfy the provision of thermal comfort as effectively as courtyards or terraces. Responses from participants highlighted different reasons for this inadequacy. First, the position of the balcony within the house plan influences the function of the balcony as the only place open to fresh air. As these participants commented:

"We are not able to use our balcony during the day, because it gets the sun from 11 am until the late afternoon. My neighbour opposite is luckier because her balcony gets the sun in the morning and it becomes shadowy in the afternoon." (Female, 25)

"My flat has two balconies. The big one is facing South, while the other one faces North. While one is exposed to direct sun, the other becomes shady. I spend most of time on the balconies if I am at home during the summer. " (Male, 38)

Courtyards and terraces in the Old Town face towards the South since the heritage town was developed on the slope of a hill. This strategy means that the sun comes to the open space in the morning and, since it goes over the hill by 1pm, courtyards become shady in the afternoon. The New Town is not developed on the hill but that does not necessarily mean a design strategy can not be formulated according to the movement of sun and the positioning of balconies in the houses.

Secondly, the size and the form of the balconies do not provide the same flexibility in terms of accommodating different functions while benefitting from climatic conditions as in courtyard or terraced areas. The following extracts present some examples of this:

"The production of sumac extract is my source of income. Sumac extract production requires large open spaces where you can spread out the boiled sumac as a thin layer in trays. Trays should receive direct sun rays in order to be dried in 2-3 days. Otherwise it moulds. The terrace is the best place to dry it since it is totally open to the sky. Balconies are not large enough to do it." (Female, 49)

"Courtyard is like a "joker" place that we can use for different purposes. As you see, during the summer it is convenient for my children to play in the inflatable pool. During the evenings we usually have our dinner in the courtyard. It also allows for drying of laundry and desiccating the food." (Female, 32)

The same comparison is made for winter thermal comfort perceptions in the vernacular and contemporary samples of houses. Table 7.9 shows the model of thermal comfort (Adjusted R^2: 0.38, F= 47.11, p<0.05) in winter. In the model, only one attribute made a contribution to explaining the variance in perceived thermal comfort in winter. The attribute of 'location of service zones' explains the variance in thermal comfort by 38 percent. That shows the location of service zones in the vernacular houses has a significant contribution on the perceived thermal comfort in winters.

Table 7.9 Results of the regression analysis of housing design attributes and perceived thermal comfort in vernacular architecture in winter

VARIABLES	R^2	R^2 ***Change***	***b***	***T***	***p***
(1) Location of Service Zones	.383	.383	-2.564	-6.864	.000
(constant)			7.721	14.475	
	Standard Error: 1.56 Adjusted R^2: 0.38 df1= 1 ,df2= 76 For Model: F= 47.112, $p<0.05$				

Source: Output of SPSS analysis

> *"When we were living in the Old Town, I was around 10 years old. I remember that we had to step on the snow to reach the bathroom in the winter. There was a wood-stove for heating the bathroom but the transition from bathroom to living room was freezing."* (Male, 25)

The above quotation is one of the most frequently made complaints about the winter conditions in vernacular houses. As discussed before, there was limited technical infrastructure in the period when the heritage town was developed, leading to the separation of service zones from the living spaces of houses. Today, although there are different reasons to move from Old Town to New Town, the uncomfortable winter experience is the only thermal comfort related reason for moving. Participants whose service zones are designed as a part of the indoor living space of their house present high thermal comfort satisfaction compared to others. Today, people who are not willing or able to move due to financial reasons try to bring additional solutions, such as building an additional zone in the living space or constructing a canopy layer for the transition zone to minimize discomfort in winter.

Later on, the same regression analysis was performed for the design attributes and thermal comfort evaluations conducted by users living in the contemporary apartment flats. However, regression results did not show any significant outcome for the relationship between the housing design attributes and the winter comfort in the flats.

In summary, the regression results present that the role of housing design attributes on the perceived thermal comfort is much more significant in the vernacular houses compared to contemporary apartment flats. Furthermore, the relationship between physical design attributes and the perceived thermal comfort in both cases is more visible in the summer. That is highly correlated with the problem of cooling which has been discussed in the Chapter 5. Table 7.10 shows the attributes which contribute to the explanation of variation in the thermal comfort perceptions according to vernacular and contemporary houses in different seasons.

Table 7.10 Housing design attributes influencing the perceived thermal comfort levels in vernacular and contemporary housing samples

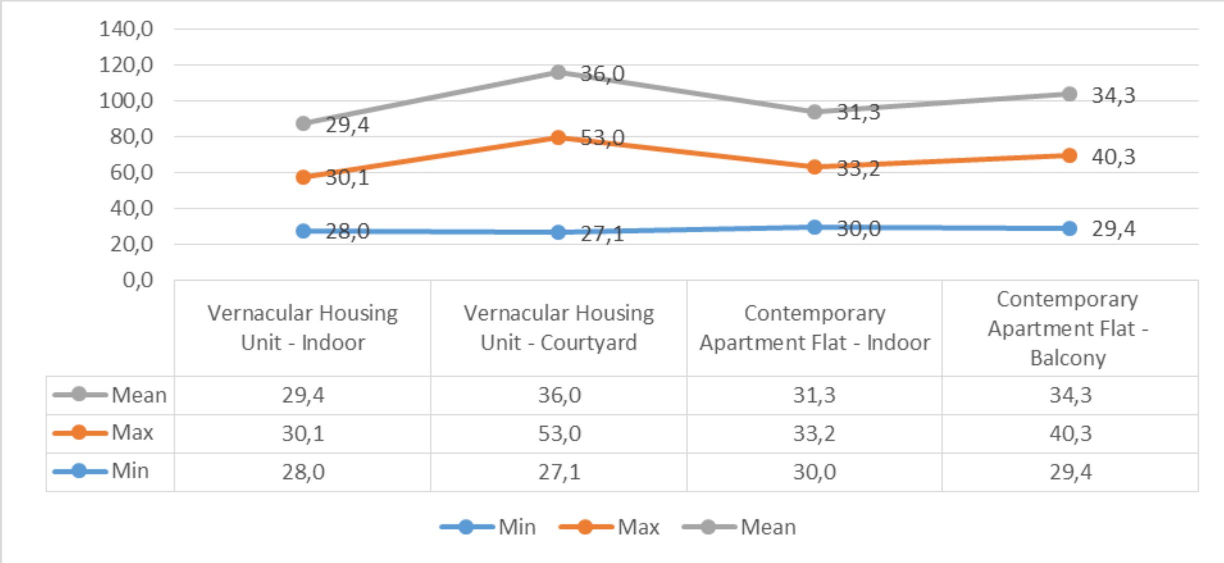
	Vernacular Architecture	Contemporary Apartment Flat
Attributes influencing Thermal Comfort in Summer	Number of rooms Number of open space extensions Typology	Number of rooms
Attributes influencing Thermal Comfort in Winter	Location of service zones	

Regression analysis revealed that while three attributes (typology, number of open space extensions and number of rooms) positively influence the perceived comfort in the vernacular houses, the variance of comfort in the apartment flats is slightly influenced by the number of rooms in the house.

The only attribute that was not included in the regression models was the construction material of the houses. As explained in Chapter 5, both towns have a dominant type of construction material. While samples from the Old Town present stone houses, samples from the New Town represent concrete apartment flats. Therefore material as an independent attribute was not included in the comparative analysis. In order to understand the role of material, and triangulate the socially constructed data with a technical experiential data, a comparative measurement was conducted in order to control the variance in the climatic values -such as temperature and humidity- on the inner and external surface of the walls of sample houses.

Figure 7.1 presents the records of the measured temperature values in the sample houses. The technical measurements taken in the courtyard type of housing unit and apartment flat presented a significant level of difference in the measured temperature values. As seen in Figure 7.3, while the average temperature difference between the balcony and indoor space was 3 °C in the sample flat (New Town), the average value difference between courtyard and the indoor space was 6.6 °C in the vernacular housing unit (Old Town). This 3.6 °C difference can be explained by the thermal mass of walls which is mainly composed of large stones (thickness: 100 cm) in the courtyard type of house and thin bricks (19 cm) in the contemporary apartment flat. The stone, as a high thermal mass material, has more potential to absorb, store and release heat than the brick, which represents a low thermal mass material. As Kosny et al. (2001) assert, a thicker building envelope structure delays and flattens thermal waves caused by fluctuations in the outdoor temperature.

Figure 7.1 Comparison of recorded temperature values (°C)

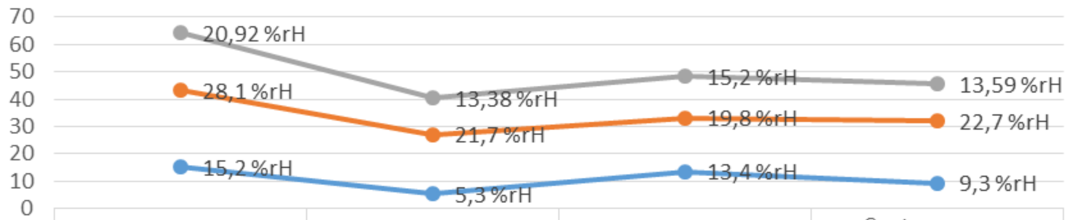


Author`s original

Although the mean values above do not show extreme levels of difference, it is possible to see significant differences in the indoor and outdoor temperatures for different hours of the day. For instance, while at 11am the data logger in the balcony shows 42 °C, the data logger inside the contemporary flat shows 32.2 °C. Simultaneously, while a temperature of 51.60 °C was recorded in the courtyard (due to direct exposure to the sun), the indoor temperature in the vernacular room was recorded as 29.5 °C at 11am. That shows the wall structure made of stones with a width of 100cm in the vernacular houses prevents overheating and provides cooler indoor environment compared to the walling structure made of brick with a width of 19cm.

On the other hand, as seen in Figure 7.2, measurements of humidity values do not present extreme variations. While average humidity is measured as 13.59 %rH in the balcony, it is recorded as 13.38 %rH in the courtyard. However, there is a 5.9 %rH difference in the average values of indoor humidity levels in the rooms of courtyard housing unit and the apartment flat. This variation does not create a significant impact on the perceived thermal comfort since levels of relative humidity in a hot dry climate are too low to affect evaporation from the body which has a cooling effect on thermal comfort (Hanna, 1997).

Figure 7.2 Comparison of recorded humidity values (%rH)

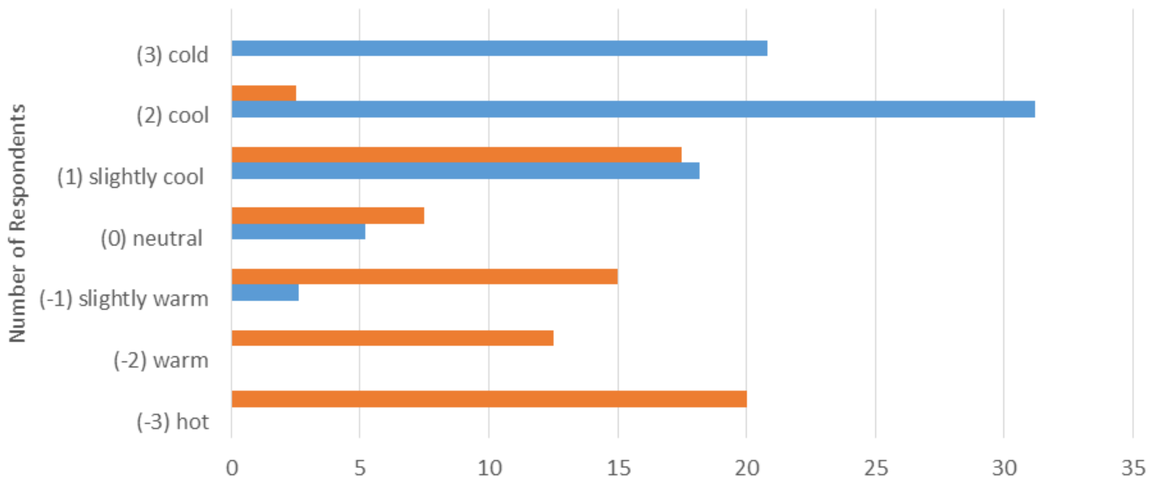


	Vernacular Housing Unit - Indoor	Vernacular Housing Unit - Courtyard	Contemporary Apartment Flat - Indoor	Contemporary Apartment Flat - Balcony
Mean	20,92	13,38	15,2	13,59
Max	28,1	21,7	19,8	22,7
Min	15,2	5,3	13,4	9,3

Author`s original

In-depth interviews also support the difference of measured values in sample housing units. As seen in Figure 7.3, while the respondents from the Old Town cluster towards the 'cooler' side of the diagram, respondents from New Town cluster towards the 'warmer' side.

Figure 7.3 Comparison of perceived indoor thermal comfort in vernacular and contemporary houses

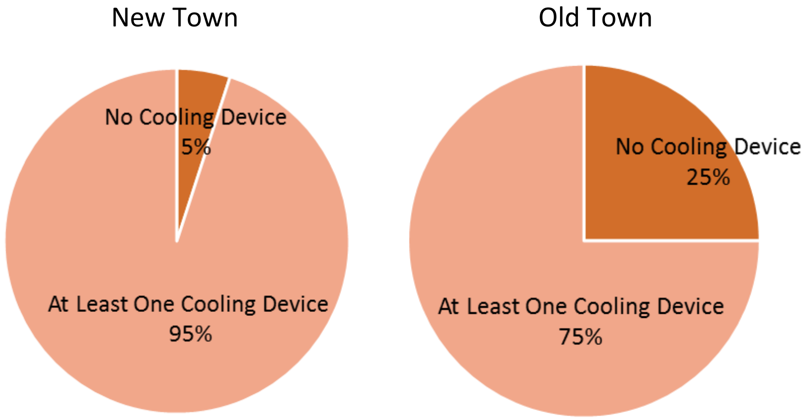


	(-3) hot	(-2) warm	(-1) slightly warm	(0) neutral	(1) slightly cool	(2) cool	(3) cold
New Town	20	13	15	8	18	3	0
Old Town	0	0	3	5	18	31	21

Author`s original

In line with comfort rankings, statistics also support the difference recorded for indoor climatic values. As seen from Figure 7.4, 95% of participants in the New Town need at least one cooling device while this ratio decreases to 75% in the Old Town.

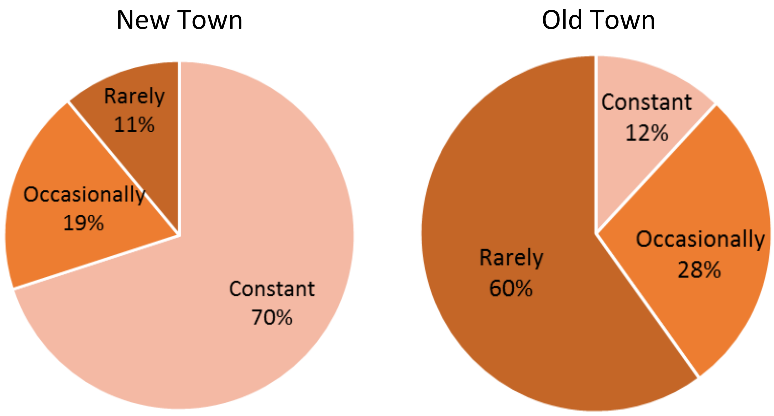
Figure 7.4 Presence of cooling device at homes



Source: Author`s original

Figure 7.4 demonstrates the requirement of additional cooling devices in both Towns. However, the type of device and the frequency of usage of devices varies from Old Town to New Town. For instance, Figure 7.5 presents the frequency of usage of air-conditioners in the Old and New houses. The ratio of constant use of cooling device in the New Town (70%) is extremely high comparted to the ratio in the Old Town (12%). On the other hand, only 11% of participants rarely use air conditioners in the New Town while this ratio increases up to 60% in the Old Town. It is essential to emphasize that Figure 7.5 represents the distributions of residents who have air-conditioners in their homes. This difference shows that the vernacular architecture allows provision of cooling with some other small electronic appliances rather than air-conditioners as in the apartment flats.

Figure 7.5 Distribution of use of air-conditioners in the Old and New Town



Source: Author`s original

The following interview extracts show the level of dependency on the use of air-conditioners significantly varies from Old Town to New Town:

"We have been using the air-conditioner for the last 3years. I don't know why, but summers became extremely hot in the recent years. We are still lucky compared to others (meaning New Town), our house is cool most of the time. We use air-conditioner only for a few hours, usually around 1pm or 2pm. Once the room gets cooler, it remains in a tolerable level all-day long. In the evenings, we are in the courtyard anyway." (Female, 28, Old Town)

"The air-conditioner is our lifesaver. Without cooling the house, it is impossible to stay at home, particularly when we have more people in the house. When we are alone, my children are almost naked. Imagine when we host our guests, you can't even drink a cup of tea if I close the air-conditioner. Would you like to experience it? (Interviewee jokes)" (Male, 35, New Town)

Contrary to the New Town, the vernacular architecture of the type found in Old Mardin provides particular advantages to maximizing the benefits from natural air ventilation. Two of the significant features most frequently mentioned in the interviews were the presence of courtyards and terraces in residential units. These two architectural features provide air ventilation, natural cooling and also the opportunity for local people to escape to an external space when they experience thermal discomfort inside their home. The next section explores to what extent the use of cooling devices explains the differences between the perceived thermal comfort in the Old and New Towns.

7.2.2 The Relationship between the Use of Cooling and Heating Devices and Differences in the Perceived Thermal Comfort in Old and New Town

In order to understand the extent to which technical attributes explain the difference between the Old and New Towns, two regression analyses were performed separately for each of the sample groups. The first was performed for the number of cooling devices and thermal comfort evaluations conducted by users living in the apartment flats. As seen from the Table 7.11, multicollinearity does not constitute a problem for this test.

Table 7.11 Pearson correlation of cooling devices

	DV	IV1	IV2	IV3
DV: Comfort in summer	1.000	-.455	.270	.
IV1: Number of Electric Fans	-.455	1.000	-.120	.
IV2: Number of air-conditioners	.270	-.120	1.000	.
IV3: Number of Ceiling Fans	.	.	.	1.000

Source: Output of SPSS analysis

Table 7.12 shows the model of thermal comfort (Adjusted R^2: 0.23, F= 4.54, $p<0.05$). In the model, the number of electronic fans and air-conditioners made a contribution to explaining the variance in perceived thermal comfort in apartment flats in the New Town. Two attributes explain the variance in thermal comfort by 25 percent.

Table 7.12 Results of the regression analysis of cooling devices and perceived thermal comfort in apartment flats in summer

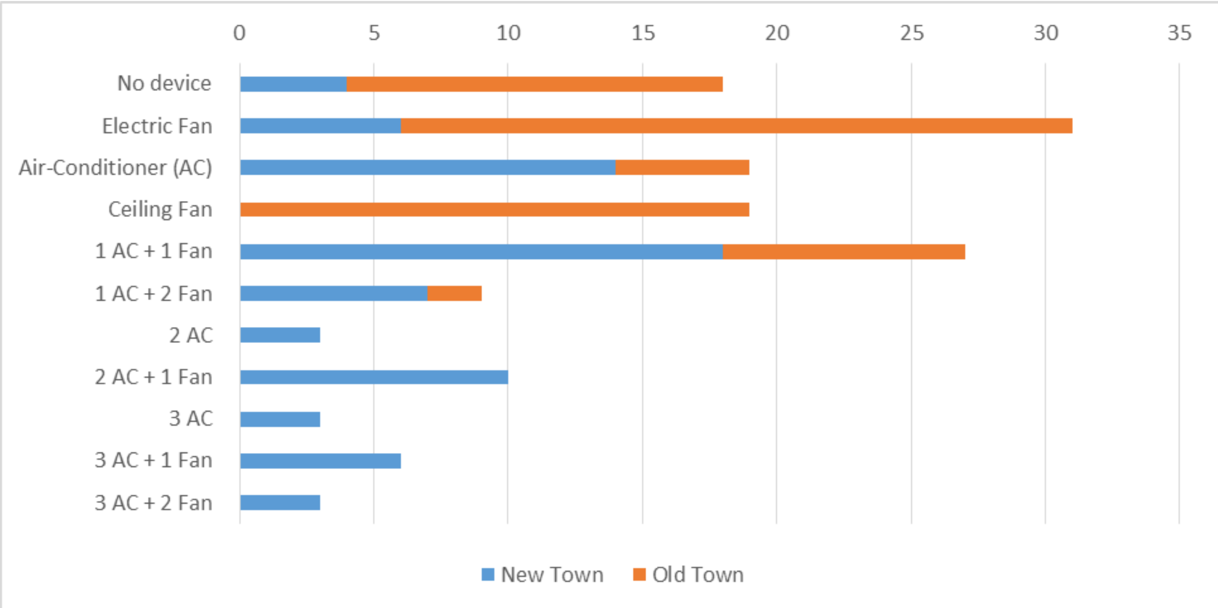
VARIABLES	*R^2*	*R^2 CHANGE*	*B*	*T*	*P*
(1) number of electric fans	.207	.207	-1.210	-4.187	.000
(2)number of air-conditioners	.254	.047	.369	2.131	.037
(constant)			3.138	7.646	

Standard Error: 1.41
Adjusted R^2: 0.234
df1= 1 ,df2= 72
For Model: F= 4.539, p<0.05

Source: Output of SPSS analysis

On the other hand, the regression analysis performed for the vernacular housing samples did not give significant outputs regarding the number of cooling devices used for the provision of thermal comfort in the houses. Both regression outcomes present that the influencing level of cooling devices on the comfort level in the New Town is stronger than in the Old Town. The following figures supports that argument by presenting the distribution of number of various cooling devices among the total sample housing units included in this research.

Figure 7.6 Distribution of number of cooling devices in the old and new houses



Source: Author`s original

As seen in Figure 7.6, people in the apartment flats provide indoor thermal comfort by using various numbers of electronic devices. It is observed that the variance in the apartment flat is larger than in the vernacular housing units. The number of cooling devices goes up to 5 (3 air-conditioners + 2 electric fans) in some samples in the New Town. Comparatively, the use of devices in vernacular houses is accumulated more towards the use of small appliances such as electric and ceiling fans.

This variation could be explained by the particular advantages of getting the benefit of natural ventilation via the design of vernacular houses.

The previous chapter demonstrated a correlation between the design of houses and the perceived thermal comfort in the houses. In line with that, the following section presents the differences between the perceived attributes of thermal comfort in the Old and New Towns. It aims to clarify the variance displayed in Figure 7.6.

7.2.3 Housing Design Creates Differences between the Perceived Attributes of Thermal Comfort in the Old and New Town

Recalling the defined attributes of thermal comfort extracted from the in-depth interviews, Table 7.13 presents the differences between the frequency with which each content group defined by the participants from the Old and the New Town was mentioned. As seen in the table, almost all content groups present variations in terms of the ratio of frequency of mention.

Table 7.13 Content groups of perceived attributes that enhance thermal comfort in a house

Content Groups	Sub-groups	OLD TOWN	NEW TOWN
Open space extensions	Courtyard Terrace Garden Balcony	40 %	36 %
Walling	Wall thickness Wall material Insulation	14 %	27 %
External cooling devices	Air-conditioner Electric fan Ceiling fan	9 %	23 %
Housing typology	Building form Ceiling structure	17 %	11 %
Accessibility to service zones	Accessibility to kitchen Accessibility to bathroom	13 %	1 %
Others	Interconnectedness between rooms Diversity of rooms Renewable Energy	7 %	2 %
TOTAL		**100 %**	**100 %**

Source: Author`s original

Not surprisingly, the presence of an open space extension is the most important attribute for both participant groups from the Old and New Town. However, the ways in which participants expressed their ideas vary in the two towns. As seen in the extracts below, participants living in the Old Town mostly expressed their pleasure in having open spaces such as courtyard, terrace and housetops, while participants in the New Town suffered from the lack of open space extensions and the insufficiency of balconies in subsidizing the functions of open spaces found in the Old Town. More than half of the participants mentioned their desire to live in a house with a garden in the New Town. However, it is very uncommon to find this kind of detached housing typology in Mardin. There was only one sample unit representing a detached typology in this research.

> *"The terrace provides a slight breeze in summer evenings. We usually spent time in terrace until 12-1am in the night. My husband made a working table for our son and daughter here. With additional lighting now they have an open air study room."* (Female, 33, Old Town)

> *"I would like to live in a detached house with a garden, rather than living in this flat. I really miss my old days in the heritage town, especially in the summer. We were living in touch with nature. Here everything is unnatural, even the air that we breathe. It is produced by this machine (points the air-conditioner), we are like patients addicted to respiratory equipment."* (Male, 24, New Town)

In line with the lack of open spaces extensions, the inevitable use of air-conditioners comes out due to the 'suffocating' feeling in indoor spaces. As seen in Table 7.13, while the frequency of the mention ratio of `cooling devices` was 23% in the New Town, this ratio decreases to 9% in the Old Town. Although some participants from the New Town define air-conditioners as lifesavers, many respondents mentioned undesirable issues that originated from the cooling devices:

> *"We moved to New Town 5 years ago for my mother`s regular medical treatment in the central hospital. She is 75 years old and it was not easy for her to travel from Old Town to the hospital regularly. After we moved, she couldn't adapt to living with air-conditioners for a long time. With an air conditioner, we are able to cool only one room and it is dangerous to sleep when the air conditioner is on in the night. She is very sensitive and she gets sick easily." (Male, 37, New Town)*

The above quotation also underlines the importance of adaptation of the human body to alterations in climatic conditions at the domestic scale. It supports the fact that, as Robertson et al. (1985) assert, air-conditioners can cause various syndromes such as rhinitis, nasal blockage and dry throats, and headaches.

Another content group presenting difference between the Old and New Towns is the structure of walls, including thickness, material and insulation. Similar to the attribute of open space extensions, the walling type in vernacular houses was pointed to as a positive attribute that enhanced thermal comfort, while the walling type in apartment flats was mostly mentioned as a weak component of the housing design. The following extracts support that difference in the way that walling was perceived by respondents:

> *"After my older son got married, we built that additional room for my new daughter in law. But this additional room is not built of stone, it is made of regular brick. There is a big comfort difference between this room and the main house. Brick absorbs the sun and the room gets really hot especially in the afternoon. During the night, they open the door and keep the electric fan turned on."* (Female, 55, Old Town)

> *"Contractors usually try to minimize the materials required for the proper construction of an apartment. The walls are very thin, almost like a cardboard, they don't provide good protection for heat and noise."* (Male, 37, New Town)

In brief, the statistical regression models, technical climatic measurements and interviews demonstrated that housing design has an important role on the provision of thermal comfort in everyday life experiences. The variation of perceived thermal comfort in the vernacular houses and the apartment flats was also clearly measurable and observable. Taking this as an evidence base, the next section focuses on the influence of this difference on the energy consumption patterns for the provision of indoor thermal comfort.

7.2.4 Housing Design Creates Differences in the Amount of Energy Consumed for the Provision of Thermal Comfort in the Old and New Towns

In order to understand the variation in the amount of energy consumed for the provision of thermal comfort, four sets of data were used in the comparative analysis. Housing scale energy consumption attributes defined in this research were (1) heating costs, (2) cooling costs, (3) electric costs and (4) water costs. Energy consumption attributes refer to attributes which contribute to environmental damage either through carbon emission or the consumption of natural resources. In this respect, all of the cost values collected during interviews were converted into consumption units according to heating and cooling devices, electric devices and domestic water usages in each sample house. In order to understand which energy consumption attributes explain the difference between the Old and New Town, a discriminant analysis was then performed. In the discriminant analysis of vernacular houses and apartment flats, the possibility of groups being distinguished was examined by using the energy consumption attributes as discriminating variables.

Table 7.14 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicates how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 7.14 presents that cooling cost (.655), heating cost (.649), electric cost (.585) and water cost (.000) are correlated with the discriminant score.

Table 7.14 Structure matrix of domestic energy consumption attributes

Energy Consumption Attributes	**Function**
	1
Cooling cost	.655
Heating cost	.649
Electric cost	.585
Water cost	.000

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.

Table 7.15 shows the standardized canonical discriminant function that indicated how much each variable contributes, and in which direction, to the differentiation between the Old and New Towns. The larger the magnitude of the coefficient, the greater that discriminating variable's contribution is. According to Table 7.15, heating cost has the most significant contribution to the differentiation between the Old and New Towns. Afterwards, cooling and electric costs explain the differentiation almost to the same extent.

Table 7.15 Standardized canonical discriminant function coefficients matrix

Energy Consumption Attributes	***Function***
	1
Heating cost	.696
Cooling cost	.430
Electric cost	.457
Water cost	-.511

Source: Output of SPSS analysis

Table 7.16 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicate that the group means are significantly different to the discriminant scores and the group mean of Old Town (-1.078) scored significantly different to the New Town (1.122).

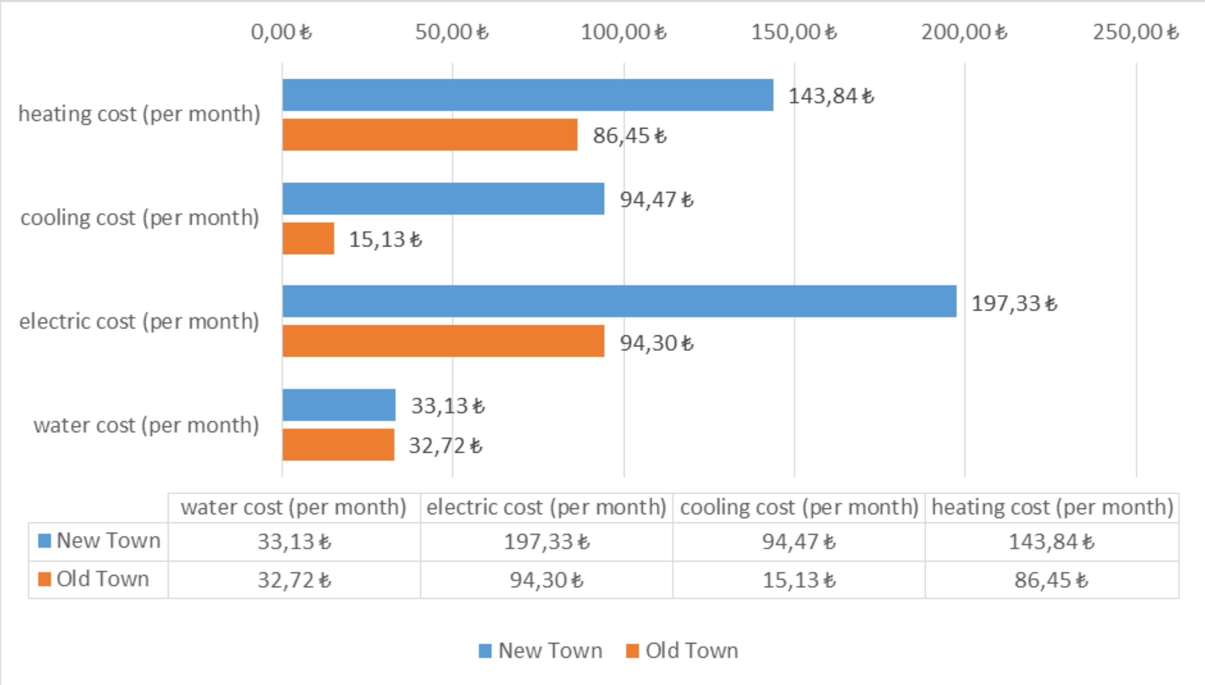
Table 7.16 Functions at group centroids

Town	**Function**
	1
Old Town	-1.078
New Town	1.122

Source: Output of SPSS analysis

In line with the outcomes of discriminant analysis, descriptive data regarding the cost of heating, cooling, electric and water usages supports the significant discrimination between two towns. As seen in Figure 7.7, while the average heating cost for an apartment flat is 144 ₺, the average cost in the vernacular units is 86 ₺. This is mainly caused by the use of stoves in the vernacular houses. The cost of coal and wood used for burning is less than the cost of central heating in the new town. Since the use of natural gas has not yet been introduced in Mardin, central heating systems are also run using coal. However, it is not accurate to say there is an overconsumption in the New Town. This is because the use of stone usually allows the heating of one or two rooms in the vernacular units, while central heating provides equal heating for each rooms. This is why the satisfaction level of indoor thermal comfort in New Town is higher than the one recorded for the Old Town in winter. However, in terms of climate responsivity, the use of coal in both towns stand as a threat to the climate given its high carbon emission potential.

Figure 7.7 Comparison of average heating, cooling, electric and water cost in the Old and New Town



Author`s original

When it comes to cooling, while the cost of cooling in vernacular units is approximately 15 ₺, the average cost of cooling in contemporary apartment flats is 94 ₺, almost 6 times more. The gap between the average electric costs is almost parallel to the gap in the cooling cost. While average electric cost in the apartment flats is 197 ₺, the average cost in the vernacular units is 94 ₺. That shows almost 50 % of the electricity consumed in contemporary apartment flats goes towards cooling, while this ratio is 15% in vernacular houses.

Interview outputs also reveal that daily life in the New Town is highly dependent on the use of electricity. In case of an electricity power-cut (which happens frequently in Mardin), people are not able to use the air conditioner, boiler, lift and other facilities essential to everyday life. The following extract from the research diary displays the researcher's experience of a power cut during the interviews:

> *"…Today I have understood very well what an air-conditioner means for those who are living in the New Town. The electric cut during the interview was a terrible experience. The room became like a sauna in 10 minutes and we were drinking tea (we had to in a way, that's a part of hospitality in Mardin). The landlady opened the windows and tried to make feel us comfortable but indeed we were there to explore this kind of moments…"* (21.08.2014, research diary)

Electricity-dependent life in the New Town starts with the use of air-conditioners. People are unaware of the fact that they were triggering a vicious cycle between cooling the indoor environment and heating the urban outdoor environment. It is possible to see that almost every single building in the New Town has a facade covered by external engines of air conditioners (see Figure 7.8).

Figure 7.8 Sample facades covered with engines of air-conditioners

Source: Author's original

The heat re-released by these engines contributes to increase in the urban temperature which is referred as the urban heat island effect in the literature (Hassid et al., 2000; Kikegawa et al., 2006). In summary, the use of air-conditioners for the provision of indoor thermal comfort leads to an increase in urban heat, and the increase in urban temperature triggers the requirement of cooling in indoor spaces.

7.3 The Formation of the Streetscape as a Contributing Factor in Perceived Thermal Comfort

Analysis performed at the housing scale showed that both vernacular houses and apartment flats have some shared components which foster the provision of thermal comfort and affect energy consumption patterns. This section explores the differences in urban thermal comfort that were perceived for street level experiences. With this purpose in mind, three sets of attributes were used in the comparative analysis. Firstly, `perceived attributes of thermal comfort` (introduced in Chapter 6) were used to compare the influence ratio of each attribute on thermal comfort experiences of respondents from Old and New Town. Perceived attributes of thermal comfort identified by interviewees were (1) arcaded passages, (2) breeze, (3) landscaping, (4) pavement, (5) shading, (6) urban furniture, (7) water elements and (8) separated walk way. Secondly, `perceived climatic attributes` which were identified by pedestrians regarding their perception of (1) thermal sensation, (2) sun exposure, (3) wind and (4) humidity, were used for understanding the differences between sample streets from Old and New Town. Thirdly, experimental measurements of urban microclimatic data such as temperature and humidity were used to explain the differences between two sample streets in terms of "perceived climatic attributes". Finally, the mode of daily commute and perceived walkability in the streets were used to compare the role of physical design on energy consumption for daily commuting in both towns.

Table 7.17 Categories of attributes used in comparative street scale analysis

Attribute Categories	Source of Data	Attributes
Perceived attributes of thermal comfort	In-depth Interviews	(1) arcaded passages (2) breeze (3) landscaping (4) pavement (5) shading (6) urban furniture (7) water elements (8) separated walk way
Perceived climatic attributes	Street Questionnaire	(1) felt temperature (2) felt sun (3) felt wind (4) felt humidity
Perceived thermal comfort	Street Questionnaire	(1) hot (2) warm (3) neutral (5) cool (5) cold
Microclimatic data	Technical Measurement	(1) temperature (2) humidity

Source: Author`s original

7.3.1 Difference between the Old Town and New Towns in Terms of Perceived Attributes of Comfort in the Streets

Chapter 6 has demonstrated the attributes influencing thermal comfort perceptions for street level experiences. This section explores whether perceived attributes of comfort in the street explain the differences between the Old and New Town at the street scale. In order to understand the extent to which perceived attributes of comfort at the street scale explain the difference between the Old and New Town, a discriminant analysis was performed using the pre-defined attributes of thermal comfort.

In the discriminant analysis, the possibility of groups being distinguished when the perceived attributes of comfort in the street were used as discriminating variables was explored; an analysis of the nature of the differences was then performed.

Table 7.18 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 7.18 presents that `Vegetation` (.538), `Separated walk way` (.474), `Urban Furniture` (-.367) and `Pavement` (-.312) are correlated with the discriminant score.

Table 7.18 Structure matrix of perceived attributes of comfort in the street

Perceived attributes of comfort in the street	**Function**
	1
Vegetation	.538
Separated walk way	.474
Urban Furniture	-.367
Pavement	-.312
Arcaded passages (a)	.140
Breeze (a)	.097
Shading (a)	-.031
Water elements (a)	.003

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.
a. This variable was not used in the analysis.

Table 7.19 shows the standardized canonical discriminant function that indicated how much each variable contributed, and in which direction, to the differentiation between the Old and New Towns. The larger the magnitude of the coefficient, the greater that discriminating variable's contribution is. According to Table 7.19, `Vegetation` is the most influential discriminating variable among all general attribute groups of urban thermal comfort. This means `Vegetation` makes the largest contribution to the differentiation between Old and New Towns.

Table 7.19 Standardized canonical discriminant function coefficients matrix

Perceived attributes of comfort in the street	**Function**
	1
Vegetation	.769
Pavement	-.482
Urban Furniture	-.546
Separated walk way	.497

Source: Output of SPSS analysis

Table 7.20 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicates that the group means are significantly different to the discriminant scores and the group mean of Old Town (-.389) significantly scored different than the New Town (.405).

Table 7.20 Functions at group centroids

Town	**Function**
	1
Old Town	-.389
New Town	.405

Source: Output of SPSS analysis

The lack of vegetation in the New Town was one of the most frequently mentioned problems in the interviews. Participants declared their desire to have more trees for a comfortable walking experience, as in the following sample extract:

> *"I don't understand why the municipality does not plant trees alongside the streets. All streets are defined by apartment blocks, but they don't provide shadow if the sun is on the top. Trees can provide a shady path which we can walk under for protection."* (Female, 25, New Town)

Since narrow streets defined by the walls of vernacular houses provide a reasonable level of shading for pedestrians, the lack of vegetation did not significantly come to fore as it did in the New Town. Literature (see for instance: Emmanuel, 2007) identifies shading as one of the main strategies for providing comfortable conditions in warm climates. Added to that, the following extract exemplifies a smart way of positioning the streets to temper movements of the sun in the heritage town:

> *"In the morning, until the sun goes up to the top (of the hill), the left side of the streets are under the shadow of the walls. In the afternoon, the right side of the street becomes shady since the sun goes back to the hill."* (Male, 20, Old Town)

Another factor that influences comfort experiences in the streets of New Town is the lack of separated walk-ways. The only opportunity provided for pedestrians in the New Town are the narrow sidewalks attached to the traffic way without separation by vegetation or any other elements. This creates variations in thermal comfort of pedestrians as exemplified in the following extracts:

> *"In the first days of my work, I planned to go to my office on foot. I thought it was good for my health and also cost free. I tried it for a few days, then I realized that it was not as healthy as I had thought before. Sun beams amalgamated with the exhaust fumes coming from the road makes it hard to breathe."* (Male, 28, New Town)

> *"The back streets are fully pedestrianized and therefore not as wide as the main traffic road is. The sun is already disturbing, with the engines of cars, crowd and the congestion, it becomes even more unbearable to walk in the main street (referring to the only traffic street in the Old Town)"* (Male, 25, Old Town)

Walkability presents a significant influence on people`s preference to commute by vehicles or on foot. In this sense, participants mentioned urban furniture as a parameter that potentially encourages walking preferences in everyday life. For instance, as seen in the following extract, older participants mostly mentioned the requirement of resting stops alongside the walking paths:

> *"I am 70 years old now. 10 years ago, it was not a challenge for me to climb the stairs in the back streets. I was able to walk from the Republic Square to the end of shopping street. (Approx. 2 km). But now I desire sitting benches and resting points, it is hard for me to walk continuously when it is very hot. The sun is disturbing… Your uncle (interviewee points to her husband) doesn't even go out unless an urgent need emerges."* (Female, 70, Old Town)

Under extremely hot climatic conditions, any simple detail potentially creates a change in the perceived thermal comfort. The pavement is one of these details. Respondents mentioned the way in which pavement types influence the comfort of walking experiences, as demonstrated in the two extracts below.

> *"Since secondary streets are all paved with stone and framed by the stone walls of houses, it is cooler than the main street."* (Male, 38, Old Town)

> *"It is really difficult to walk when it is sunny. Walking on asphalt makes it hard since you feel the reflection of sun in your face. It feels like a steam engine is working under the road. Recently some streets have been paved with cobblestone and there is a tangible difference."* (Female, 23, New Town)

Both the discriminant analysis and content analysis revealed the significance of 'perceived comfort attributes' in explaining the variations between the Old and New Town. 'Perceived comfort attributes' were extracted from the most frequently mentioned factors emphasized during the interviews. The next section explains the way in which the physical formations of the streetscape influence the 'perceived climatic attributes' in both towns.

7.3.2 Perceived climatic attributes (temperature, sun, wind, humidity) and perceived overall thermal comfort variations in the Old and New Street

To understand how the physical formation of streets affects the perceived thermal comfort in everyday life, a street scale thermal comfort comparison was done between two sample streets representing the same characteristics from each town. As discussed in the methodology chapter, first, two sample streets representing the dominant street typologies in each town were identified. At this stage, two main criteria - pre-defined as "layout" (Gut and Ackerknecht, 1993) and "sky-view factor" (Oke, 1987) in the literature - were taken into consideration. Added to these two factors, "land use characteristics" were also taken into consideration on the assumption that it influences the ways and frequency in which people use streets (e.g: the variety of shops that might encourage walking).

As Chapter 5 demonstrated, while there is not a clear design strategy regarding street alignments in the New Town, it is possible to observe an obvious street design principle which suggests development in the direction of E-W in the Old Town. In line with this information, two sample streets presenting similar characteristics in terms of pavement and trees but different street alignments, were selected for comparison. Both streets present nearly the same sky-view factors however this does not necessarily mean that they have a similar width. The urban settings vary according to different factors such as irregularities in building heights or the location of crossing streets.

As presented in Chapter 4, three sets of data: (1) perceived climatic attributes (temperature, sun, wind, humidity), (2) technical measurements controlling the variations in temperature and humidity values, and (3) perceived overall thermal comfort, were used in street scale comparisons.

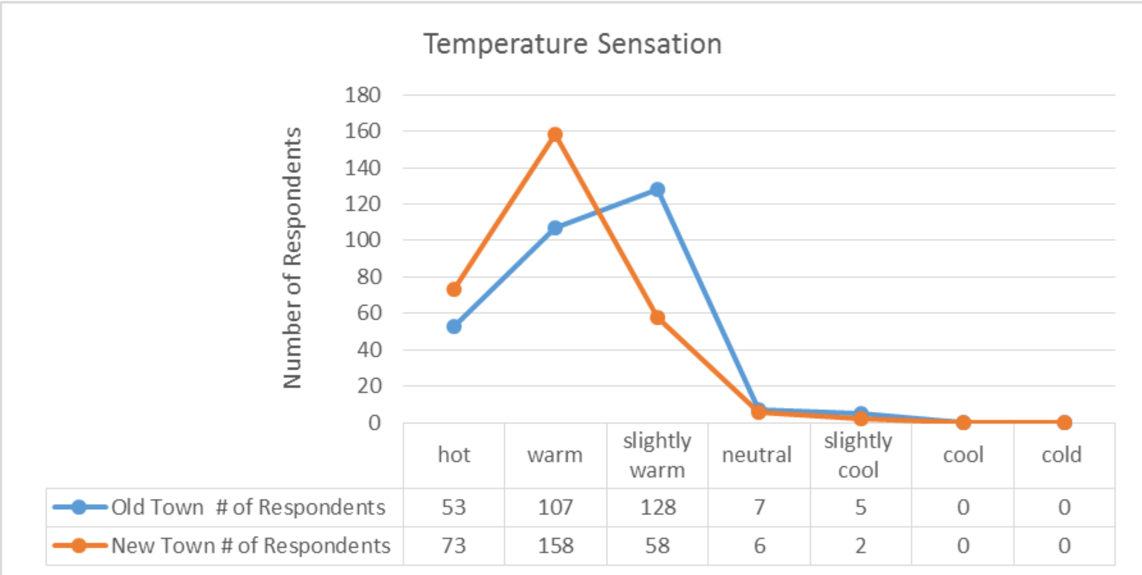
The street questionnaire was designed based on subjective assessment of pedestrians with regards to five sensation questions. The content of the questionnaire was prepared based on the ASHRAE (2004) standard questionnaire for thermal comfort studies and previous thermal comfort studies done by Yang et al. (2013) and Nikolopoulou and Lykoudis (2006). Participants were first asked about their feelings in terms of temperature sensation and to rate their feelings by using the scale shown in Table 7.21. Since the survey was conducted on a hot summer's day, responses were assigned values from (-3) to (3) as from "hot" to "cold".

Table 7.21 7-point temperature sensation scale

How do you feel in terms of temperature? (7 point scale)						
Hot	Warm	Slightly warm	Neutral	Slightly cool	Cool	Cold
-3	-2	-1	0	1	2	3

It was observed that people walking in the Old Street expressed different sensation values compared to people walking in the New Street. As seen in Figure 7.9, almost half (42%) of the people on the Old Street describes their thermal sensations as "slightly warm", while half (50%) of the people on the New Street reflected as "warm". On the other hand, while the ratio of people expressing their sensation as "hot" is 17% in the Old Street, it increases to 24% in the New Street. Not surprisingly, responses do not show a significant difference in terms of feelings such as "neutral", "cool" or "cold" since the average temperature measured in that date was 37 °C.

Figure 7.9 Comparison of temperature sensations of users in the sample streets



Source: Author`s original

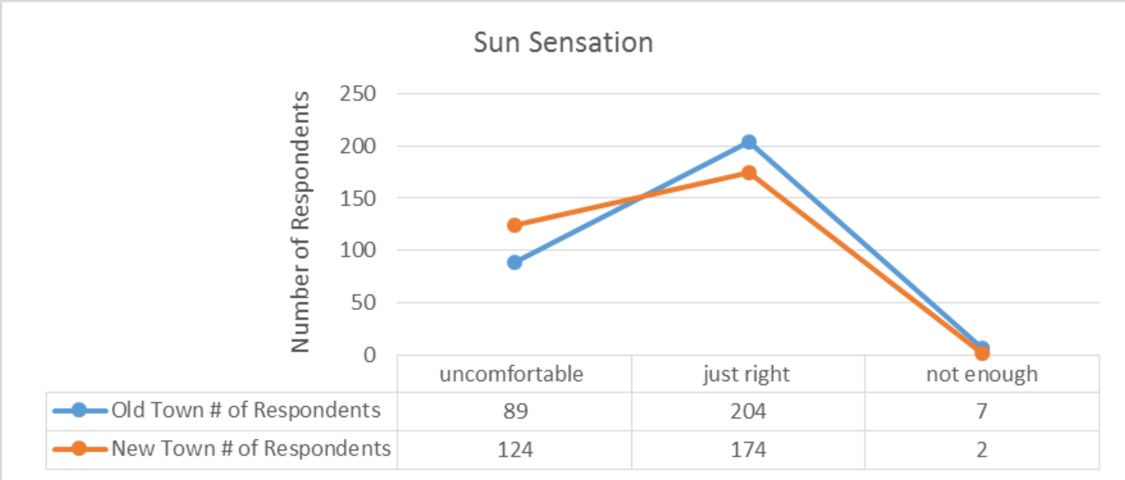
In relation to thermal sensation, participants were asked to evaluate their feelings about the sun. The aim was to understand the role of sun in shaping peoples' comfort in daily life experiences on the streets. To do this, participants voted for a value according to their experiences and feelings by using a 3-point scale seen in Table 7.22.

Table 7.22 3-Point sun scale

How do you feel about the sun? (3 point scale)		
Uncomfortable	Just right	Not enough
-1	0	1

As seen in Figure 7.10, 70% of participants from Old Town Street expressed that they were able to tolerate the sun during walking in the street, while this ratio was 58% in the New Town Street. Expressed another way, while 29% of people in the Old Town Street found the sun “uncomfortable”, this ratio increased to 41% in the New Town Street. Results present that there was a significant difference in terms of being exposed to sun in the Old and New Town. This difference can be explained by variances in the levels of shading on the streets. Statistics support the outcomes of in-depth interviews which reveal that people in the New Town present less tendency to walk outside, especially before 6pm, due to the lack of shading and intolerable effect of the sun.

Figure 7.10 Comparison of feeling of users in terms of exposure to the sun in the sample streets



Source: Author`s original

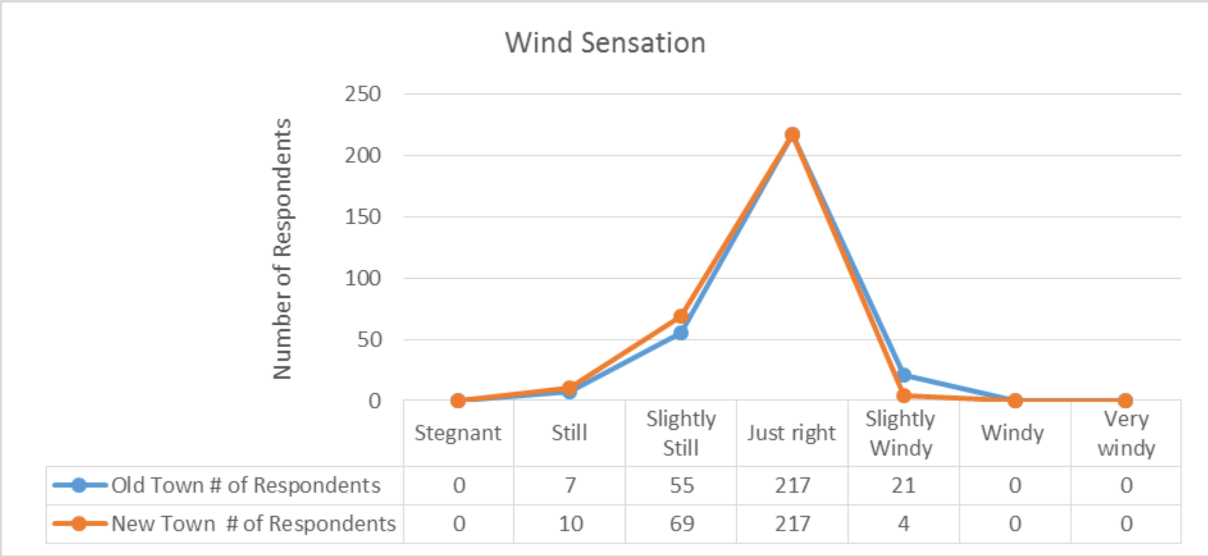
Participants were also asked to evaluate their feelings about the wind. The aim was to understand whether the formation of the built environment has a significant influence, or, in other words, a perceptible level of difference on the wind pattern in a street. With this purpose in mind, participants voted for a value according to their feeling about the wind by using a 7-point scale, seen in Table 23.

Table 7.23 7-Point wind scale

How would you describe the current wind condition? (7 point scale)						
Stagnant	Still	Slightly still	Just right	Slightly windy	Windy	Very windy
-3	-2	-1	0	1	2	3

Comparative results present that there is not a significant difference in terms of frequency of answers about the experienced wind. Three quarters of people in both Old and New Streets describe the felt wind as “just right”. However, it should be noted that the days in which street questionnaires and technical measurement were conducted were slightly windy compared to the general trend of the Mardin climate. Therefore, most participants expressed their appreciation for feeling at least a slight breeze which made them to define it as a “just right”.

Figure 7.11 Comparison of felt wind in the sample streets from Old and New Town



Source: Author`s original

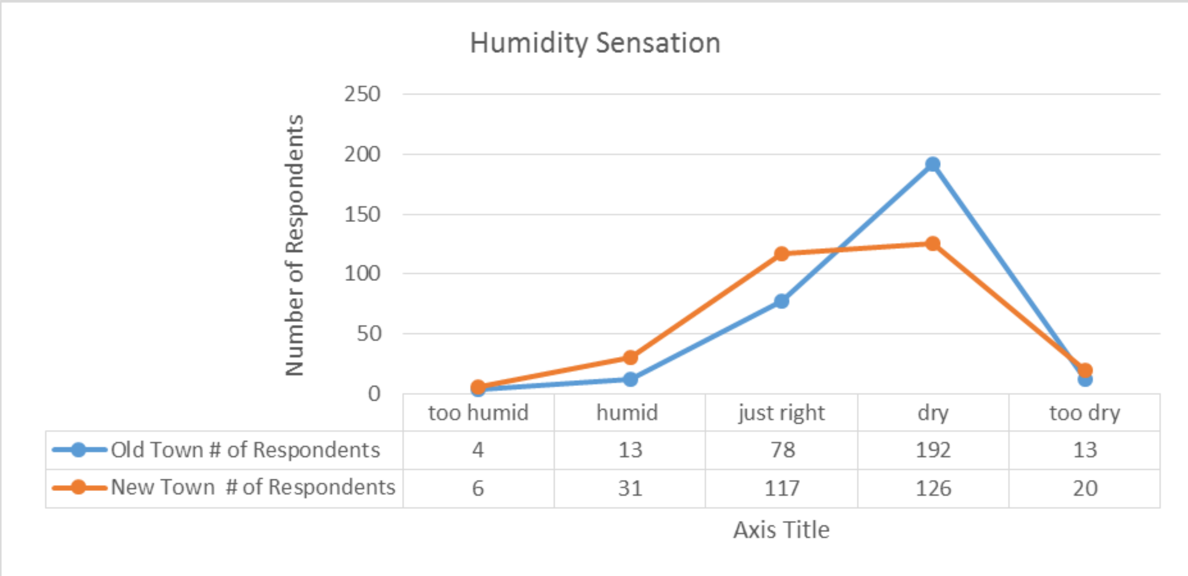
In order to understand whether measured values of humidity in the sample streets create a perceptible difference in people’s sensations, participants were asked to rank their feeling in terms of humidity in the air. Participants voted for a value according to their feeling about humidity by using a 5-point scale seen in Table 7.24. Considering that humidity creates more uncomfortable condition in hot temperatures, the voting scale was assigned values from (-2) to (2) from “too humid” to “too dry”.

Table 7.24 5-Point humidity scale

How do you feel about the air, in terms of humidity? (5 point scale)				
Too humid	Humid	Just right	Dry	Too dry
-2	-1	0	1	2

As seen from the distribution of humidity sensation votes (presented in Figure 7.12) most of the responses both in the Old and New town were clustered on the “dry” side of the scale. However, there is a slight difference in the frequencies of recorded votes from the two sample groups. While 65% of participants found the weather “dry” in the Old Street, the ratio decreases to 40% in the New Street. But it can be said that people still find the level of humidity tolerable so far as they accept it as “just right”. It was also observed that participants appreciated the dryness of weather compared to the cities like Istanbul and Izmir where high humidity causes thermal discomfort, mostly in the summer months. However, a small ratio of participants (4% in Old Street and 10% in New Street) still voted for "humid" and "too humid", which might be explained by individual preferences.

Figure 7.12 Comparison of felt humidity in the sample streets from Old and New Town



Source: Author`s original

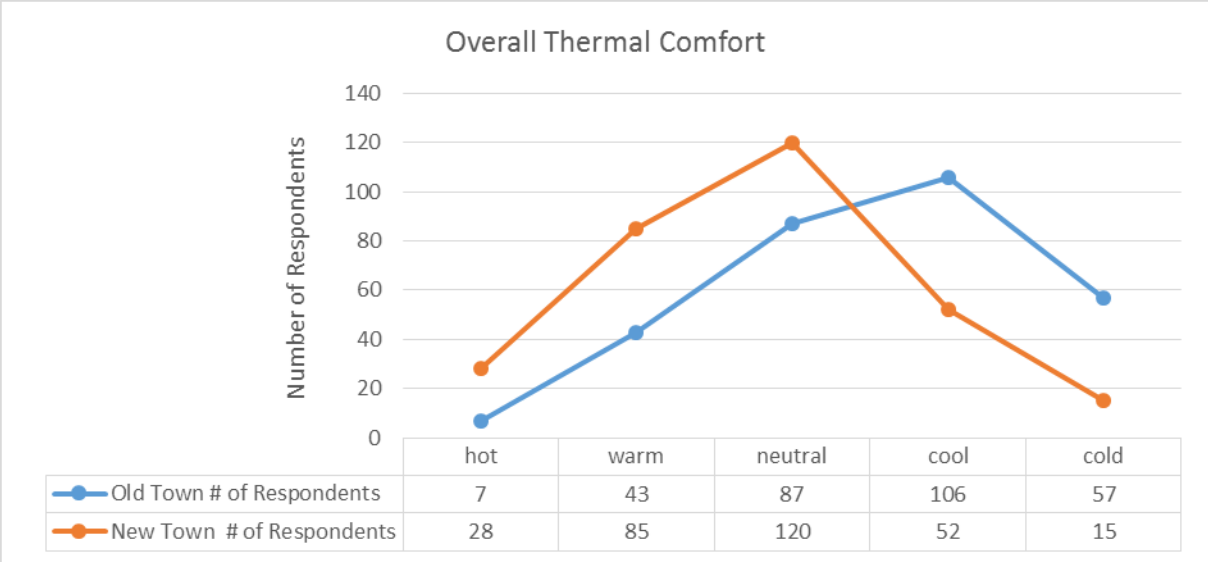
After asking about the climatic variables one by one (temperature, solar radiation, wind, humidity), participants were asked to rate their overall thermal comfort at the moment at which they took part in the survey. The aim was to understand participants` overall evaluation of experienced thermal comfort on the sample streets. Participants voted on their thermal comfort levels by using the scale seen in the Table 7.25.

Table 7.25 5-Point thermal comfort scale

What would you say about overall thermal comfort of this street? (5 point scale)				
Hot	Warm	Neutral	Cool	Cold
-2	-1	0	1	2

As seen in Figure 7.13, while 55% of responses from Old Street clustered on the "comfortable" side, only 22% of participants in the New Street felt thermally comfortable. Reading the graphic from the other way around, while 17% of participants feels thermally "uncomfortable" in the Old Town Street, the ratio of voted for thermal discomfort reaches up to 38% in the New Town Street.

Figure 7.13 Comparison of overall thermal comfort in the sample streets



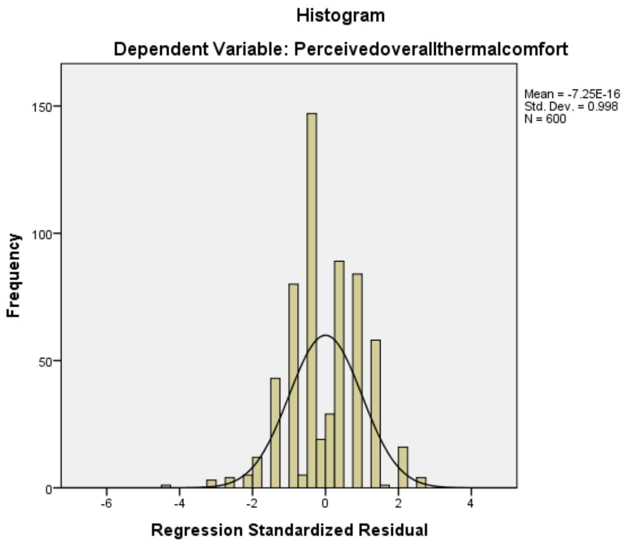
Source: Author`s original

In order to understand to what extent felt climatic variables explain the variance in the perceived thermal comfort in the streets, a multiple regression analysis was performed between the felt values and the perceived overall thermal comfort on the streets. Table 7.26 shows the model of thermal comfort (Adjusted R2: 0.281, F= 53.029, p<0.01). In the model, attributes of "felt temperature" and "felt sun" explain the variance in perceived thermal comfort by 28 percent. The "felt temperature" made the most significant contribution to explaining the variance in overall thermal comfort by 21 percent. Subsequently, the attribute of "felt sun" contributed to the model by 7 percent.

Table 7.26 Results of the regression analysis of felt climatic variables and perceived overall thermal comfort on the street

VARIABLES	***R^2***	***b***	***t***	***p***
(1) Felt Temperature	.219	.044	10.422	.000
(2) Felt Sun	.281	.074	7.282	.000
(constant)		1.256	9.191	

Standard Error: 0.8679
Adjusted R^2: .281
df2= 597
F= 53.029
p<0.01



Source: Output of SPSS analysis

In brief, descriptive statistics display the variance in the subjective judgements of participants from the sample streets in the Old and New Town. In order to understand whether the perceived climatic attributes (temperature, sun, wind, humidity) and perceived overall thermal comfort statistically explain the difference between the Old and New Town, a discriminant analysis was performed.

In the discriminant analysis of Old and New Towns, the possibility of groups being distinguished by the perceived climatic attributes (temperature, sun, wind, humidity) was assessed. Perceived overall thermal comfort was used as a discriminating variable and the nature of the differences was analysed.

Table 7.27 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 7.27 presents that `Perceived overall thermal comfort` (.713) and `Felt Humidity` (.600) are correlated with discriminant score.

Table 7.27 Structure matrix of perceived climatic attributes and perceived overall thermal comfort

Perceived climatic attributes and perceived overall thermal comfort	**Function**
	1
Perceived overall thermal comfort	.713
Felt Humidity	.600
Felt Wind (a)	.415
Felt Temperature (a)	.401
Felt Sun (a)	.350

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions.
Variables ordered by absolute size of correlation within function.
a. This variable not used in the analysis.

Table 7.28 shows the standardized canonical discriminant function that indicated how much each variable contributes, and in which direction, to the differentiation between Old and New Towns. The larger the magnitude of the coefficient, the greater is that discriminating variable's contribution. According to Table 7.28, `Perceived overall thermal comfort` is the most influential discriminating variable among all general attribute groups of comfort. This means `Perceived overall thermal comfort` has the largest contribution to the differentiation between Old and New Towns.

Table 7.28 Standardized canonical discriminant function coefficients matrix

Perceived attributes of comfort in the street	**Function**
	1
Felt Humidity	.629
Perceived overall thermal comfort	.660

Source: Output of SPSS analysis

Table 7.29 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicates that the group means are significantly different based on the discriminant scores and the group mean of Old Town (.267) scored significantly different than the New Town (-.267).

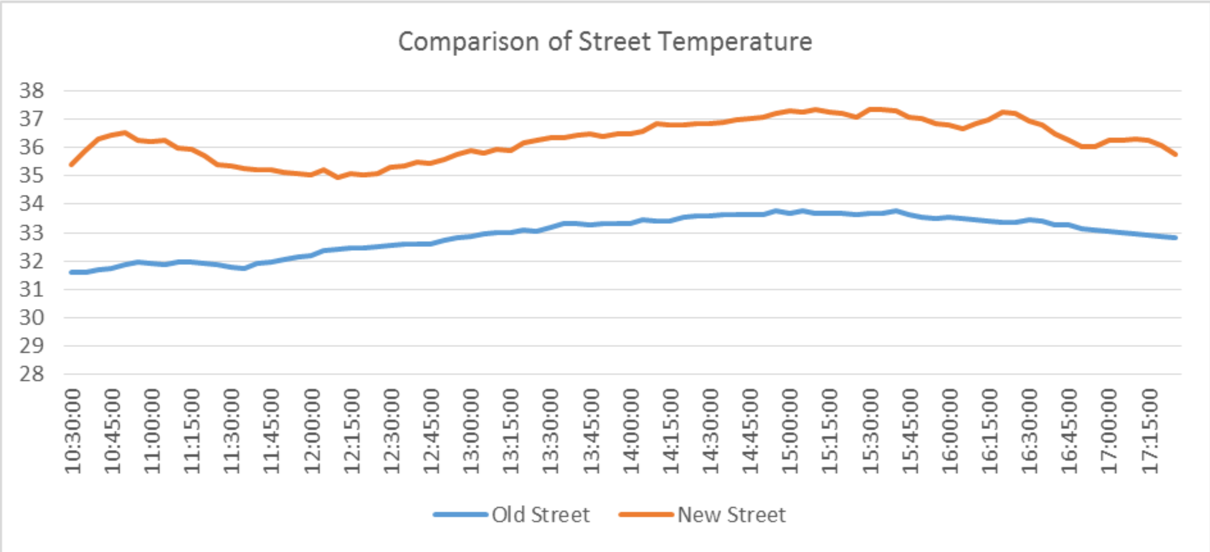
Table 7.29 Functions at group centroids

Town	Function
	1
Old Town	.267
New Town	-.267

Source: Output of SPSS analysis

Both descriptive statistics and the output of discriminant analysis correspond with the technical measurements conducted in the selected sample streets from both towns. Technical measurements conducted on the sample streets from Old and New Towns present a 4°C difference in the measured temperature. Considering the altitude difference between in the Old and the New Town (400m), there is still a 2°C temperature difference which can be explained by the formation of the built environment (see Figure 7.14).

Figure 7.14 Temperature values recorded in the sample streets from Old and New Towns



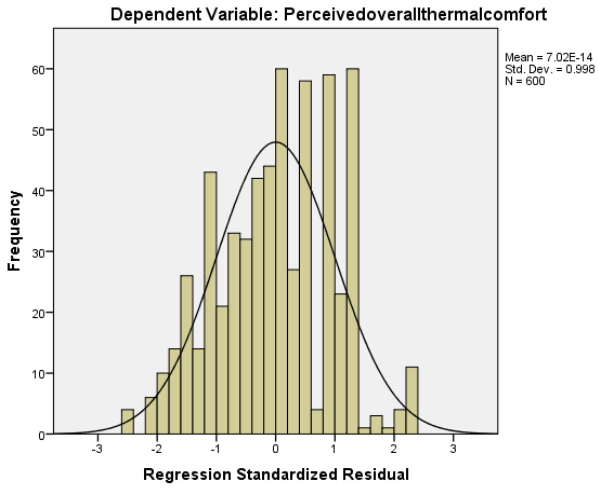
Source: Author`s original

In order to understand to what extent temperature and humidity attributes explain the variance in the perceived thermal comfort in the streets, a multiple regression analysis was performed between the measured values and the perceived thermal comfort ratings of participants. Table 7.30 shows the regression of thermal comfort (Adjusted R2: 0.20, F= 18.9, p<0.01). In the model, attributes of `temperature` and `humidity` explain the variance in perceived thermal comfort by 20 percent. The `temperature` made the most significant contribution to explaining the variance in thermal comfort by 18 percent. The `humidity` has little contribution (2 percent).

Table 7.30 Results of the regression analysis of climatic variables and perceived thermal comfort on the street

VARIABLES	R^2	*b*	*t*	*p*
(1) Temperature	.180	-.395	-10.563	.000
(2) Humidity	.206	-.162	-4.343	.000
(constant)		19.568	10.846	

Standard Error: 1.2885
Adjusted R^2: .203
df2= 597
F= 18.861
p<0.01



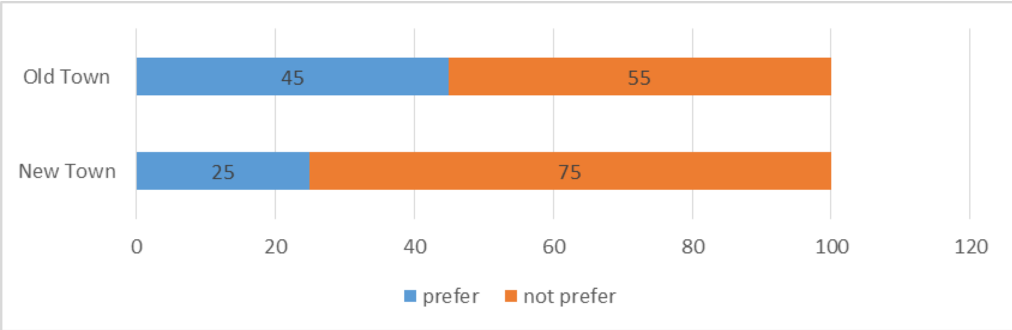
Source: Output of SPSS analysis

The recorded difference in temperature values (2°C) explains the role of the physical formation of the street scape in the creation of micro-climatic variations among the sample streets. This variation in microclimatic values influences the perceived thermal comfort in urban space. In the Mardin case, even the temperature values recorded in the Old Town Street were higher than the ones recorded in the New Town Street; participants` ranking of urban thermal comfort presents more satisfaction in the Old Town. This shows that the alignment/positioning of streets according to movements of sun significantly affects participants` thermal comfort perceptions.

Technical measurements carried out at the street scale also correspond with the outcomes of street questionnaires that were conducted on sample streets. It was observed that number of males walking on the streets was clearly more than females. This is not only because socio-cultural relations but also corresponds with the outcomes of in-depth interviews which revealed the tendency of women to walk less during day time than in the evenings.

As Figure 7.15 demonstrates, 75% of survey respondents mentioned that they do not enjoy going out during the daytime in the New Town. According to these respondents, a lack of shading and trees makes walking or using open spaces almost impossible on sunny days. Conversely, the narrow streets of the Old Town, which are surrounded by the walls of houses and oriented via the correct angle according to the sun, create comfortable walking environment for pedestrians.

Figure 7.15 Preference of going out during the day time



Source: Author`s original

Figure 7.16 A narrow pedestrian street in the Old Town

Source: Author`s original

"It is possible to find shaded streets in the old town, but if you want to walk in the new town you have to wait for the setting of the sun" (Male, 19, Old Town)

This response, from a 19 year old interview respondent, demonstrates how the formation of the built environment affects the way people behave and commute in their daily lives. This highlights the role of urban design in terms of its capacity to shape or influence the way people use the built environment.

Figure 7.17 Women challenging the uncomfortable experience of sun

Source: Author`s original

"In summer, going out before 7pm is nightmare for me. I wear a topcoat and scarf due to the requirements of my religious beliefs. Of course, there are some synthetic, thin and permeable products for hot seasons. But it is not affordable for everyone to buy different sets of clothes for different climatic conditions." (Female, 25, New Town)

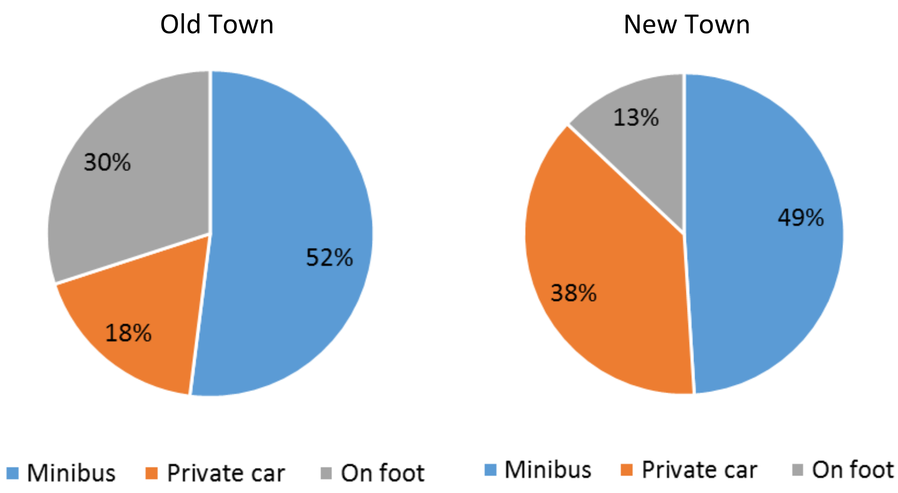
The above extract present an extreme case where a participant's right to use the city in a comfortable way was limited due to her religious beliefs. This points to the significance of context-based design which considers local values and lifestyles that are generated by these values.

In brief, this section has presented that the design of street scape potentially affects the way respondents behave and move in the streets and also has an important role on the perceived thermal comfort in street level experiences, particularly walking experiences. In line with this relationship, the next section examines whether the design of streets affects the preference of daily commute modes and the energy consumed for the provision of comfortable daily transportation.

7.3.3 Street Design Creates Differences between the Daily Commuting Pattern in the Old and New Town

The street network, including its design and physical layout, influences the way people commute in the city. Regarding thermal comfort in streets, the research findings present that the more comfortable streets are, the less tendency there is to use vehicles for daily commuting. Figure 7.18 presents the preference of transportation mode for commuting for daily needs in the Old and New Town.

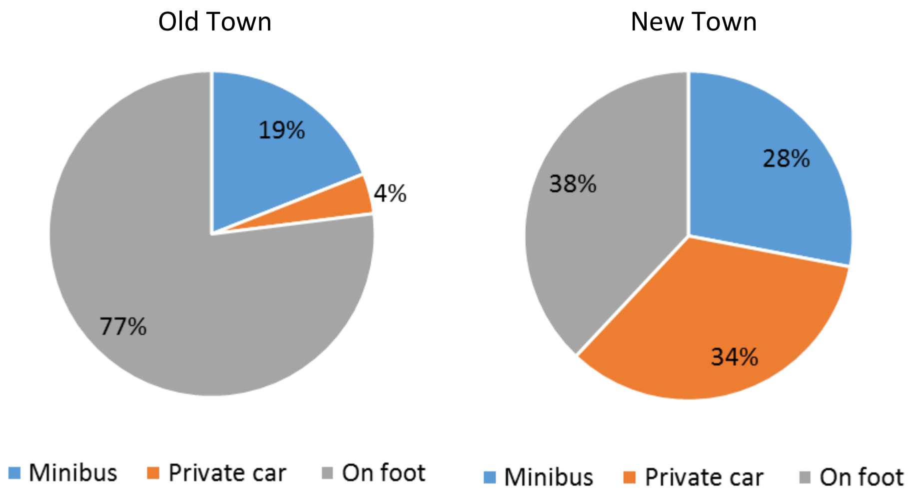
Figure 7.18 Transportation modes for commuting to working place



Source: Author`s original

As seen in Figure 7.18, while the ratio of participants who prefer walking for their daily commuting is %30 in the Old Town, only %13 of participants prefer to walk for every day. Of course, this difference cannot be explained by the variance in the thermal comfort of the streets in the New and the Old Town. Preferences for walking might be affected by many other factors, one of which is the location of a working place or school to which people travel every day. These factors are explored in the third section (city scale) of this chapter. However, the following figure presents the significant role of street design in the perceived walkability of participants. Even if walkability is not explained wholly by the provision of thermal comfort, Figure 7.19 presents that the majority of respondents (77%) in the Old Town prefer walking unless there is an accessibility problem.

Figure 7.19 Transportation mood for commuting for daily needs within the Town



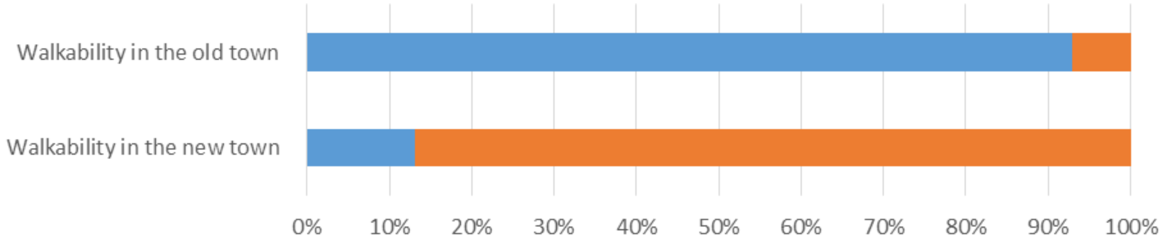
Source: Author`s original

On the other hand, the pie chart for the New Town shows that more than a half of the participants prefer vehicles -even for simple requirements such as shopping for groceries or clothing, or going to religious places- since they do not want to be exposed to the sun. The following extract from an interview exemplifies the preference of vehicles even for the short distances:

> *“There is no way for me to go to supermarket on foot during the day. It is already a big problem to walk in this heat and I can’t imagine myself walking under the sun with shopping bags. This is why I usually wait for my husband to come and collect me by car after his work. When he is not available I try to go on foot after 6 or 7pm and try to buy the minimum amount of stuff that I urgently need.”* (38, F, New Town)

Figure 7.20 presents the perceived walkability in terms of thermal comfort in the streets of the Old and New Town. While 92% of participants find the streets in the Old Town walkable in terms of thermal comfort, only 13% of participants perceive the streets of the New Town as comfortable for a walking experience.

Figure 7.20 Perceived walkability in terms of thermal comfort in the streets of Old and in the New Town



	Walkability in the new town	Walkability in the old town
Good	33	235
Poor	220	18

Source: Author`s original

In brief, the design of streets and the provision of thermal comfort in streets influence commuting patterns and, therefore, impact upon the amount of energy consumed for transportation. In line with previous research findings (Sharmin and Steemers, 2013) this study reveals that comfortable urban space can encourage the use of more sustainable forms of urban transport such as walking. Considering that streets are highly dependent upon the approach taken to the formation of the entire city, this research also argues that the provision of thermal comfort during daily commuting is also dependent on the plan of the city which is, in a way, the determinant of the zoning for working places, residential areas and any other urban services. In this respect, the following section explores the role of city planning in the provision of urban thermal comfort and the energy consumed for the sustainability of everyday life practices.

7.4 City Plan as the Principle Definer of Urban Thermal Comfort

At both the housing and street scales, findings revealed that various attributes have an influential role on the perceived thermal comfort and the energy consumed for the provision of a certain level of comfort. Reflecting back to the nature of urban planning, all of the discussed design attributes, either at the housing or street scales, are mostly defined, planned (or expected to be planned) within a broader urban design approach, which brings a sense of vision and supporting guidance to delivering a targeted vision with master plans. In the Mardin case, the way the Old and New Town is developed presents a significant difference. That also leads to a significant difference in the way people live in the city.

In line with the main focus of this research, Chapter 6 demonstrated the attributes of urban thermal comfort in the city of Mardin. Content analysis conducted using interview transcripts from both Old and New Town defined six different content groups as determinants of the city level. These were (1) accessibility without sun exposure, (2) breathing/outdoor spaces, (3) building density, (4) children and elderly-friendliness, (5) green space and (6) accessibility to urban services. This section explores how these defined attributes explain the variance in thermal comfort and the way people adopt/modify their everyday life experiences/behaviours/preferences in the Old and New Towns.

7.4.1 Perceived Attributes of Comfort in the City Explains the Difference Between the Old the New Town

In order to understand to extent which perceived attributes of comfort in the city explain the difference between the Old and New Town, a discriminant analysis was performed. In the discriminant analysis, the possibility of groups being distinguished was analysed with the perceived attributes of comfort in the city used as discriminating variables.

Table 7.31 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores are correlated within groups. The structure matrix in Table 7.31 presents that `Green space` (1.000) is strongly correlated with discriminant score.

Table 7.31 Structure matrix of perceived climatic attributes and perceived overall thermal comfort

Perceived attributes of comfort in the city	**Function**
	1
Green space	1.000
Children friendliness (a)	.298
Breathing outdoor spaces (a)	.200
Building density (a)	.169
Accessibility to urban services (a)	.060
Accessibility without sun exposure (a)	-.039

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.
a. This variable not used in the analysis.

Table 7.32 shows the standardized canonical discriminant function that indicated how much each variable contributes, and in which direction, to the differentiation between Old and New Towns. According to Table 32, `Green space` has a great contribution (1.000) to the differentiation between Old and New Towns.

Table 7.32 Standardized canonical discriminant function coefficients matrix

Perceived attributes of comfort in the city	**Function**
	1
Green space	1.000

Source: Output of SPSS analysis

Table 7.33 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicate that the group means are significantly different on the discriminant scores and the group mean of Old Town (-.366) significantly scored different than the New Town (.380).

Table 7.33 Functions at group centroids

Town	**Function**
	1
Old Town	-.366
New Town	.380

Source: Output of SPSS analysis

Green space is a significant discriminator between the two towns, since it was perceived as the only `*breathing point*` which functions as an assembly points for people who get exhausted from heat in the apartment flats. The lack of green space comes to the fore significantly in the New Town, not because the Old Town is full of green areas but the general comfort in the city is provided by a compact form of development which considers the natural climatic parameters in the Old Town. This response from a 35 year old mother gives a better understanding of the way green spaces influence the everyday life in the New Town:

"We come to this park almost every late afternoon. We don't want to be stuck in the house sitting in front of TV under the air-conditioner. My children are able to move the way that they want here. In the house we cannot even move not to sweat. Imagine children, they are more active than us, and they need to run, play and have fun." (35, Female)

Figure 7.21 The only public park in Mardin

Source: Author's original

The lack of green space or `*breathing spaces*` in the New Town is related to planning decisions which determine the building/construction density, floor area ratio (FAR), building coverage ratio (BCR) and amount of green space per individual. Development of high-rise apartment blocks increases the construction density while decreasing the ratio of open/green space provided as recreational areas for people. As seen in Figures 7.22 and 7.23, neither private sector-led nor government-led housing development presents a living environment in the way that respondents defined their perceived and desired urban settings during the interviews.

Figure 7.22 A typical neighbourhood developed by sub-contractors

Source: Author's original

It is observed that apartments, especially on the periphery of Mardin, are built before the provision of basic infrastructure services such as roads and sidewalks. This development trend pushes citizens to use private cars for daily commuting needs. Accessibility to these areas is only possible via vehicles since none of the attributes of walkability defined in the interviews (i.e.: vegetation, shading, separated walk way, urban furniture) exist in these roads.

Figure 7.23 A typical neighbourhood developed by National Housing Administration of Turkey

Source: Author's original

Land use decisions also affect the way in which people commute in the city. As seen in Figure 7.23, the residential neighbourhood developed by government is located on the outskirts of central Mardin (8 kms away from the centre). The previous chapter demonstrated the significance of accessibility to urban services such as hospitals, schools and working places in the overall thermal comfort in the city. Although this neighbourhood has its own services like schools and a health centre, it is disconnected from the New Town. It functions as a satellite neighbourhood which allows connection to Mardin via a highway. Access to shopping places and/or working offices is only possible with a minibus[22] or private car.

In both cases, building density and the distance between buildings also stand as a barrier to the provision of thermal comfort in the New Town. The following extracts from the interviews supports this argument:

Figure 7.24 Lack of space between apartment blocks

Source: Author`s original

"Look at the distance between buildings! (interviewee points to the next building) Opening the window doesn't provide any slight breeze, it doesn't help for cooling the room. The apartment is totally blocked by two sides. I can almost reach my neighbours` balcony from my living room. Shouldn't be there a rule for minimum distance between buildings?" (32, Male)

Figure 7.25 An example of courtyard

Source: Author`s original

"I would prefer to die rather than move to one of those high-rise 'cage' blocks in the new town! Look at this lovely courtyard [interviewee points] I am able to see the sky, I am able to breathe fresh air whenever I want" (Male, 75)

This response from a 75 year old male interviewee indicates that these external architectural features do not only present significant importance in terms of thermal conditions, they also play a crucial role in terms of mental and physical well-being.

[22]Minibus is the major public transportation mode in the province of Mardin.

The comparison between two towns shows there is an inconsistency between the existing development trends and the local requirements in the city of Mardin. Considering the fact that the Old Town first developed thousands of years ago under vastly different social, cultural and political conditions, it is unrealistic to expect the repetition of same development strategy under today's neo-liberal conditions. However, there should be moderate ways to respond to local requirements as well as keeping development in line with contemporary political and economic agendas. This will be explored in following chapter in which the planning and the design politics in Mardin is discussed.

7.4.2 The Relationship between Perceived Urban Thermal Comfort, Every Day Life and Housing Preferences in Mardin

In order to explore the ways in which the formation of towns influence everyday life practices in Mardin, a discriminant analysis was performed with the attributes of everyday life practices, as defined during interviews according to respondents' thermal comfort perceptions. As seen in Table 7.34, respondents declared different attributes which can be categorised under four headings; behavioural, emotional, economic and social attributes. Behavioural attributes are (1) clothing, (2) food production, (3) hosing the courtyard and/or house, and (4) living in open space extensions. Economic attributes include (5) the cost of cooling, (6) cost of heating and (7) over consumption. Emotional attributes are (8) pleasure in nature and (9) privacy. The social attribute was (10) neighbourhood relations.

Table 7.34 Attributes of daily life in Mardin

Attributes	Attribute Type	Frequency of mention	Percentage
Living in open space extensions	Behavioural	166	22 %
Hosing the courtyard and-or house	Behavioural	120	16 %
Pleasure in nature	Emotional	110	15 %
Over consumption	Economical	90	12 %
Neighbourhood relations	Social	88	12 %
Cost of cooling	Economical	72	10 %
Privacy	Emotional	46	6 %
Clothing	Behavioural	22	3 %
Cost of heating	Economical	22	3 %
Food production	Behavioural	14	2 %
TOTAL		**750**	**100 %**

Source: Author`s original

In the discriminant analysis, the possibility of groups being distinguished when the perceived attributes of everyday life in the city were used as discriminating variables was analysed.

Table 7.35 shows the structure matrix that combined the pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions. The pooled within-group correlation indicated how the discriminating variables and the discriminating scores were correlated within groups. The structure matrix in Table 7.35 presents that `hosing the courtyard and/or house` (.758) and `pleasure in nature` (-.164) were correlated with the discriminant score.

Table 7.35 Structure matrix of perceived every day life attributes

Attributes of everyday life	**Function**
	1
Hosing the courtyard and/or house	.923
Privacy (a)	-.210
Pleasure in nature	-.164
Food production (a)	.158
Clothing (a)	-.146
Cost of cooling (a)	-.070
Neighbourhood relations (a)	.057
Living in open space extensions (a)	.007
Cost of heating (a)	.000

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.
*. Largest absolute correlation between each variable and any discriminant function
a. This variable not used in the analysis.

Table 7.36 shows the standardized canonical discriminant function that indicated how much each variable contributed, and in which direction, to the differentiation between Old and New Towns. The larger the magnitude of the coefficient, the greater that discriminating variable's contribution is. According to Table 7.36, `hosing the courtyard and/or house` is the most influential discriminating variable, while `pleasure in nature` also discriminates significantly.

Table 7.36 Standardized canonical discriminant function coefficients matrix

Attributes of everyday life	**Function**
	1
Pleasure in nature	-.396
Hosing the courtyard and/or house	1.013

Source: Output of SPSS analysis

Table 7.37 displays the results of testing significant differences for Old and New Towns. The results of the discriminant analysis indicate that the group means are significantly different based on the discriminant scores and the group mean of Old Town (.837) scored significantly differently than the New Town (-.513).

Table 7.37 Functions at group centroids

Town	Function
	1
Old Town	.837
New Town	-.513

Source: Output of SPSS analysis

Apparently, people living in the Old Town adapted to extreme climatic conditions with the help of the physical (re)organization of their living environments. Hosing the courtyard and/or house is a widely used adaptive technique which provides natural cooling with the effect of evaporation, especially in the afternoons (see Figure 7.26). Some respondents state that they also hose the floor of indoor areas since the whole house is made of stone. In this way, users clean their houses while providing cooling at the same time. It was noted that some families that had moved to the New Town from the Old Town still continue to use the same habits even in the apartment flats in which the floors are covered entirely by glazed ceramic tiles.

Figure 7.26 A woman hosing the courtyard to create cooling in the afternoon

Figure 7.27 A women preparing the sleeping throne in the terrace

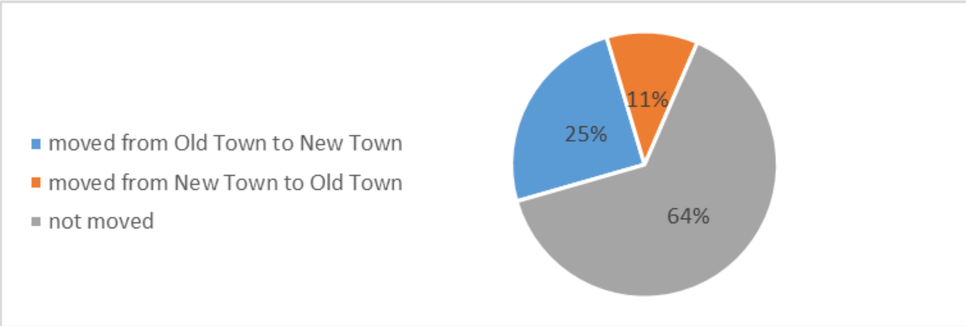
Source: Author`s original

Pleasure in nature was also one of the most mentioned attributes that positively affects thermal comfort in the daily life. For instance, sleeping on terraces is a common activity seen in the Old Town. As seen in Figure 7.27, almost all households have 'sleeping thrones' on their terraces. Thrones are covered by white cheesecloth to prevent the sun penetrating in the small hours of the morning; it also provides privacy. In most cases, sleeping on balconies is impossible to do due to way in which apartments are orientated towards one another in the New Town.

As this chapter has demonstrated, both the Old and New Towns have particularities that affect people's perceptions and the preference of houses (i.e. preference to certain typology). Figure 7.28

presents the distribution of respondents` movement (change of location from one settlement to another) in Mardin. While 25 % of respondents had moved from the Old Town to New Town, 11 % of respondents had moved from the New Town to Old Town. Major reasons for moving to the New Town were marriage, the desire to be close to workplaces, hospital (mostly for older participants), a preference to live in modern houses and live without a stove in the winter. Reasons for moving from the New to Old Town included a yearning for a more traditional way of life, the desire to live in close contact with neighbourhoods, to live in thermal comfort and a desire to live in touch with nature.

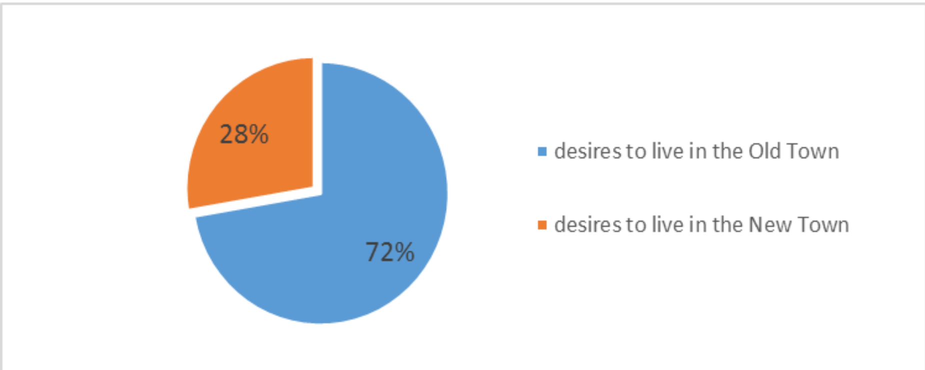
Figure 7.28 Distribution of respondents` relocation status



Source: Author`s original

Respondents were also asked for their preferences for living with regards to thermal comfort, on the assumption that all urban services are equally provided in both towns. As seen in Figure 7.29, almost three fourths of respondents desire to live in the Old Town.

Figure 7.29 Distribution of respondents` desired living place in term of urban thermal comfort



Source: Author`s original

In brief, a comparative analysis conducted at the city scale presents that the way the New Town was planned presents significant differences from the Old Town. First, while the Old Town presents a compact and horizontal macroform, the New Town presents a vertical form of development in which the beginnings of urban sprawl can already be seen. Second, while the Old Town encourages car-free, pedestrian oriented city development, the New Town has been developed in a car-oriented way. Third, while the formation of the built environment in the Old Town considers and responds to local climatic factors and the role of the sun, the New Town presents few clues of much consideration being given to these issues.

7.5 Conclusion

This chapter has demonstrated the ways in which the formation of the built environment in the Old and New Towns influence the way people live under local climatic conditions, the way they adapt (or cannot adapt) to climate, and the way they provide a reasonable level of thermal comfort in everyday life.

It is seen that there is a clear difference between the contemporary urban development pattern which introduces a more `modern` standard of life in the New Town and the traditional urban pattern that has developed more organically in response to climatic conditions and lifestyles adopted by occupants throughout the years. Both technical measurements and findings from in-depth interviews reveal that most of the attributes which provide harmony with climatic conditions in the heritage town have not been reflected in areas developed after the 1960s in Mardin. Within this context in mind, Chapter 8 explores the politics of urban development and housing provision in Mardin. In line with the theoretical framework of this research, the Chapter identifies the barriers to the production of climate responsive urban built environments in the context of the contemporary urban condition.

CHAPTER 8

THE CHALLENGES OF PRODUCING CLIMATE RESPONSIVE URBAN SPACE IN MARDIN

8.1 Introduction

Chapter 7 has demonstrated that the two different development patterns in the Old and New Towns do not present the same degree of responsivity to local climatic characteristics, nor do they contribute equally to changes in the urban climate. While the Old Town presents relatively more responsivity in terms of climate and the provision of thermal comfort in urban daily life, the New Town provides some other amenities which increases the quality of urban life in other aspects such as health, education and leisure. However, this research focuses on the trilateral relationship between the climate, thermal comfort and urban space, rather than other indicators of quality of life. Therefore, the research acknowledges thermal comfort as one of the attributes of quality of life, but it does not elaborate other aspects, such as access to facilities, which one might argue that the New Town presents more sensitivity towards.

Based on this assumption, the research does not aim to make a judgement or superiority comparison between the Old and New Town, rather it aims towards a balanced development approach that integrates the positive aspects/dimensions of thermal comfort in each development pattern. This is essential not only for shedding light on the future development practices in Mardin (or Turkish context) but also for introducing ways of synthesising the key niches drawn from past development practices which is valid and essential for any urban context aspired after climate responsivity.

In this regard, the chapter aims to evaluate the research findings and discuss possible ways of reflecting lessons from the past into contemporary urban development practices. Accordingly, the chapter elaborates the political dimension of urban space production and discusses the challenges of producing climate responsive urban environments under existing socio-political conditions in Mardin. While doing this, the chapter focuses on the research findings relevant to the climatic features discussed under different scales and elaborates these from an urban design point of view.

8.2 Ensuring Responsivity of Urban Development: Addressing the Interplay of Climate and Urban Life

As presented in the previous Chapter, perceived thermal comfort in Mardin varies at the different layers of urban life, from domestic life in indoor spaces to public life conducted in urban outdoor spaces. In terms of domestic thermal comfort and energy consumption, housing provision stands as the main determinant and the catalyser of behavioural adjustments developed by end-users. For outdoor thermal comfort, the provision of shading in such a way to encourage pedestrian movements on streets, and the provision of green spaces which can function as breathing points within the dense construction pattern of the entire city stand as two major outdoor design concerns for the hot and arid climate of Mardin.

In order to create a climate responsive urban built environment where new developments are concerned, it is important to consider three main themes regarding new urban development areas. First, housing should present responsivity towards the local climate with a concern to a) enable end-users to adapt to harsh conditions, and b) to reduce the contribution to a change and/or increase in the urban heat island effect. Second, development proposals should ensure that the streetscape embodies the correct technical dimensions with respect to shady and comfortable commutes. Third, the macro form of the city should accommodate a smart solid-void balance, which reduces the heat island effect derived from the building blocks.

8.2.1 Ensuring Climate Responsivity in Housing Provision (Domestic Life)

The previous chapter indicated that existing development trends in the residential housing sector show few signs of change towards climate responsive design and construction. This exemplifies a robust `landscape` of housing provision which embodies the `hardness` of change as identified by Geels (2005b). Creating change in this deep-seated and dominant model of housing provision, mainly based on apartment development by conventional construction techniques, stands as a challenging task. The change here refers to a transition from conventional apartment development to alternative housing provision models derived from climate responsive design. In this regard, the robustness of the current `modern` development needs to be (re)examined from both a supply and demand side of the residential development market. The construction of high-rise apartment blocks has been continued and indeed has increased in Mardin. This is partly supported by the tendency of residents to buy a new flat in the New Town as it provides better infrastructure and public services and contemporary housing units, a so-called more `modern life`. Developers and private land-owners aim to maximize profit via constructing as many flats as possible within the boundaries of their building rights.

Looking at the demand side, home purchase decisions, as Brown and Vergragt (2008) claim, are mostly influenced by the location, appearance and the nature of the host community. Therefore, in most cases post-sale usage, maintenance requirements and costs are not considered much during the decision-making to buy house, as is the case in Mardin. In addition, the ownership period is rarely long enough to justify additional upfront investments in green technologies; few buyers are able to meet the purchase cost of the house as one single instalment. These factors discourage homebuyers from considering green or environment friendly technologies at the purchasing stage. Looking from the supply side, developers whose main goal is for short-term profit do not have much motivation to view energy efficiency and environmental sensitivity as selling points. For instance, the following extract from an in-depth interview with a private developer, one of the participants from the housing interviews, exemplifies the priorities influencing the housing sales.

> *"We used to sell the houses according to their size and the number of the rooms, but recently there has been a huge demand for air-conditioners. Interestingly, home-buyers are questioning the number of air-conditioners nowadays. Usually, the houses with more than two air-conditioners are more likely to be sold. Even though people can put two or three air-conditioner after they purchase the flats, it is assumed as the fixed asset/inventory of the flats."* (Private developer, M)

The developer`s statement indicates an important issue regarding the change in the public knowledge and perception of thermal comfort in the New Town. It shows that people perceive air-conditioners as one of the main determinants of comfort in houses. Buyers apparently do not consider energy consumption or the environmental impacts of this until they have moved in to their new houses. This is partly because the supply side of the housing market directs buyers towards one channel rather than offering alternative solutions.

However, it is possible to produce alternative housing provision which captures the local climatic characteristics and local habitants` responses and requirements. Locating a breaking point in the existing housing provision system is not a simple issue that can be framed within the building plots. Moreover, it is not realistic to expect private developers to provide new typologies which may bring financial burdens such as hiring climate experts, producing innovative architectural design solutions or transition to green technologies. The problem is not about changing the design of single building units, rather it is about bringing a 'high level' design notion which can guide the entire urban development process, including activity located at different scales from housing to street and the city level.

For instance, the `vertical forest` concept (see Figure 8.1) emerged in Italy and introduces a way to combine high-density residential development with tree planting in dense urban areas. The concept suggests that conventional residential blocks are not the only solutions for vertical development to accommodate more people in urban centres. The concept is developed to respond to the identified challenges in the city of Milan. The `vertical forest` is proposed to absorb dust in the air and to help depollute the city. The vegetation is proposed to create a humid-climate that produces oxygen whilst shading residences from harsh sunlight. It is noteworthy that the concept is not produced for one or two single units, rather the main idea is to create a number of `vertical forests` in the city in order to create a network of green corridors connecting streets and green spaces with various spaces of spontaneous vegetation growth.

Figure 8.1 The concept of the `Vertical Forest` as a way to combine high-density residential development with tree planting

"As a new growth model for the regeneration of the urban environment, the design creates a biological habitat in a total area of 40,000 square metres." (Boeri Studio, 2015)

Source: www.stefanoboeriarchitetti.net (2015)

Another example from Singapore (Figure 8.2) introduces a radical alternative to high-rise residential blocks in urban areas. The `interlace life` concept is formed from a series of stacked housing blocks arranged in a hexagonal grid with spectacular views from the penthouses. The idea behind the concept is to interweave the architecture with features such as sky gardens, water bodies, courtyards and green communal areas to create ample space for social interaction and recreation along both vertical and horizontal axes.

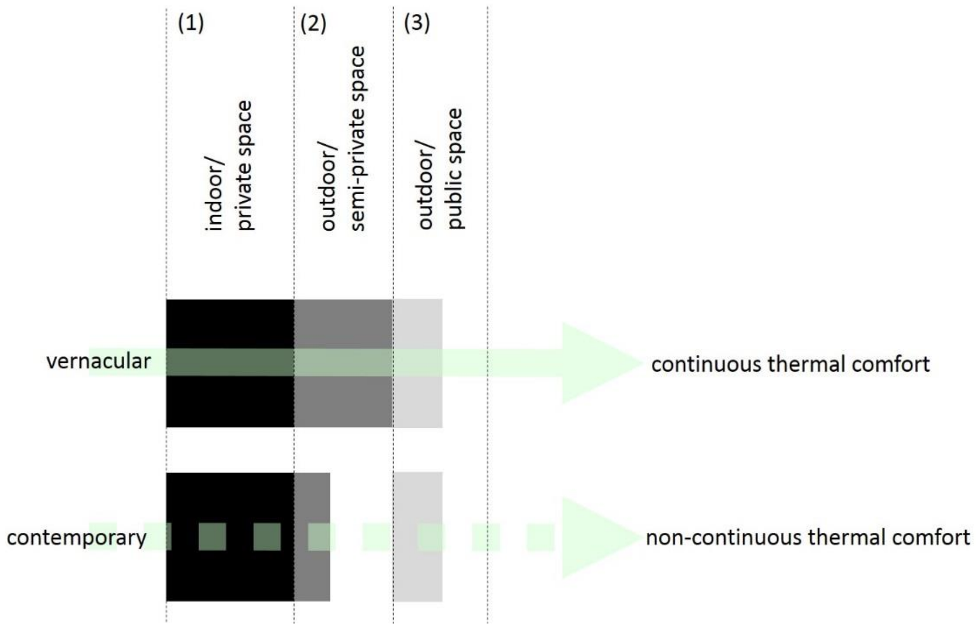
Figure 8.2 The concept blending nature, design and community

Source: www.theinterlace.com.sg (2015)

The argument here is not to recommend the `vertical forest` or `interlace life` concept as appropriate/unique solutions for alternative housing provision in Mardin, rather it is to highlight the significance of urban design and more specifically its capacity to generate creative and alternative design proposals against conventional residential developments. These two examples show the possibility of producing alternative housing typologies, which are able to accommodate higher population density within relatively small sites but which provide better thermal comfort standards. The key point here is to determine the local requirements and developing proposals which respond to local climatic variables such as hours of sunshine, dominant wind direction and amount of precipitation.

Considering the relatively low precipitation values (approx. 3.1 kg/m2 in summer months) seen in Mardin, it is unlikely that large-scale tree plantation can be the main source of more sustainable residential development. Rather it can serve as a supporting mechanism. In other words, vertical tree plantation could be a minor design indicator for the provision of shadowing and comfort, only with an integrated maintenance and management plan. Instead, the core essential change can be reached with alterations in the forms and the mass of the building blocks. Previous chapters have revealed that the current development system offers prototype apartment blocks as the single option for the housing typology in the New Town. In addition, the human experiences show that single blocks do not respond to the local requirements shaped by local climatic variables. Regarding the form and typology of residential units, the research findings indicate that residential user experiences at the housing scale do not correspond to the physical spaces supplied by the apartment flats in Mardin. In this regard, the first point to take into consideration is the way in which local people perceive the concept of the `house` and the `function` of the house in climatic context of Mardin. In-depth interviews show that local people perceive the housing unit as an integrated living space which accommodates different volumes of indoor and outdoor spaces providing partly private rights along with semi-private sections. For-instance semi-private areas such as courtyards serve for daily life interaction(s) with neighbourhoods in a thermally comfortable setting. This corresponds with what Chappell and Shove (2004) call the fulfilment of cultural norms and collective conventions. Horizontal development provides a continuous connection from private space towards semi-public spaces (i.e. courtyards) and public spaces (i.e. streets). Provision of this continuity is challenging to achieve in vertical development models, mainly due to the lack of physical connection between indoor and outdoor, private and public spaces.

Figure 8.3 Relationship between solid-void balance of housing units and the continuity of thermal comfort



Source: Author`s original

As seen in Figure 8.3, the vernacular pattern presents a transitive and interlocked series of sub-spaces. Transition between different sub-spaces provides opportunity for users to move and relocate between the spaces in the face of a thermal discomfort. In other words, the transitive and interlocked solid-void balance facilitates end-user's adjustment skills described as physiological, behavioural and psychological by Brager and de Gear (1998). Transition between the sub-spaces encourages behavioural adaptation. Variety in behavioural choices increases the chance of developing different physiological (e.g. adjusting body temperature by sleeping in courtyard) and psychological (e.g. feeling at peace by feeling the natural ventilation in a terrace) responses as exemplified in detail in the previous chapter.

In vertical development models based on apartment flats, the main barrier of continuity between sub-spaces is derived from the urban planning approach which divides the urban land according to single building plots, rather than introducing/guiding joint space production that allows for interaction between housing provision and the formation of streetscape. This is related to the argument of the lack of a 'high level design notion', which can catalyse the coherency within the sub-components of urban built environment. Housing design itself cannot ensure the thermal comfort and reduction of energy consumption in urban life. Therefore it is worth elaborating the housing provision associated with the formation of the entire city, which is envisioned via urban development plans.

8.2.2 Ensuring Climate Responsivity in Urban Space (Urban Life)

Although this research examines the formation of built environment at three different scales, it does not argue that each scale should be handled separately; rather it emphasizes that scales shape, and are shaped by, one another. Scaling is essential in order to understand the significance of the details regarding the provision of thermal comfort. To what extent urban development plans respond to the climatic niches at different scales such as building or streetscape is essential for thermal coherency in the entire city.

Figure 8.4 shows an example of building blocks from the latest development plan produced for the New Town in Mardin. The sample building block accommodates four 10-storey apartment blocks positioned in the corners of the borders. The borders of the building block are indicated by the bold black solid line.

Figure 8.4 A sample building plot from 1/1000 development plan

Source: Greater Municipality of Mardin, 2015

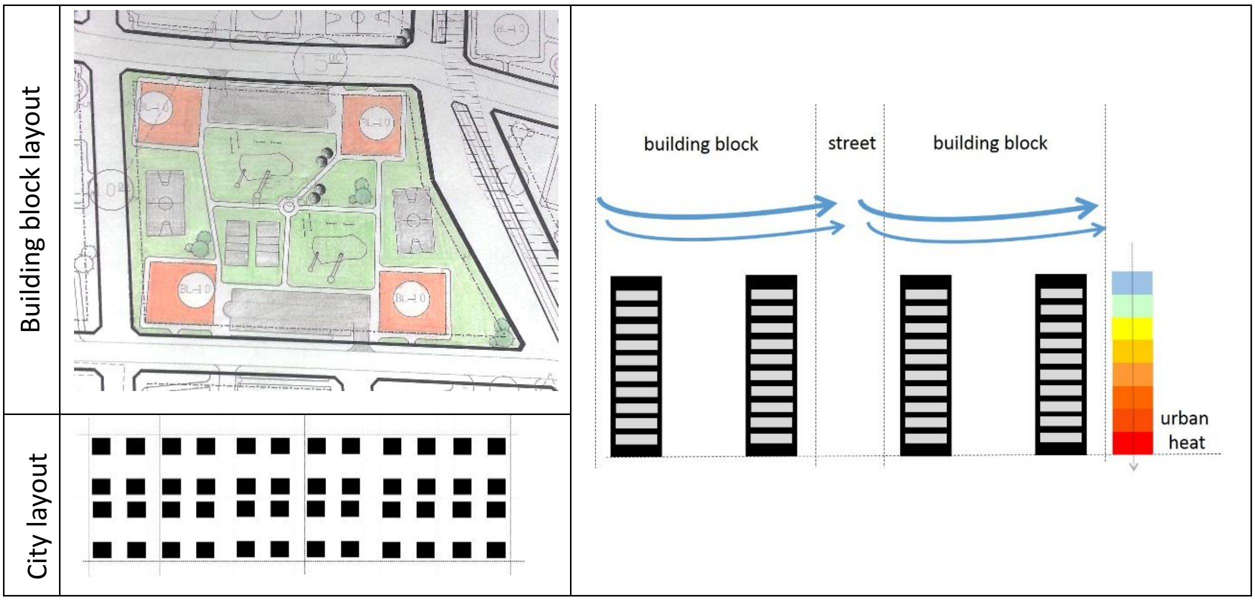
As seen in the figure, the space between the blocks is left for facilities such as sports fields, parking lots and the green spaces. A senior planner in the Greater Municipality explained the way they approach new development as such:

> *"We know that the lack of open/green space is one of the main problems in Mardin. However, ownership patterns in the city don't allow us (i.e. municipality) to provide urban standards for the green spaces due the lack of public lands. To overcome this challenge, we aimed to provide social standards of green space within the border of each development block. By using the `tevhid-ifraz` tool which enables the unification of all small private lands within the building block and the redistribution of development rights according to the proposed typology."* (Senior planner, GMM)

Considering the lack of sufficient public land to provide social reinforcement according to the planning standards, one can say that the decision to provide green spaces within the building block is an effective way of delivering urban development according to a joint ownership land pattern. However, the provision of open space itself does not respond to the other technical and social requirements explored throughout the fieldwork. For instance, the new development site created with the implementation of the plan presented in Figure 8.4 will embody streets with large SVF open to direct solar radiation. Thus, those streets defined by the boundaries of building blocks will not provide a comfortable walking experience due to the lack of shading. This shows an absence of a design concern with respect to the formation of surrounding areas beyond the provision of housing.

Providing housing based on the division of land and the (re)distribution of the building rights within the identified/proposed boundaries of building blocks does not respond to the requirements described by inhabitants regarding the thermal comfort in Mardin. In addition, development based on the proposed implementation plan will lead to the creation of a flat canopy layer which will disable the natural air ventilation over the urban areas (see Figure 8.5). Thus, the new development will trigger the continuity of the thermal dissatisfaction perceived in everyday life in the New Town.

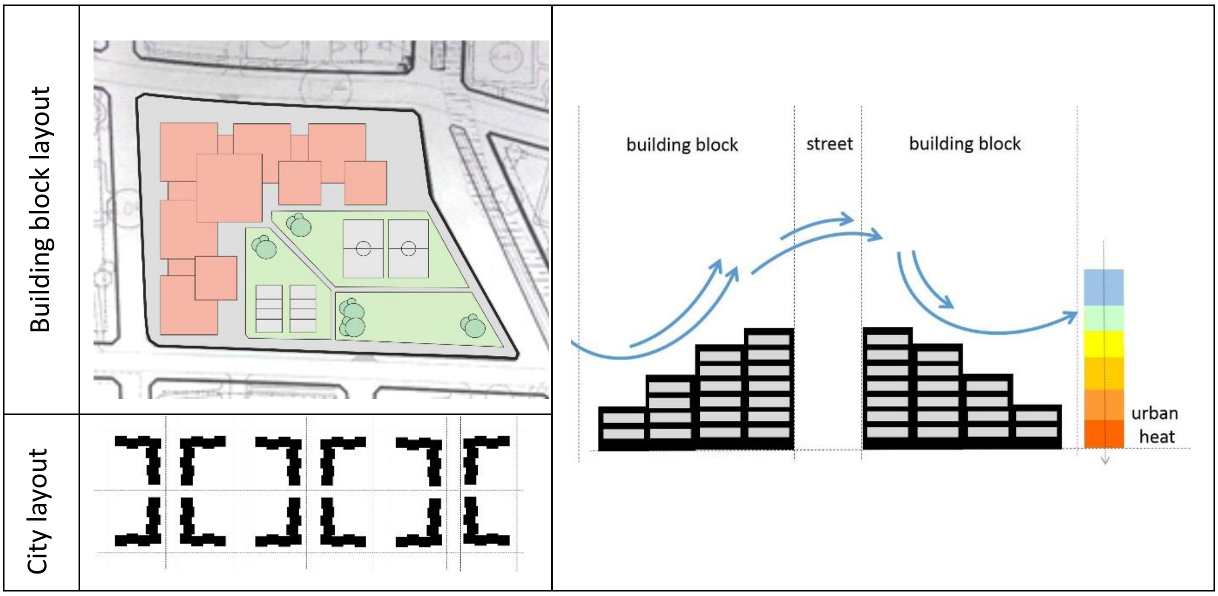
Figure 8.5 Proposed development plan for residential neighbourhoods



Source: Author's Original

As seen in Figure 8.5, the proposed silhouette of the building blocks creates a concrete urban layer on top of the city due to the plain land form. This contradicts the argument about the benefits of creating inner-city air circulation via building forms (Littlefair et al., 2000). Articulation of the building blocks that accommodate single apartment blocks within the development boundaries leads to the creation of a monotonous city layout which catalyses urban heat. This presents a lack of coherence between the way housing provision is framed and the way in which the new city plan is produced. A plan which carries the vision of creating an `ecological` Mardin, - *in the way described by the principle clerk of the municipality*-, could have embodied more responsive nuances to the problem of cooling, one of the major challenges of Mardin as a city located in a hot and arid climatic zone. Responsive nuances here refer to the tactical decisions concerning climatic factors. For instance, Figure 8.6 shows an alternative development pattern which can create a relatively more comfortable urban experience as well as responding to the requirements and expectations of local people in Mardin. This research does not aim to provide design guidelines or unique development patterns suitable for the future of the city, rather it aims to underline the possibility of providing urban thermal comfort via developing alternative vertical development proposals as exemplified in Figure 8.6.

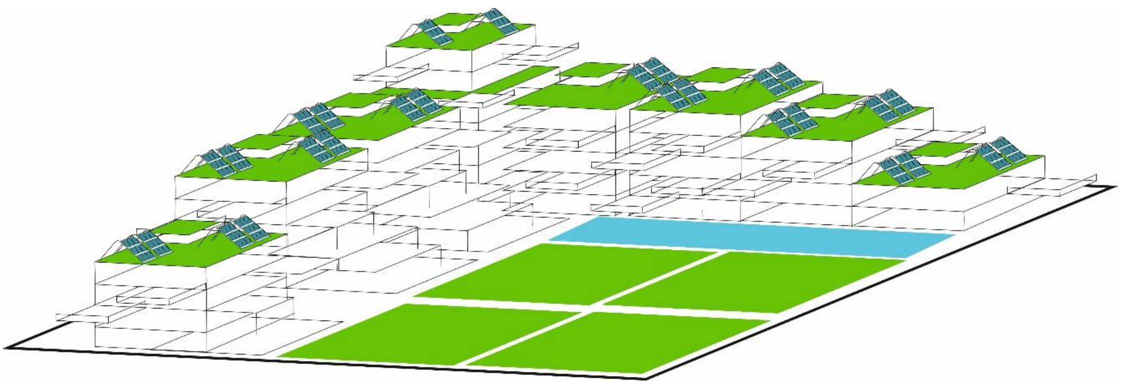
Figure 8.6 An alternative development proposal for residential neighbourhoods



Source: Author's Original

For instance, the positioning of building masses and the open spaces within the boundaries of building block can be (re)organized in such a way that considers the direction and movement of the sun. In this way, the provision of shade in open space can be assured in order to maximize the hours of shading. In addition, vertical development can be designed with modular units which form a man-made slope in the boundary of building block. Modularity here refers to the combination of modular units embodying open space extensions (created by gaining the benefit of the slope) in a vertical axis (see Figure 8.7).

Figure 8.7 3D-representation of the alternative development proposal in Figure 8.6



Source: Author's Original

This example shows the possibility of approaching urban space production from a socio-technical perspective that accommodates the technical dimensions of housing provision as well as responding to the social outputs derived from the comparative work of this research. Apparently, one can say that economic dimensions regarding the provision of alternative development models using renewable energies for the provision of thermal comfort in urban life also calls for in-depth research. This includes the determination of funding mechanisms, incentives for alternative construction systems, and establishment of public-private partnerships. However, as discussed in Chapter 3, the functioning of urban design as a socio-technical system is hinged upon the appreciation of the discipline within the political scene. The trilateral cycle between technical, social and political dimensions of climate responsive space production is possible only if decision-makers partaking in urban planning processes are aware of the catalysing power of design.

Reflecting back to the practicality/implementation of alternative design proposals in the current socio-political context, the main challenge stands as the lack of awareness and the lack of coherence between different levels of decision-makers under different professional bodies partaking in the process of urban development. Urban planning is perceived as the division of urban land for constructing an urban life. Decision-makers' perception of planning presents a lack of design notion which stands as the main barrier of creating built environments as exemplified in the heritage site of Mardin. This perception is nourished by the common conceptualization of urban design as a 'bridge' between architecture and planning (Krieger, 2009). The 'bridge' refers to establishing design criteria for development projects beyond basic zoning in planning. It is the urban designer's presumed insights about good or appropriate urban form that are seen as vital to translate objectives of plans into architectural proposals. However, the translation of urban plans into designs, as Krieger, 2009 asserts, is not meant to be a sequential process, rather, it should be an interactive one. Therefore, urban design should inform the formulation of planning ideas, not as a 'bridge' but as a 'spine' connecting different disciplines and constituting the desired structure of the city.

Having an understanding of what might be called the 'politics of urban development' is instructive in order to place the role of urban design in space production. This involves exploring the current working mechanisms that operate within the various institutions delivering urban development in Mardin. In this regard, the following section focuses on the barriers that may be stalling the introduction of climate responsive urban design in the current socio-political context of Mardin.

8.3 Challenges of Translating the Lessons from the Past to Contemporary Urban Development

This research argues that urban design has the power to help catalyse a transition from conventional urban development systems towards more climate-responsive models. This process can be facilitated by lessons extracted from the vernacular settlement. To achieve this, it is essential to ensure that urban design is given enough space within existing decision-making processes regarding the formation of the built environment. In the Mardin context, the challenges of translating these lessons derive from two main channels, (1) the inactive role of urban design discipline in the politics of space production and (2) the dissonance among the institutions involved in urban development.

8.3.1 The Inactive Role of Urban Designers in the Politics of Space Production

Although disciplines such as urban planning, architecture and urban design have essential roles to play in the formation of the built environment, many of the decisions regarding urban land, as Knox and Ozolix (2000) emphasize, are controlled by architects or planners as well as by other actors such as developers, landlords and politicians. Therefore, it is important to approach urban space production with awareness of the actors involved. The challenge of translating niches extracted from the past to future development proposals can be correlated with the reality of urban design`s standing in the middle of an essential political milieu. As McGlynn and Murrain (1994) assert, urban design involves the person (who is in charge of design) making political choices since (s)he is expected to represent and mediate the values and interests in the activity of design. Therefore, the political matters attached to the design of urban spaces create a series of challenges in urban development practices.

One of the major challenges in Mardin, and in the Turkish context in general, is the power of urban design in the process of urban development. It is essential to understand where urban design stands within the power structure of the urban development system and how designers are involved or excluded from this system. This is important for the epistemological position of this research with the argument being that a socio-technical approach to CRUD - with its (1) social, (2) technical and (3) political dimensions (as explained in Chapter 3) – is needed. With this argument in mind, the role(s) and potential effectiveness of urban design in the development process in Mardin is depicted with the use of a `powergram`, a special matrix developed by McGlynn (1993, p.6). Figure 8.8 presents an adapted version of the `powergram` to illustrate the context within which urban designers operate in the Mardin context.

Figure 8.8 `Powergram` for urban design in the urban development process of Mardin

	Actors						
	Suppliers		Producers				Consumer
Elements of Built Environment	Land owner	Funder	Local Authority		Developer/ Contractor		End-users /local people
			Technical Staff	Urban Designers	Technical staff	Urban Designers	
Land use	–	–	●🔴	–	○🔵	○🔵	🟢
Street Patterns	–	–	●🔴	–	○🔵	○🔵	🟢
Building Blocks	–	–	●🔴	–	○🔵	○🔵	–
Building Plots	●	●	●🔴	–	○🔵	○🔵	–
Building Form	–	●	●🔴	–	○🔵	○🔵	🟢
- height/mass	–	🟢	●🔴	–	○🔵	○🔵	🟢
- orientation	–	🟢	●🔴	–	○🔵	○🔵	🟢
- materials	–	🟢	●🔴	–	○🔵	○🔵	🟢

Legend	
	● Power (either to initiate or control) 🔴 Responsibility (legislative) 🔵 Responsibility (contractual) 🟢 Interest/influence (by argument or participation) - No obvious interest

Source: Adapted from McGlynn (1993)

In the `powergram`, the left column presents the physical components of the built environment in terms of climate responsivity. Following the design variables analysed under different scales in previous chapters, the matrix includes decisions regarding land use, street patterns, building blocks, building plots and the technical details related to the buildings. On the horizontal row, the actors partaking in the urban development processes are abstracted under three categories as suppliers, producers and the consumers. Suppliers are the actors who provide the land and capital for development. Producers consist of local authority and developers, including technical staff such as planners, designers, architects and engineers who are working under directorates of the municipality or for private firms. Lastly, consumers are the local people who are the end-users of the built environment.

As seen in Figure 8.8, the distribution of power in urban development in Mardin concentrates on the left side of the matrix, this includes the local authority, land owners and funders. The Greater Municipality of Mardin has the power to initiate and control the preparation of local level plans which include the decisions related to land use (master-planning), street network, building blocks and plots. However, the municipality does not have the institutional capacity to prepare local level plans (1/25.000, 1/5.000 scales) within the municipality. This is mainly because of the lack of qualified/authorized planners within the technical staff working under the Directorate of Development and Urbanisation in the Greater Municipality. In addition, there are no design experts employed in the municipality currently. The following statement exemplifies the indispensability of contractual planning in Mardin:

> *"Although our planning team is sensitive in terms of environmental issues, we don't have qualified (authorized) planners, the restriction for preparation of Greater Municipal Plans. Therefore, we have to tender for a contract with a qualified planning firm. What we are trying to do is work collaboratively with the planning team in a private firm in order to achieve the best plan, responding the local specifics of Mardin."* (Planner, GMM)

The lack of institutional capacity leads to collaboration with developers which have the required licences and qualifications/authorizations to prepare development plans. At this point, the developer takes the contractual responsibility which includes the power to bring design knowledge into practice. In other words, the role of urban design and the power of designers within the planning system depends upon the presence of an invitation and involvement of private developers at different scales of space production. This shows how, as a profession, urban design stands in a weaker position than other professional groups (i.e. planners, architects) who are guaranteed representation in the urban development process.

Moreover, as seen in Figure 8.8, consumers (citizens) stand in the weakest position with their limited influence on the development system. In line with the main argument of this research, integrating local people into the formation of built space is essential. However, currently local government faces difficulties in communicating with its citizens. For instance, the following extract exemplifies the expectations of citizens and the way in which technical staff respond to their demands.

> *"I appreciate the demands of living in the vernacular houses or living in a new neighbourhood which provides similar features such as more open space extractions or detached houses, as your comparative work has demonstrated. However, as a planner I am struggling with identifying a simple parcel for a public park due to the limits of public land in the New Town. When it comes to negotiating for 1% increase in the expropriation ratio from private lands, no one wants to contribute; everyone wants to maximize their profit and development rights within their parcels."* (Planner, MA)

The capacity of urban design, as this quote from McGlynn and Murrain (199, p.316) suggests, can respond to the identified problem of communicating with citizens via different channels mostly supported by visual communication tools:

"There are many people who can talk extremely coherently and contribute great skills and expertise to the overall design process, but there is a lack of people who can translate the values, qualities and objectives derived from that process into a drawing or model with anything like the equivalent skill and precision. This is the unique selling proposition of urban designers: we are concerned with the design of the physical fabric itself via an open and interactive process. We must therefore be able to demonstrate by drawing products, and the variants in product demanded by a pluralist process, how goals, aspirations and design intentions are translated into spatial configurations and patterns of uses and which can be shown to maximize the aspirations of particular groups."

Furthermore, as presented in the first section of this chapter, urban design has the potential to bring the 'high level of design' notion which establishes the ground for the development of the entire city from single building units to streets, neighbourhoods and districts. The lack of designers engaged in space production processes means that it is shaped by the other actors (i.e. planners, engineers, architects) who are generally not specialized in urban design, and who have the authority to take decisions in the development of Mardin. Within the current planning system (as explained in Chapter 5), different institutions with different directorates have a role in the formation of the urban space. However, unfortunately none of these directorates embody urban design experts who can bring the power of design into the development scene. Therefore, the role of urban design as a 'spine' that connects the 'vertebras', that is to say various concerns of different disciplines towards one single target –shaping the ideal city- falls short in the city of Mardin. In the Mardin case, shaping the city's form, with all of its sub-components, is a challenge, in part due to the lack of coordination among the different bodies partaking in the process of urban development. Looking from the perspective of fostering a transition to a more climate responsive mode of urban development, uncertainty in the delegation of authorities and the roles of different sub-directorates within the planning system makes it even more challenging to introduce more climate-responsive ideas or proposals.

8.3.2 Malfunction in the Coordination of the Institutions Involved in Urban Development

Decision-making processes in urban development have a poly-dimensional contexture which create conflicts in practice, especially when different institutions partaking in the process do not work in line with the same target(s). As Bulkeley and Betsill (2005) argue, the urban governance of climate protection involves relations between levels of the state and new network spheres of authority which challenge the traditional distinction between local, national and global environmental policies. Different levels of policies point to specific concerns with regards to the reduction of the negative influence derived from different sectorial activities. Looking from the perspective of urban development, national and local authorities have different levels of power, capacity and knowledge with regards to climate responsivity and local responses. Therefore, in order to create a change/break in the current dominant landscape of urban development, it is necessary to understand the challenges that stem from the working mechanisms between different authorities.

8.3.2.1 The Delegation of Authority and the Lack of Coordination in Urban Development

The previous chapter has demonstrated that the Old and New Towns present variations from macro scaled (i.e. urban form, street network) to micro scaled (i.e. construction materials) components of urban space. Interviews with decision-makers facilitate an understanding of some of the reasons why contemporary developments are unable to benefit from what we know works in the provision of more comfortable thermal environments. As Chapter 7 has shown, many of these can be derived in the form of 'design clues' extracted from the heritage (Old Town) site. The lack of reflection upon / translation of past experiences is partly caused by the unclear delegation of authorities and the way bodies (mis)interpret laws defining their roles and the powers. For instance, Chapter 5 presented that after the foundation of the Ministry of Environment and Urbanization, the aim of introducing provincial level directorates was to enhance the level of collaboration between local authorities and the central authority. However, the current scene presents a lack of coordination rather than that the hoped-for collaboration through producing a collective plan for the city of Mardin. Interviews reveal that there is a reciprocal excoriation between the local authorities (GMM and MA) and the middle ground authority (MPDUE), representing the national authority (MUE). The following extract exemplifies this excoriation with respect to the power over local development plans.

> *"In my opinion, the definition and power of 'local government' should change. When the entire responsibility and power is accumulated in one single body, it turns into a risk. They decide all building rights including the heights of buildings, floor area ratio (FAR), building coverage ratio (BAR) etc. Should the powerful body consist of sensitive individuals who attach importance to the environment and the nature, it might be easier to produce climate responsive or environment friendly spaces. If not (which is the most often the case) then climatic issues or any other environmental issues have got to be at the end of priority list of actions."* (Architect, MPDUE)

The architect's concern expressed here underlines the importance of collective decision-making among different working groups/institutions in order to minimize the emergence of climatically unresponsive decisions framed by other priorities or external factors. The staff in the MPDUE claim that the plan-making power of the municipality stands as a threat since it gives the full power regarding the determination of development rights in the city. In line with this argument, another member of MPDUE mentions that their current role does not contribute to the generation of development plans, rather it only serves as a cross check mechanism for integration with the upper level plans. The following statement exemplifies how the staff working in MPDUE express their 'inactive' role in the decision-making processes with respect to implementation plans:

> *"The power of the Greater Municipality needs to be limited and the Ministry (MUE) should have more power over local authorities. In the current situation, we as MPDUE, stand as a monitoring institution who report on the functioning/operation but we don't have the power to create change during the process. In a way, we act as a controller as to whether the decisions are made in line with the laws and regulations. I think this is not collaboration, rather it is more like an inspection and reporting of one single body (referring to GMM)."* (Planner, MPDUE)

The lack of collaboration between GMM and MPDUE contradicts the idea of decentralizing the national authority`s power over local municipalities. MPDUE does not function as a mediator between GMM and MEU, rather it serves as a one-way reporting institution which does not fulfil the purpose of translating the national level policies and programmes into localities. In other words, the lack of collaboration is not only because GMM has the power of urban planning within the boundaries of local province but also because MPDUE falls short in terms of guiding local authorities through translating the national level objectives of adaptation to climate change. Therefore, it becomes essential to understand how national level programmes (i.e. national climate change action plan) or international agreements (i.e. signed protocols regarding the reduction of CO2 emissions) are reflected/projected to local level development plans. A lack of guidance and example of actions stands as a barrier to this reflection/translation.

8.3.2.2 Lack of Guidance and Example

In Turkey, the municipal authorities are the key actors in the production of urban space with their power to co-ordinate actions among different stakeholders and enable (or disable) community involvement with policy programs. With respect to climate responsivity, the municipality's power and the key role in shaping the urban space began to be filtered by national, state-led climate change policies and programs (Bulkeley and Betsill, 2005). For instance, the National Climate Change Action Plan (NCCAP) defines various actions under different sectors, including the coordinator institution and the stakeholders needed to partake in the action. The building and transportation sectors are prominent sectors which have direct influence on the formation of urban built environment. Table 8.1 presents the highlights from the NCCAP, which defines the roles for municipalities regarding the issues related to construction and transportation.

Table 8.1 National planning policy guidance relating to urban energy use

	Goals	Objectives	Action (which local municipalities are defined as relevant actors)
Buildings	Increase the energy efficiency in buildings	- Ensure the efficient use of the 'directive on the energy performance of buildings' by 2017. - Provide an 'energy performance certificate' for all buildings by 2017. - Reduce annual energy consumption in public buildings by %20 by 2023.	N/A
	Increase the use of renewable energy in buildings	- As from 2007, at least %20 of the annual energy requirement of new buildings should be obtained from renewable energy sources.	N/A
	Decrease greenhouse gas emissions derived from urban areas	- Reduce local level carbon emissions in the new development areas (target is at least %10 reduction according to existing urban areas)	Prepare a guideline for energy efficient and climate responsive planning principles suitable for local climatic conditions
Transportation	Provide sustainable urban transportation	- Reduce the emissions derived from private car usage in inner-city transportation	Enhance public transportation by 2016 Encourage cycling and pedestrianisation by 2016
	Use alternative clean energy for urban transportation	- Encourage the use of clean energy and alternative fuelled vehicles by 2023	Introduce ageing limit for the public vehicles Provide energy stations for electric cars
	Increase the energy efficiency in transportation	- Reduce the urban energy consumption by 2023	Enhance research and development activities on 'smart transportation systems' and 'traffic management'

Source: National Climate Change Action Plan, 2011-2023

The NCCAP mostly distributes responsibilities to institutions such as the Ministry of Energy and National Resources, the Ministry of Internal Affairs, the Turkish Standard Institution, local municipalities and professional associations. However, the roles identified for local municipalities are not clearly set out. For instance, while the NCCAP requires municipalities to prepare guidelines for energy efficient and climate responsive planning principles suitable for local climatic conditions, some action steps such as increasing the energy efficiency in buildings or increasing the use of renewable energies do not involve local municipalities as relevant stakeholders. Vague statements such as 'enhancing research and development activities for smart transportation' or general/broad statements such as 'reducing energy consumption in public transportation', do not give guidance on the (critical) question of 'how'. The following extract from the interviews exemplifies how both the municipality and MPDUE, the middle ground institution has been facing the challenge of translating the national objectives to localities.

> *"I am responsible for monitoring the implementation of action steps regarding environmental issues identified in the NCCAP. My role also includes giving guidance/support to the municipality when it is required. I sometimes find it challenging since most of the objectives identified in the plan are quite new in the Turkish context. It would be better if we had some examples showing good practice."* (Engineer, MPDUE)

As seen in Table 8.1, energy efficiency and climate responsive planning is set out as an action for reducing the local level carbon emissions in the urban areas developed from scratch (i.e in newly designed/delivered urban development schemes). However, introducing new guidelines into the pre-existing urban political and planning landscape can be challenging, not least because actors may not be familiar with the concept of climate responsive design. The same challenge is also valid for the staff working in the Greater Municipality of Mardin in a different form. As seen in the following interview extract, technical staff face the difficulty of translating actions identified in national level action plan in their localities:

> *"When you read the objectives and the action steps identified in the NCCAP, it is hard to transfer what is written in the document to our local plans. Some actions do not make sense for a middle scale city like Mardin. For instance, electronic cars or electric power stations may be valid for metropolitan cities but I don't know how these actions can be actualized in the Mardin context"* (Planner, GMM)

No doubt, urban planning is not done solely for the provision of thermal comfort in cities. However, all of the objectives and actions presented in Table 8.1 have an influential role on the formation of urban space, the main determinant of urban thermal comfort and the energy consumption patterns for the provision of comfort in the face of extreme climatic conditions. For instance, encouraging the use of clean energy and a reduction in energy consumption in inner-city transportation are identified as objectives for 2023. The action steps for that target are listed as the promotion of cycling and walking as well as clean public transportation modes. However, as previous chapters have demonstrated, development in the New Town does not present responsivity in terms of sustainable transportation modes in Mardin. Rather, the new development sites demonstrate the absence of infrastructure such as walkable paths or cycling routes. This problem is not only about a lack of knowledge regarding more climate responsive development. Even citizens (non-experts) can identify the fact that the new neighbourhood developments contradict the idea of providing climate responsive living settings in the Mardin context. That means there is a meta-level problem alongside the lack of knowledge or good practice examples.

8.3.3 A Lack of Design Vision for Climate Responsive Space Production

Creating climate responsive urban settings which provide urban thermal comfort with minimum energy consumption calls for a rooted change in the existing urban development landscape. However, the lack of design vision for this change/ transition is a significant barrier against the implementation of micro-scale climatic niches conceptualized in Chapter 3. Interviews with decision-makers reveal a better understanding of this challenge by revealing its correlations with the priorities, moral issues and inspection mechanisms that make up the contemporary Turkish urban planning system.

8.3.3.1 Priorities in Urban Development: Underestimation of the Climate Issue

The Greater Municipality of Mardin defines its mission as creating an *"ecologic, democratic and non-sexist"* city. Although this target could potentially act as a catalyser for the provision of climate responsive urban space in Mardin, the achievement of these three major goals generates different sets of challenges in practice. The stress on the "ecology" concept is an important asset in terms of triggering the change towards more climate responsive urban development. However, the dominance of the existing development trend and on-going preference towards high-rise apartment construction arguably contradict the ecological understanding in development. The following interview extract exemplifies the contradiction between the 'desired' and the 'produced' urban space in Mardin:

> *"I can say that the development in the New Town is not human oriented, rather it is post-liberal profit-oriented. If you look at the development plan, you can see parcels identified with BAR values of 2-2,5. These values are extremely high and it is obvious that you can't provide social standards such as green or open spaces. But who cares? The idea is "the more profit, the better"…* (Engineer, MPDUE)

It is essential to emphasise that the current development plan was prepared under the previous government in which a different political view was in power. The authority changed hands following the local elections in 2014. This has impacted upon the coherency of the plans and their implementation. Taking an optimistic point of view, technical staff partaking in urban development processes showed awareness of the inconsistency between the main 'mission' and the actions taken by different sub-directorates working on different themes under local authorities. This inconsistency is a result of two main factors. As shown in the extracts below, it can be caused by the lack of information regarding the methods for implementing climate responsive principles and / or the absence of 'expert knowledge' of individuals working as technical staff.

"I can say that there is an indigenous belief and demand for creating more climate responsive city. But, I believe that the lack of knowledge regarding the methods, in other words the question of 'how to do it?' is a challenge for us." (Planner, MA)

"Most of the directors in different institutions don't give value to the experience and expert knowledge of their own technical staff. I can call this something like an 'obedience culture'. Same as the one in military service. You don't have the chance to apply or even propose something which you think is essential for sustainable development. You find yourself in a 'funny' position when you express your ideas in a context where the sustainability or climate responsivity is not the concern of directors. Unfortunately, what was thought by us at the university was composed of utopia. The real world dynamics don't allow us to implement these 'ideal' planning principles" (Planner, GMM)

Problems emerge from the underestimation of the severity of climate related issues. Interviews present that different actors partaking in decision-making processes have different levels of awareness. Considering that the planning system is composed of different institutions and thematic sub-directorates that sit underneath these institutions (see Chapter 5), a malfunction in one of the links in the chain creates complications in practice. For example, as exemplified in the following extract, the absence of a landscape architect, couple with the way in which landscape is perceived by some actors, prompts a failure in the implementation of an action which is essential for thermal comfort in the city:

"…a considerable amount of investment is made in tree plantation at different points in the city. However, after the plantation, the maintenance of these green areas became a big challenge. The same thing is also valid for the typology of the trees which were chosen for Mardin. Some of them already died back. When we question these issues, the municipality complains about the lack of financial sources. I believe this is something more than a financial problem. Do you think it is normal not to have any landscape architect in the local planning team? It is assumed that landscape is only about aesthetic beauty…" (Engineer, MPDUE)

The point which the interviewee references here is very important for the mission of creating an ecological city. However, the problem should not be simplified into statistical facts, that is to say the number of landscape architects or experts for specific issues with respect to climatic concerns. What is pointed to here by the interviewee is also related to sustainability of the actions as exemplified in the tree plantation strategy. Sustainability here refers to continuity of the actions with their management, maintenance and monitoring after the planning and implementation stages. This calls for a stronger coordination between different local authorities introduced in Chapter 5. For instance, both GMM and MPDUE have a sub-directorate called the 'Directorate of Development and Urbanization' and most of the urban components compared in the previous chapter are produced with the guidance of these directorates. However, the current condition does not indicate a situation of collaboration or the creation of common ground, rather it reveals a certain level of polarization between two institutions. The following extract summarizes the difficulties in achieving this collaboration:

> *"To be honest, most of our time passes with evaluating the 'plan amendments' and responding to the objections and demands regarding these amendments. Therefore, we don't have extra time to work on alternative development patterns or collaborate with the municipality to re-think the city's plan. Each department has its specific task, what you have in your mind is very utopic"* (Planner, MPDUE)

The above extract also shows that the staff got used to working within this uncoordinated system and they are not optimistic about the possibility of a change/transition towards a more sustainable system. This is partly because of personal beliefs and barriers but is also related with other moral issues that they have been witness to in different planning cases, a subject to which the discussion now turns.

8.3.3.2 Moral Issues

Interviews revealed that relatively less-experienced staff were more motivated and excited by the preparation of a new development plan that responded to local climatic values. Contrastingly, the more experienced staff presented less optimism and belief in the creation of a sustainable built environment in Mardin. This sense of discouragement is likely to originate from the piecemeal alterations that are directed by top-down processes. The following extract illustrates that, even within the working mechanism of the Greater Municipality, amendments in plans emerge not as an outcome of common ground, but rather by influence of some external factors outside of the control of the technical staff in the municipality:

> *"It is not easy to follow the "planning revisions" done in the municipality. Unfortunately, these revisions mostly are done for single/piecemeal alterations such as increasing the building permission for one single building block or changing the land use decision of a parcel from green space to commercial use. Since we are dealing with buildings more at the parcel scale, we often witness unethical planning alterations which don't have any logical explanation in terms of sustainable development. But at the same time, they are legitimate in the legal base."* (Architect, MPDUE)

The amendments introduced by actors (i.e. executive members of municipal assembly) other than technical experts (i.e. planners, architects, engineers) distorts the unity/integrity of development plans. For instance, a parcel-based increase in the development rights leads to a change in the construction density, the planned/calculated population projections, and the planning standards (i.e. green space per person). One can see this change as a small amendment to the plan, however any small amendment can lead to emergence of unresponsive living settings that embodies the undesired features (i.e. lack of green space, narrow space between buildings), as mentioned in the previous Chapter. Interviews present that these piecemeal plan amendments damage the unity of plans not only because of unconscious (i.e. lack of technical knowledge) top-down interventions but also because of personal power relations, as it appears in the following interview extract.

> *"Each director in different directorates under the Greater Municipality of Mardin acts like a 'president'. There is a perception that collaboration or sharing knowledge between staff or other directorates may make them lose their power (I mean prestige) in the political sense. No one can say that there is a democracy within the directorates."* (Planner, GMM)

8.3.3.3 Lack of Inspection/Control

As discussed in the previous section, the lack of guidance and epitome is a challenge for technical staff to introduce climate responsive solutions into a robust planning landscape. Similarly, the lack of inspection mechanisms to identify decisions contradicting the planning goals and objectives stand as a challenge. This is also related to a lack of design vision for the entire city. In the current condition, MPDUE is responsible for controlling the plan revisions and amendments. Although the MPDUE was introduced to function as a cross-checking 'middle ground' institution between the Ministry and the Municipality, it does not have a role in deciding the 'content' of the plans, revisions or amendments, rather it controls only the 'format' of the proposed revisions. Therefore, the judgement made by MPDUE happens without referencing the future design of the entire city, instead it occurs in a piecemeal manner, as do the plan amendments*:*

> *"Unfortunately rules and regulations don't contain any limitation for 'plan amendments'. Therefore initial plans are exposed to several alterations even in the short term. This leads to piecemeal amendments at the parcel scale or building block scales. These amendments are controlled only within the boundaries of the plan area that is proposed for revision. Therefore, the influence of piecemeal amendments on the entire city is not considered".* (Planner, MPDUE)

Weaknesses in inspection mechanisms also open spaces for the emergence of unethical decisions discussed in this chapter under the wide heading of 'moral issues'. Considering the deadlines set in the NCCAP to identify actions that will need to be completed by 2017, the strict control and promotion of mechanisms is required. Otherwise, piecemeal amendments will continue to contradict objectives such as the reduction of carbon emissions or increase in the energy efficiency in urban settlements. The following extract shows the risk of underestimating the influence of these amendments:

"I shouldn't say this but the main problem is a lack of respect to rules and regulations. As you know, we are responsible for (MPDUE) controlling the local development plans if they fit/take reference from the upper scale plans such as 1/50.000 scaled Environmental Plan. I am afraid almost 50% of what we have identified as 'contradiction' gets approval from the Ministry of Urbanization and Environment. I have witnessed so many plan alterations such as from green space to residential usages. There are informal/invisible connections between decision-makers. We as technical staff don't have the chance to change this procedure." (Planner, MPDUE)

8.4 Conclusion

The production of climate responsive urban space is a relatively new concept that was introduced to the Turkish urban planning system after the publication of NCCAP 2011-2023. The current planning system cannot completely fulfil the requirements identified for the transition to climate responsive space production. This Chapter has presented the barriers to the introduction of design principles - extracted from the heritage town of Mardin- into new urban development sites.

The chapter has demonstrated that the challenges are derived from (1) the inactive role of urban design in the current urban development system in Mardin, (2) a lack of coordination amongst the different institutions partaking in the urban planning process and (3) the lack of a 'design vision' for climate responsive space production.

The chapter presented that the current urban development system does not benefit from the capacity of urban design to respond to local citizens' demands and introducing climate responsive solutions to the formation of the built environment. This is partly caused by the contractual development system due to the lack of qualified technical experts in GMM and also the way in which directors perceive the discipline and the roles of urban designers in the planning system.

Beside the role of urban design in the urban development system, malfunctions in the coordination of institutions involved in the urban development in Mardin stands as the other main challenge for introducing more climate responsive design solutions. This challenge is correlated with the delegation of authority among different actors and lack of guidance and examples regarding the use of climate responsive methods in urban space production.

Finally, the chapter ended by demonstrating the lack of design vision for creating more climate responsive space and by showing how there is an underestimation of climate issue among the priorities in the urban development.

CHAPTER 9

CONCLUSIONS

"…We entered into a new era in which we aim to reduce the carbon emissions. As the Ministry of Environment and Urbanization, we aim to encourage the use of renewable energy technologies and development of environment-friendly, green buildings… We will give preference to horizontal approaches rather than vertical development models. Turkey embodies very rich cultural and social diversities. Therefore, our new/modern development should maintain this richness. With this purpose, we believe that the horizontal development concept can provide the continuation of our neighbouring relations, more liveable urban spaces with full of green areas in which families and children can comfortably live… (Fatma Guldemet Sari, The Minister of Environment and Urbanization, December 2015)

9.1 Introduction

The above press briefing by the Minister of Environment and Urbanization presents that the desired urbanization model of the Ministry closely overlaps with the main concern of this research. However, what is observed through the case of Mardin, particularly the horizontal vs. vertical differentiation between the Old and the New Town, shows a significant contradiction between the political rhetoric and the implemented actions on the ground.

In an era where governmental bodies try to achieve, or at least present an intention to create, a change in the urbanization modes to reduce the impacts of cities on climate, the socio-technical approach adopted in this research can contribute to the achievement of this targeted change in the space production system. This research has argued that a change in the space production system calls for the integration of residents' socio-ecological values. These can be as important as the 'expert' knowledge produced by built environment professionals such as planners, architects and designers. This is important not only because residents are the decision-makers who determine the amount of energy consumed in urban daily life, but also as they instinctively produce the social knowledge to adapt themselves to local climatic conditions. Therefore, this research values the locally produced social knowledge as a significant catalyser for finding a responsive design vision for urban space production.

Reflecting on the reciprocal relationship between the way urban thermal comfort is provided in urban daily life and the socio-spatial formation of urban living settings is a core contribution of this research. In the remainder of this concluding chapter, the main findings of the research are set out and aligned in response to the research questions outlined in Chapter 4.

Section 9.2 considers the research contributions in relation to the role of urban space on energy consumption levels for provision of thermal comfort in urban life. Relatedly, it also (re)presents the thesis's argument that a (re)conceptualization of urban thermal comfort is required. In 9.3, the discussion turns towards the findings generated by the comparative analysis of the Old and New Towns in Mardin, and particularly the lessons that can be carried forward into the delivery of future developments/design proposals. Section 9.4 presents the research`s contributions related to the discussion of the catalysing power of urban design and, more specifically, the need for a socio-technical approach to climate responsive urban design. Section 9.5 presents the research implications of climate responsive urban design in Turkey. In section 9.6, the discussion turns towards the methodological contributions of the research and considerations of the lessons, for policy and academic research, to be learned from the Mardin case. This leads into a discussion, in 9.7, about limitations, future research agendas and directions.

9.2 (Re)conceptualizing Urban Thermal Comfort: Local Specificities Matter

A central aim of this research has been to explore, and critically reflect upon, the ways which thermal comfort in indoor and outdoor spaces is identified, brought together into a recognisable `agenda` in urban development practice. These are matters that have received much attention from urban scholars over the years, yet gaps in knowledge remain, most particularly around the social and cultural experiences which directly influence the formation of thermal expectations as well as the human adaptation capacities.

One contribution of this research has been to explore Chappell and Shove`s (2004) argument that thermal comfort depends upon the social and cultural context in which it is defined and structured and in which the comfort expectations are shaped. The research support this assessment and, in so doing, highlights the socially and culturally-embedded nature of the term thermal comfort. It contends that thermal comfort is a `social convention` which calls for understanding of intangible values (e.g. cultural factors) as well as the technical dimensions regarding the formation of urban space (e.g. architectural details, city form).

Chappel and Shove`s (2004) `social convention` concept was used to theorize observations of the Mardin case. A key finding of this element of the research is that urban thermal comfort should be (re)conceptualized within and through the production of urban space, as well as by taking into account the ways in which end-users interact, adopt and sustain their everyday life in accordance with the local climatic characteristics. In the Mardin instance, coherency between the local climatic conditions and the formation of urban space in the heritage town, explains, at least in part, the way people have sustained their lives in relatively comfortable conditions in the different layers of urban space (building, street scale, etc.) throughout the years. As Chapter 7 has shown, the formation of physical urban space has a significant impact on the provision of thermal comfort both in indoor and outdoor spaces. The Chapter has also demonstrated that the physical space influences, and is influenced by, the social and/or cultural assets of localities. This interaction/mutual effect determines thermal comfort experiences that are central to the concept of `social convention` (as elaborated in Chapter 2).

A second core contribution of the research has been to (re)consider the individuals/end-users that constitute the inhabitants of the designed/delivered urban living settings. It has highlighted the increasingly standardized and repetitive nature of urban planning bodies, who are aligning themselves with mainstream planning issues such as the preparation of local master plans, the (re)distribution of urban development rights, but also, increasingly (especially after the political changes seen in local government) with somewhat ‘softer’ social and lifestyle issues. In so doing, the research has contributed to understanding of the role of local planning directorates such as the Directorate of Urbanization and Environment, which, as Guy (2013) notes, is seeking for alternative ways to superficially universalized systems of measurements as a guide through cultural diversity.

This seeking was also noted in this research, and the Greater Municipality of Mardin was shown to be more sensitive (compared to previous administrations) towards the local people`s need and requirements of climate in which they try to sustain their life with an optimum comfort level. While an intention was observed at both the national and local authority levels, when it comes to the implementation and development of plans, the research has shown that current space production mode falls short in considering the local specificities and responding to the requirements (e.g. need of shading, comfortable pedestrian paths) shaped within the harsh climatic characteristics of Mardin.

The practice of climate responsive urban design is a context-dependent affair and as presented in Chapter 7, the contextual specificities vary, even from the architectural to city scale within the same case study. The contextual nature of CRUD, as Guy and Karvonen (2011) have noted, calls for particular attention while transferring techniques, skills and knowledge (regarding urban development) from one context to another. For example, Masdar city project in Abu Dhabi, formulated with an argument of creating zero carbon development in a desert climate, faces the challenges of mismatches between the western-originated technologies and local lifestyles mostly identified with high energy consumption profiles. Bringing better or smarter construction technologies is not sufficient enough to achieve the desired change towards providing climate responsivity. Rather, a better understanding of the ways/patterns in which local people use, live, interact within the urban built environment is required. This research has explored these patterns through the case of Mardin and highlighted the lessons that can be learned from the comparative study conducted in two different 'town' contexts within the same province.

While exploring the lessons through the comparative study, the research utilized the socio-technical system approach to interpret urban space as a socio-technical system in which people and technologies interrelate through the political and socio-cultural realities of everyday life. Socio-technical systems thinking constituted a key concept for approaching urban design as the catalyser of climate responsive urban space production. The concept provided an umbrella for joint understanding of the technical dimensions (regarding climate responsiveness) of urban space production and the social dimensions of everyday life urban space.

The research viewed climate responsive design as an ongoing transformational process in which different actor interests and struggles are integrated. As argued in Chapter 3, the current urban planning system in Turkey represents a mechanical system highly dependent on technical determinism that underestimates the significance of socio-cultural and climatic variations in different localities across the country. This research claimed that changing this technical-oriented robust planning system is possible through exploration of local specificities and activation of urban design discipline to use these locally explored inputs (i.e. local adaptive mechanisms, climate-responsive solutions) into the space production system. This argument is constructed based on the theorization of multi-level perspective (MLP) developed for conceptualization of transition from a robust system to a new system through activation of local niches. MPL provided a useful theorization of the process of transition from the current urban development system to a more climate responsive form of space production. In this research, the concept of niche in MLP is interpreted as the clues of climate responsive urban design which potentially can be used for future urban development proposals and these clues are explored through the comparative case study that revealed the lessons that can be learned from the past.

9.3 Learning From the Past: Scale Matters

A central objective of this research was to shed light on the way(s) in which the formation of the urban built environment influences the provision of thermal comfort and energy consumption needed to achieve an optimal level of thermal comfort. The vernacular urban pattern in Old Mardin, which has largely been sustained in its present form since the medieval era, demonstrated that even though many of the technological solutions (i.e. construction technologies) in housing and urban development that we utilise today were not yet invented, it was nonetheless possible to find adaptive solutions to variations in local climatic conditions. The research shows that technological development and 'expert' knowledge are not the only preconditions of climate responsive space production. Rather, the responsivity in the Old Town is derived mainly from a typology of development that has been generated in accordance with local climatic characteristics and lifestyles that have instinctively developed to suit these conditions.

The comparative research demonstrated the significance of understanding/exploring urban space with respect to the specificities of different scales, starting from the housing scale and escalating through to the street and city scales. This is important since it enables the development of a methodology by which to examine the formations in the two towns but also allows us to conceptualize the space production and understand the way end-users use space, construct social relations and sustain their lifestyles under local climatic characteristics.

The research has revealed that in order to achieve indoor thermal comfort at the housing scale, rather than being attributable to one or more climate variables, climate components such as the movement of the sun, breeze-generating strategies, and heat gain and loss dynamics (through materials) in urban settings need to be considered in a holistic manner. It is essential to bear in mind that each territory has different climatic factors and each locality has its own unique culture. Therefore, each locality requires certain interventions according to specific climatic and cultural characteristics; these may not correspond with pre-defined strategies in the literature.

The research has demonstrated that contemporary apartment flats do not provide the same level of thermal comfort as those developed more than a thousand years ago, with one consequence being that people living in contemporary flats consume more energy than those in vernacular units. This difference highlights the need, at least in the Turkish case where the New Town style of development is being repeated in urban areas across the country, for a different housing typology which considers the local climatic characteristics, local peoples' lifestyles and the way in which they interact with urban spaces and buildings. Government-developed 'prototype'-style apartment blocks as seen in almost all cities across Turkey, apparently fit neither local requirements nor respond sufficiently to climatic variations of the type seen in Mardin. Modifications to these development typologies could be made to better incorporate local conditions. For example, vertical typologies which embody more open space extensions, as discussed in Chapter 8, could be formulated for new housing proposals. The institutional context is key here. For instance, in terms of creating more responsive design solutions, an initial drive needs to come from the Housing Development Administration of Turkey, an institution that defines its role as *"guiding, supervising and educating organization in the housing sector[23]"*. It is this body that oversees the majority of new public sector housing developments, of the

[23] www.toki.gov.tr

kind featured in the Mardin case study. However, the current reality is that Turkey witnesses the same prototype government-led apartment construction in all geographic regions regardless of the climatic characteristics and localised cultural requirements. In addition to being more sensitized towards these contexts, there is also arguably a need for other strategic or national-scale interventions, such as the preparation of housing design guidelines or codes for the provision of thermal comfort. Guidelines to encourage energy conservation in different territories would also be useful for local municipalities to help them direct and control housing construction processes via developers and sub-contractors.

The thesis has also emphasized that levels of thermal comfort in Mediterranean climatic conditions are highly correlated with the design of streetscapes. The formation of the streetscape in urban heritage sites represents a sensitive type of design in which measures exist to escape from negative climatic influences such as sun exposure and to gain benefit from the movements of the sun via smart street alignment strategies. The statistical results presented in Chapter 7 support existing research that has shown how streets can be designed in order to minimize the undesirable effects of dominant climatic characteristics such as extreme heat and direct solar radiation. Existing climate characteristics can also be turned into an advantage through design by considering measures such as street layout, street canyons, surface cover and shading. The case study also exemplified that the lack of comfortably walkable streets in Mediterranean climates stands as a major factor triggering the use of energy consumer transportation modes in the daily commute.

With relevance to the discussion of commuting patterns, the research has also shown that the city form with its transportation network and land use distribution has a direct influence on everyday life comfort experiences. As compared in Chapter 7, urban sprawl in the New Town leads to an increase in the distances between the working and living space. The lack of comfortable pedestrian paths connecting different zones pushes people to use transportation modes which they can commute more comfortably even for the short/walkable distances.

No doubt cities are not planned with the provision of thermal comfort as the main purpose. However, in extreme cases where the climatic conditions influence the flow of daily life, thermal comfort needs to be included in the ‘priority list’ of planning issues. As discussed in Chapter 8, the planning system commonly seen in almost every region of Turkey fails to fully respond to local climatic conditions and satisfy inhabitant`s comfort requirements. To overcome this failure, this research has argued that governmental bodies can benefit from the capacity of the urban design discipline to deliver the necessities of climate responsive space production. This is possible through the activation of urban design and by giving a place to designers to introduce a holistic vision and future `picture` for the entire city. Otherwise, as Chapter 8 demonstrated, piecemeal interventions by planning amendments will remain incapable of responding to local requirements.

9.4 Urban Design as Catalyser of Climate Responsive Space Production

The research has demonstrated that climate responsive space production calls for a understanding of the way in which local residents use the built environment and adopt and/or avoid urban certain climatic conditions. Analysis of the current planning and urban development system revealed that the desired change, as indicated in several press briefings by the Minister of Environment and Urbanization, depends upon overcoming barriers against climate responsive urban development including the inactive role of urban designers in space production (see Chapter 8.3.1). In order to achieve this, conveying a 'design vision', which brings an holistic understanding of both technical determinants and the socio-cultural factors generated within and by inhabitants, is essential. The production of housing and the surrounding built environment is not only about designing physical structures in an urban setting. Rather, following a Lefebvrian approach, it is essential to emphasize the reciprocal relation between the formation of the built environment and the way people use, live in and perceive the urban settings.

Considering that this reciprocal relation influences the energy consumption levels for the provision of thermal comfort in indoor and outdoor spaces in cities, housing provision and the distribution of building rights should not be approached as separate dimensions from the design of the entire city. For instance, Chapter 8 has demonstrated that the local authority faces the challenge of convincing people to generate public land in order to provide enough green space as identified in the planning standards. Urban design, with the help of emerging technological tools such as digital applications and 3-D visualization techniques, can contribute to the negotiation process through which urban land is (re)organized. It is inevitable that landowners will want to maximize the economic benefit from their building parcels, that is to say the more construction rights they receive from the municipality, the better. However, if land owners are approached with tangible/visible proofs (e.g. 3-D models or renderings) of a designed future city, as Sheppard et al. (2011) noted, they may be better able to recognize that a small sacrifice from releasing their land may actually turn as a benefit towards their desired thermal comfort living standards in the harsh climatic conditions of Mardin.

What was explored in Chapter 7 was the difference between one town produced as an outcome of a relatively standardized planning process and another one that was not planned but rather emerged more organically in line with a `high level design notion` that generates an un-institutionalized frame for the formation of the entire town. This design notion forms the backbone to ensure that the built environment is shaped responsively both in terms of local climatic variations and with respect to the daily practices and experiences of urban inhabitants. The backbone here linked to the basis of transitive and interlocked series of sub-spaces argued in Chapter 8 (see Figure 8.3).

This is one finding that speaks directly to the argument posed in Chapter 3 of the thesis about the potential of urban design discipline to moderate the technical knowledge regarding measures and responses to climate sensitivity with the social knowledge that is generated within and by local communities. While the former provides measurable and/or controllable indicators for the reduction of energy consumption in urban daily life, the latter ensures the creation of sensitive, resilient and more intelligent urban spaces that understand and draw upon local specificities. As Carmona (2014) noted, urban design is fed by different intellectual roots such as sociology and anthropology; and by the different professional practices of architecture or planning. This is why the discipline embodies a catalysing power to approach urban development from a socio-technical perspective and to bring a holistic understanding to both dimensions. For instance, one way to actualize this holistic perspective is to bring together design charrettes with new technologies and applications which supports participatory and collaborative platforms. This serves not only to bring local people together and ask their opinions about the future of the city, but also to construct socio-technical basis, a reconciliation and commitment platform, for a better-integrated design for the city.

This is one conclusion that speaks directly to the question posed in Chapter 4 of the thesis about how to (re)define climate responsive urban design both to capture technical dimensions such as the use of appropriate design typologies, construction materials and insulation techniques and to look from the perspective of end-users to achieve the locally desired level of urban comfort as far as possible. The socio-technical perspective adopted in this research to activate the catalysing power of urban design, constitutes the research`s core methodological contribution. Empirically, the research has sought a thorough and in-depth study of the inter-relations between urban space production, thermal comfort and energy consumption in the case of Mardin in order to develop greater joint understanding of the technical and social dimensions of climate responsive urban design.

9.5 Implications of Climate Responsive Urban Design in Turkey

The research revealed that the implementation of climate responsive design in Turkey calls for (1) activation of urban design discipline in the politics of space production and (2) a better harmony among the institutions involved in urban development practices. The researcher claims that achievement of these two challenging missions is possible with strategic modifications in the institutional design process and accordingly reforms/revisions to current polices, rules and regulations for the preparation and implementation of urban development proposals.

As argued in Chapter 8, bringing 'design knowledge' in to practice is highly correlated with institutional capacity. In the current conditions, the lack of capacity (i.e. qualified/licenced urban designers) is one of the weaknesses of current municipal level urban development practice. This weakness could be eliminated with the introduction of a revised employment strategy (at national, regional and municipal scales) for the formulation of the core planning bodies responsible for preparation and coordination of the implementation of urban development plans. Designing the future of cities should not be formulated in the absence of urban designers who are particularly educated for creating/describing/depicting the future alternative schemes for urban settings. It is essential to underline that this study stresses the significance of the role of urban designers not to bring 'expert' knowledge gained by academic education but to highlight the capacity of designers to produce 'design knowledge' which was referred to in previous chapters as the combination of both technical and social knowledge generated within and by users of local settings. Integration of the two is possible through collaborative decision-making processes in which a reciprocal learning environment is constructed.

Current policies make space for local authorities to use collaborative ways of decision making at different levels. However, despite the opportunity for applying it, there is not a regulatory restriction for application of participatory methods enhancing collaborative decision-making. Therefore municipalities could design their local planning processes either with a modernist approach (i.e. based on expert knowledge) or a collaborative approach which opens ways of dialogue and co-production with different stakeholders. The planning process itself influences the plan decisions and also the outcome of the implementation (i.e. produced urban scene). Intentionally or unintentionally, if municipalities fail to collaborate with relevant stakeholders, particularly the local land owners, it is not likely to create climatically responsive urban built environments as identified/targeted in the national level strategy documents.

Reflecting national level plans and programs to local level urban development practice stands as a problematic area which is partly related to the institutional capacity and partly the lack of implementation tools. As argued in the example of NCCAP, local authorities find it difficult to 'read' and reflect the national level documents into their everyday work schedules. Considering the relatively new concept of climate responsive urban development in Turkey, additional training such as 'staff capacity development programmes' can be useful for solving the problems argued in Chapter 8, section 3.2.2. This is also applicable to university curriculum design for the built environment disciplines in the long run. However, for the short run, staff training can include best practice examples, alternative way(s) of using plan implementation tools and potential way(s) of understanding and generating their own local knowledge.

In order to minimize the emergence of climatically unresponsive decisions in different working groups under different institutional bodies, the roles and the working mechanisms should be revised in a way to generate collective decision making. For instance, the current working structure between the MPDUE and GMM is based on a 'cross-check' mechanism ensuring the reflection of upper level plan decisions on the local urban development plans. This mechanism fails to create an environment of dialogue between the two bodies, rather all communications are based on written reports and prepared plans. Thus, the lack of deliberating on the plan decisions stands as a barrier to taking collective decisions. This research argues that periodical 'action meetings' in which the staff of both institutions get the opportunity of working together and 'cross-checking' by consulting, negotiating and deliberating simultaneously could be an efficient mechanism. Although this calls for additional time and resource to arrange collaborative working settings, it can reduce the loss of time for the files/plans which go back and forth many times for minor or major revisions between institutions. This can also put an end to generation of bias against the staff working in 'other' institutions and may reduce the problems that occur due to the moral issues discussed in Chapter 8.

9.6 Conducting Socio-Technical Research in an `Open Laboratory`

This research, in adopting an intensive and locally grounded approach, demonstrates the value of case study research. Indeed, a methodological contribution of the thesis is to show how and why urban heritage sites can stand as an `open laboratory` to trace the clues of socio-technical form of space production. While the presence of the Old Town (heritage site) in Mardin represents a unique arrangement of spatial elements that has organically emerged over time, nonetheless key features of the spatial organization in evidence here provides grounds for a comparative approach with more recent developments (the New Town) under the same climatic challenges.

The thesis used this comparison to demonstrate that there is a trilateral relationship between the design of urban space, the way thermal comfort is provided and the amount of energy required for the provision of thermal comfort in urban daily life. This multi-dimensional relationship requires understanding of the city as a socio-technical artefact composed of people, technology and nature. This understanding requires, as Guy and Karvonen (2011) have noted, the researcher to embrace the complexities of urban development and then develop research approaches to unravel these complexities. As presented in the Chapter 4, the presence/continuity of life in the urban heritage site provided the basis for living, observing, 'feeling the ground'. Thus, this helped to explore the ethnographic dimensions of the research with regard to understanding the lifestyles and everyday life experiences in the locality. A methodological highlight of the study was the amalgamation of qualitative techniques for revealing the context-dependent interactions between inhabitants and urban built environment, and quantitative techniques to statistically testify the role of space design in the `social convention` of thermal comfort. This approach was taken not only to triangulate or methodologically 'prove' the validity of the techniques selected, but also to foster the theoretical understanding of socio-technical nature of climate responsive space production.

9.7 Limitations, Towards an Agenda for Future Research

The press briefings quoted at the beginning of the Introduction and the Conclusion Chapters exemplify that the political discourse on climate change places emphasis on alternative/responsive urbanization modes to achieve the upper scale targets related to reduction of energy consumption and carbon emissions derived from cities. Although this study was limited to the provision of thermal comfort in a hot and arid climate, it has claimed there was potential for urban design to help achieve the desired/intended urban settings, if locally specific urban design programmes, tools and techniques are adopted by authorities. The research explored mainly the challenges of providing thermal comfort in summers; mostly because the city of Mardin has been facing the problem of cooling and because the limits of funding and the time lag to conduct winter measurements. Thus, a further study can be designed for exploration of winter conditions, particularly to examine the way(s) the Old and New Towns respond to the local climatic characteristics in winter and to find out potential ways of benefiting from the natural sources such as the sun.

Additionally, regarding introduction of more responsive urbanization modes, the research revealed most of the socio-political barriers to achieving this change in Turkish context. However, this exploration was limited to the local authorities and residents of Mardin. Therefore, further research can be carried out with other actors such as private developers or funders who has significant role on urban space production processes. This may also help to respond to the following question raised by Barlas (2013, personal communication), a professor of urban design.

> *"Is `climate responsive urban design` a dead-end `game` within the current urban space production systems which habitually compel urban land to be perceived as the source of economic production for nations?"*

This is not a question which can really be answered in `black or white`, `yes or no`. Yet the question was not raised to get a response in that sense. However, Barlas, with his question, strikingly remarked on the rigidity of creating the change in the ongoing urban development patterns which mostly identify urban land as a meta on which urban living spaces are produced as an outcome of profit-oriented development approach. This is interlinked with Geel`s (2012) argument of `hardness` in creating a `breaking point` in existing deep-rooted regimes, such as urban development. As argued in Chapter 3, creating a `breaking point` in the robust development landscape requires revisions in policies and modification in the construction system. Therefore, a further research on the actors of the urban construction system may help achieving this `breaking`.

In the growing climate crisis, developing countries like Turkey urgently seek for solutions and potential ways of creating change, in other words to achieve `breaking`. This research showed a wider need to recognise and embed urban design as a valuable discipline alongside and within planning professions and systems. In order to share the deeper understating of the Mardin case and the way urban space is shaped according to climatic conditions with a broader audience, the researcher aims to produce a documentary as a channel to catalyse the construction of a bridge between scientific and community-led knowledge, leading to actionable knowledge in urban development practices around climatic adaptation. The documentary, and related research publications, will establish an impactful and innovative feedback 'loop' rarely achieved in research in which local people are given an opportunity to see the ways in which their own modifications (i.e. in the way they use the built environment to manage climatic extremes) become critical junctures in the 'professional' challenge of addressing climate change.

APPENDIX A

Questionnaire for In-depth Interviewing

- This questionnaire has been prepared for PhD research which aims to explore how socio-ecologic values can be integrated into the process of creating climate responsive urban environments.
- The research has been carried out by Ender Peker in the School of Real Estate and Planning in the University of Reading, UK.
- Gathered information will be used only for scientific purposes.
- The questionnaire is composed of three sections and it takes approx. 45 minutes.
- Participants can contact the researcher at any stage of the research and can withdraw from the study at any point.
- Researcher's contact details: Tel: 0533 352 37 94, e-mail: pekerender@gmail.com

Participant Information

Gender: ☐ Male ☐ Female

Age: ☐ 18 - 25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 55-65 ☐ 65+

Educational Status:

☐ Illiterate ☐ Primary school ☐ Secondary school ☐ High-school ☐ University +

Household Status:

☐ Owner ☐ Renter

Length of residence ……..

<u>PART 1</u> ***Housing Scale _ Energy Consumption & Comfort***

<u>Please identify the features of your house from question 1 to 3</u>

1. **Building Type**

☐ Apartment ☐ Vernacular (courtyard) type ☐ Single detached ☐ other ....

2. **Building Material**

☐ Concrete ☐ Stone ☐ Adobe ☐ other ....

3. **Size of the house** ....m^2

4. **Heating System**

☐ Wood stove ☐ Coal stove ☐ Central heating (coal) ☐ Central heating (natural gas)

5. **What is your average cost for the heating for one year?** .... (TL)

6. **Do you use any equipment for cooling?**

☐ No/ natural ventilation ☐ Electric ventilator ☐ Air Conditioner

7. **What is your average cost for cooling for one year?** .... (TL)

8. **Have you ever been a resident in the old/new town?**

   If yes, please answer questions 9 and 10, if not please go to question 11

9. **When and why did you move?**
   ....
   ....
   ....

10. **How do you think your energy consumption for heating and cooling would change if you were living in the old/new town? Would it be less or more? Please explain briefly.**
   ....
   ....
   ....

11. **How do you rate your comfort level in your house in summer?**

   Very poor/uncomfortable ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 Very good/comfortable

12. **How do you provide optimum thermal comfort level in summer? How do you achieve it?**
   ...
   ...
   ....

13. **How do you rate your comfort level in the house in winter? (1 is min. - 7 is max.)**

   Very poor/uncomfortable ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 Very good/comfortable

14. **How do you provide optimum thermal comfort level in winter? How do you achieve it?**...
   ....
   ....

15. **How would you describe the level of urban infrastructure provision in your neighbourhood, in the last two years? (e.g.: sewage system, domestic water) in the last two years? Please explain briefly.**

....
....

<u>PART 2</u> ***Street Scale_ Urban Commute & Comfort***

16. **What is your dominant mode of transport for short/everyday trips?**
☐ Bus ☐ Private Car ☐ Motorcycle ☐ Bicycle ☐ Animals ☐ On foot ☐ Other...............

17. **Can you indicate the origin and the final destination of your typical daily journey? (Please write the name of neighbourhood)**
.... → To..

18. **What is your average commute time?** .... (minutes)

19. **Can you identify the features that make a street comfortable for you in terms of thermal conditions?.**..
....
....

20. **I am interested in your experiences of thermal comfort in the new and old parts of the city. Can you reflect on this?**
....
....
....

21. **If you were a designer and responsible for designing a new neighbourhood including residential units and pedestrian streets how would you design in order to provide optimum thermal comfort?**
....
....
....

Thank you for your attention!

Please fill your contact details, if you are volunteer to take part in the video-making phase of this research. For further details please contact the researcher.
Name:
Home address:
Phone:
Available days/hours:

APPENDIX B

Information Sheet and Consent Form for In-depth Interviewing

I am visiting your city in order to understand the climatically responsive built environment pattern of historical and contemporary parts of Mardin. This visit is a part of the case study of my PhD research which aims to develop an alternative urban design approach that integrates local people's socio-ecological values in the production of climate responsive urban built environments.

The research in Mardin involves two phases. You are welcome to participate either one or both phases.

1) In the first phase of the research, I would like to interview with you to understand your experienced thermal comfort level in the urban built environment that you live in. To accelerate the process, a questionnaire (see Appendix A) will be distributed to you before we start conversation. With your permission, I would like to take photographs and voice record my conversation with you. There won't be any digital voice recorder or camera if you feel uncomfortable. I reassure that your identity will not be revealed while decoding the recorded voice data.

2) In the second phase of the research, there will be a filmmaking study which aims to explore the relationship between climatically responsive urban pattern in the historical part of Mardin and the way you use the benefit of this climatic responsiveness in your daily life. I would like you to introduce your living environment and express its features from the point of your experiences under extreme climatic conditions of Mardin. With your permission, I would like to take photographs and also video/voice record of this visit. If you want to show or demonstrate something significant in terms of thermal comfort inside your home, I and my research assistant will be entering your home to record those scenes that you want to share with us. Recording times will be decided according to your program and availability to host us at your home. Following editing of the video recording, I will seek your permission to use excerpts in the production of outputs from the research. You will be sent a copy of the final edit of any video or photographic media in which you appear, prior to any public or academic use.

Arrangements have been made to securely store video and photographic material collected during the field visit. Visual (photographic and video) and sound data will be securely archived in accordance with the University of Reading Data Management guidance:
http://www.reading.ac.uk/internal/res/ResearchDataManagement/reas-ResearchDataManagement.aspx

There will be no disclosure or use of information provided that may harm or compromise the person or persons taking part in the research, and no disclosure to another party.

Signed Consent

By agreeing to participate in this research, you are acknowledging that you understand the terms of participation and that you consent to these terms.

PARTICIPANT

Name of Participant: Signature of Participant:

Permission to audio record and photograph during **interviews**:

- ◯ Granted
- ◯ Not Granted

Permission to video/audio record and photograph in your home/courtyard for **filmmaking**:

- ◯ I volunteer to take a part of the filmmaking process.
  (If so, please fill your contact details at the end of the page)
- ◯ I don't want to take a part of filmmaking process.

RESEARCHER

Name of Researcher: Signature of Researcher:

Date: ……. August 2014

Please retain a copy of this form for your records.

Your contribution to the research can be withdrawn at any stage and removed from the research if desired. If at any stage you wish to receive further information about the research you can contact the researcher, using the contact details below.

Ender Peker, PhD Researcher	
Contact Details for UK	**Contact Details for Turkey**
Real Estate and Planning Henley Business School University of Reading Whiteknights Campus Reading, RG6 6UD Tel: +44 7940086562 e-mail: pekerender@gmail.com	Middle East Technical University Faculty of Architecture Department of City and Regional Planning Ankara 06800 Tel: +90 5333523794 e-mail: pekerender@gmail.com

Participant's Contact Details (Please fill this section if you are volunteer to take part in the filmmaking)
Name of Participant: **Address:** **Phone:**

APPENDIX C

Street Questionnaire

- This questionnaire has been prepared for a PhD research carried out by Ender Peker in the School of Real Estate and Planning in the University of Reading, UK.
- Gathered information will be used only for scientific purposes.
- The questionnaire is composed of three sections and it takes approx. 5 minutes.

Participant Information

Gender: ☐ Male ☐ Female

Age: ☐ 18 - 25 ☐ 26-35 ☐ 36-45 ☐ 46-55 ☐ 55-65 ☐ 65+

1. **In the past 15 min. prior to the survey, have you been to air conditioned indoor spaces (cooled or heated spaces including bus, taxi etc.)?**

   ☐ Yes ☐ No

2. **How do you feel in terms of thermal sensation (7 point scale)**

   ☐ hot ☐ warm ☐ slightly warm ☐ neutral ☐ slightly cool ☐ cool ☐ cold

3. **Is the subject's head/body exposed to direct sunlight? (observation by interviewer)**

   ☐ Yes ☐ No

4. **How do you feel about the exposure to the sun? (3 point scale)**

   ☐ Sun makes me uncomfortable ☐ just right ☐ not enough

5. **How do you feel about the wind? (7 point scale)**

   ☐ Stagnant ☐ still ☐ slightly still ☐ just right ☐ slightly windy ☐ windy ☐ very windy

6. **How do you feel about the air, in terms of humidity? (3 point scale)**

   ☐ Humid ☐ just right ☐ dry

7. **Overall, what would you say about this place? (3 point scale)**

   ☐ very comfortable ☐ comfortable ☐ neutral ☐ uncomfortable ☐ very uncomfortable

Thank you for your attention!

APPENDIX D

Questionnaire for Elite Interviewing

- This questionnaire has been prepared for PhD research which aims to explore how socio-ecologic values can be integrated into the process of creating climate responsive urban environments.
- The research has been carried out by Ender Peker in the School of Real Estate and Planning in the University of Reading, UK.
- Gathered information will be used only for scientific purposes.
- The questionnaire is composed of three sections and it takes approx. 30 minutes.
- Participants can contact the researcher at any stage of the research and can withdraw from the study at any point.
- Researcher's contact details: Tel: 0533 352 37 94, e-mail: pekerender@gmail.com

Participant Information:

Institution/Department:

Role/Gender/Age:

1. Are there any sub- groups or teams working on climate change and/or adaptation? Particularly on energy policies and urban development?

2. What kind of themes are they working on?

3. How do you integrate their work with the new urban development?

4. Do you have objectives regarding development responding to local climatic conditions?

5. Is there any regulation specifically prepared for climate responsive urban development?

    5a. If yes, what does this regulation(s) dictate?

6. What can you say about the development patterns in the Old and the New Town?

7. What type of design tools has been used while planning the New Town?

8. What are the dynamics that influence the formation of urban space in the New Town?

9. Why do we observe such a rigid variation between the Old and the New Town?

APPENDIX E

Consent Form for Elite Interviewing

This research aims to analyse urban development patterns in the Old and the New Towns of Mardin. The aim of this interview is to understand the urban development dynamics in hot and arid climate of Mardin. Information gathered from interviews will be used only for academic purposes and both the name and the position of the participant will be kept confidential.

<u>Signed Consent</u>

By agreeing to participate in this research, you are acknowledging that you understand the terms of participation and that you consent to these terms.		
PARTICIPANT	Name of Participant: Permission to audio record during the **interview**: ○ Granted ○ Not Granted	Signature of Participant:
RESEARCHER	Name of Researcher: Date: ……. August 2015	Signature of Researcher:

Please retain a copy of this form for your records.

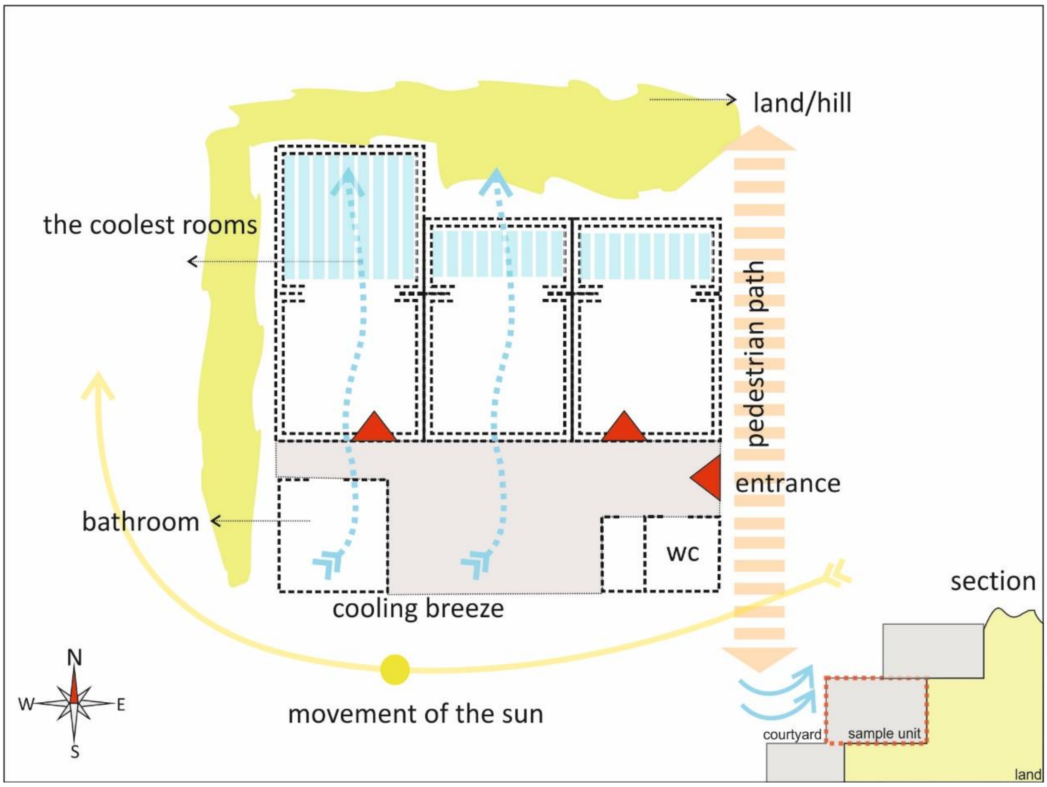
Your contribution to the research can be withdrawn at any stage and removed from the research if desired. If at any stage you wish to receive further information about the research you can contact the researcher, using the contact details below.

Ender Peker, PhD Researcher
Real Estate and Planning Henley Business School University of Reading Whiteknights Campus Reading, RG6 6UD Tel: +44 7940086562 e-mail: pekerender@gmail.com

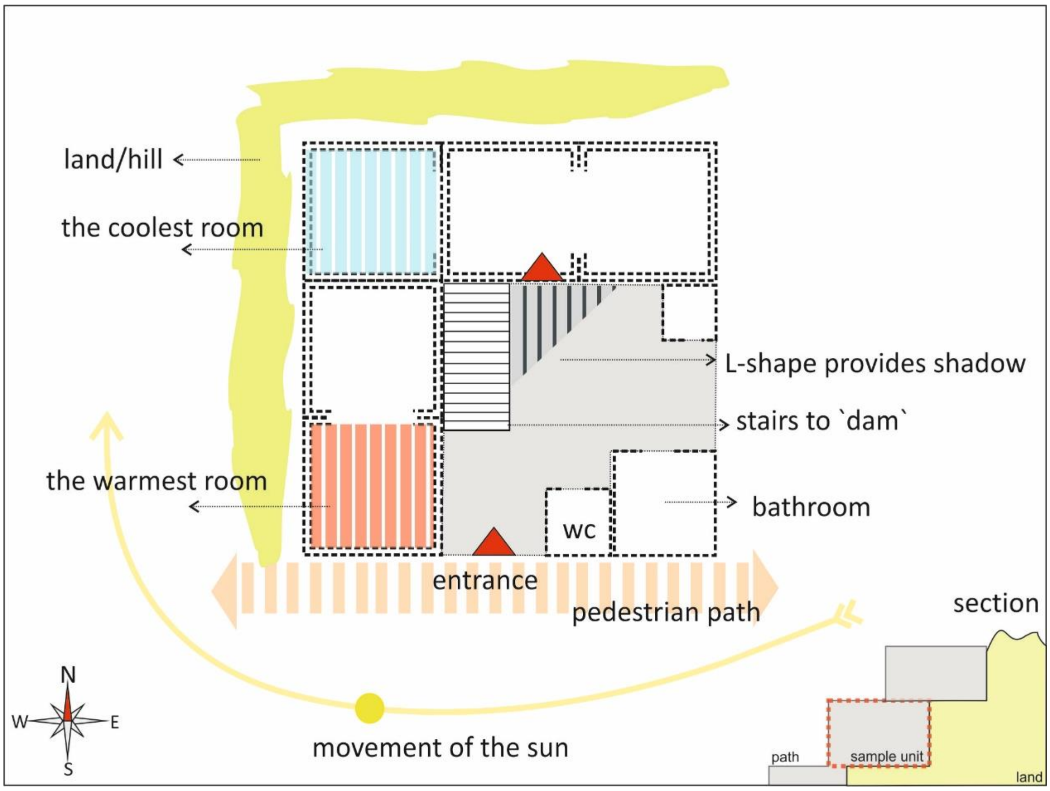
APPENDIX F

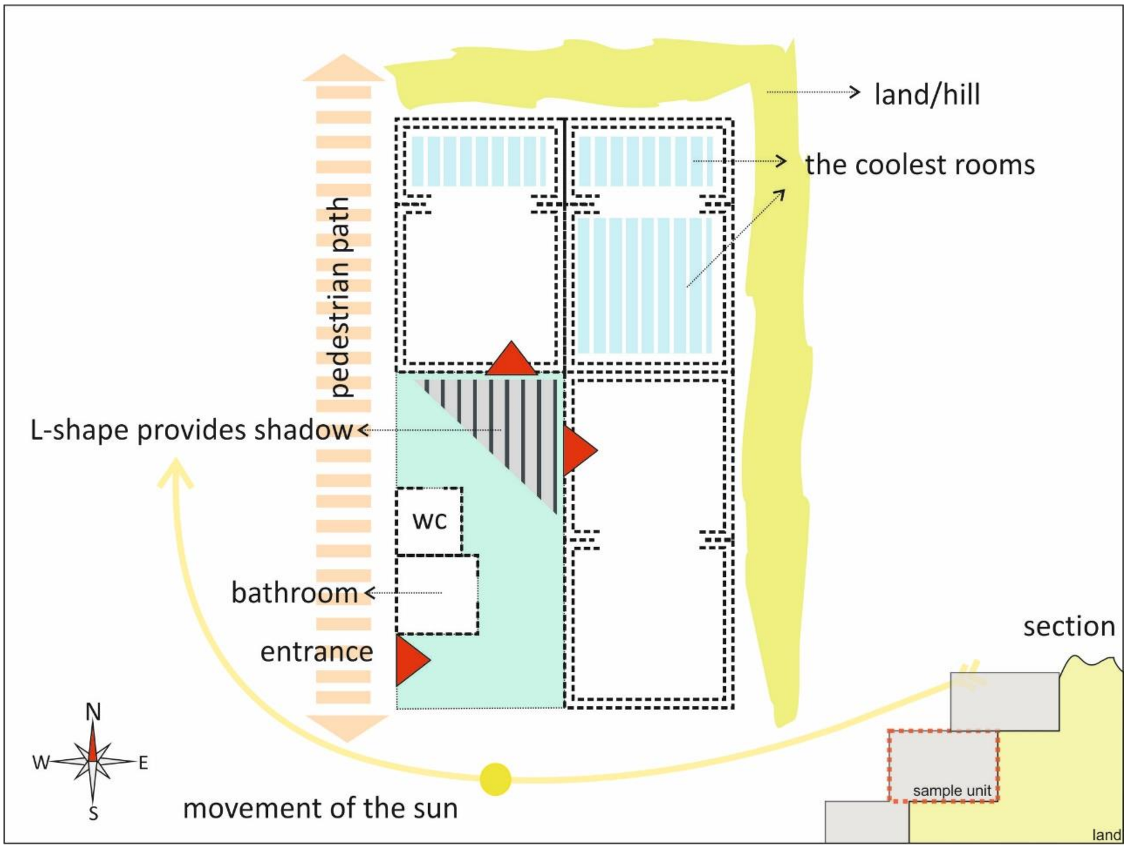
Plan Layouts of Sample Housing Units

Vernacular sample unit 1



Vernacular sample unit 2





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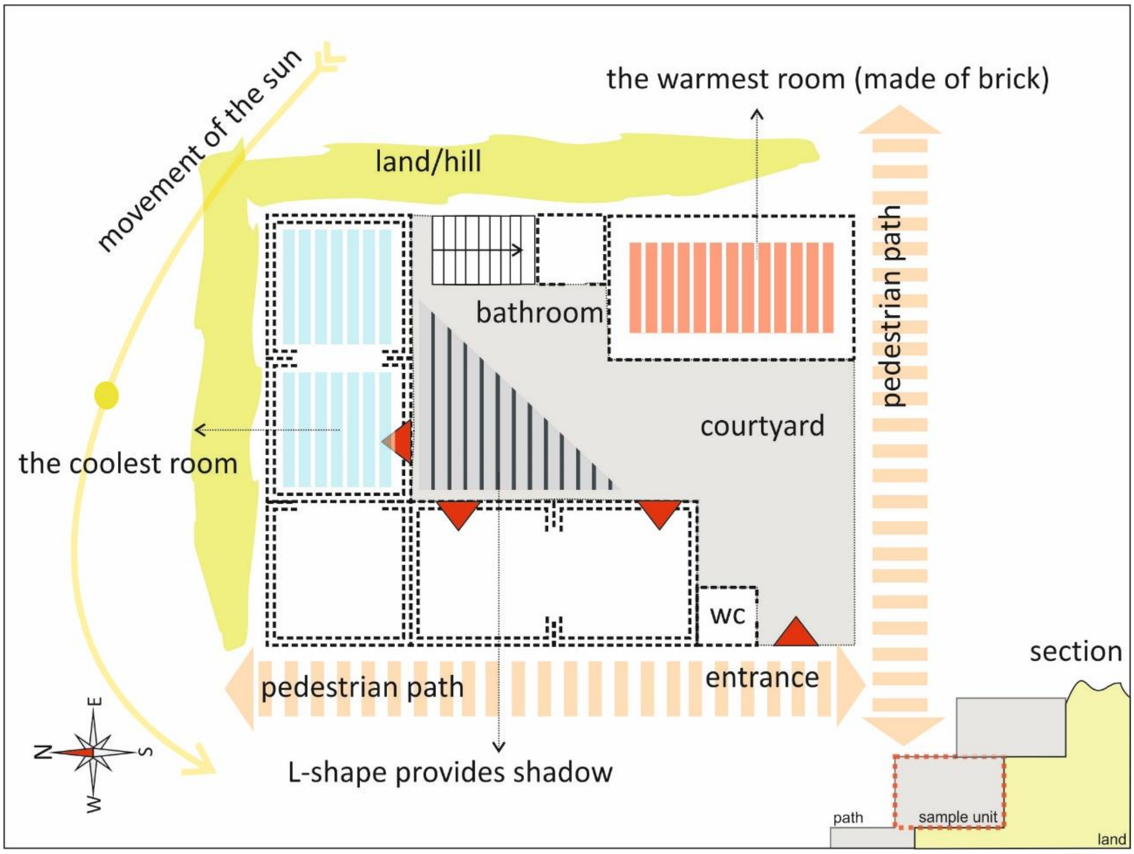
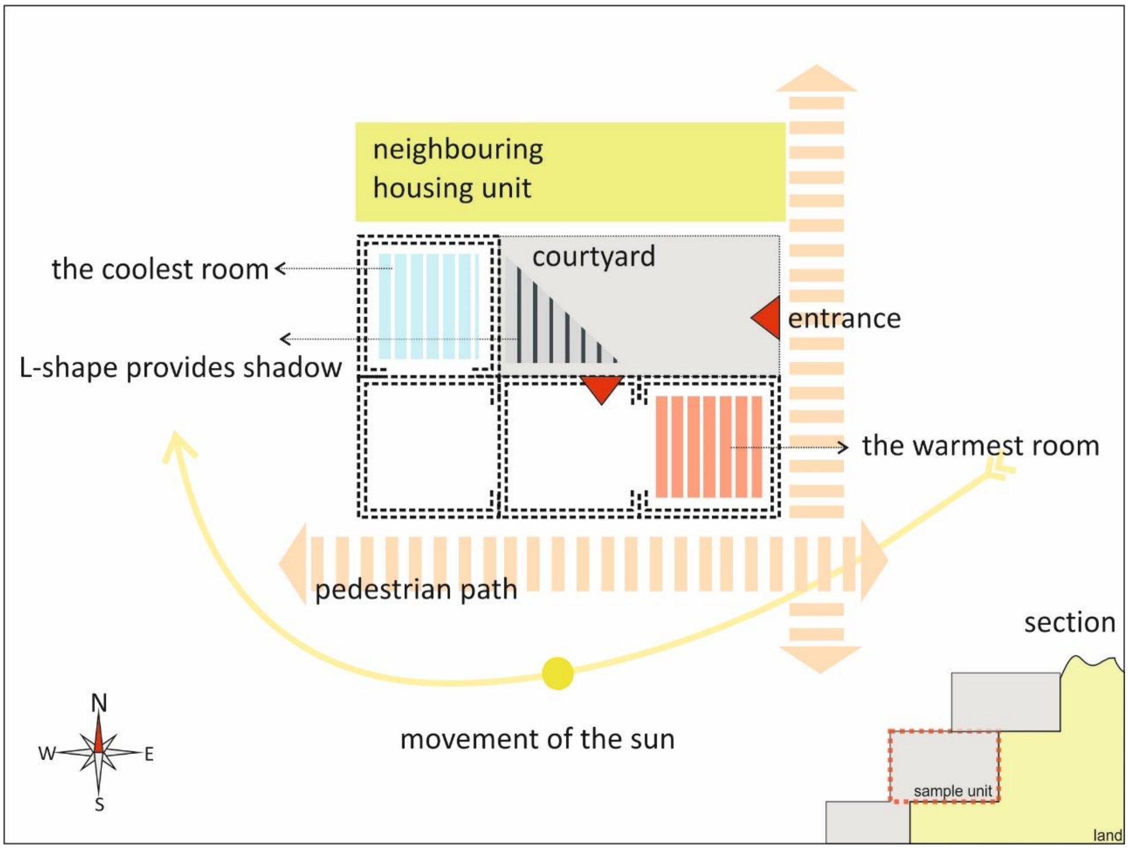


Vernacular sample unit 4

Vernacular sample unit 5



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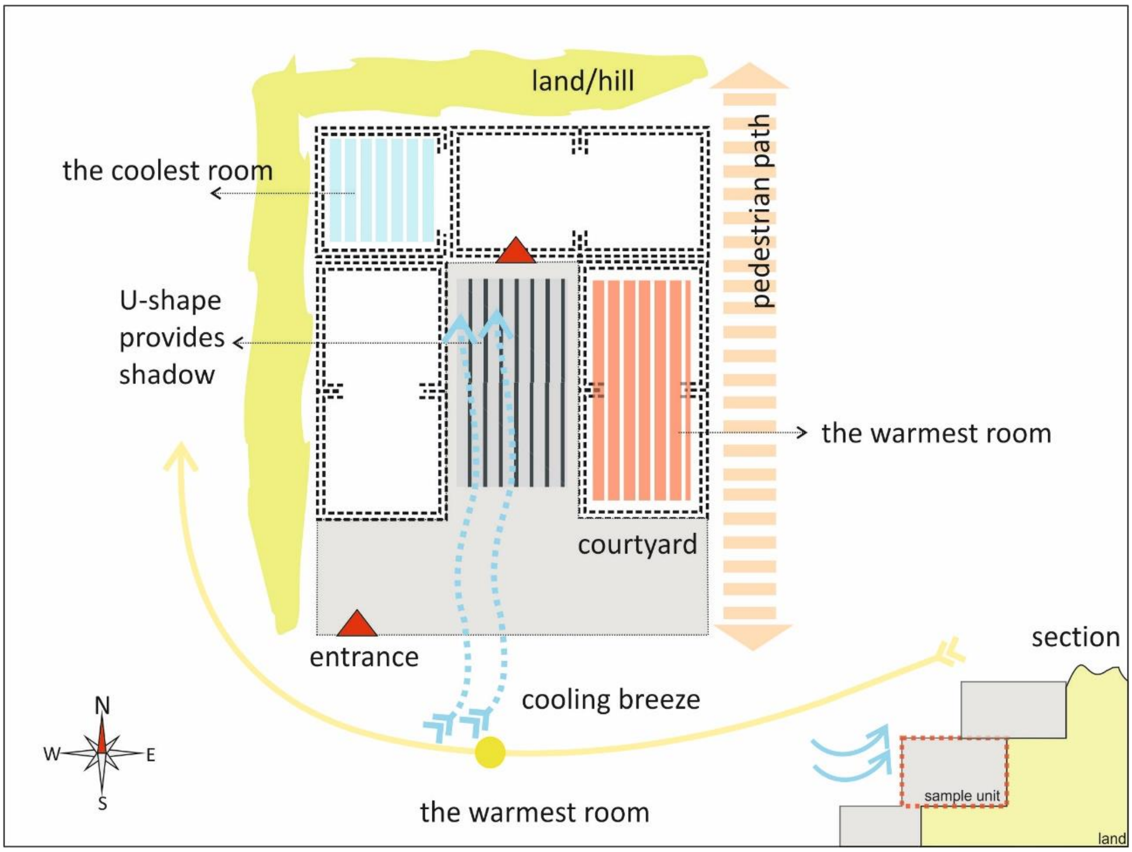
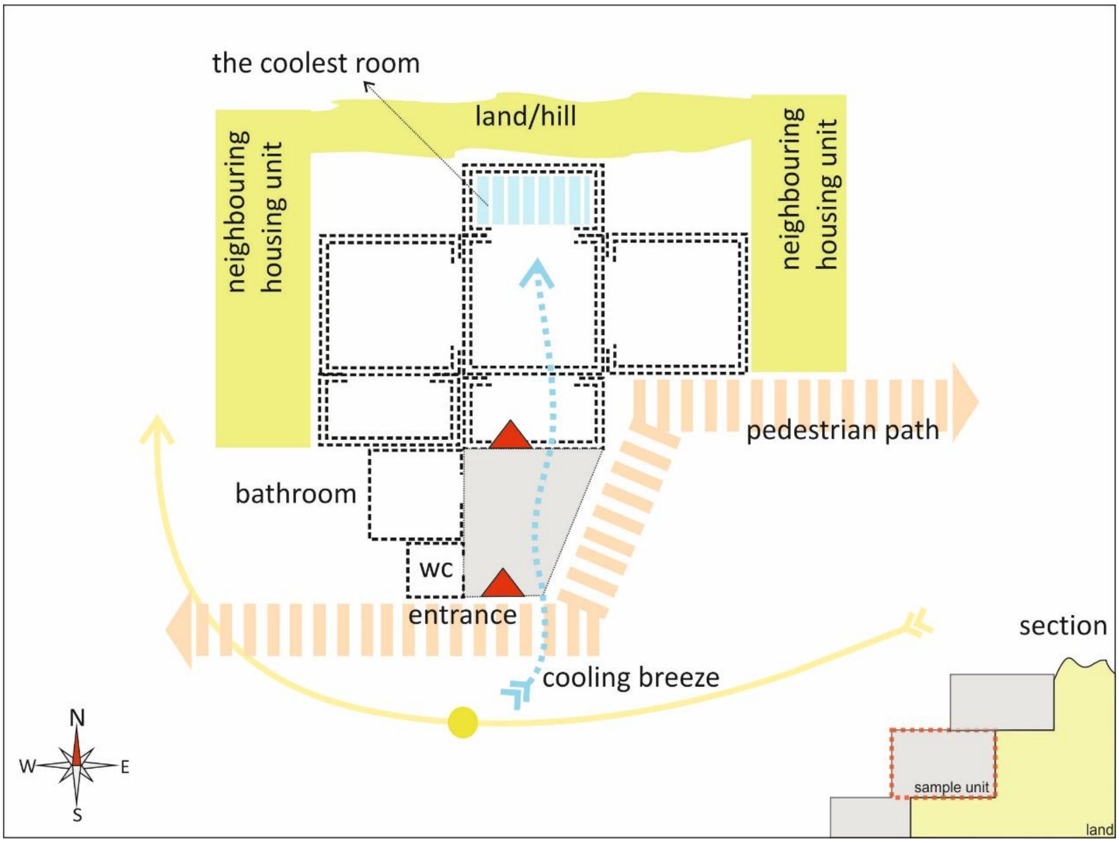


Vernacular sample unit 7



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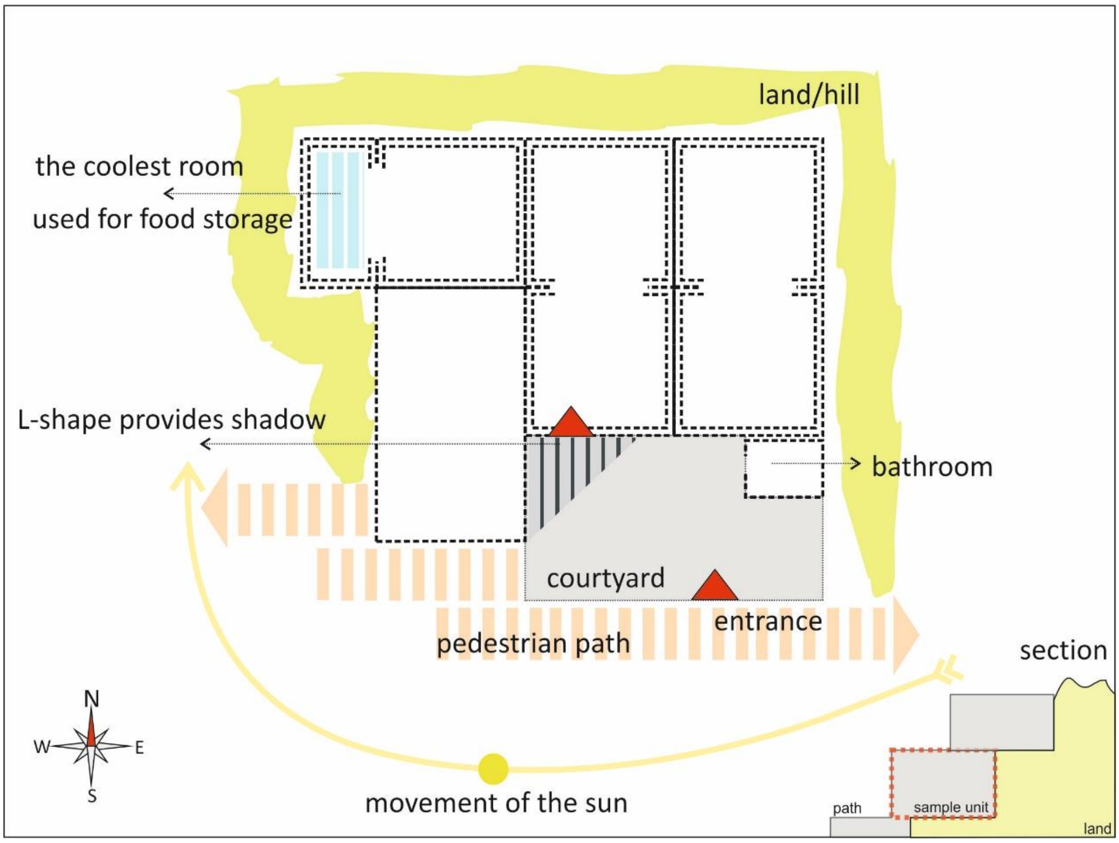
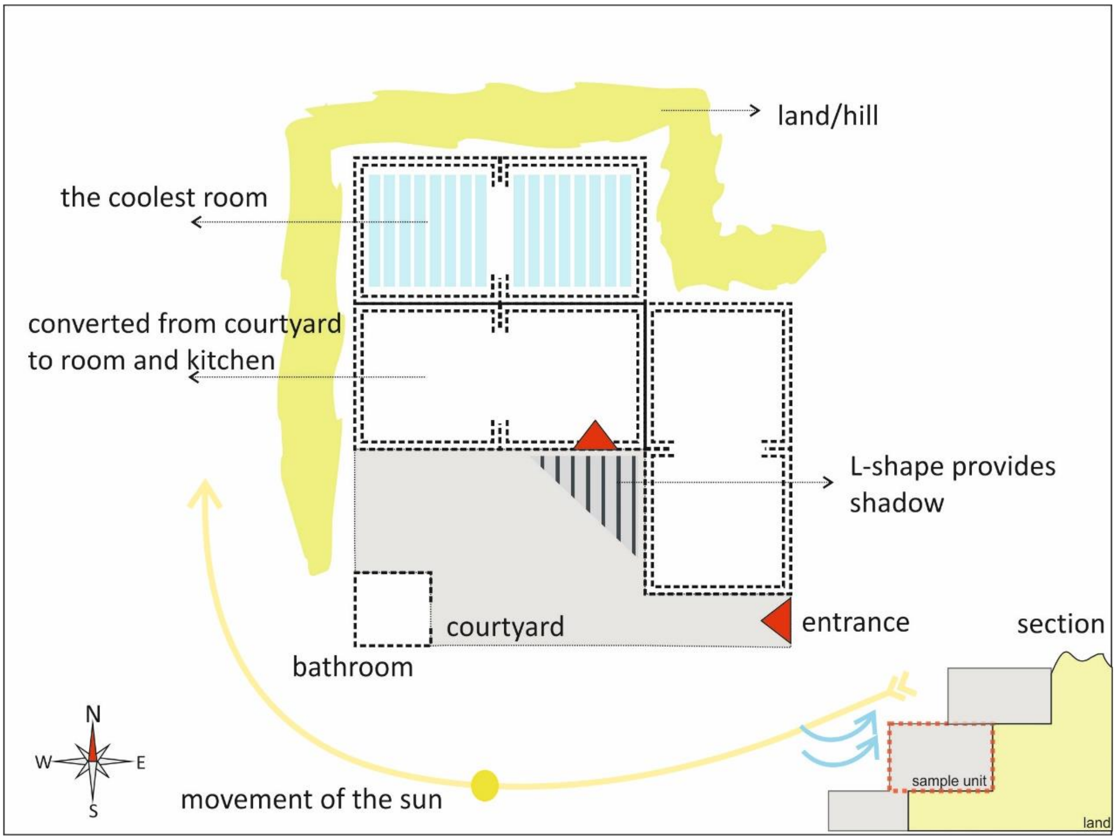
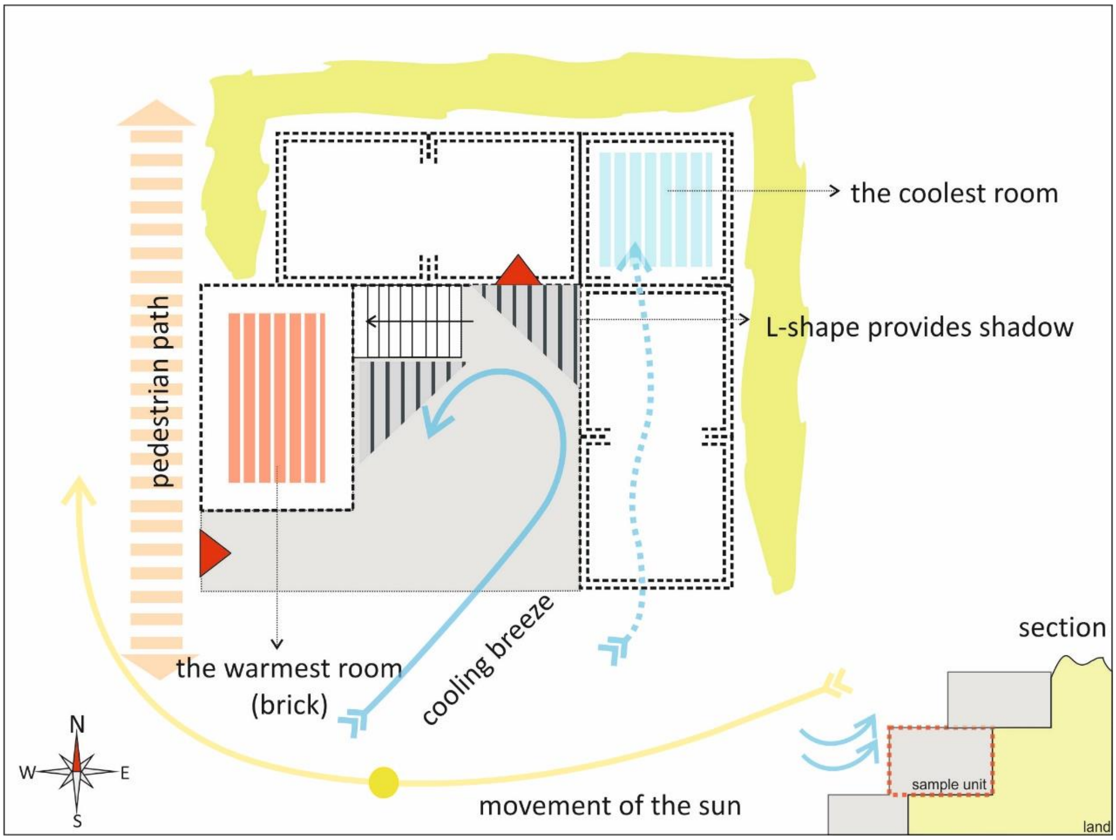
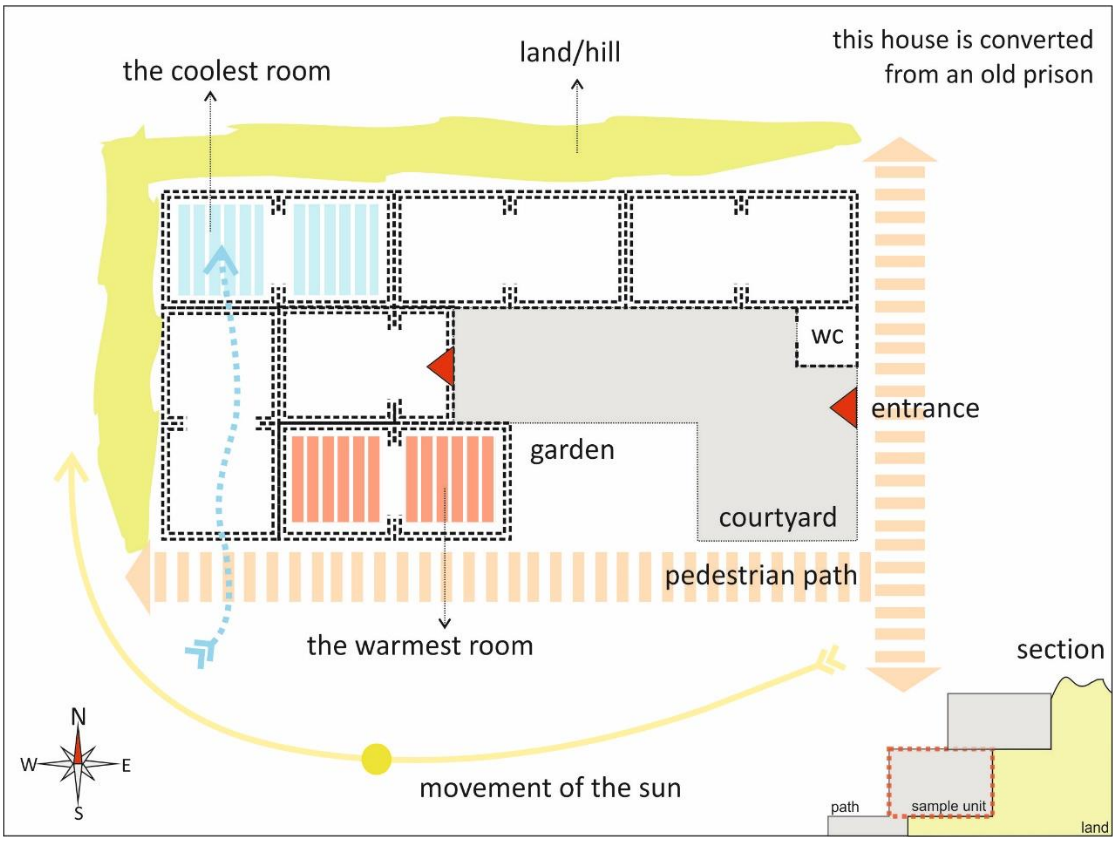


Vernacular sample unit 9



Vernacular sample unit 10





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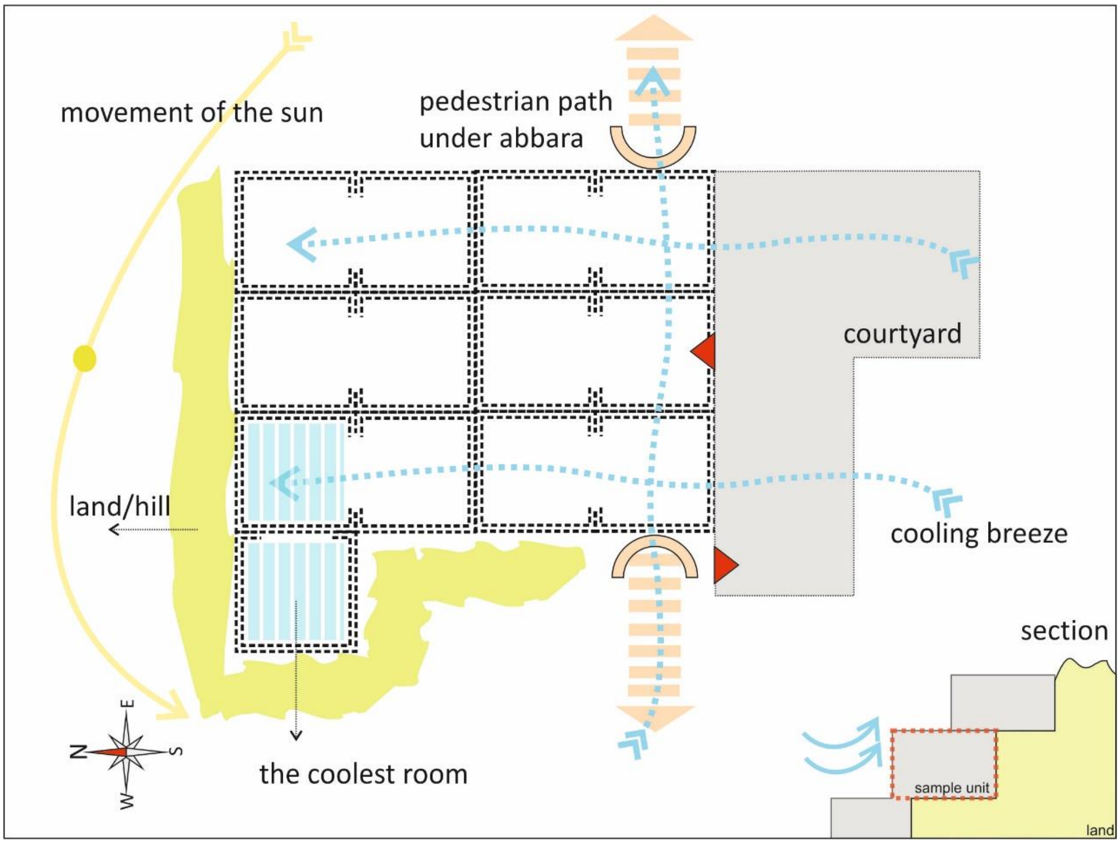
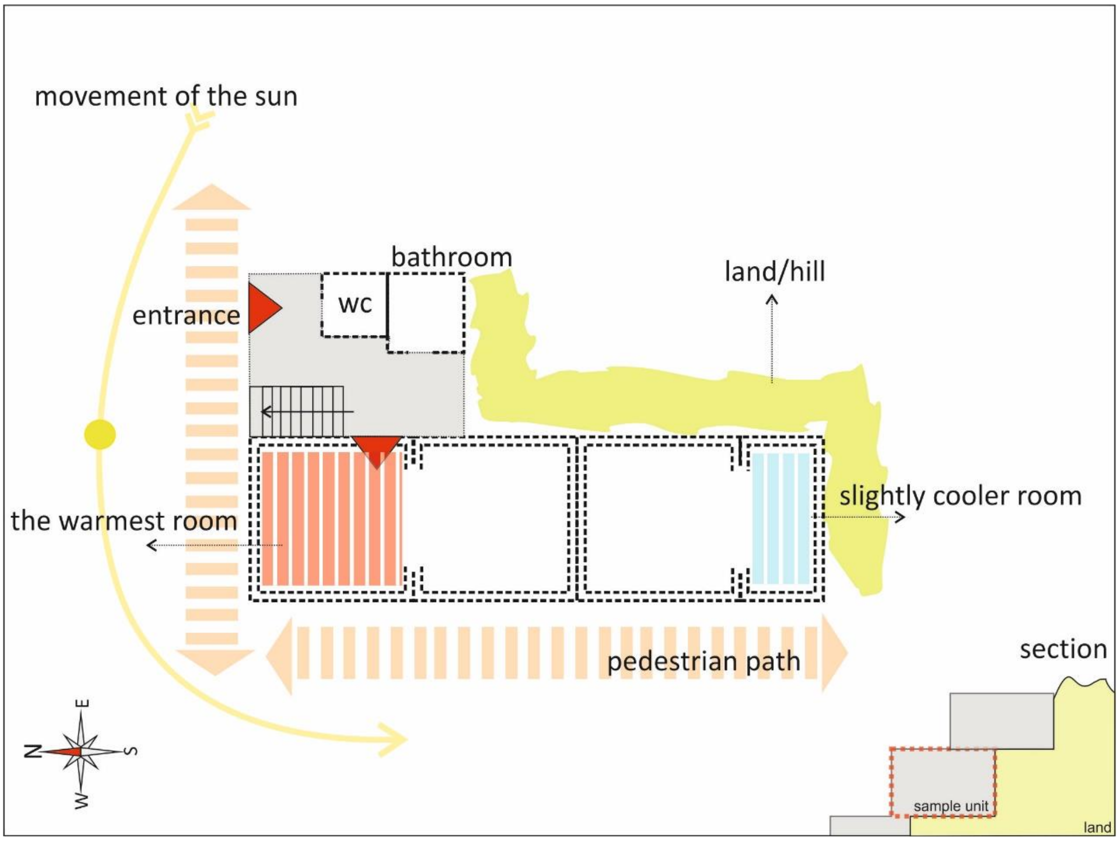
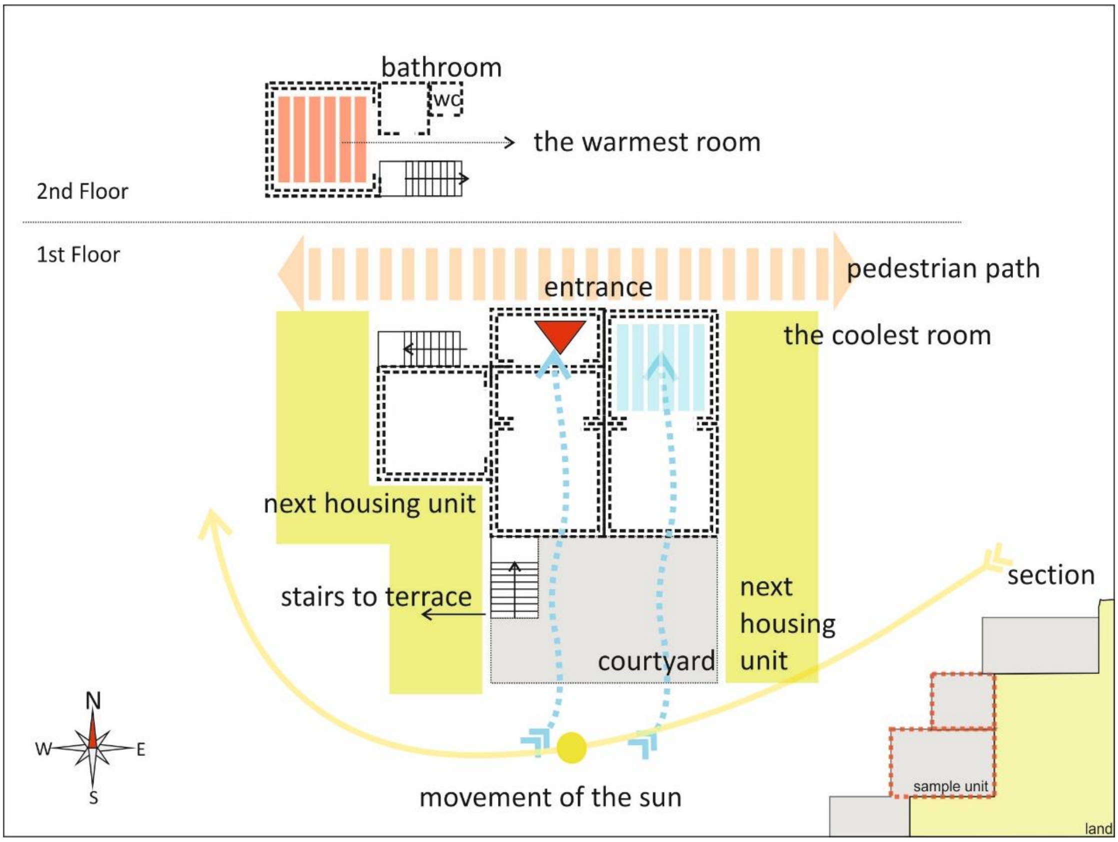


Vernacular sample unit 12

Vernacular sample unit 13



Vernacular sample unit 14



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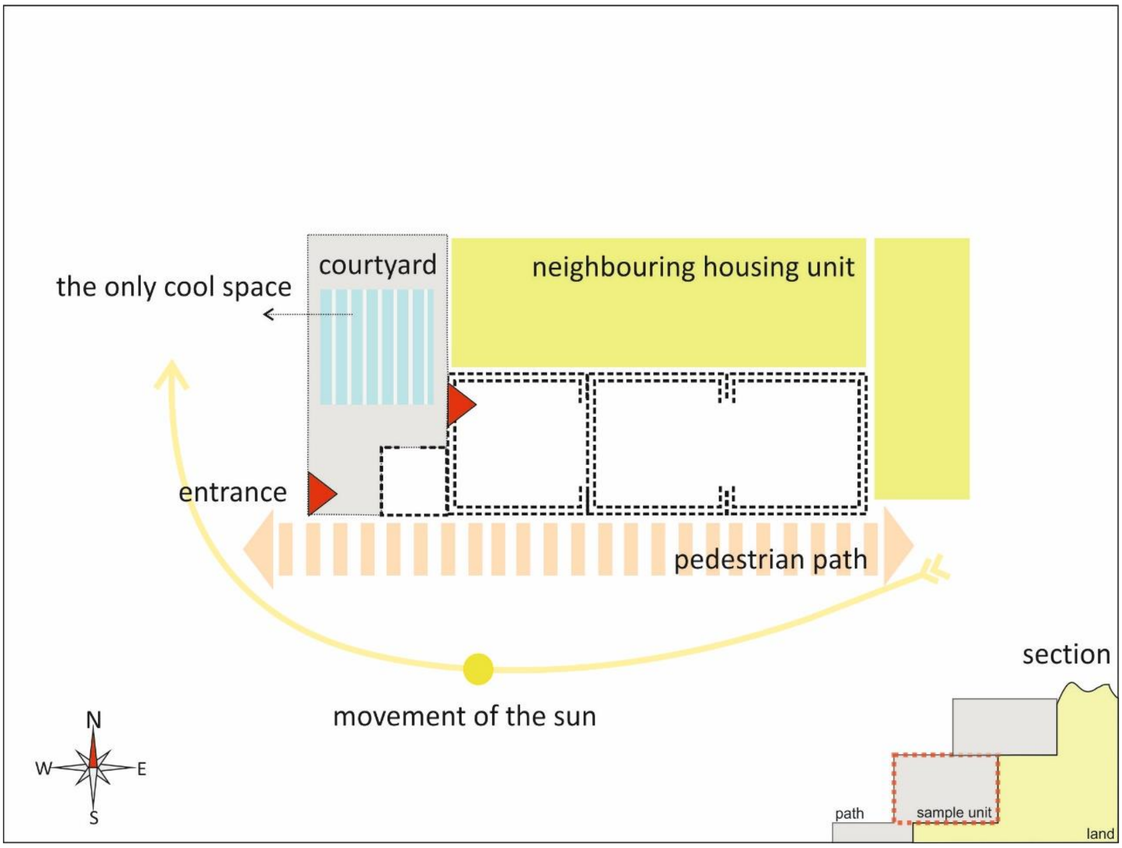

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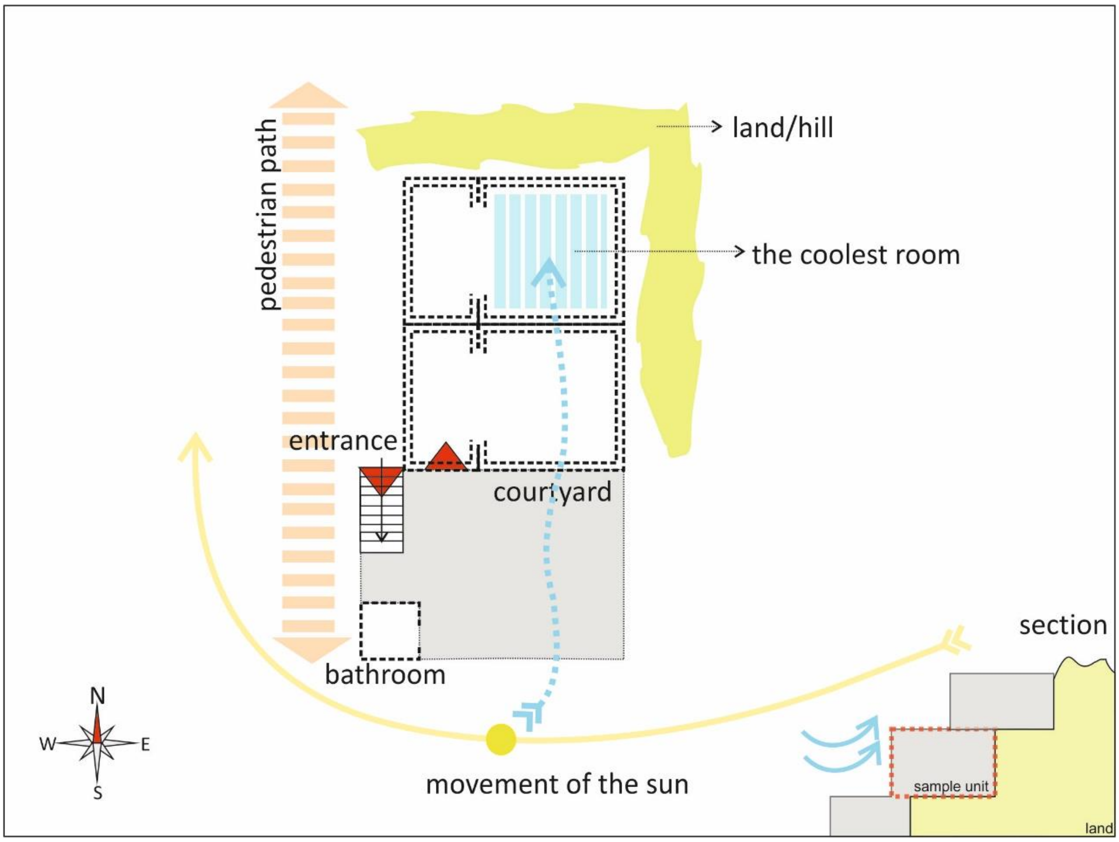
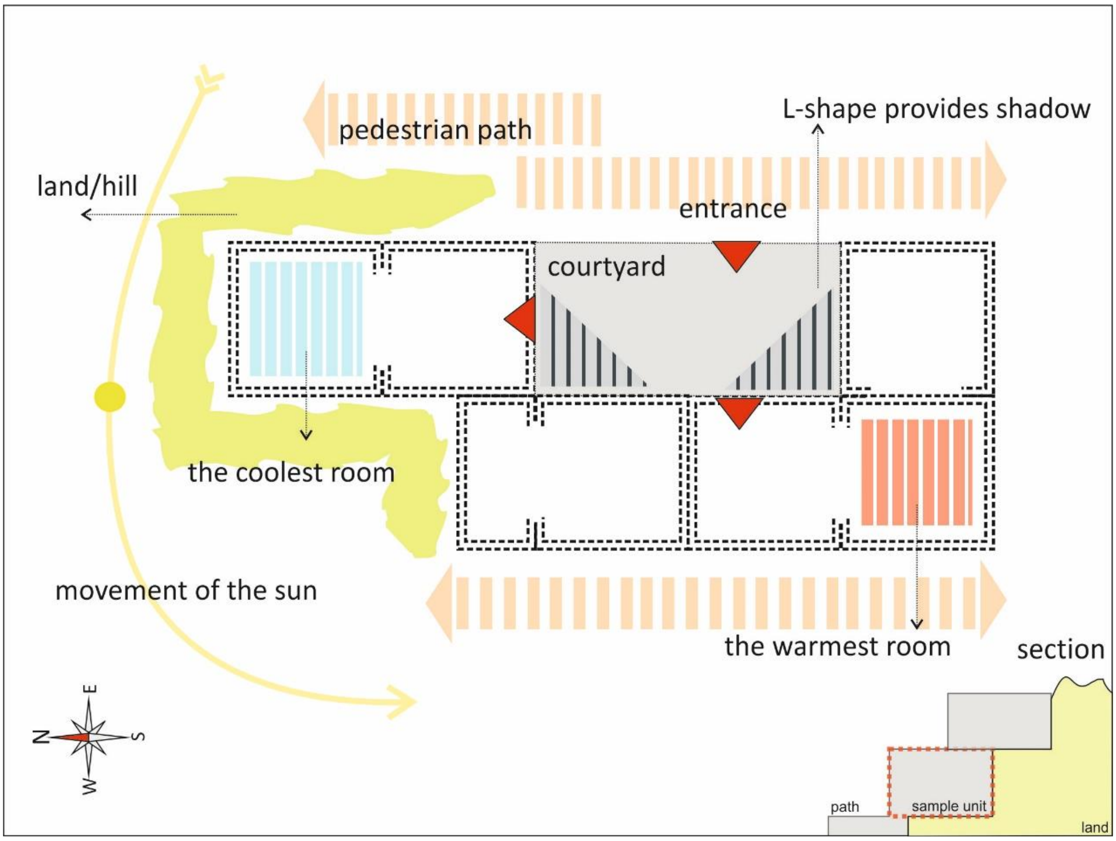


Vernacular sample unit 17



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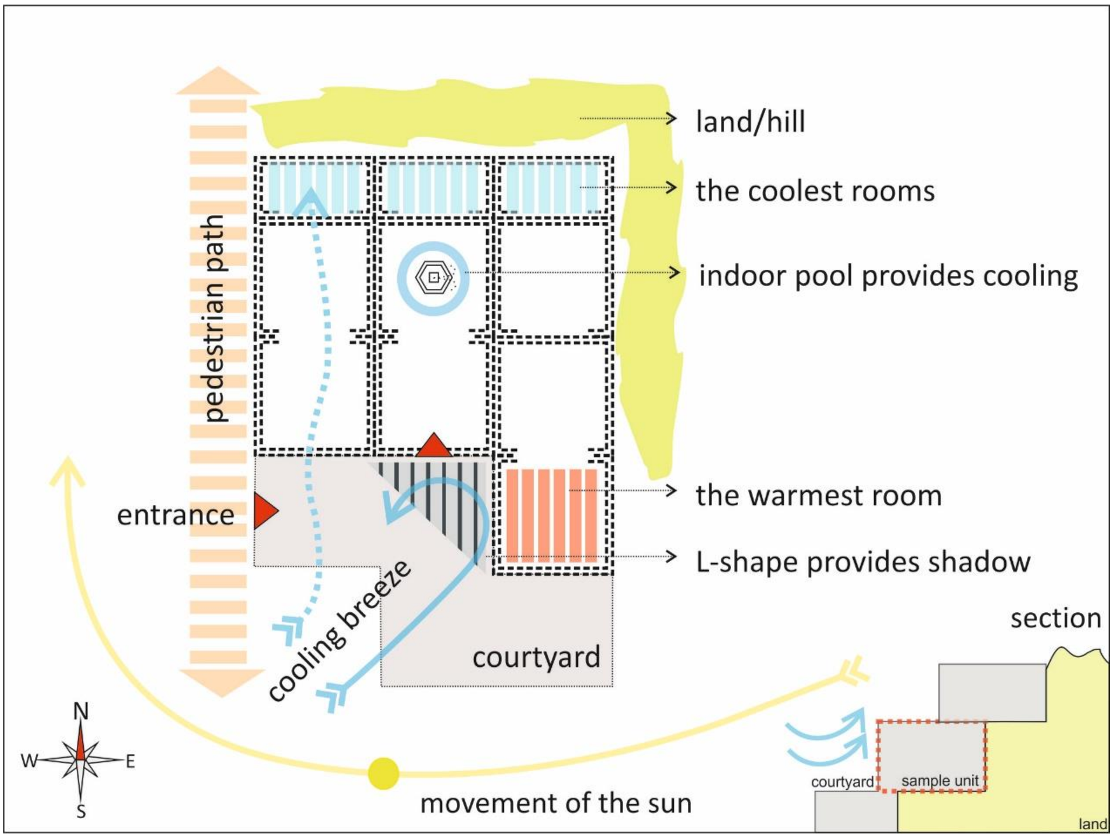

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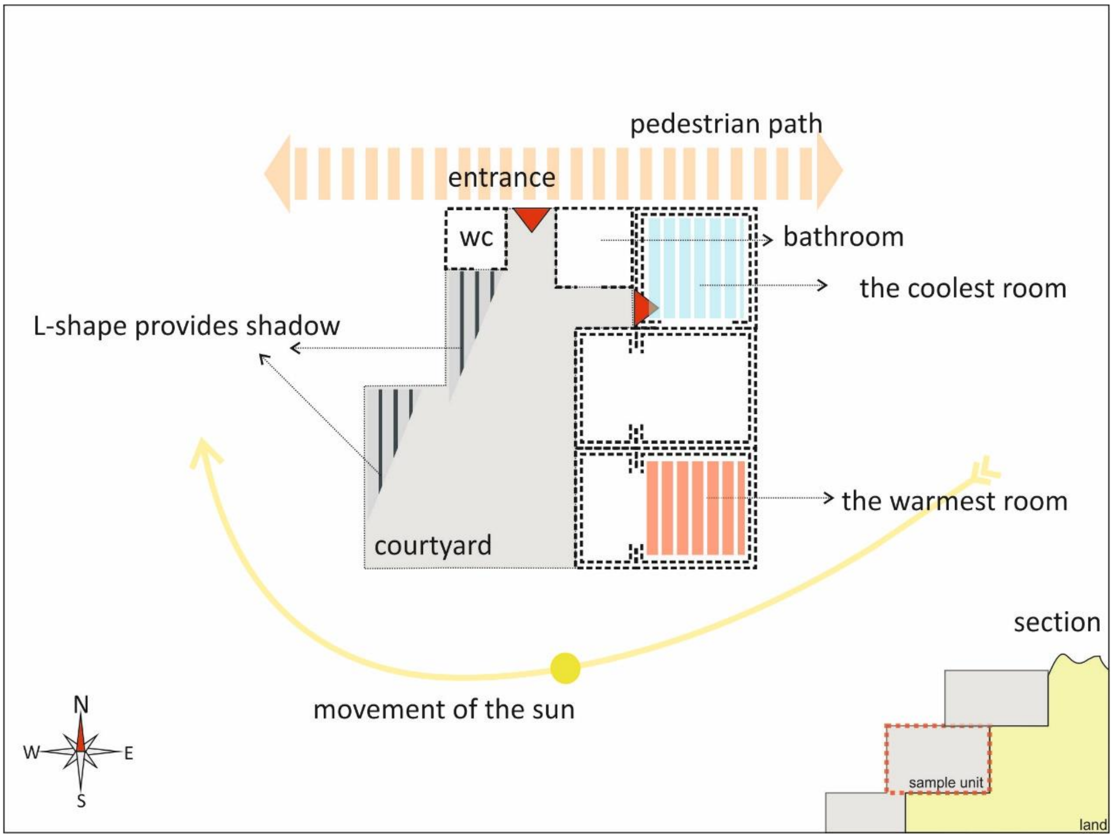
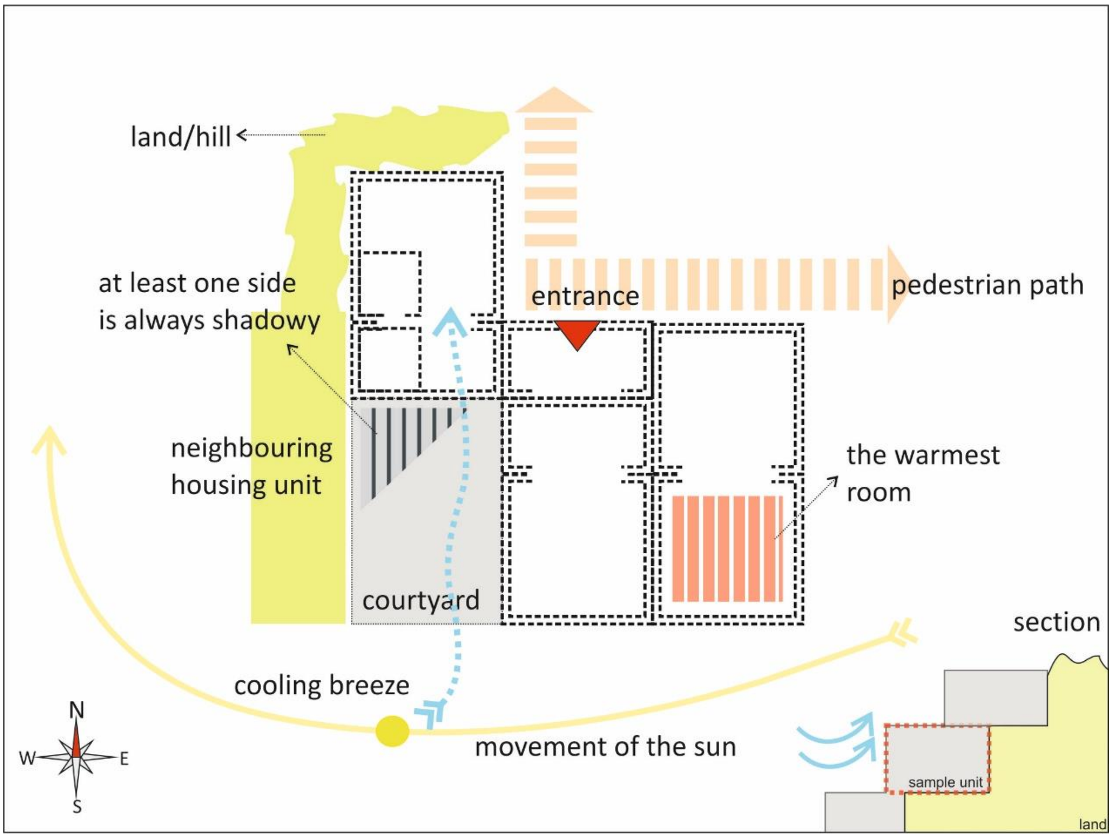


Vernacular sample unit 20



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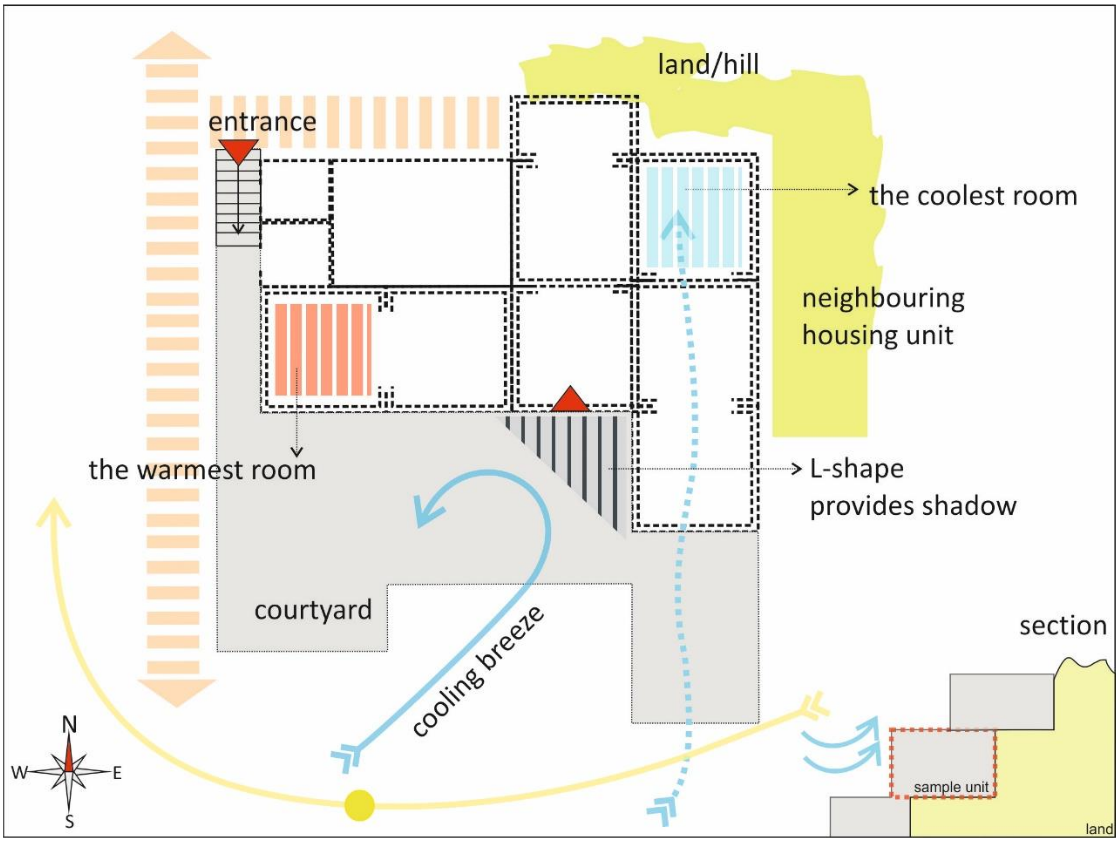

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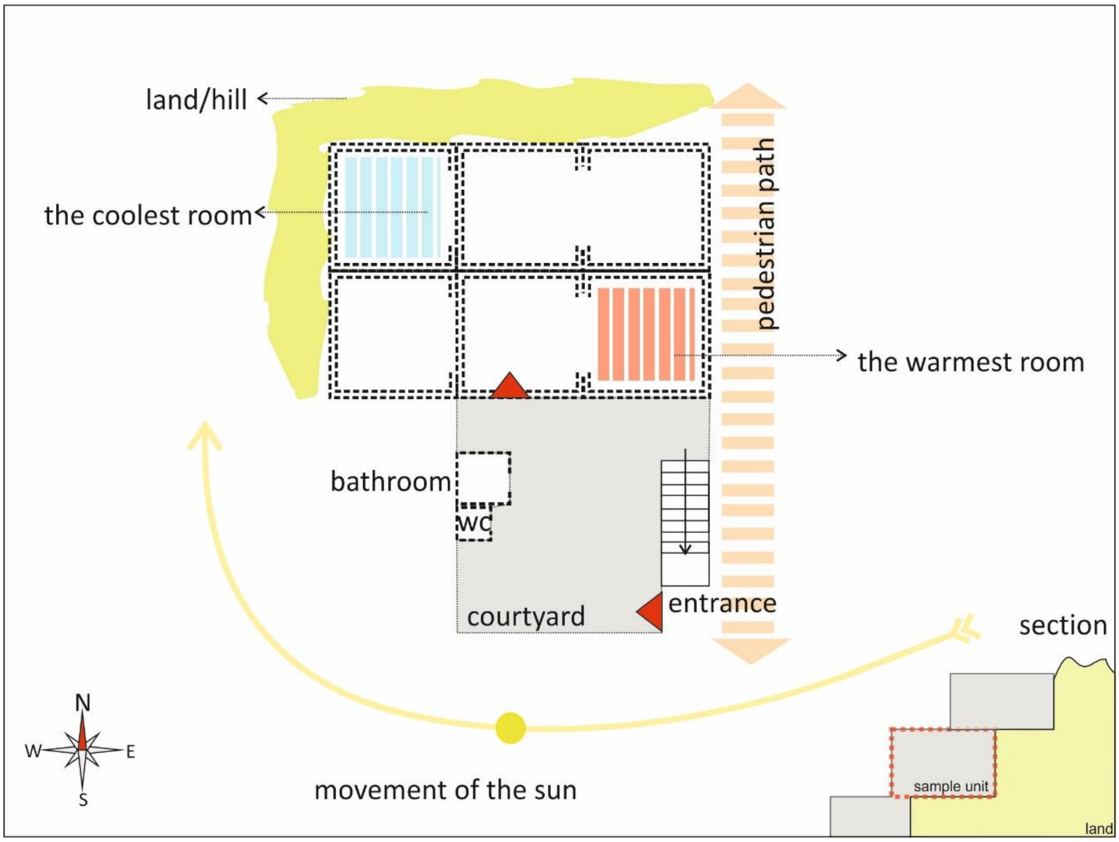

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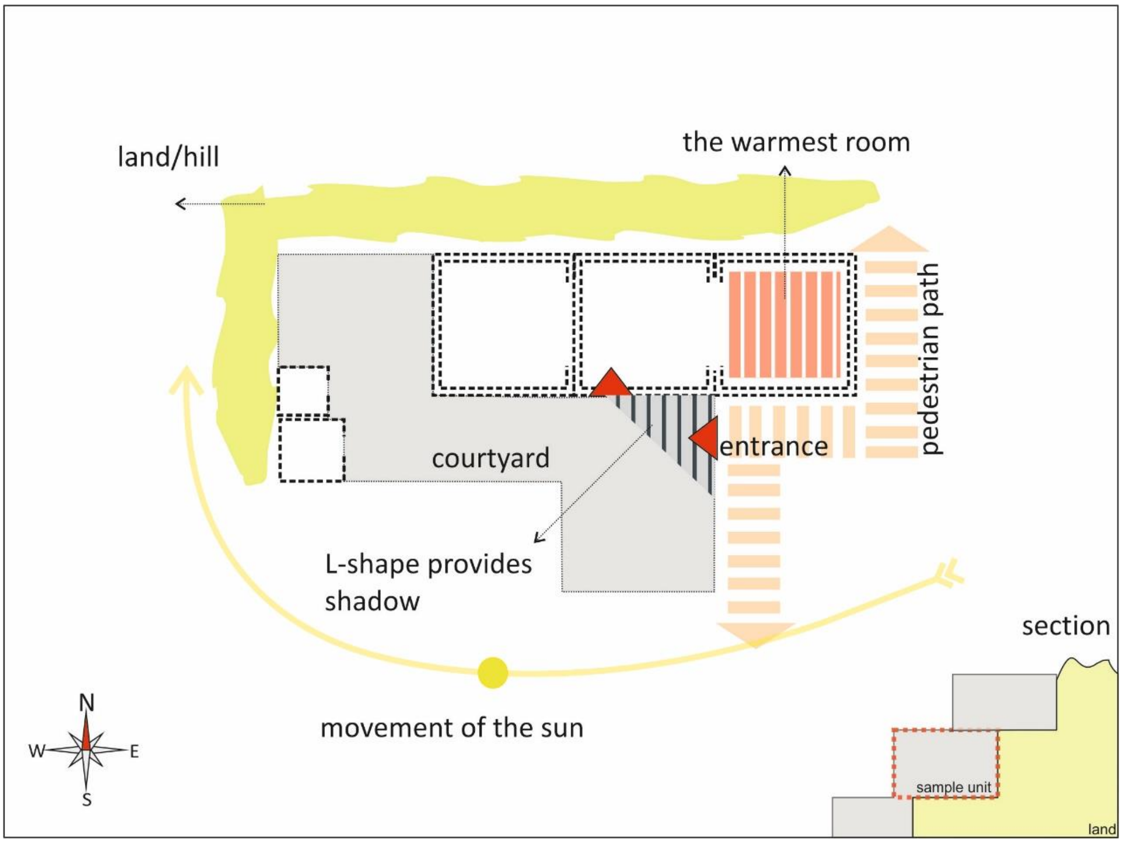

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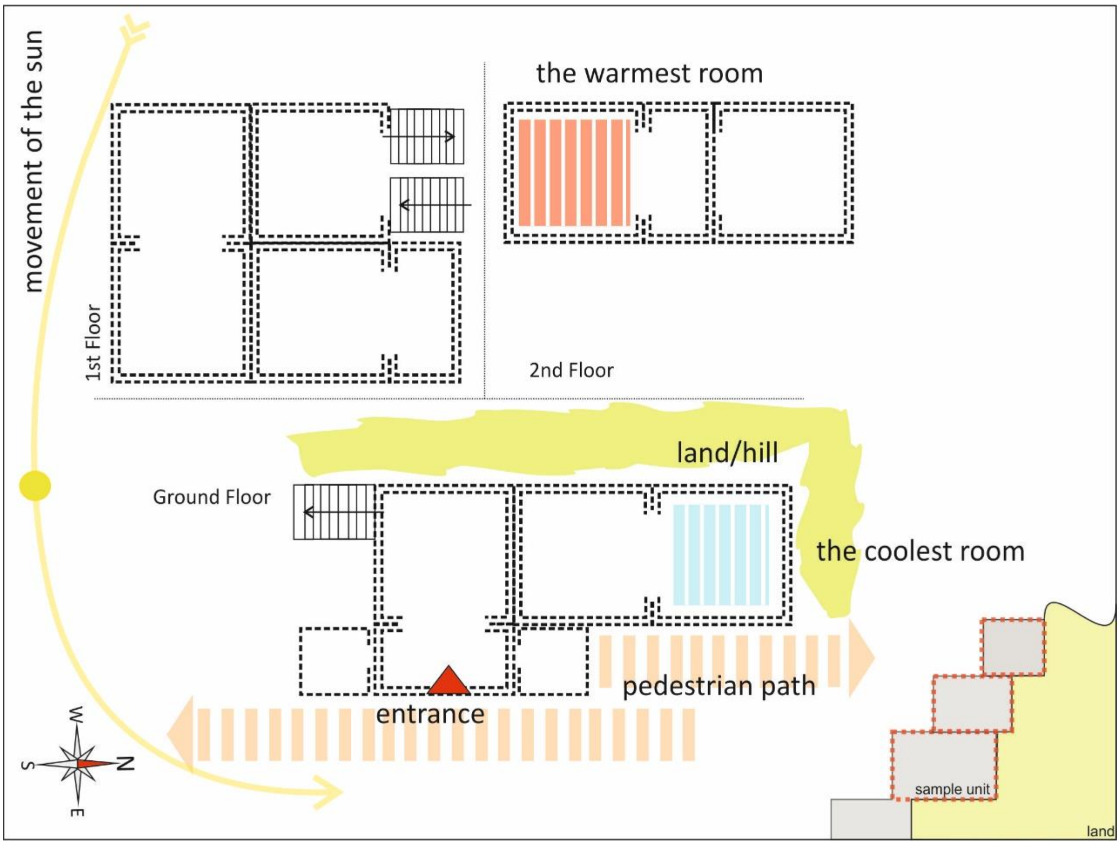

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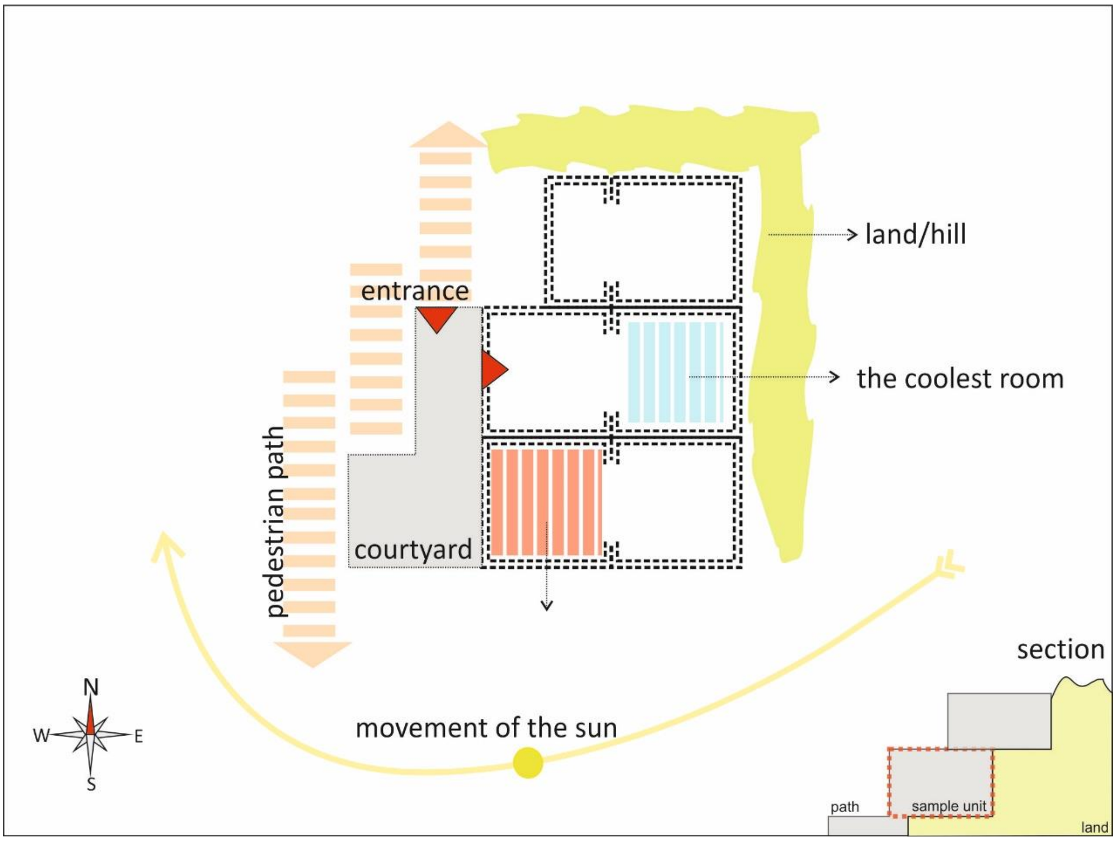

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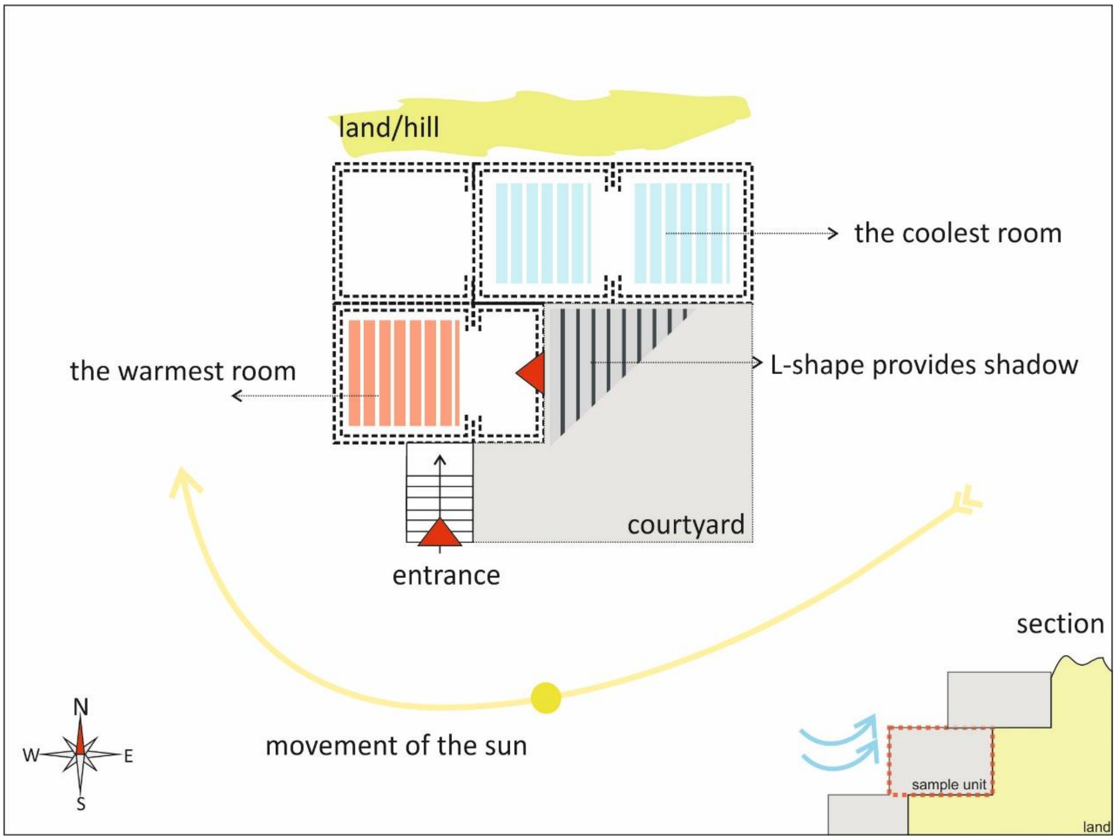

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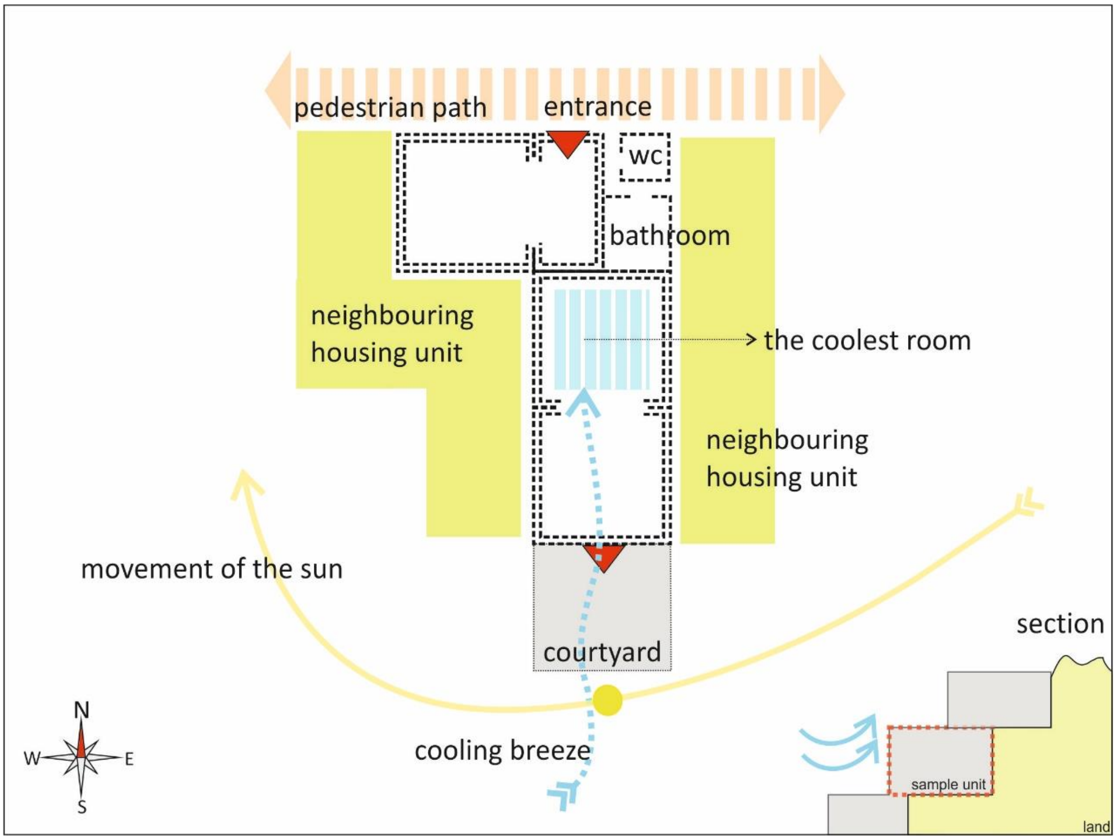

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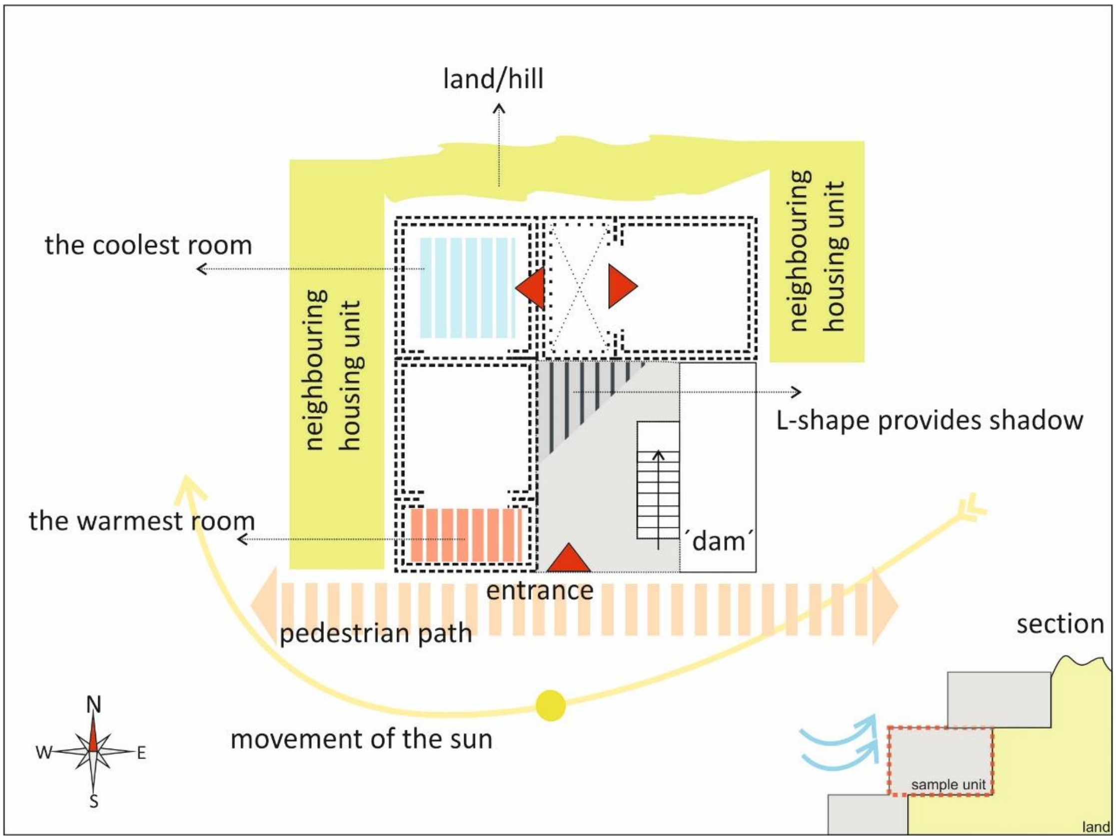

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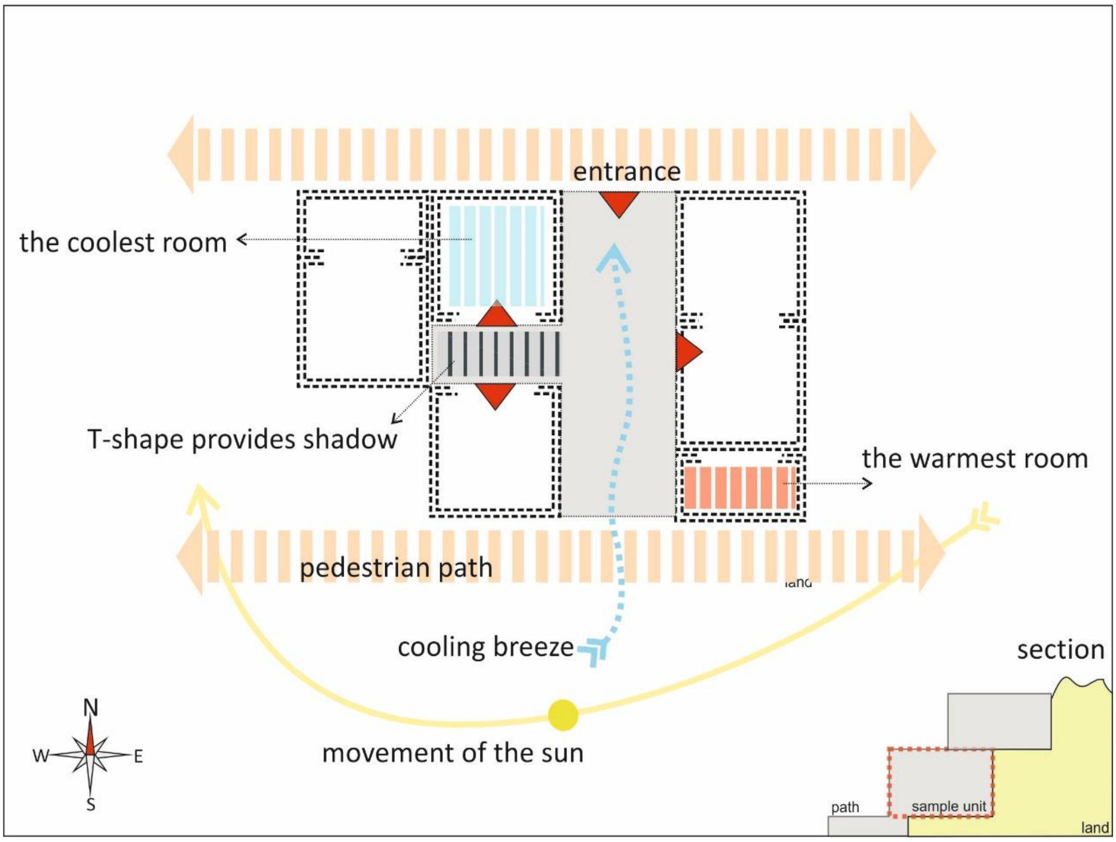

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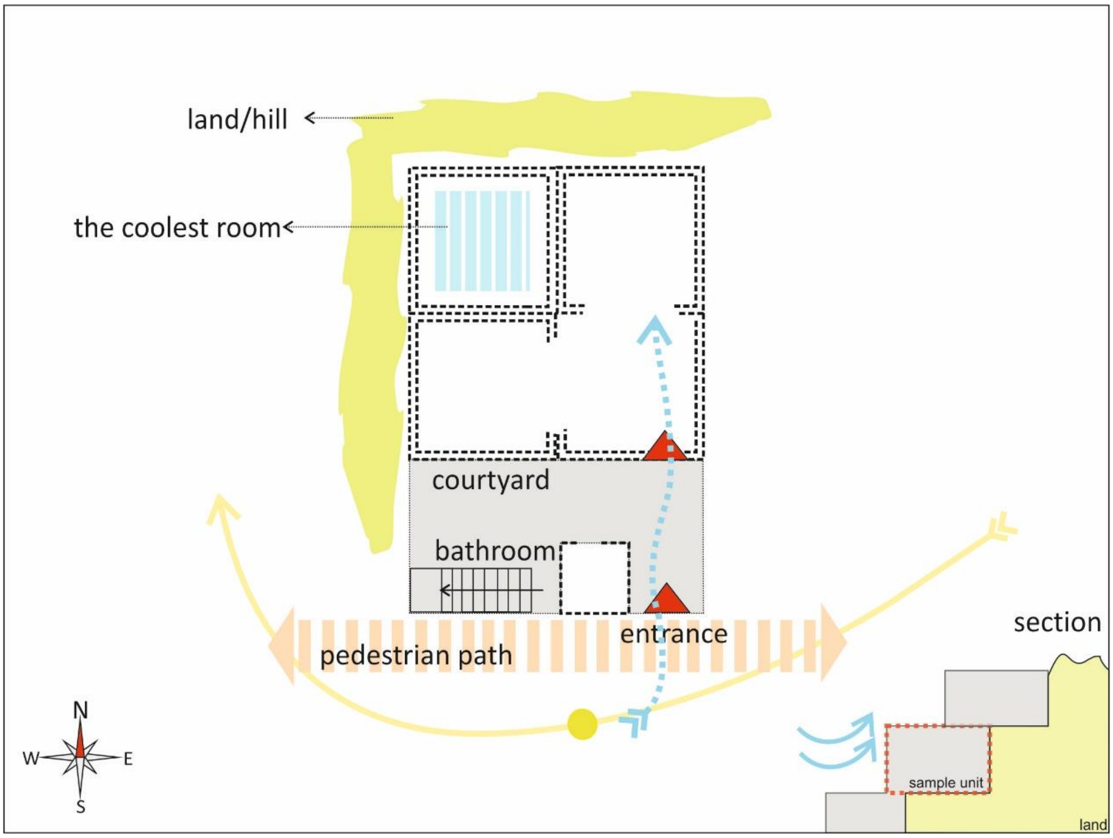
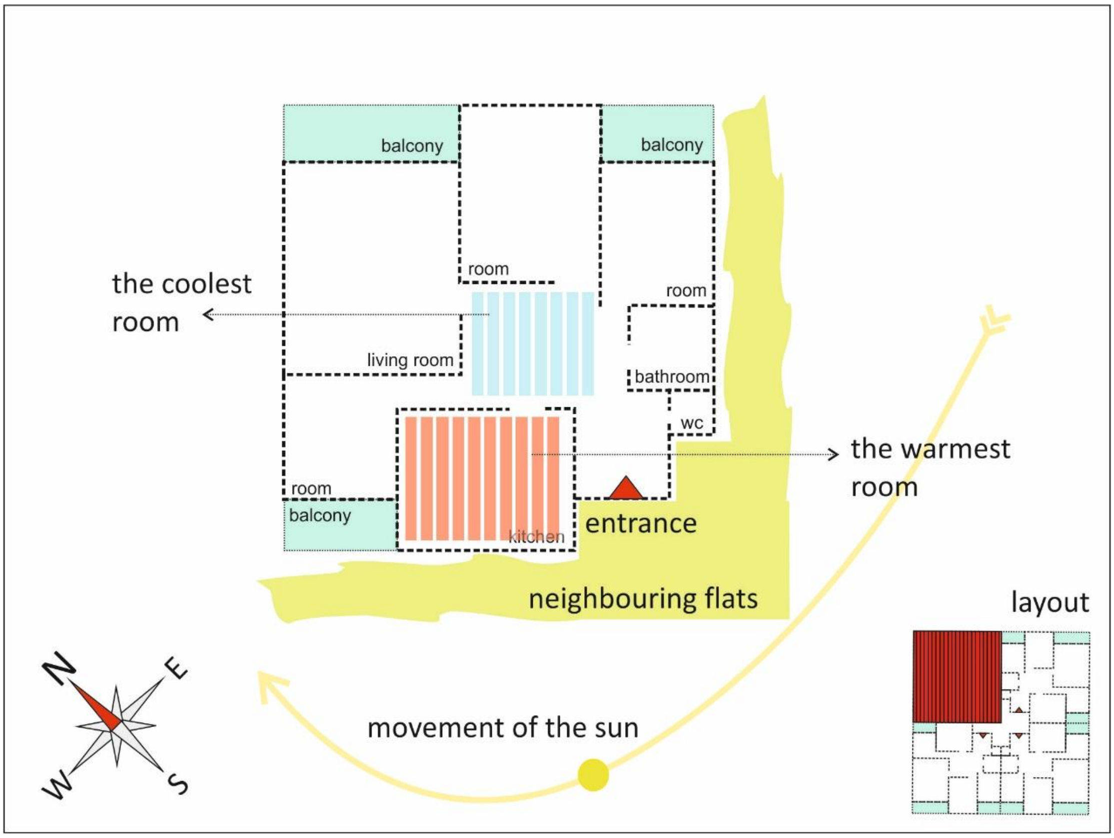


Contemporary sample unit 1



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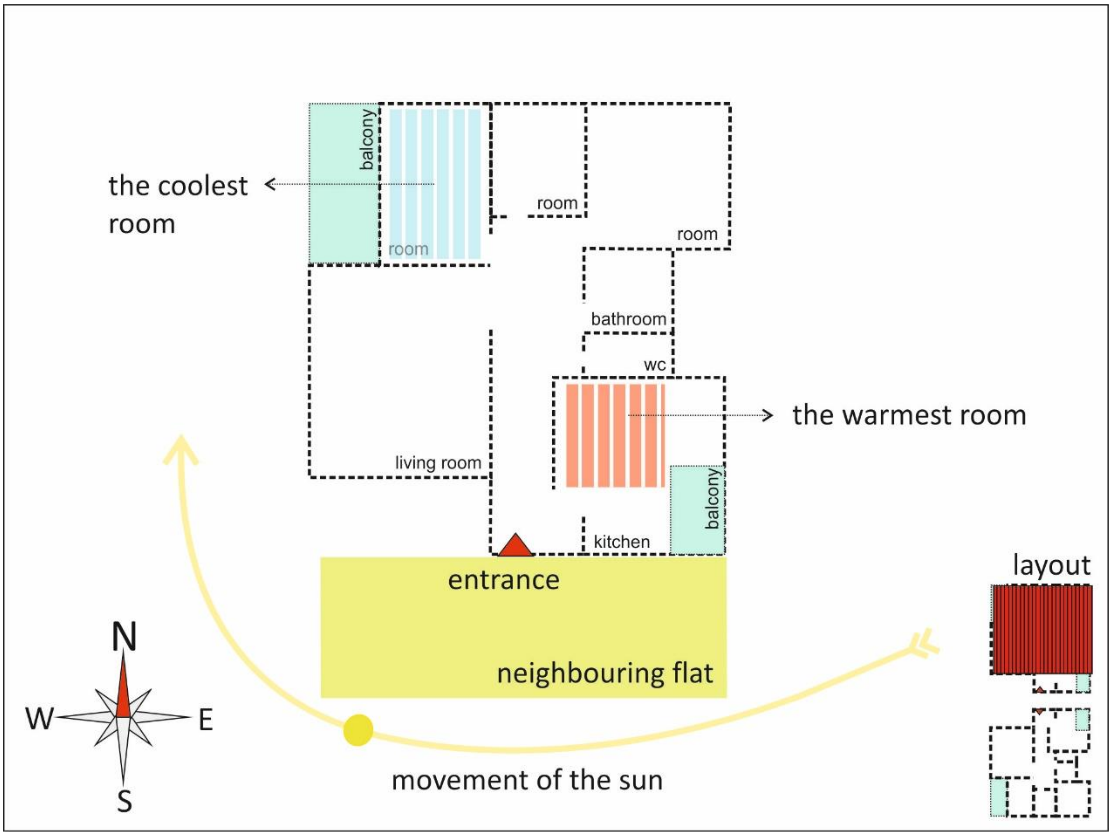

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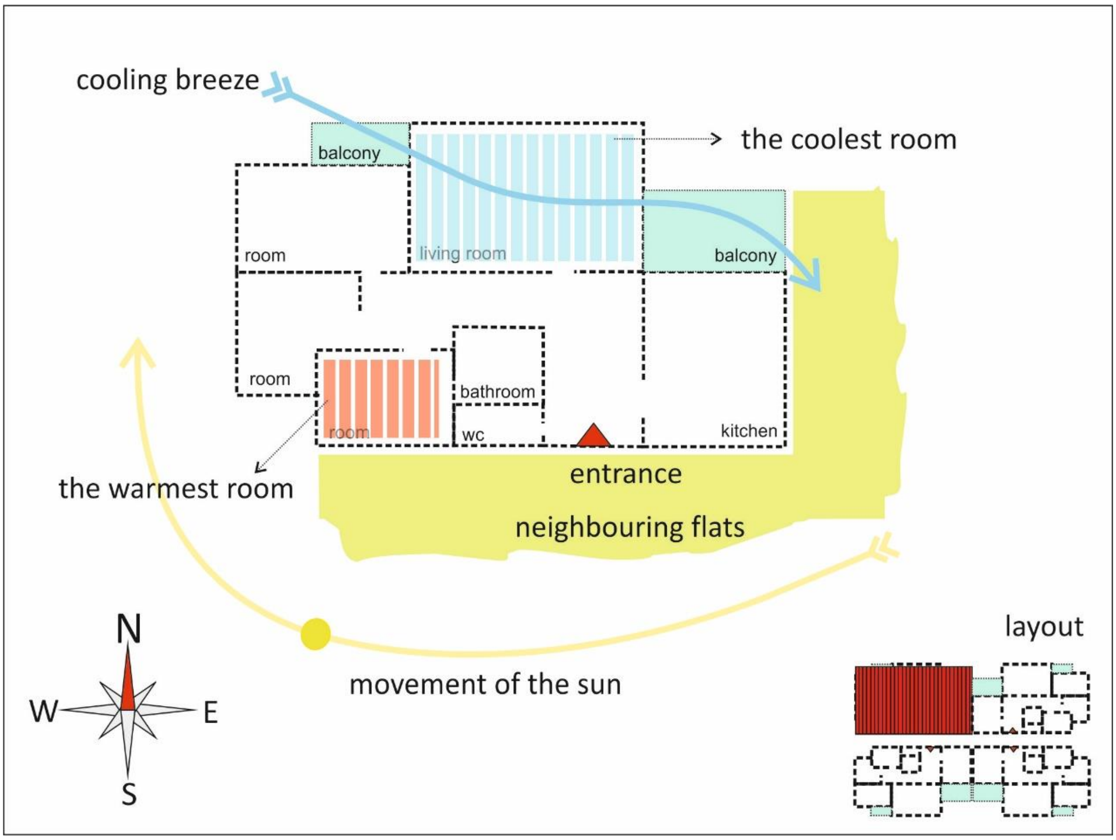

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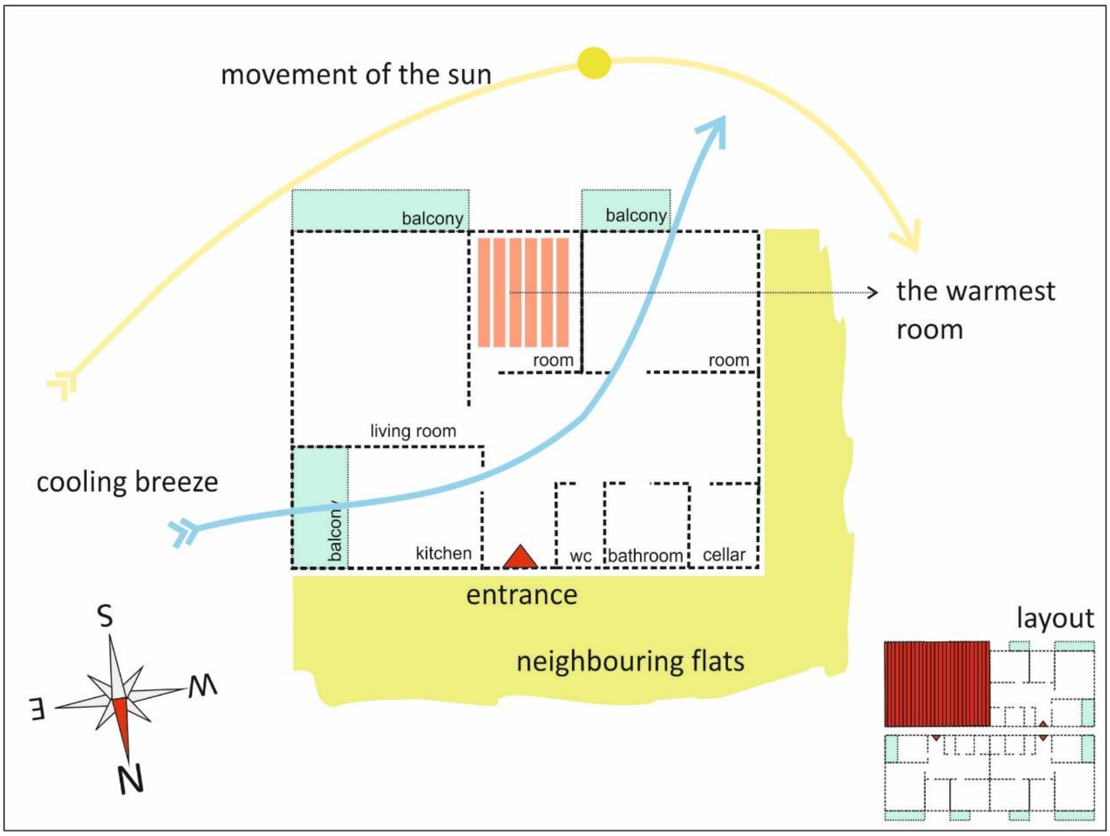

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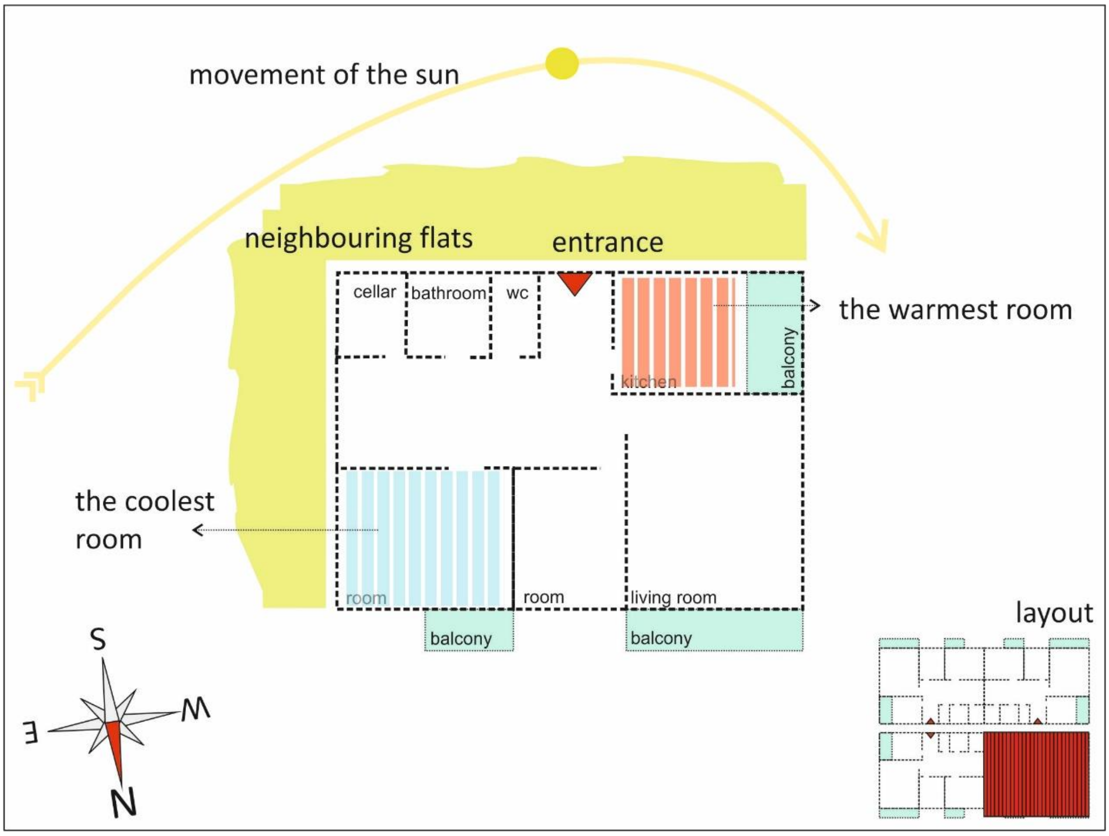

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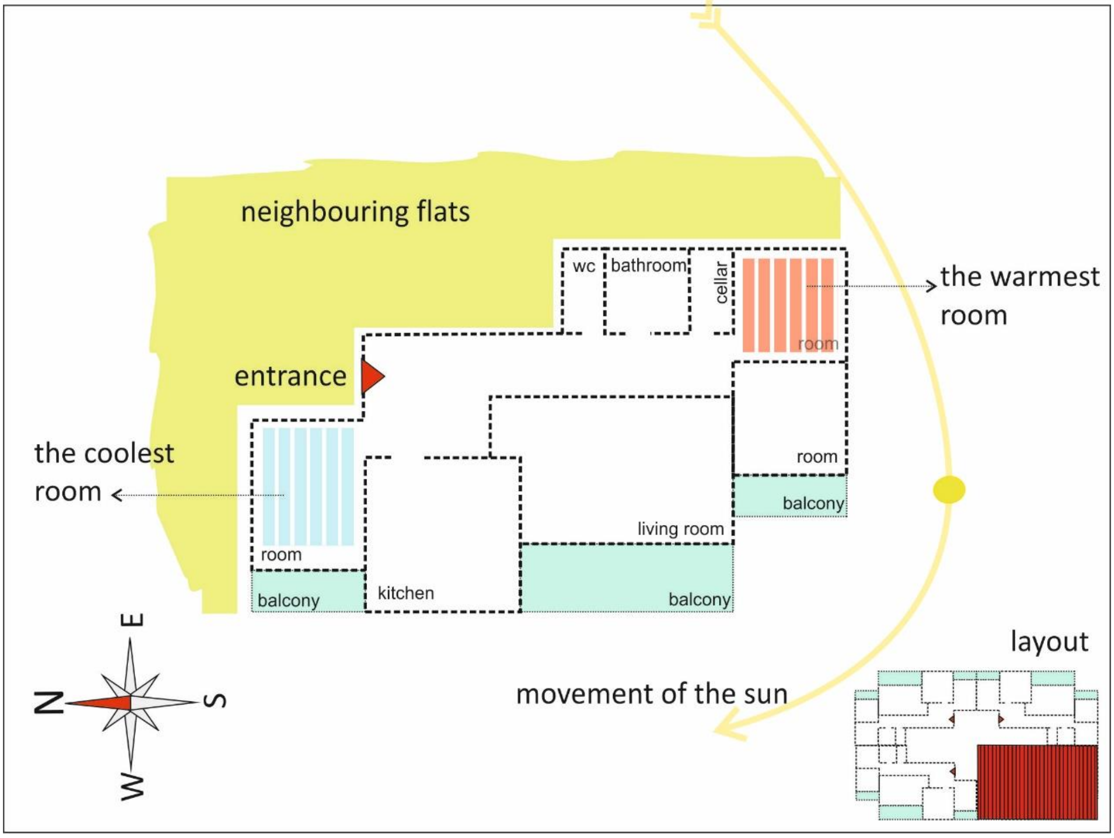

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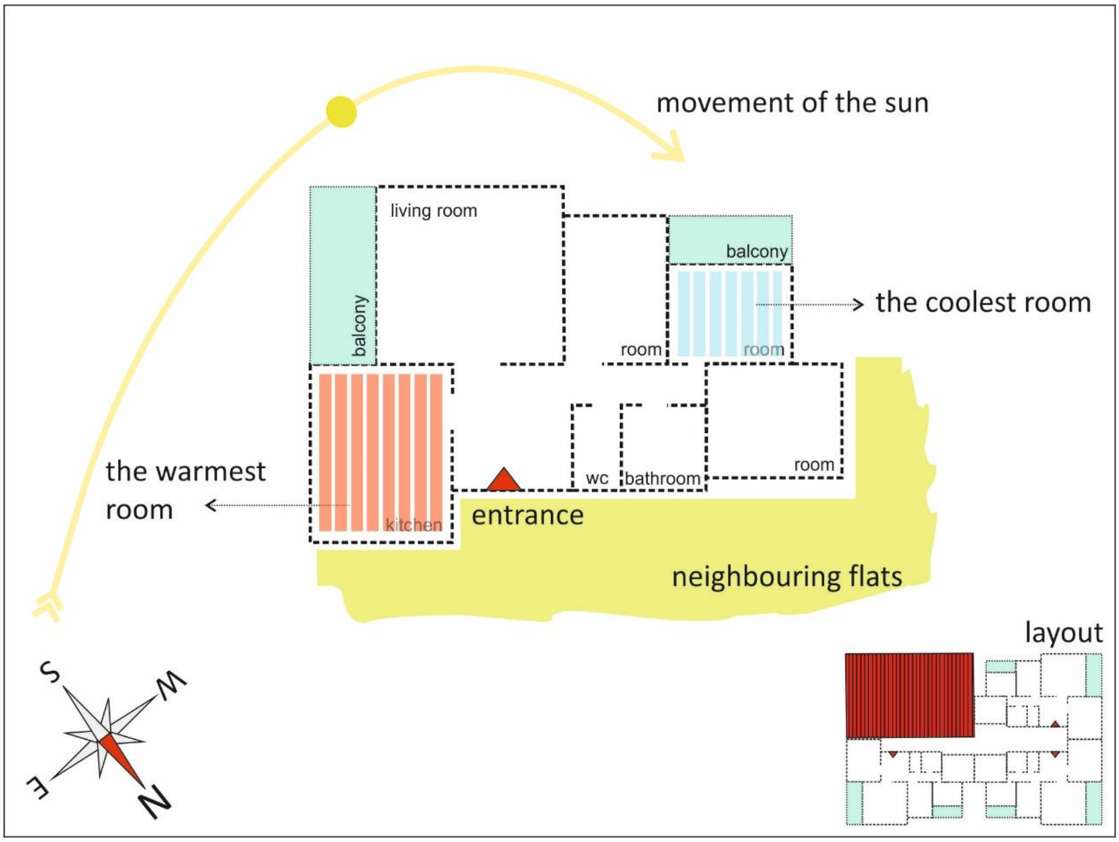

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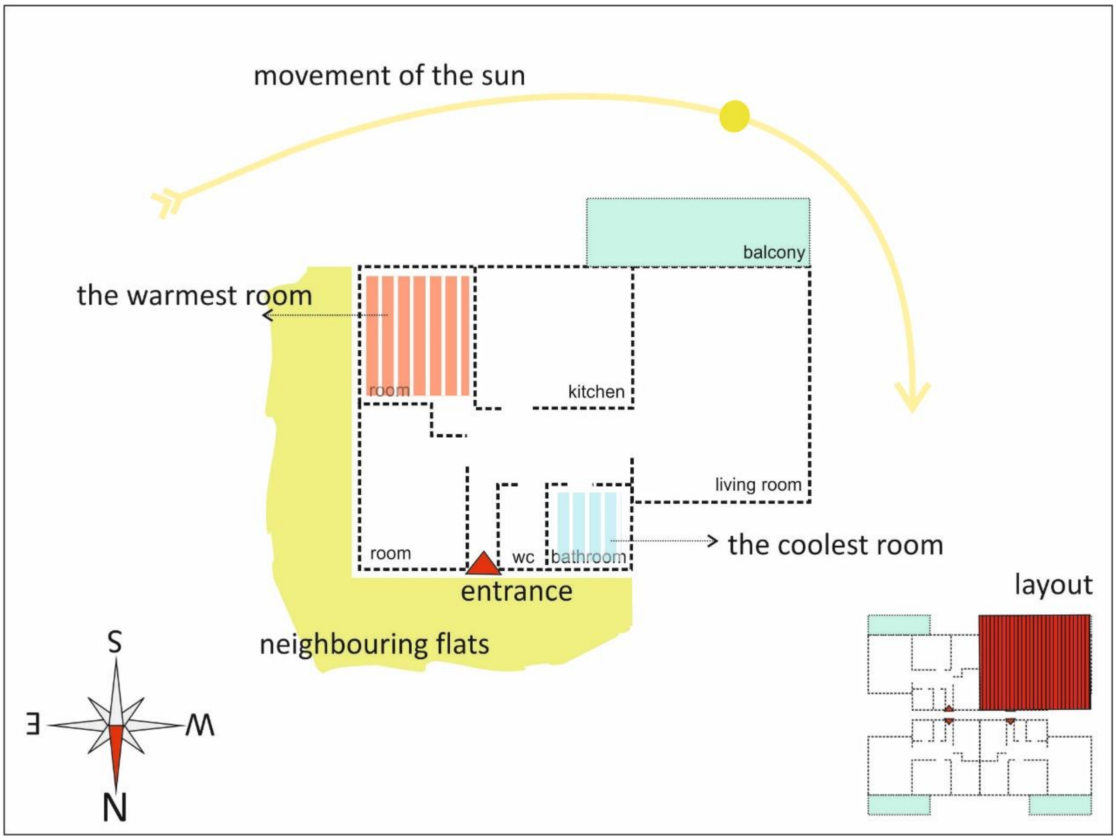

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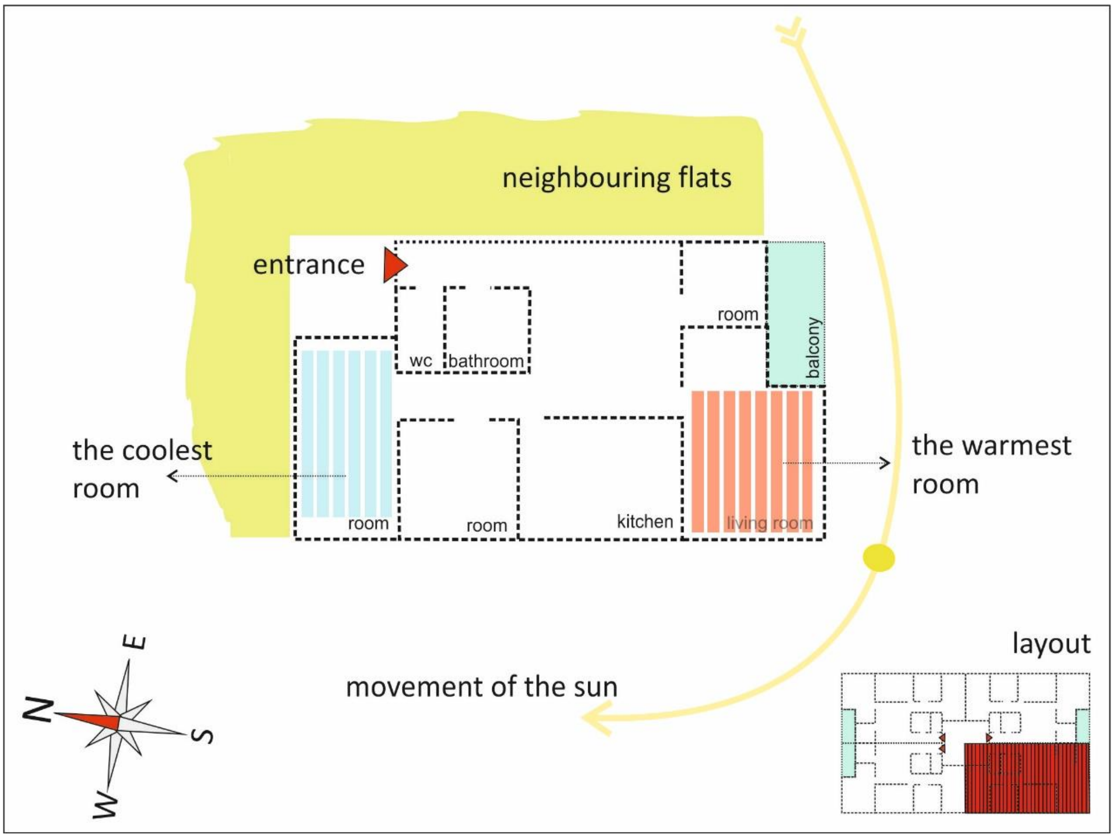

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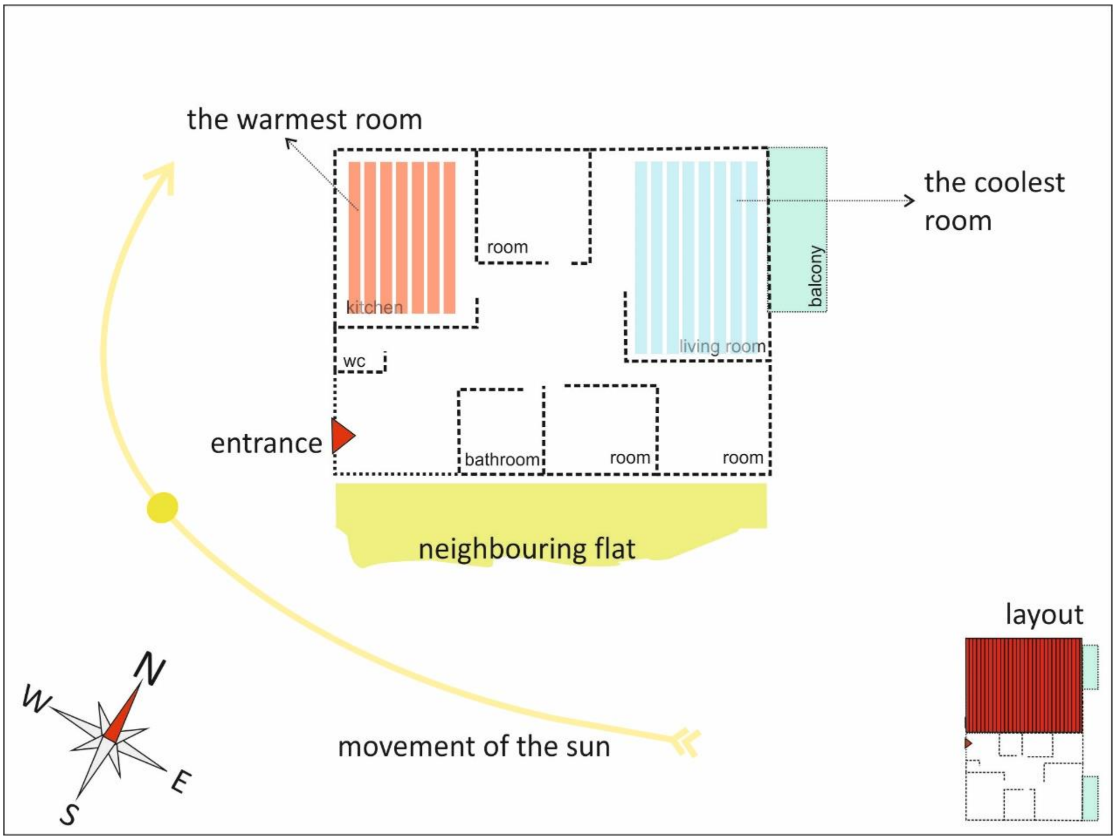

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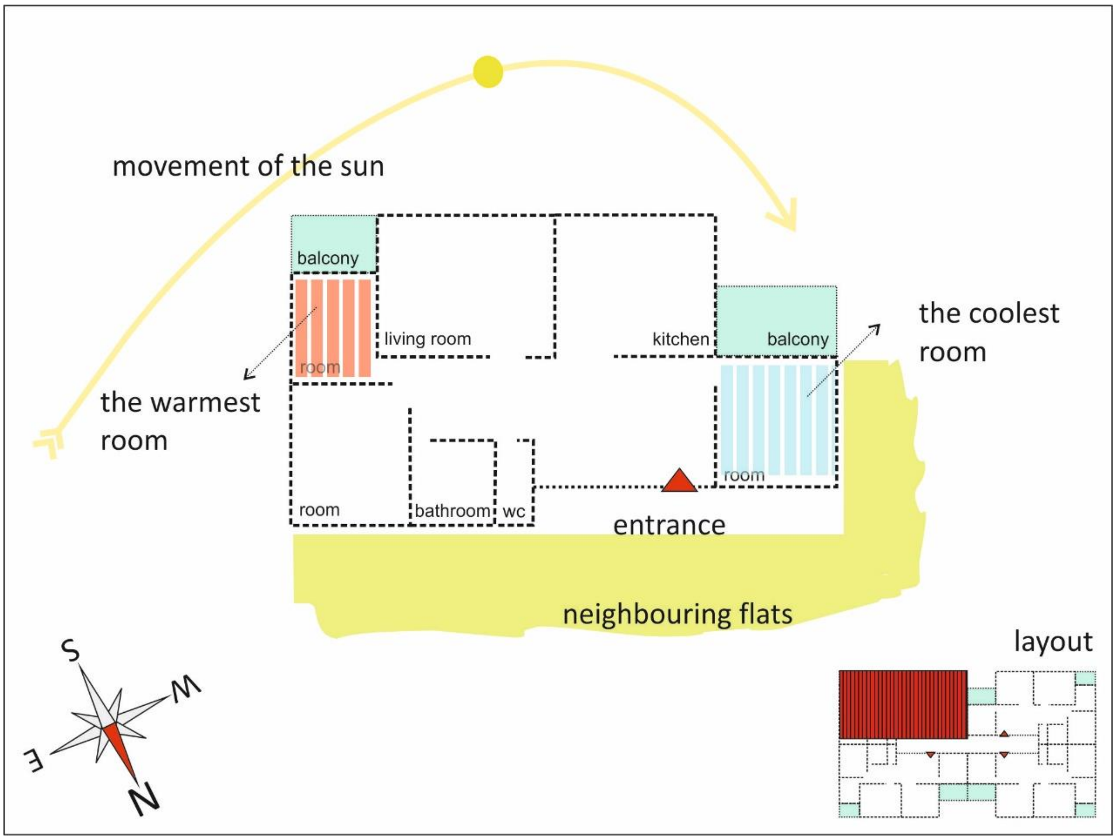

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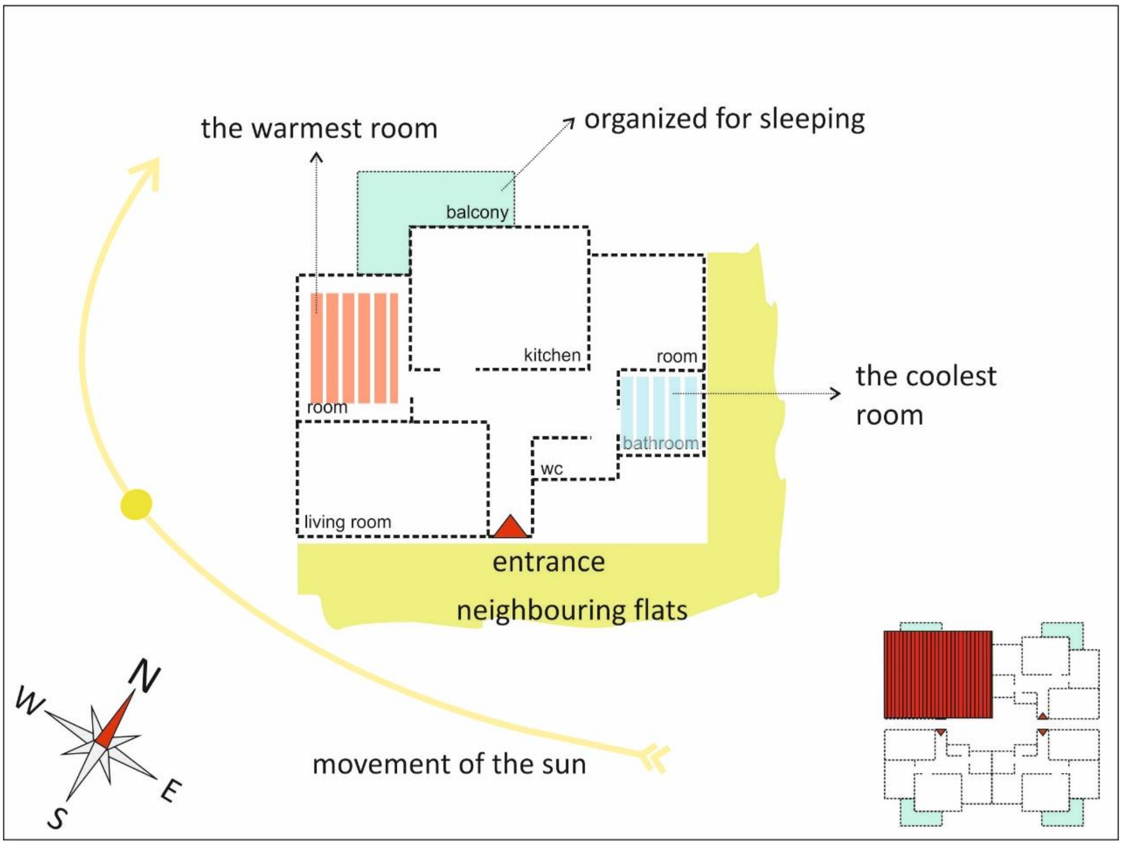

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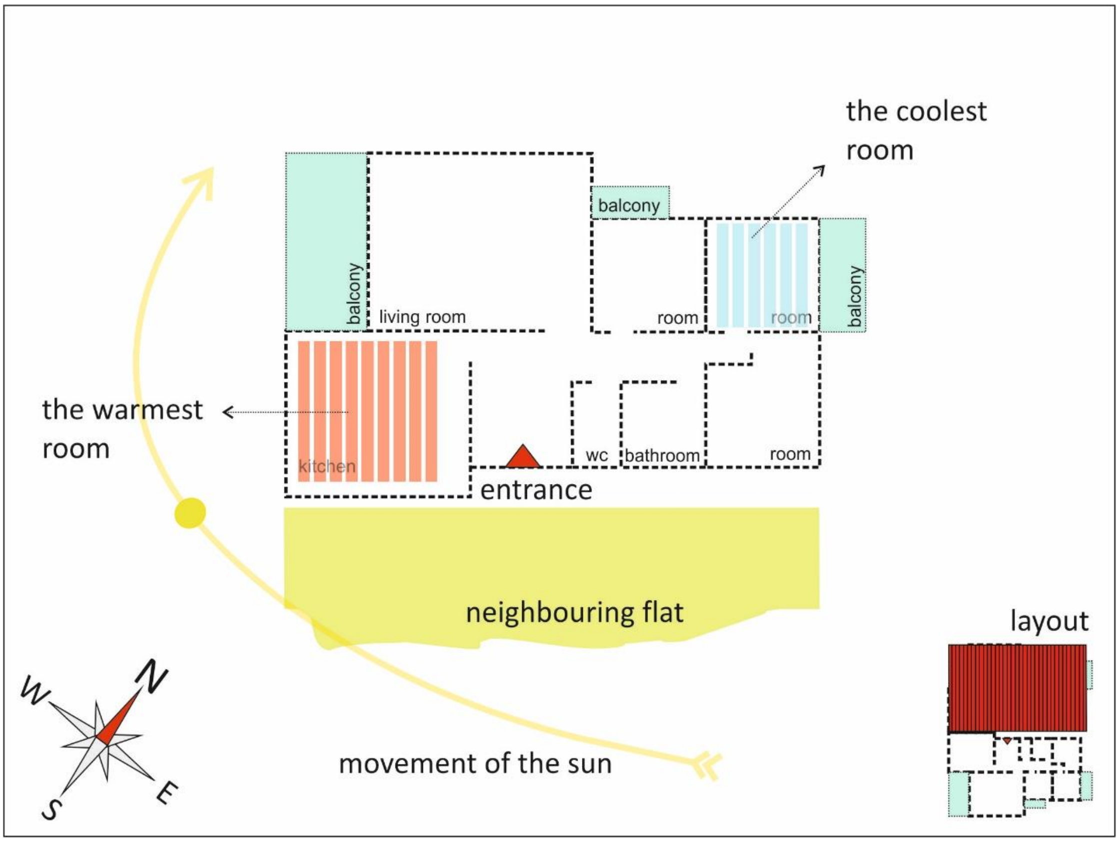

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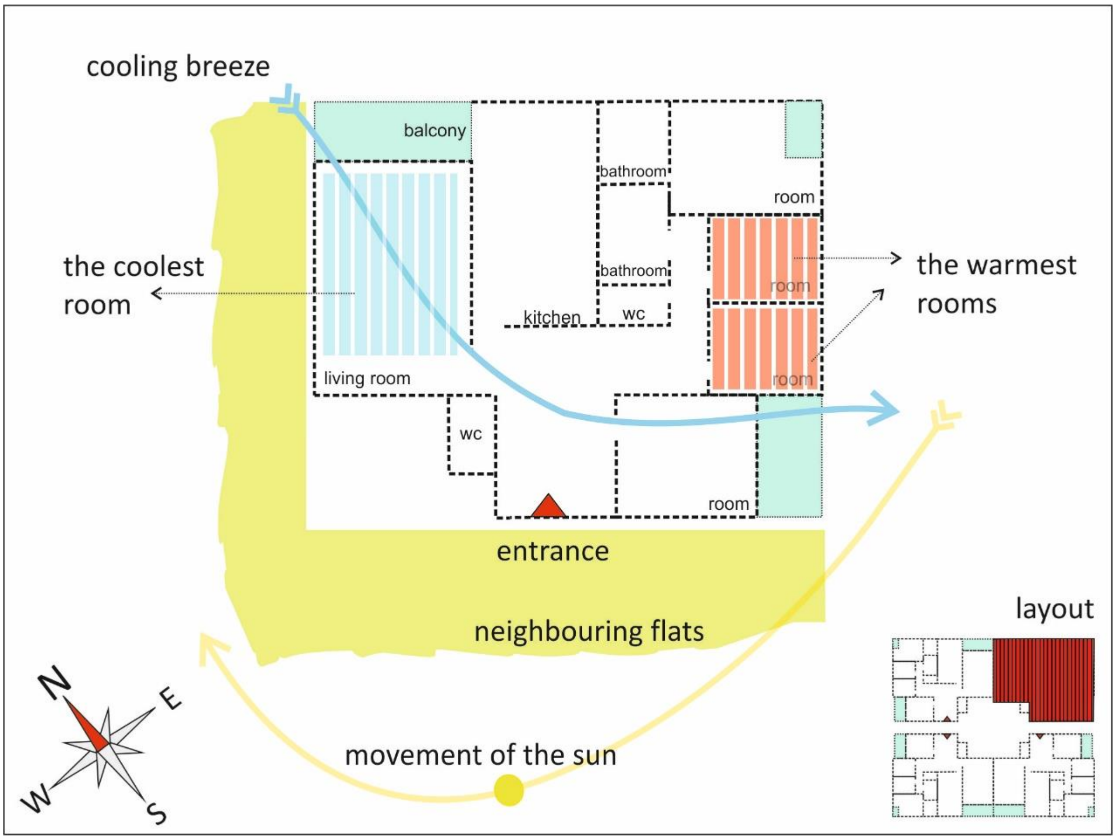

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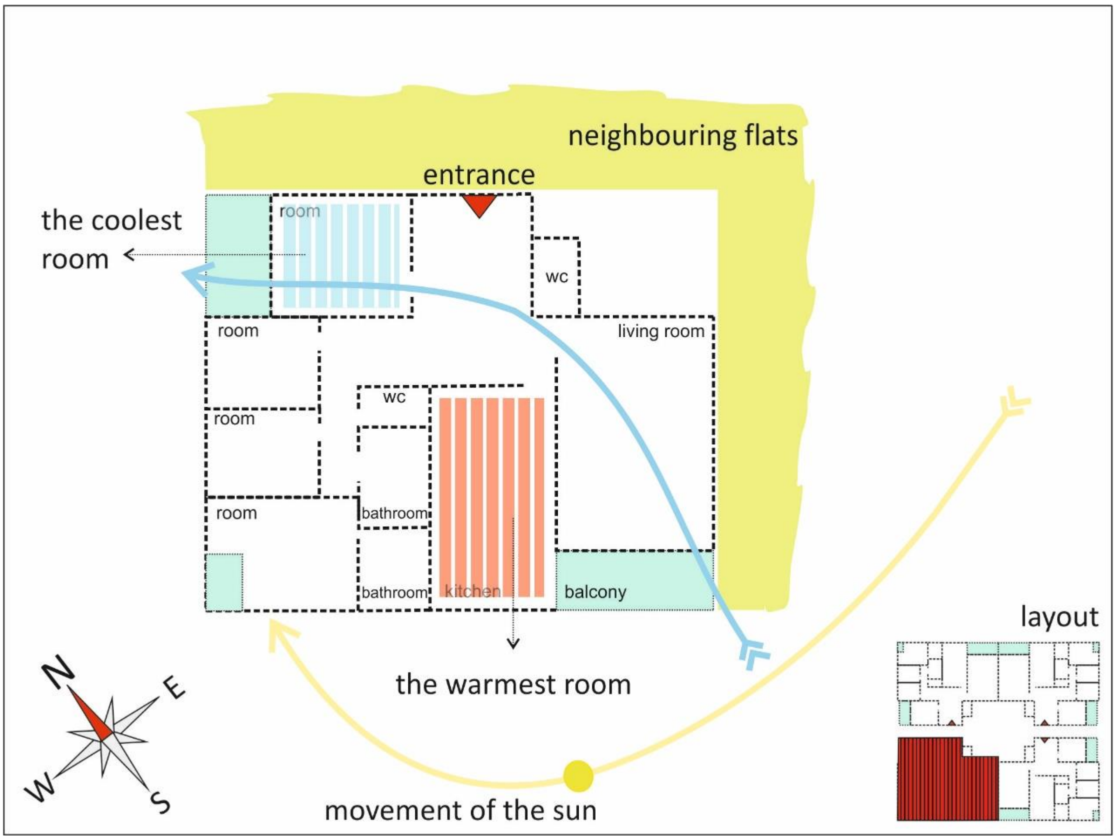

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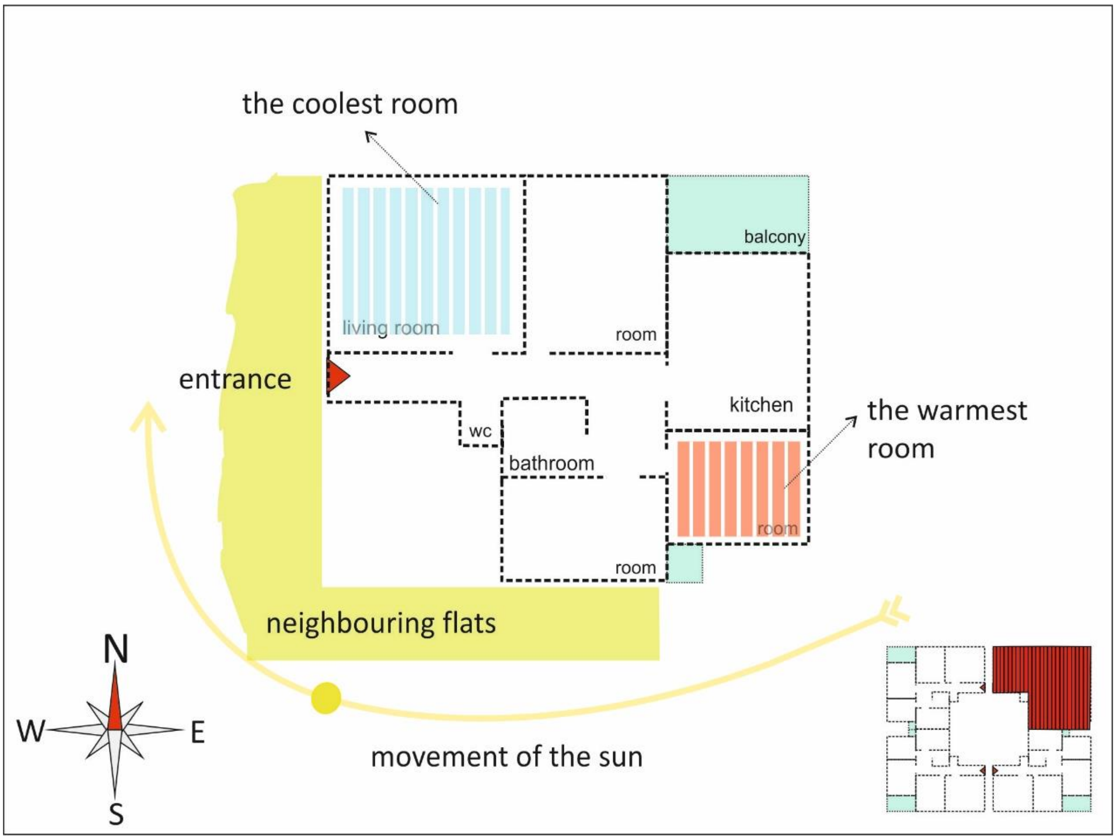

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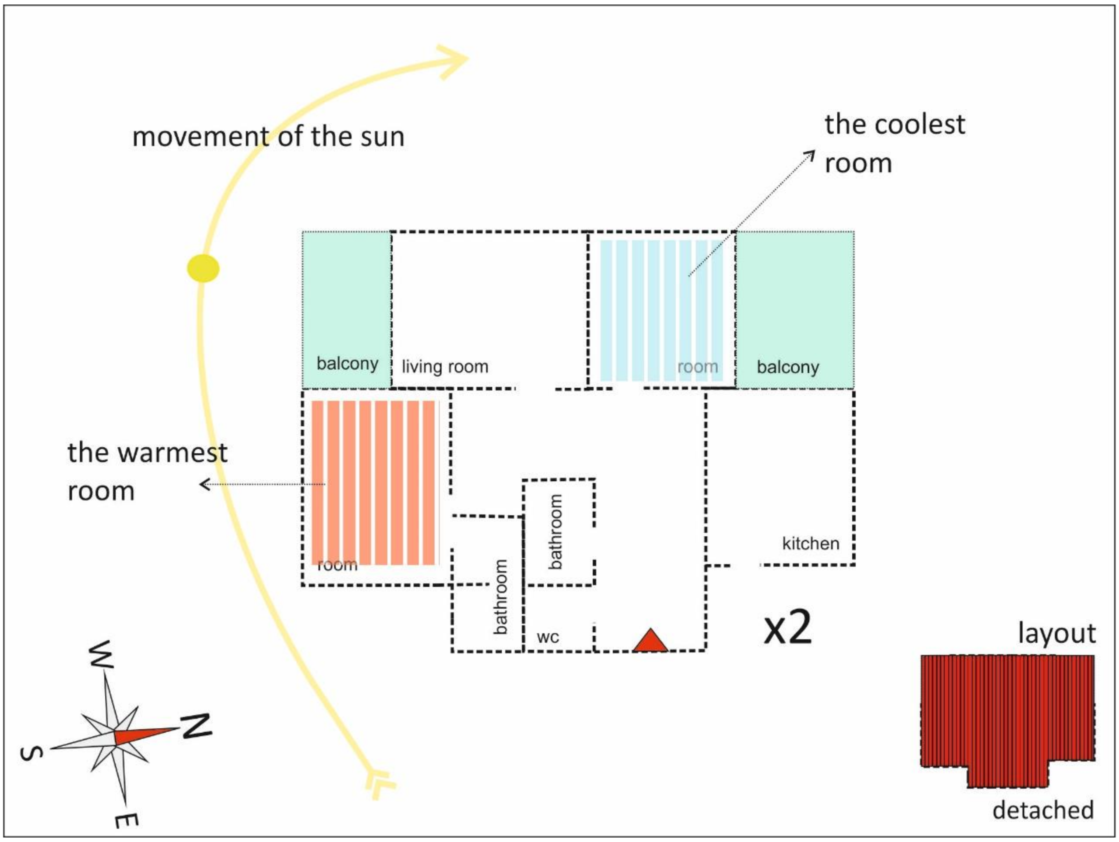

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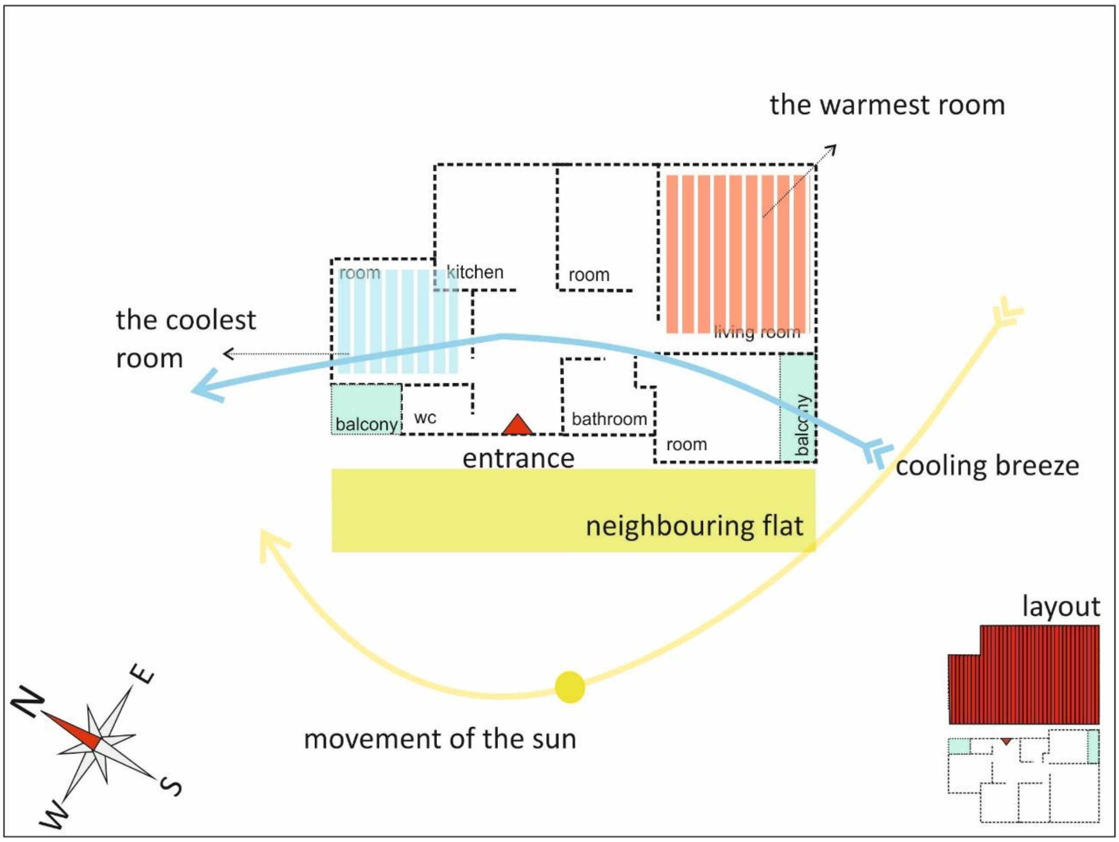

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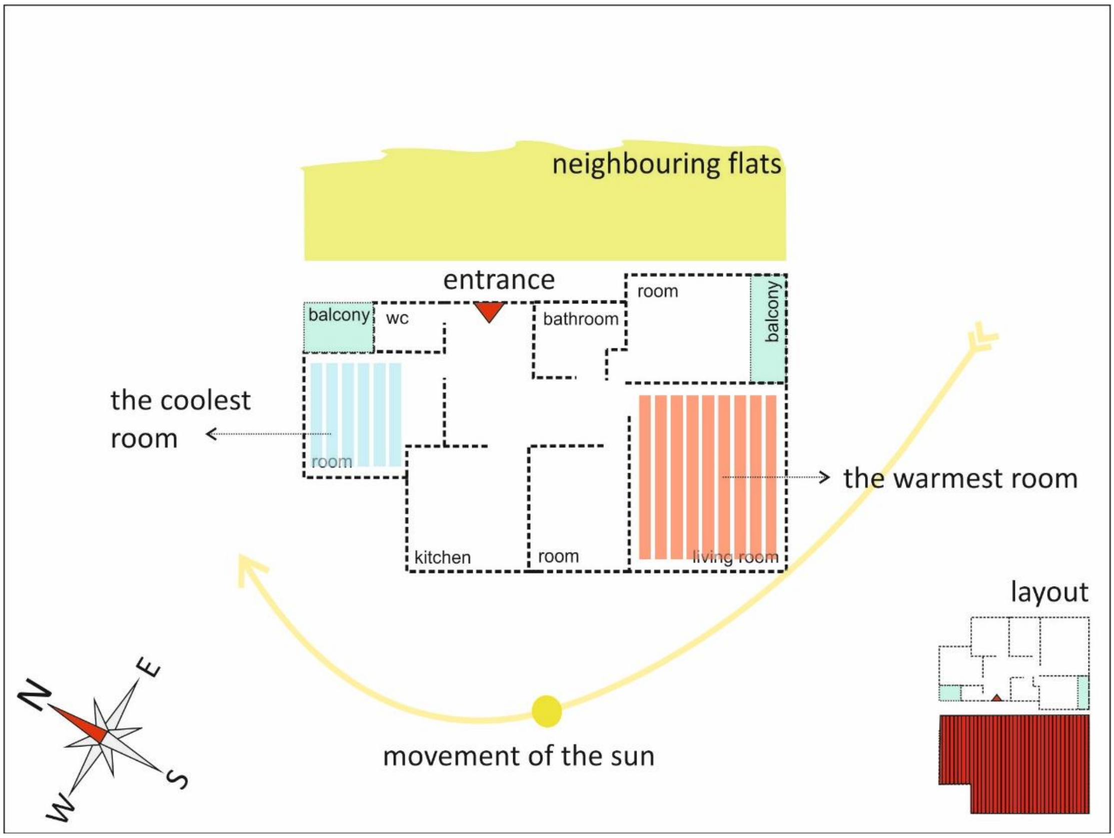

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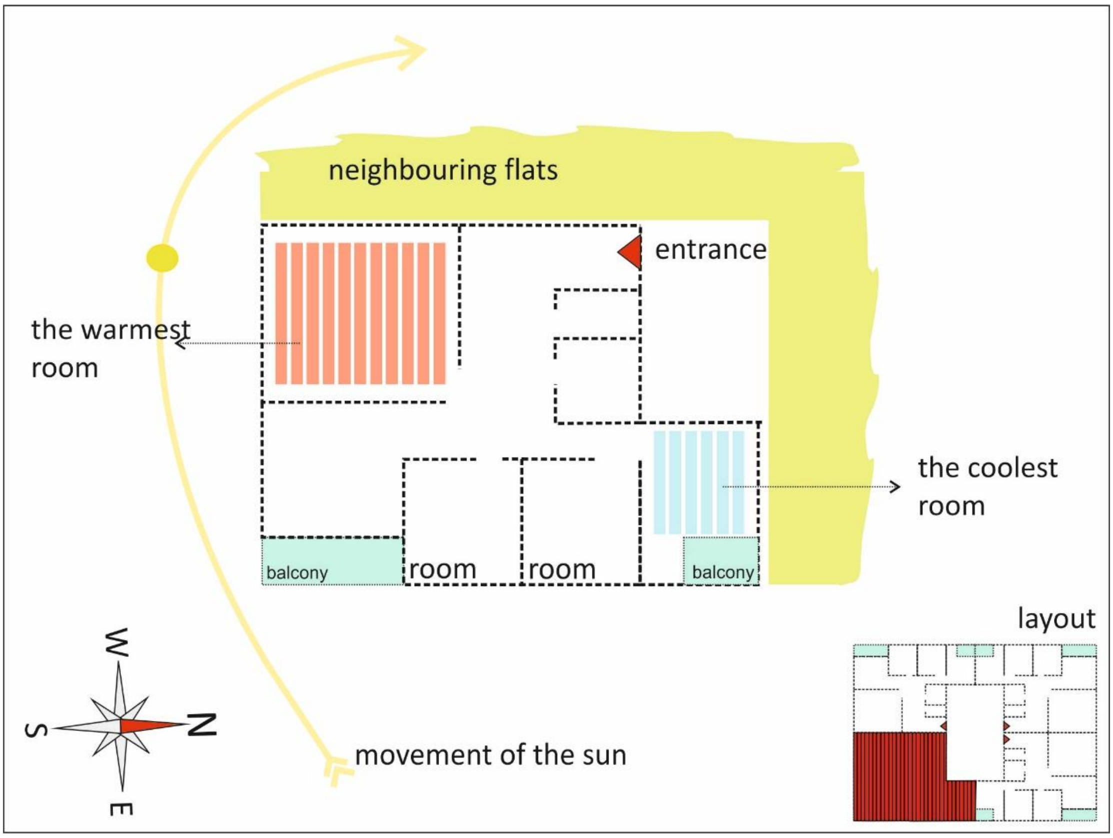

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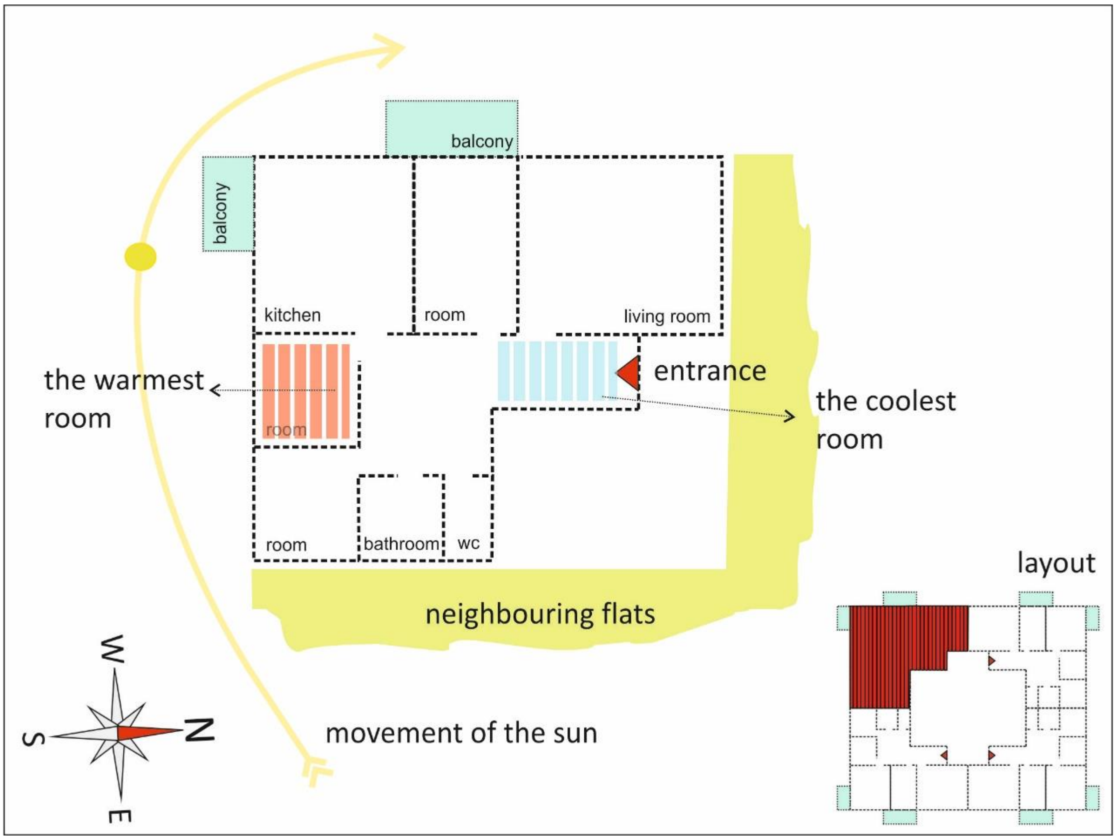

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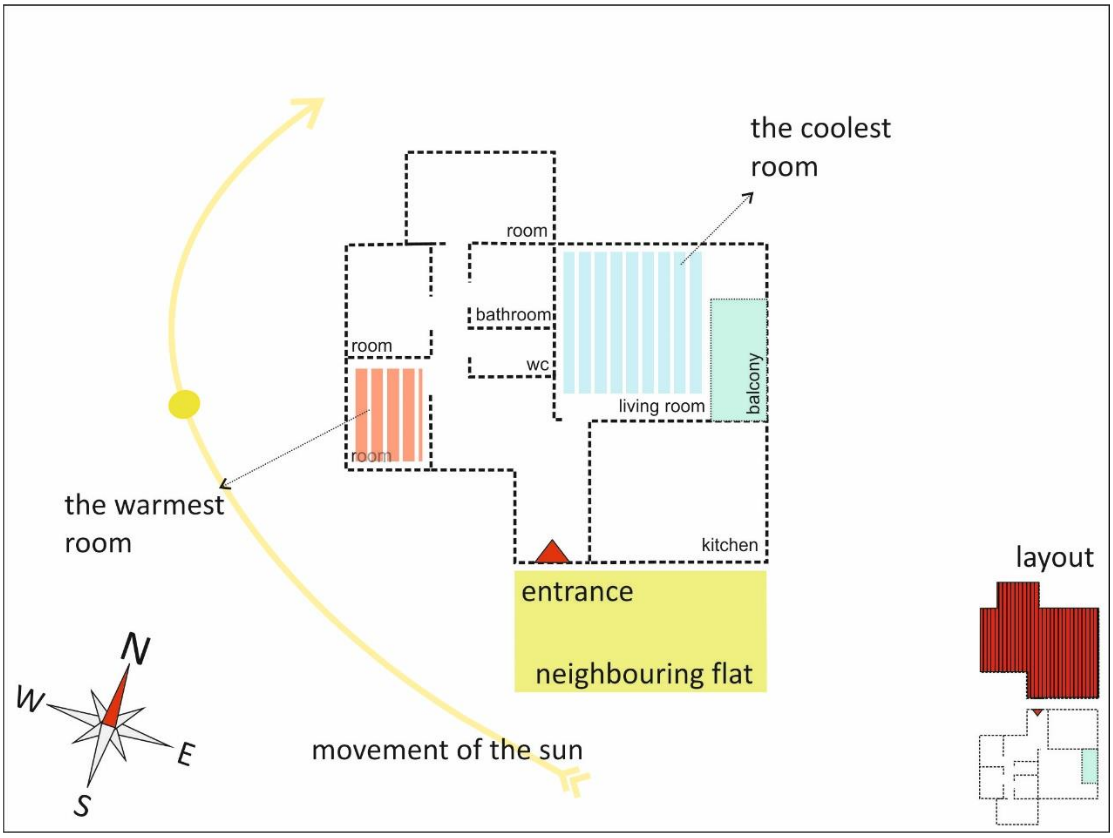

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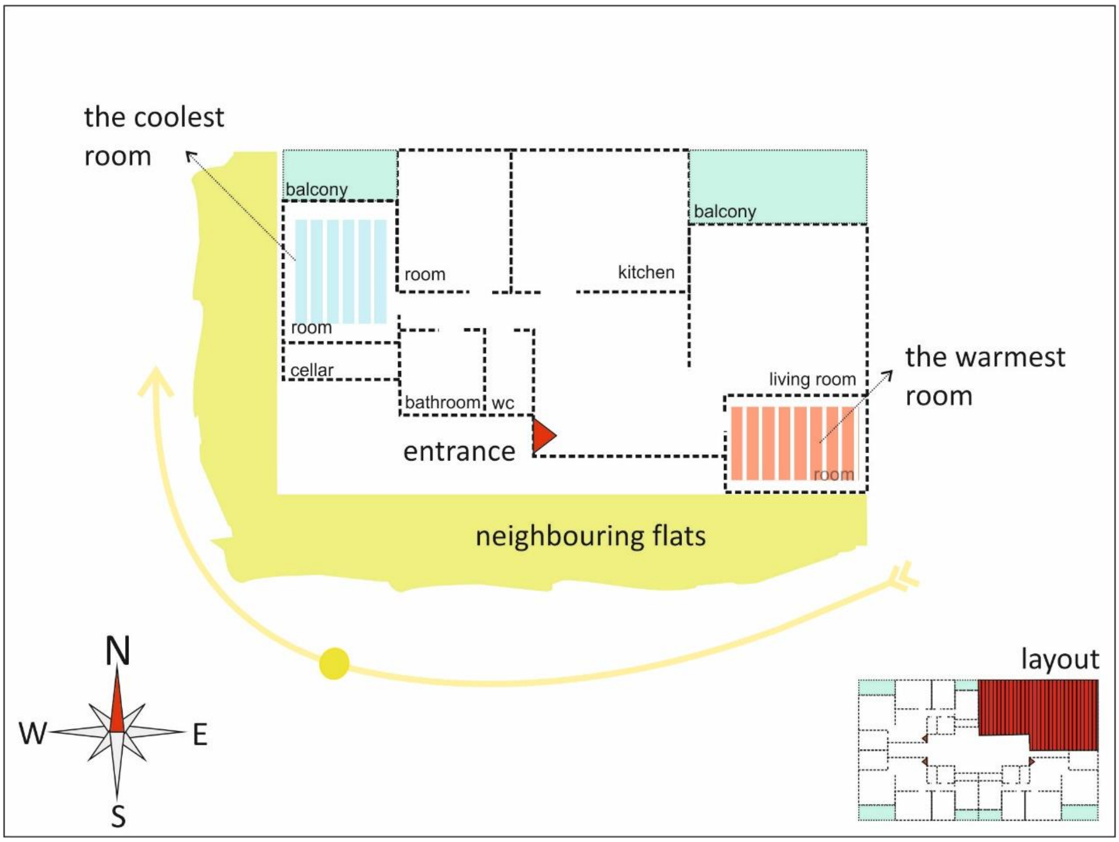

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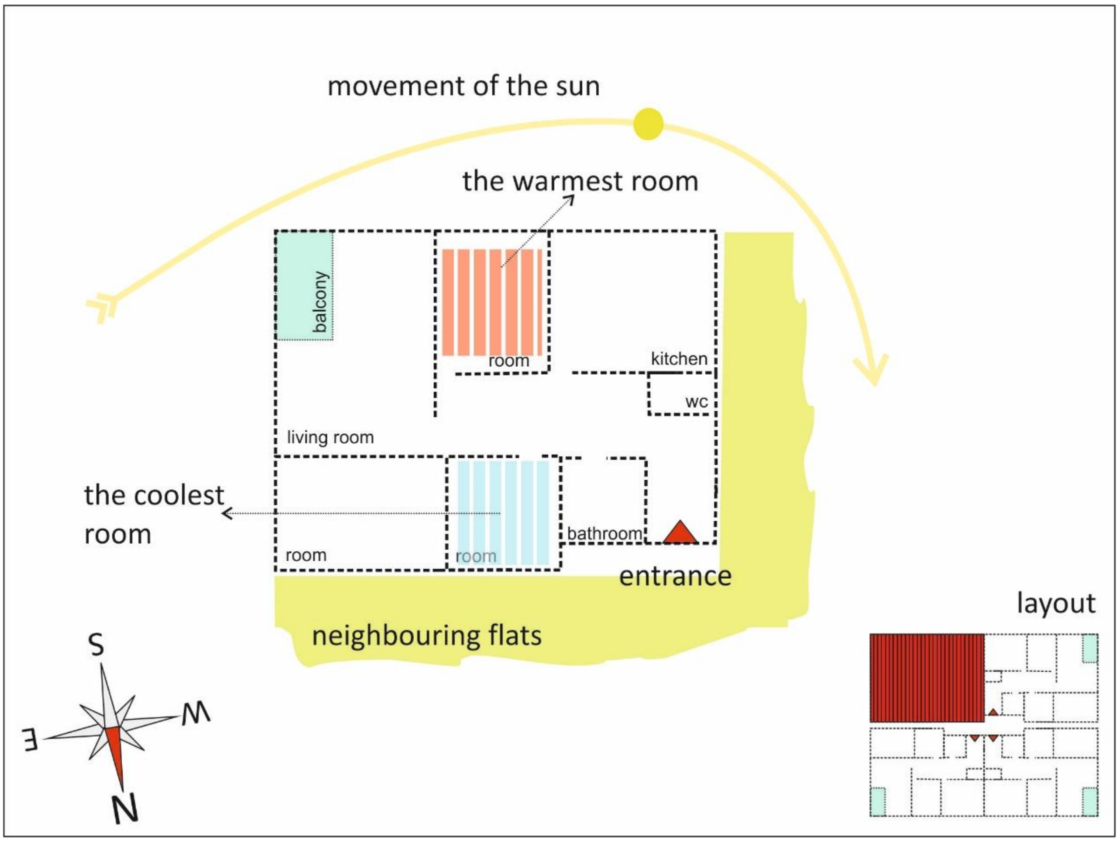

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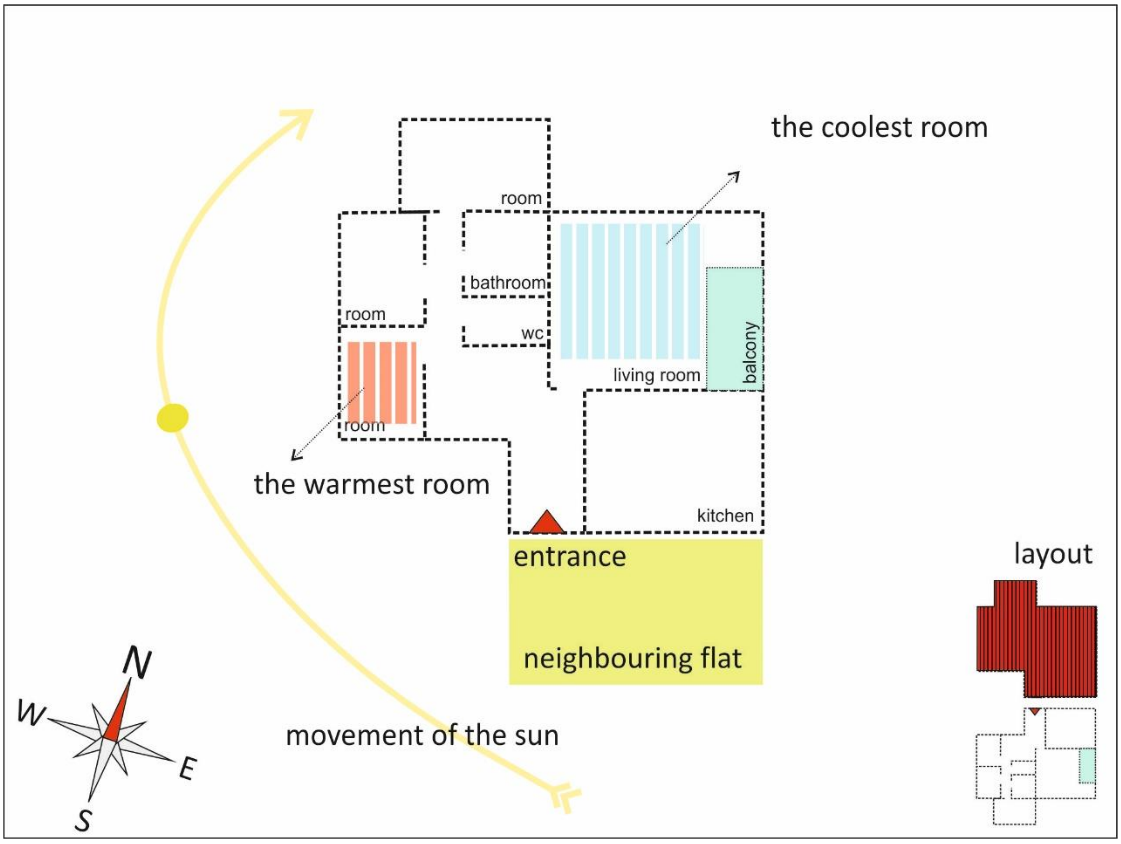

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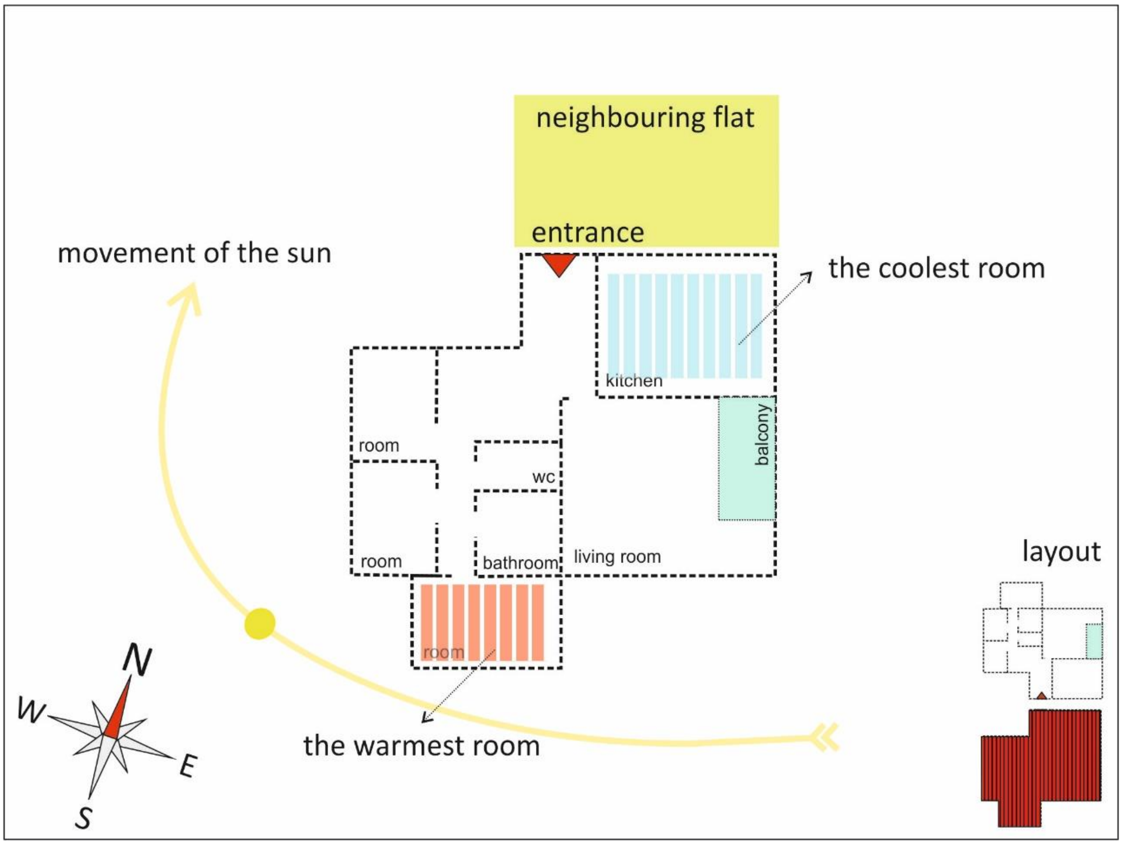

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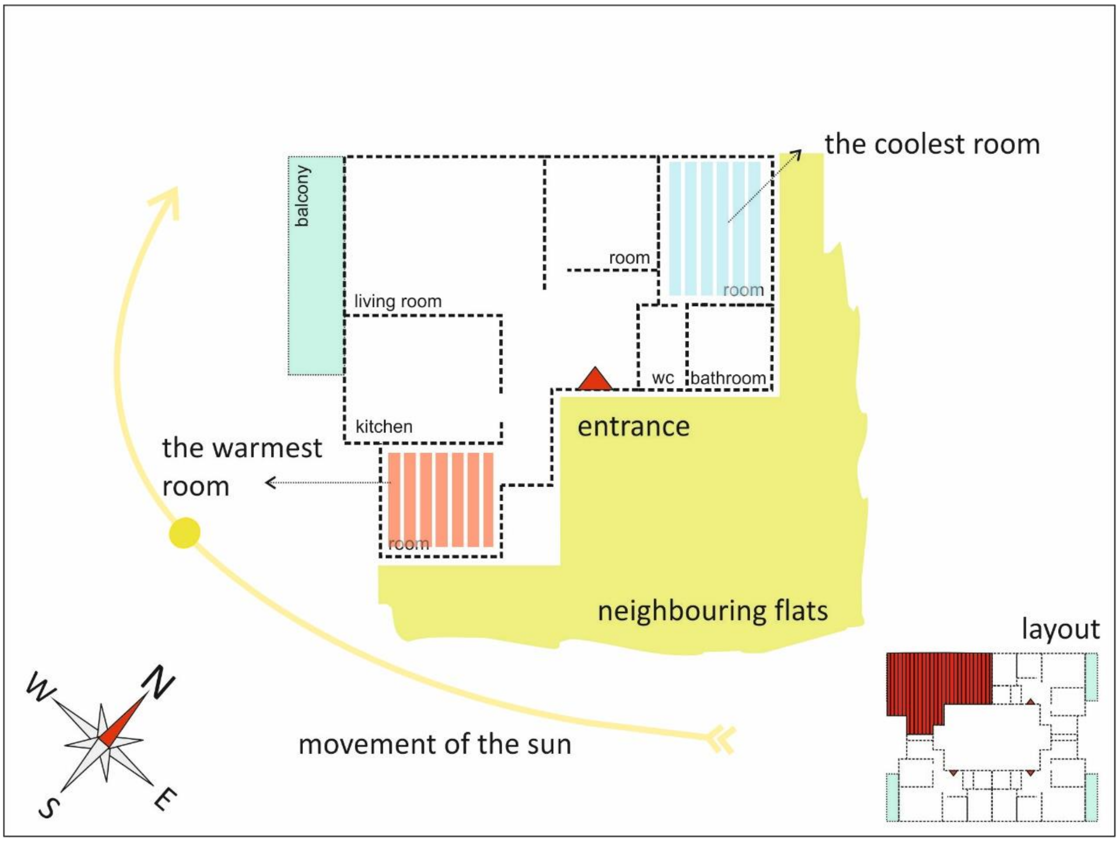

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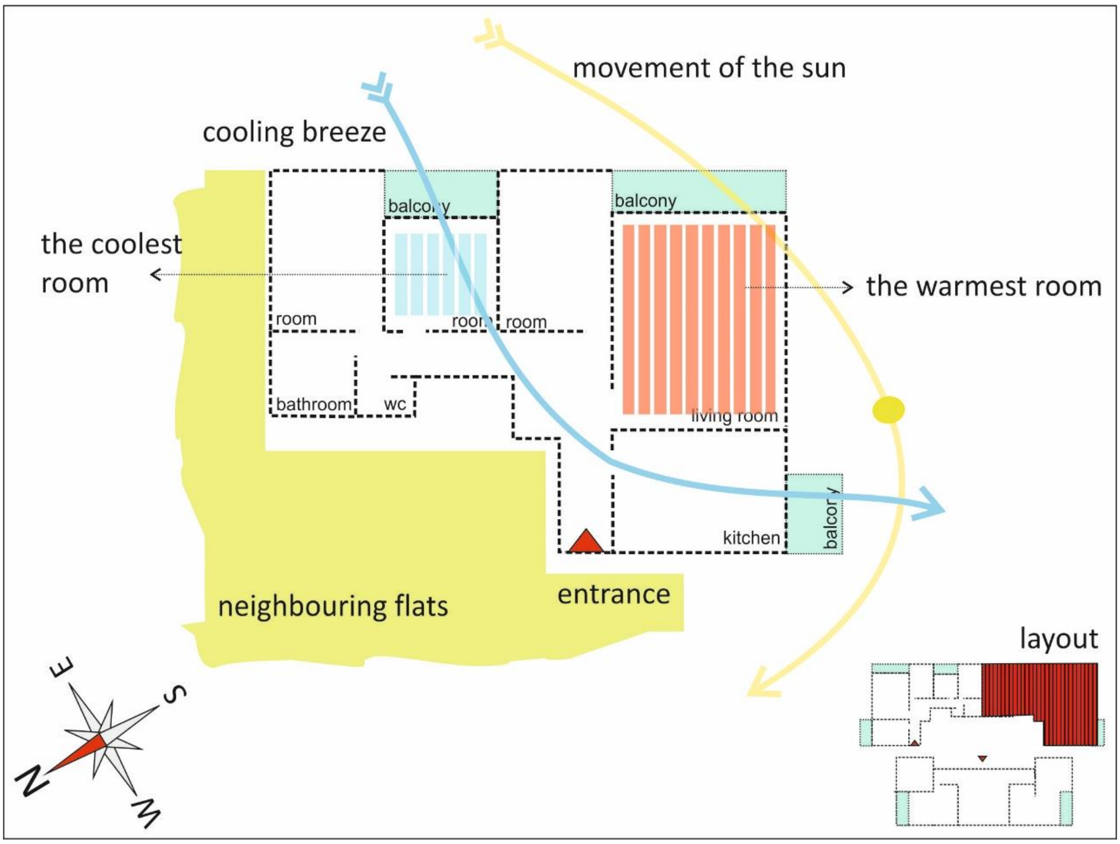

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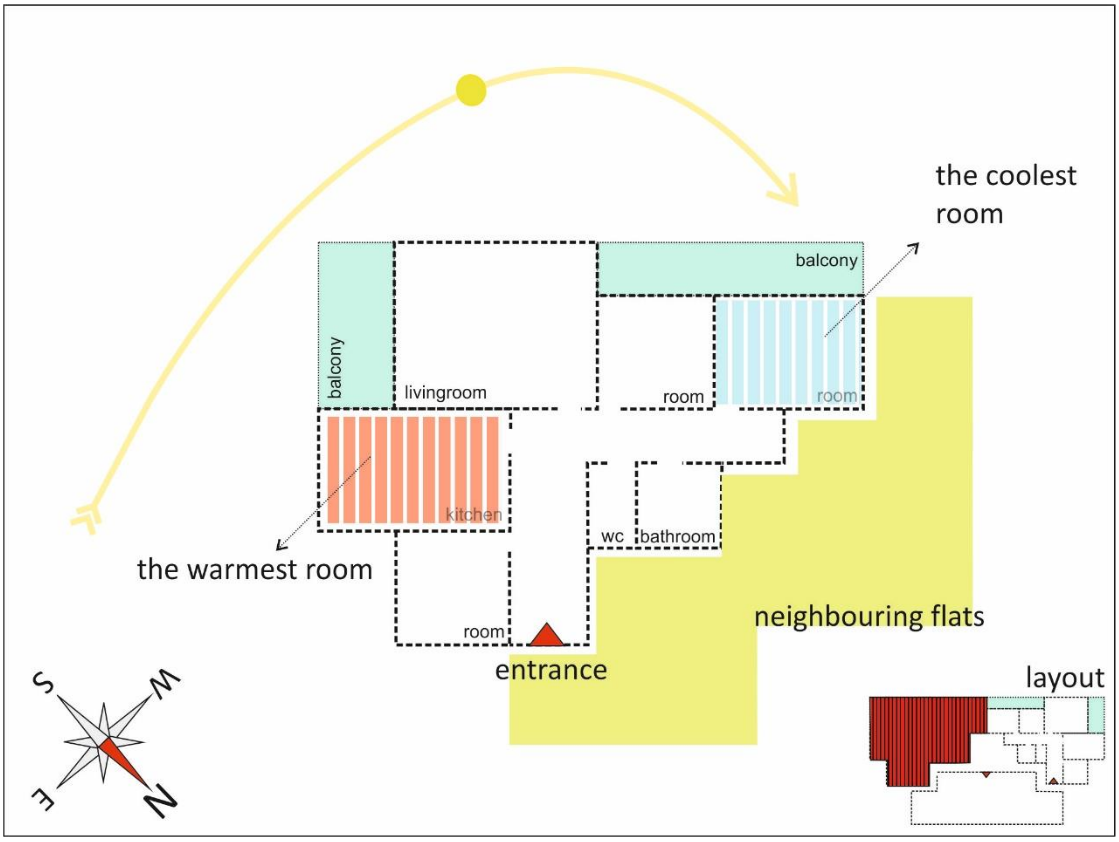
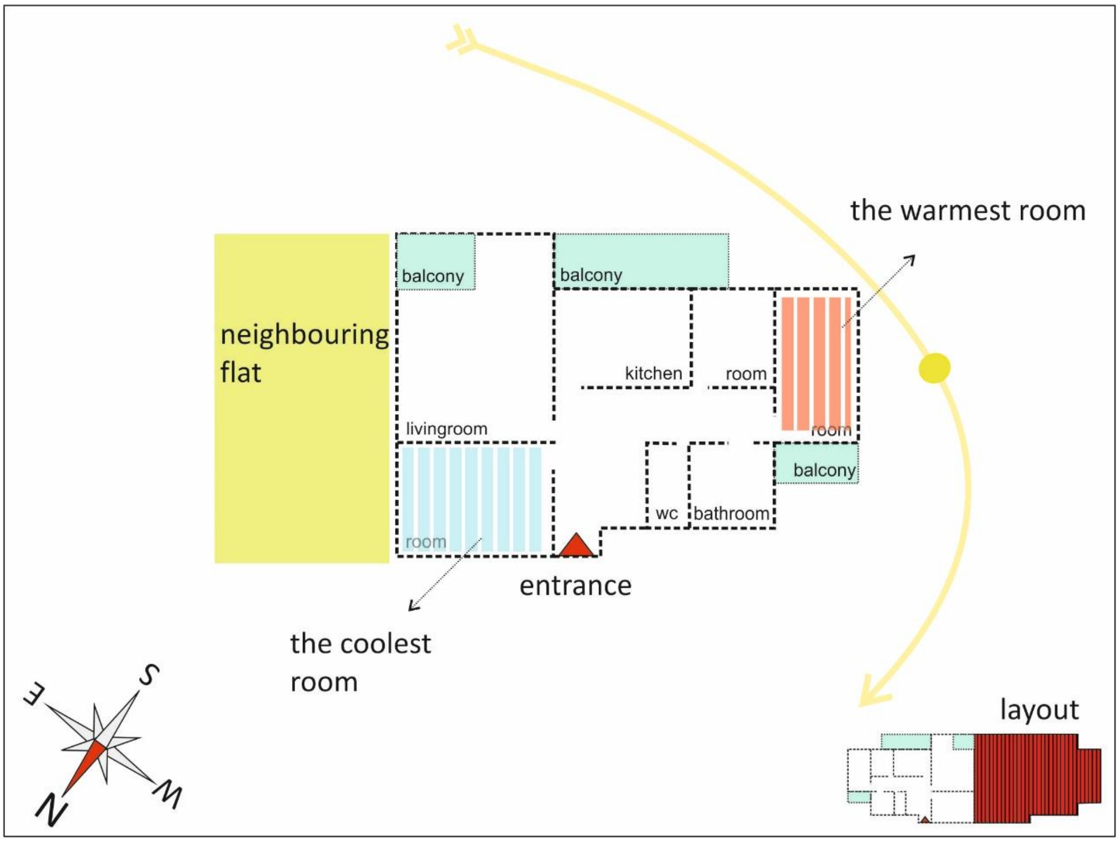


Contemporary sample unit 30



APPENDIX G

SPSS Outputs

G1. Results of the regression analysis of built environment attributes and perceived thermal comfort in summer

Descriptive Statistics

	Mean	Std. Deviation	N
Comfort in summer	4.431	2.0351	153
Material	1.510	.5015	153
Size	145.850	71.5542	153
Orientation	2.980	1.8370	153
Of open space extensions	1.556	.7599	153
Location of K amd B	1.176	.3825	153

Correlations

		Comfort insummer	Material	Size	Orientation	Of open space extensions	Location of K amd B
Pearson Correlation	comfortinsummer	1.000	.769	-.028	-.307	-.369	.366
	Material	.769	1.000	-.153	-.546	-.524	.454
	Size	-.028	-.153	1.000	.106	.105	-.038
	Orientation	-.307	-.546	.106	1.000	.380	-.248
	ofopenspaceextensions	-.369	-.524	.105	.380	1.000	-.340
	LocationofKampB	.366	.454	-.038	-.248	-.340	1.000
Sig. (1-tailed)	comfortinsummer	.	.000	.367	.000	.000	.000
	Material	.000	.	.029	.000	.000	.000
	Size	.367	.029	.	.097	.098	.321
	Orientation	.000	.000	.097	.	.000	.001
	ofopenspaceextensions	.000	.000	.098	.000	.	.000
	LocationofKampB	.000	.000	.321	.001	.000	.
N	comfortinsummer	153	153	153	153	153	153
	Material	153	153	153	153	153	153
	Size	153	153	153	153	153	153
	Orientation	153	153	153	153	153	153
	ofopenspaceextensions	153	153	153	153	153	153
	LocationofKampB	153	153	153	153	153	153

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Material	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Orientation	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: comfortinsummer

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.769[a]	.592	.589	1.3045	.592	218.930	1	151	.000
2	.781[b]	.610	.605	1.2795	.018	6.949	1	150	.009

a. Predictors: (Constant), Material

b. Predictors: (Constant), Material, Orientation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	372.565	1	372.565	218.930	.000[b]
	Residual	256.965	151	1.702		
	Total	629.529	152			
2	Regression	383.943	2	191.971	117.253	.000[c]
	Residual	245.587	150	1.637		
	Total	629.529	152			

a. Dependent Variable: comfortinsummer

b. Predictors: (Constant), Material

c. Predictors: (Constant), Material, Orientation

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions		
				(Constant)	Material	Orientation
1	1	1.949	1.000	.03	.03	
	2	.051	6.202	.97	.97	
2	1	2.684	1.000	.01	.01	.02
	2	.292	3.032	.00	.08	.41
	3	.024	10.521	.99	.91	.57

a. Dependent Variable: comfortinsummer

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-.282	.336		-.839	.403	-.944	.381					
	Material	3.122	.211	.769	14.796	.000	2.705	3.538	.769	.769	.769	1.000	1.000
2	(Constant)	-1.348	.522		-2.585	.011	-2.379	-.318					
	Material	3.477	.247	.857	14.077	.000	2.989	3.965	.769	.754	.718	.702	1.425
	Orientation	.178	.067	.160	2.636	.009	.045	.311	-.307	.210	.134	.702	1.425

a. Dependent Variable: comfortinsummer

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Size	.093[b]	1.771	.079	.143	.976	1.024	.976
	Orientation	.160[b]	2.636	.009	.210	.702	1.425	.702
	ofopenspaceextensions	.047[b]	.769	.443	.063	.726	1.378	.726
	LocationofKampB	.022[b]	.371	.711	.030	.794	1.260	.794
2	Size	.089[c]	1.734	.085	.141	.976	1.025	.693
	ofopenspaceextensions	.027[c]	.440	.661	.036	.713	1.402	.585
	LocationofKampB	.022[c]	.378	.706	.031	.794	1.260	.594

a. Dependent Variable: comfortinsummer
b. Predictors in the Model: (Constant), Material
c. Predictors in the Model: (Constant), Material, Orientation

G2. Results of the regression analysis of built environment attributes and perceived thermal comfort in winter

Descriptive Statistics

	Mean	Std. Deviation	N
comfortinwinter	4.784	1.9465	153
Material	1.510	.5015	153
Size	145.850	71.5542	153
Orientation	2.980	1.8370	153
ofopenspaceextensions	1.556	.7599	153
LocationofKampB	1.176	.3825	153

Correlations

		Comfort in winter	Material	Size	Orientation	Of open space extensions	Location of Kamp B
Pearson Correlation	comfortinwinter	1.000	-.271	-.053	.124	.340	-.523
	Material	-.271	1.000	-.153	-.546	-.524	.454
	Size	-.053	-.153	1.000	.106	.105	-.038
	Orientation	.124	-.546	.106	1.000	.380	-.248
	ofopenspaceextensions	.340	-.524	.105	.380	1.000	-.340
	LocationofKampB	-.523	.454	-.038	-.248	-.340	1.000
Sig. (1-tailed)	comfortinwinter	.	.000	.257	.063	.000	.000
	Material	.000	.	.029	.000	.000	.000
	Size	.257	.029	.	.097	.098	.321
	Orientation	.063	.000	.097	.	.000	.001
	ofopenspaceextensions	.000	.000	.098	.000	.	.000
	LocationofKampB	.000	.000	.321	.001	.000	.
N	comfortinwinter	153	153	153	153	153	153
	Material	153	153	153	153	153	153
	Size	153	153	153	153	153	153
	Orientation	153	153	153	153	153	153
	ofopenspaceextensions	153	153	153	153	153	153
	LocationofKampB	153	153	153	153	153	153

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	LocationofKampB	.	Stepwise (Criteria: Probability-of-F-to-enter <= .010, Probability-of-F-to-remove >= .100).

a. Dependent Variable: comfortinwinter

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.523[a]	.273	.269	1.6646	.273	56.839	1	151	.000

a. Predictors: (Constant), LocationofKampB

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	157.491	1	157.491	56.839	.000[b]
	Residual	418.392	151	2.771		
	Total	575.882	152			

a. Dependent Variable: comfortinwinter
b. Predictors: (Constant), LocationofKampB

Coefficient Correlations[a]

Model			LocationofKampB
1	Correlations	LocationofKampB	1.000
	Covariances	LocationofKampB	.125

a. Dependent Variable: comfortinwinter

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions	
				(Constant)	LocationofKampB
1	1	1.951	1.000	.02	.02
	2	.049	6.330	.98	.98

a. Dependent Variable: comfortinwinter

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	7.915	.437		18.131	.000	7.053	8.778					
	LocationofKampB	-2.661	.353	-.523	-7.539	.000	-3.359	-1.964	-.523	-.523	-.523	1.000	1.000

a. Dependent Variable: comfortinwinter

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Material	-.042[b]	-.539	.591	-.044	.794	1.260	.794
	Size	-.073[b]	-1.055	.293	-.086	.999	1.001	.999
	Orientation	-.006[b]	-.084	.933	-.007	.939	1.065	.939
	ofopenspaceextensions	.183[b]	2.526	.013	.202	.885	1.130	.885

a. Dependent Variable: comfortinwinter
b. Predictors in the Model: (Constant), LocationofKampB

G3. Results of the regression analysis of cooling devices and perceived thermal comfort in summer

Descriptive Statistics

	Mean	Std. Deviation	N
comfortinsummer	4.431	2.0351	153
cd1electricfan	.680	.6555	153
cd2airconditioner	.804	.9036	153
cd3ceilingfan	.124	.3309	153

Correlations

		Comfort insummer	cd1 electric fan	cd2 airconditioner	cd3 ceiling fan
Pearson Correlation	comfortinsummer	1.000	-.384	-.555	.321
	cd1electricfan	-.384	1.000	.360	-.392
	cd2airconditioner	-.555	.360	1.000	-.336
	cd3ceilingfan	.321	-.392	-.336	1.000
Sig. (1-tailed)	comfortinsummer	.	.000	.000	.000
	cd1electricfan	.000	.	.000	.000
	cd2airconditioner	.000	.000	.	.000
	cd3ceilingfan	.000	.000	.000	.
N	comfortinsummer	153	153	153	153
	cd1electricfan	153	153	153	153
	cd2airconditioner	153	153	153	153
	cd3ceilingfan	153	153	153	153

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	cd2airconditioner	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	cd1electricfan	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: comfortinsummer

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.555[a]	.308	.303	1.6989	.308	67.117	1	151	.000
2	.589[b]	.347	.338	1.6557	.039	8.972	1	150	.003

a. Predictors: (Constant), cd2airconditioner

b. Predictors: (Constant), cd2airconditioner, cd1electricfan

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	193.713	1	193.713	67.117	.000[b]
	Residual	435.816	151	2.886		
	Total	629.529	152			
2	Regression	218.310	2	109.155	39.816	.000[c]
	Residual	411.219	150	2.741		
	Total	629.529	152			

a. Dependent Variable: comfortinsummer
b. Predictors: (Constant), cd2airconditioner
c. Predictors: (Constant), cd2airconditioner, cd1electricfan

Coefficient Correlations[a]

Model			cd2airconditioner	cd1electricfan
1	Correlations	cd2airconditioner	1.000	
	Covariances	cd2airconditioner	.023	
2	Correlations	cd2airconditioner	1.000	-.360
		cd1electricfan	-.360	1.000
	Covariances	cd2airconditioner	.025	-.013
		cd1electricfan	-.013	.048

a. Dependent Variable: comfortinsummer

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions		
				(Constant)	cd2airconditioner	cd1electricfan
1	1	1.666	1.000	.17	.17	
	2	.334	2.233	.83	.83	
2	1	2.369	1.000	.06	.07	.06
	2	.352	2.594	.19	.93	.19
	3	.279	2.914	.75	.00	.75

a. Dependent Variable: comfortinsummer

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	5.436	.184		29.526	.000	5.072	5.799					
	cd2airconditioner	-1.249	.152	-.555	-8.193	.000	-1.551	-.948	-.555	-.555	-.555	1.000	1.000
2	(Constant)	5.745	.207		27.755	.000	5.336	6.154					
	cd2airconditioner	-1.078	.159	-.478	-6.765	.000	-1.392	-.763	-.555	-.484	-.446	.871	1.149
	cd1electricfan	-.658	.220	-.212	-2.995	.003	-1.092	-.224	-.384	-.238	-.198	.871	1.149

a. Dependent Variable: comfortinsummer

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	cd1electricfan	-.212[b]	-2.995	.003	-.238	.871	1.149	.871
	cd3ceilingfan	.151[b]	2.127	.035	.171	.887	1.127	.887
2	cd3ceilingfan	.096[c]	1.300	.196	.106	.803	1.246	.788

a. Dependent Variable: comfortinsummer
b. Predictors in the Model: (Constant), cd2airconditioner
c. Predictors in the Model: (Constant), cd2airconditioner, cd1electricfan

G4. Results of the regression analysis of perceived thermal comfort attributes and perceived annual thermal comfort

Descriptive Statistics

	Mean	Std. Deviation	N
comfortinsummer	4.431	2.0351	153
V6 others	.33	.895	153
V5 walling	1.49	2.171	153
V4 openspaceextentions	2.876	2.5218	153
V2 typology	1.033	1.2948	153
V3 Externaldevices	1.255	1.4713	153
V1 Accessibility	.510	.9605	153

Correlations

		Comfort insummer	V6 others	V5 walling	V4 openspac eextentio ns	V2 typolog y	V3 Externald evices	V1 Accessibil ity
Pearson Correlation	comfortinsummer	1.000	.103	-.342	.098	.040	-.483	.338
	V6others	.103	1.000	.025	-.029	.048	-.064	.142
	V5walling	-.342	.025	1.000	-.168	-.022	.412	-.165
	V4openspaceextentions	.098	-.029	-.168	1.000	.217	-.181	-.153
	V2typology	.040	.048	-.022	.217	1.000	-.073	.039
	V3Externaldevices	-.483	-.064	.412	-.181	-.073	1.000	-.242
	V1Accessibility	.338	.142	-.165	-.153	.039	-.242	1.000
Sig. (1-tailed)	comfortinsummer	.	.103	.000	.115	.314	.000	.000
	V6others	.103	.	.378	.363	.280	.217	.040
	V5walling	.000	.378	.	.019	.393	.000	.021
	V4openspaceextentions	.115	.363	.019	.	.004	.013	.030
	V2typology	.314	.280	.393	.004	.	.183	.314
	V3Externaldevices	.000	.217	.000	.013	.183	.	.001
	V1Accessibility	.000	.040	.021	.030	.314	.001	.
N	comfortinsummer	153	153	153	153	153	153	153
	V6others	153	153	153	153	153	153	153
	V5walling	153	153	153	153	153	153	153
	V4openspaceextentions	153	153	153	153	153	153	153
	V2typology	153	153	153	153	153	153	153
	V3Externaldevices	153	153	153	153	153	153	153
	V1Accessibility	153	153	153	153	153	153	153

Variables Entered/Removeda

Model	Variables Entered	Variables Removed	Method
1	V3Externaldevices	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	V1Accessibility	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	V5walling	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: comfortinsummer

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.483[a]	.233	.228	1.7879	.233	45.940	1	151	.000
2	.534[b]	.285	.276	1.7320	.052	10.894	1	150	.001
3	.552[c]	.305	.291	1.7138	.020	4.209	1	149	.042

a. Predictors: (Constant), V3Externaldevices

b. Predictors: (Constant), V3Externaldevices, V1Accessibility

c. Predictors: (Constant), V3Externaldevices, V1Accessibility, V5walling

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	146.850	1	146.850	45.940	.000[b]
	Residual	482.679	151	3.197		
	Total	629.529	152			
2	Regression	179.531	2	89.765	29.922	.000[c]
	Residual	449.998	150	3.000		
	Total	629.529	152			
3	Regression	191.893	3	63.964	21.778	.000[d]
	Residual	437.636	149	2.937		
	Total	629.529	152			

a. Dependent Variable: comfortinsummer
b. Predictors: (Constant), V3Externaldevices
c. Predictors: (Constant), V3Externaldevices, V1Accessibility
d. Predictors: (Constant), V3Externaldevices, V1Accessibility, V5walling

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	5.270	.190		27.701	.000	4.894	5.646					
	V3Externaldevices	-.668	.099	-.483	-6.778	.000	-.863	-.473	-.483	-.483	-.483	1.000	1.000
2	(Constant)	4.918	.213		23.095	.000	4.497	5.338					
	V3Externaldevices	-.590	.098	-.426	-5.992	.000	-.784	-.395	-.483	-.439	-.414	.942	1.062
	V1Accessibility	.497	.151	.235	3.301	.001	.200	.795	.338	.260	.228	.942	1.062
3	(Constant)	5.039	.219		23.027	.000	4.607	5.471					
	V3Externaldevices	-.505	.106	-.365	-4.783	.000	-.714	-.297	-.483	-.365	-.327	.799	1.251
	V1Accessibility	.475	.150	.224	3.175	.002	.179	.770	.338	.252	.217	.937	1.068
	V5walling	-.145	.070	-.154	-2.052	.042	-.284	-.005	-.342	-.166	-.140	.826	1.211

a. Dependent Variable: comfortinsummer

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	V6others	.072[b]	1.012	.313	.082	.996	1.004	.996
	V5walling	-.172[b]	-2.226	.027	-.179	.830	1.204	.830
	V4openspaceextentions	.011[b]	.145	.885	.012	.967	1.034	.967
	V2typology	.004[b]	.057	.955	.005	.995	1.005	.995
	V1Accessibility	.235[b]	3.301	.001	.260	.942	1.062	.942
2	V6others	.043[c]	.618	.537	.051	.979	1.021	.926
	V5walling	-.154[c]	-2.052	.042	-.166	.826	1.211	.799
	V4openspaceextentions	.061[c]	.848	.398	.069	.926	1.080	.893
	V2typology	-.001[c]	-.015	.988	-.001	.994	1.006	.938
3	V6others	.053[d]	.764	.446	.063	.975	1.026	.797
	V4openspaceextentions	.044[d]	.610	.543	.050	.912	1.096	.777
	V2typology	.000[d]	.007	.995	.001	.994	1.006	.796

a. Dependent Variable: comfortinsummer
b. Predictors in the Model: (Constant), V3Externaldevices
c. Predictors in the Model: (Constant), V3Externaldevices, V1Accessibility
d. Predictors in the Model: (Constant), V3Externaldevices, V1Accessibility, V5walling

Coefficient Correlations[a]

Model			V3Externaldevices	V1Accessibility	V5walling
1	Correlations	V3Externaldevices	1.000		
	Covariances	V3Externaldevices	.010		
2	Correlations	V3Externaldevices	1.000	.242	
		V1Accessibility	.242	1.000	
	Covariances	V3Externaldevices	.010	.004	
		V1Accessibility	.004	.023	
3	Correlations	V3Externaldevices	1.000	.193	-.389
		V1Accessibility	.193	1.000	.074
		V5walling	-.389	.074	1.000
	Covariances	V3Externaldevices	.011	.003	-.003
		V1Accessibility	.003	.022	.001
		V5walling	-.003	.001	.005

a. Dependent Variable: comfortinsummer

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	V3Externaldevices	V1Accessibility	V5walling
1	1	1.650	1.000	.17	.17		
	2	.350	2.172	.83	.83		
2	1	1.874	1.000	.11	.10	.08	
	2	.864	1.473	.00	.21	.56	
	3	.261	2.677	.89	.69	.35	
3	1	2.373	1.000	.06	.06	.03	.06
	2	.972	1.563	.01	.05	.56	.07
	3	.393	2.456	.09	.32	.05	.87
	4	.261	3.013	.84	.57	.36	.00

a. Dependent Variable: comfortinsummer

G5. Results of the regression analysis of perceived climatic attributes and overall thermal comfort level

Descriptive Statistics

	Mean	Std. Deviation	N
Perceived overall thermal comfort	3,188	1,0237	600
Temperature	2,198	,8506	600
Felt Sun	1,700	,5037	600
Felt Wind	3,778	,5595	600
Felt Humidity	3,533	,7788	600

Correlations

		Perceived overall thermal comfort	Temperature	Felt Sun	Felt Wind	Felt Humidity
Pearson Correlation	Perceived overall thermal comfort	1,000	,469	,391	,163	,029
	Temperature	,469	1,000	,326	,219	,072
	Felt Sun	,391	,326	1,000	,226	,026
	Felt Wind	,163	,219	,226	1,000	-,058
	Felt Humidity	,029	,072	,026	-,058	1,000
Sig. (1-tailed)	Perceived overall thermal comfort	.	,000	,000	,000	,241
	Temperature	,000	.	,000	,000	,039
	Felt Sun	,000	,000	.	,000	,266
	Felt Wind	,000	,000	,000	.	,079
	Felt Humidity	,241	,039	,266	,079	.
N	Perceived overall thermal comfort	600	600	600	600	600
	Temperature	600	600	600	600	600
	Felt Sun	600	600	600	600	600
	Felt Wind	600	600	600	600	600
	Felt Humidity	600	600	600	600	600

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Temperature	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
2	Felt Sun	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

a. Dependent Variable: Perceived overall thermal comfort

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,469[a]	,220	,219	,9049	,220	168,566	1	598	,000
2	,532[b]	,284	,281	,8679	,064	53,029	1	597	,000

a. Predictors: (Constant), Temperature

b. Predictors: (Constant), Temperature, Felt Sun

c. Dependent Variable: Perceived overall thermal comfort

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	138,033	1	138,033	168,566	,000[b]
	Residual	489,685	598	,819		
	Total	627,718	599			
2	Regression	177,982	2	88,991	118,130	,000[c]
	Residual	449,737	597	,753		
	Total	627,718	599			

a. Dependent Variable: Perceived overall thermal comfort

b. Predictors: (Constant), Temperature

c. Predictors: (Constant), Temperature, Felt Sun

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1,948	,102		19,012	,000					
	Temperature	,564	,043	,469	12,983	,000	,469	,469	,469	1,000	1,000
2	(Constant)	1,256	,137		9,191	,000					
	Temperature	,460	,044	,382	10,422	,000	,469	,392	,361	,894	1,119
	Felt Sun	,542	,074	,267	7,282	,000	,391	,286	,252	,894	1,119

a. Dependent Variable: Perceived overall thermal comfort

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Felt Sun	,267[b]	7,282	,000	,286	,894	1,119	,894
	Felt Wind	,064[b]	1,727	,085	,070	,952	1,050	,952
	Felt Humidity	-,005[b]	-,138	,891	-,006	,995	1,005	,995
2	Felt Wind	,021[c]	,587	,557	,024	,925	1,081	,869
	Felt Humidity	-,006[c]	-,160	,873	-,007	,995	1,005	,890

a. Dependent Variable: Perceived overall thermal comfort

b. Predictors in the Model: (Constant), Temperature

c. Predictors in the Model: (Constant), Temperature, Felt Sun

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions		
				(Constant)	Temperature	Felt Sun
1	1	1,933	1,000	,03	,03	
	2	,067	5,360	,97	,97	
2	1	2,880	1,000	,01	,01	,01
	2	,079	6,019	,10	,98	,19
	3	,041	8,388	,89	,01	,80

a. Dependent Variable: Perceived overall thermal comfort

G6. Results of discriminant analysis to explore whether perceived climatic attributes and perceived thermal comfort values vary at different time intervals

Group Statistics

Time		Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
morning	Temperature	2.309	.9032	194	194.000
	FeltWind	3.727	.6459	194	194.000
	FeltSun	1.758	.4643	194	194.000
	FeltHumidity	3.562	.7541	194	194.000
	Perceivedoverallthermalcomfort	3.325	1.0143	194	194.000
noon	Temperature	2.213	.8228	174	174.000
	FeltWind	3.793	.5818	174	174.000
	FeltSun	1.667	.5081	174	174.000
	FeltHumidity	3.586	.7059	174	174.000
	Perceivedoverallthermalcomfort	3.213	1.0004	174	174.000
afternoon	Temperature	2.095	.8163	232	232.000
	FeltWind	3.810	.4542	232	232.000
	FeltSun	1.677	.5295	232	232.000
	FeltHumidity	3.470	.8472	232	232.000
	Perceivedoverallthermalcomfort	3.056	1.0367	232	232.000
Total	Temperature	2.198	.8506	600	600.000
	FeltWind	3.778	.5595	600	600.000
	FeltSun	1.700	.5037	600	600.000
	FeltHumidity	3.533	.7788	600	600.000
	Perceivedoverallthermalcomfort	3.188	1.0237	600	600.000

Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Temperature	.989	3.420	2	597	.033
FeltWind	.996	1.264	2	597	.283
FeltSun	.994	1.908	2	597	.149
FeltHumidity	.996	1.304	2	597	.272
Perceivedoverallthermalcomfort	.988	3.743	2	597	.024

Analysis 1

Box's Test of Equality of Covariance Matrices

Log Determinants

Time	Rank	Log Determinant
morning	1	-.204
noon	1	-.390
afternoon	1	-.406
Pooled within-groups	1	-.332

The ranks and natural logarithms of determinants printed are those of the group covariance matrices.

Test Results

Box's M		2.564
F	Approx.	1.279
	df1	2
	df2	776757.266
	Sig.	.278

Tests null hypothesis of equal population covariance matrices.

Stepwise Statistics

Variables Entered/Removed[a,b,c,d]

Step	Entered	Min. D Squared					
		Statistic	Between Groups	Exact F			
				Statistic	df1	df2	Sig.
1	Temperature	.013	morning and noon	1.193	1	597.000	.275

At each step, the variable that maximizes the Mahalanobis distance between the two closest groups is entered.
a. Maximum number of steps is 10.
b. Maximum significance of F to enter is .05.
c. Minimum significance of F to remove is .10.
d. F level, tolerance, or VIN insufficient for further computation.

Variables in the Analysis

Step		Tolerance	Sig. of F to Remove
1	Temperature	1.000	.033

Variables Not in the Analysis

Step		Tolerance	Min. Tolerance	Sig. of F to Enter	Min. D Squared	Between Groups
0	Temperature	1.000	1.000	.033	.013	morning and noon
	FeltWind	1.000	1.000	.283	.001	noon and afternoon
	FeltSun	1.000	1.000	.149	.000	noon and afternoon
	FeltHumidity	1.000	1.000	.272	.001	morning and noon
	Perceivedoverallthermalcomfort	1.000	1.000	.024	.012	morning and noon
1	FeltWind	.948	.948	.090	.023	noon and afternoon
	FeltSun	.896	.896	.343	.024	noon and afternoon
	FeltHumidity	.996	.996	.339	.015	morning and noon
	Perceivedoverallthermalcomfort	.786	.786	.232	.017	morning and noon

Wilks' Lambda

Step	Number of Variables	Lambda	df1	df2	df3	Exact F			
						Statistic	df1	df2	Sig.
1	1	.989	1	2	597	3.420	2	597.000	.033

Summary of Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.011[a]	100.0	100.0	.106

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.989	6.801	2	.033

Standardized Canonical Discriminant Function Coefficients

	Function
	1
Temperature	1.000

Structure Matrix

	Function
	1
Temperature	1.000
Perceivedoverallthermalcomfort[a]	.463
FeltSun[a]	.322
FeltWind[a]	.227
FeltHumidity[a]	.067

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.
a. This variable not used in the analysis.

Functions at Group Centroids

Time	Function
	1
morning	.131
noon	.017
afternoon	-.122

Unstandardized canonical discriminant functions evaluated at group means

Classification Statistics

Classification Processing Summary

Processed		1115
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	515
Used in Output		600

Prior Probabilities for Groups

Time	Prior	Cases Used in Analysis	
		Unweighted	Weighted
morning	.323	194	194.000
noon	.290	174	174.000
afternoon	.387	232	232.000
Total	1.000	600	600.000

Classification Results[a,c]

		Time	Predicted Group Membership			Total
			morning	noon	afternoon	
Original	Count	morning	78	0	116	194
		noon	62	0	112	174
		afternoon	69	0	163	232
	%	morning	40.2	.0	59.8	100.0
		noon	35.6	.0	64.4	100.0
		afternoon	29.7	.0	70.3	100.0
Cross-validated[b]	Count	morning	78	0	116	194
		noon	62	0	112	174
		afternoon	69	0	163	232
	%	morning	40.2	.0	59.8	100.0
		noon	35.6	.0	64.4	100.0
		afternoon	29.7	.0	70.3	100.0

a. 40.2% of original grouped cases correctly classified.
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
c. 40.2% of cross-validated grouped cases correctly classified.

G7. Results of discriminant analysis to understand which housing design attributes explain the difference between the Old and New Towns

Group Statistics

Fromwhichtown		Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
old town	Size	135.128	96.4263	78	78.000
	Orientation	2.000	.0000	78	78.000
	ofopenspaceextensions	1.167	.5446	78	78.000
	LocationofKampB	1.346	.4788	78	78.000
	Typology	2.026	.1591	78	78.000
new town	Size	157.000	24.3843	75	75.000
	Orientation	4.000	2.2056	75	75.000
	ofopenspaceextensions	1.960	.7433	75	75.000
	LocationofKampB	1.000	.0000	75	75.000
	Typology	1.120	.5918	75	75.000
Total	Size	145.850	71.5542	153	153.000
	Orientation	2.980	1.8370	153	153.000
	ofopenspaceextensions	1.556	.7599	153	153.000
	LocationofKampB	1.176	.3825	153	153.000
	Typology	1.582	.6242	153	153.000

Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Size	.976	3.634	1	151	.058
Orientation	.702	64.150	1	151	.000
ofopenspaceextensions	.726	57.033	1	151	.000
LocationofKampB	.794	39.187	1	151	.000
Typology	.471	169.917	1	151	.000

Pooled Within-Groups Matrices

		Size	Orientation	ofopenspaceextensions	LocationofKampB	Typology
Correlation	Size	1.000	.027	.029	.036	.095
	Orientation	.027	1.000	.132	.000	-.090
	ofopenspaceextensions	.029	.132	1.000	-.134	.048
	LocationofKampB	.036	.000	-.134	1.000	-.031
	Typology	.095	-.090	.048	-.031	1.000

Variables in the Analysis

Step		Tolerance	F to Remove	Wilks' Lambda
1	Typology	1.000	169.917	
2	Typology	.998	129.740	.726
	ofopenspaceextensions	.998	31.340	.471
3	Typology	.988	94.403	.585
	ofopenspaceextensions	.979	21.669	.410
	Orientation	.973	12.911	.389
4	Typology	.988	85.901	.525
	ofopenspaceextensions	.961	15.096	.366
	Orientation	.973	12.222	.360
	LocationofKampB	.981	11.500	.358

Variables Not in the Analysis

Step		Tolerance	Min. Tolerance	F to Enter	Wilks' Lambda
0	Size	1.000	1.000	3.634	.976
	Orientation	1.000	1.000	64.150	.702
	ofopenspaceextensions	1.000	1.000	57.033	.726
	LocationofKampB	1.000	1.000	39.187	.794
	Typology	1.000	1.000	169.917	.471
1	Size	.991	.991	4.661	.456
	Orientation	.992	.992	22.034	.410
	ofopenspaceextensions	.998	.998	31.340	.389
	LocationofKampB	.999	.999	20.795	.413
2	Size	.990	.989	3.352	.381
	Orientation	.973	.973	12.911	.358
	LocationofKampB	.981	.980	12.181	.360
3	Size	.989	.972	2.691	.352
	LocationofKampB	.981	.961	11.500	.332
4	Size	.988	.961	2.938	.326

Wilks' Lambda

Step	Number of Variables	Lambda	df1	df2	df3	Exact F			
						Statistic	df1	df2	Sig.
1	1	.471	1	1	151	169.917	1	151.000	.000
2	2	.389	2	1	151	117.699	2	150.000	.000
3	3	.358	3	1	151	89.000	3	149.000	.000
4	4	.332	4	1	151	74.329	4	148.000	.000

Summary of Canonical Discriminant Functions

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.009[a]	100.0	100.0	.817

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.332	164.134	4	.000

Standardized Canonical Discriminant Function Coefficients

	Function
	1
Orientation	-.343
ofopenspaceextensions	-.380
LocationofKampB	.332
Typology	.746

Structure Matrix

	Function
	1
Typology	.748
Orientation	-.460
ofopenspaceextensions	-.434
LocationofKampB	.359
Size[a]	.062

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.
a. This variable not used in the analysis.

Functions at Group Centroids

Fromwhichtown	Function
	1
old town	1.381
new town	-1.436

Classification Processing Summary

Processed		154
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	1
Used in Output		153

Prior Probabilities for Groups

Fromwhichtown	Prior	Cases Used in Analysis	
		Unweighted	Weighted
old town	.500	78	78.000
new town	.500	75	75.000
Total	1.000	153	153.000

Classification Function Coefficients

	Fromwhichtown	
	old town	new town
Orientation	.957	1.582
ofopenspaceextensions	3.001	4.648
LocationofKampB	12.726	9.993
Typology	11.382	6.490
(Constant)	-23.494	-17.042

Fisher's linear discriminant functions

Classification Results[a]

		Fromwhichtown	Predicted Group Membership		Total
			old town	new town	
Original	Count	old town	76	2	78
		new town	3	72	75
	%	old town	97.4	2.6	100.0
		new town	4.0	96.0	100.0

a. 96.7% of original grouped cases correctly classified.

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