QATAR UNIVERSITY

COLLEGE OF ENGINEERING

THE ASSESSMENT OF MICROCLIMATIC CONDITIONS, USERS' PSYCHOLOGICAL ADAPTATION AND PHYSICAL ASPECTS OF THE SPACE: ENHANCING SPATIAL QUALITY OF OUTDOOR PUBLIC SPACE (OPS)

BY

SARA ZAINA

A Thesis Submitted to the Faculty of

the College of Engineering

in Partial Fulfillment

of the Requirements

for the Degree of

Masters of Science in Urban Planning and Design

January 2017

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COMMITTEE PAGE

The members of the Committee approve the Thesis of Sara Zaina defended on 03/01/2017.

Dr. Fodil Fadli
Thesis/Dissertation Supervisor

Prof. Lamine Mahdjoubi
Committee Member

Dr. Raffaello Furlan
Committee Member

Dr. Hatem Ibrahim
Committee Member

Approved:

Khalifa Al-Khalifa, Dean, College of Engineering

ABSTRACT

ZAINA, SARA, Masters : January : 2017, Masters of Science in Urban Planning and Design

Title: The Assessment of Microclimatic Conditions, Users' Psychological Adaptation and Physical Aspects of the Space: Enhancing Spatial Quality of Outdoor Public Spaces (OPS)

Supervisor of Thesis: Dr. Fodil Fadli.

Outdoor Public Spaces (OPS) are of great necessity and importance to urban cities as they accommodate pedestrian traffic and outdoor activities, as they also contribute enormously to urban life and livability. It has been demonstrated through investigating thermal comfort conditions in OPS that a quantitative approach alone is inadequate in characterizing comfort conditions for outdoor public users'. The study revealed that although microclimate conditions are both a critical parameter for the use of outdoor spaces in the urban environment and strongly influence thermal sensation, they cannot fully account for the wide disparity between objective and subjective comfort evaluation, whereas, the role of psychological adaptation seems to become increasingly important.

The research study was carried out using a systematic questionnaire and taking microclimatic measurements of air temperature, humidity and wind speed of the OPS at Al-Corniche and Aspire, Qatar. Furthermore, this thesis concentrates on the matter of psychological adaptation of the user. This includes naturalness of the place, expectations, experience, time of exposure, perceived control and environmental stimulation. Microclimatic monitoring, role of psychological adaptation, along with on-site observational mapping and visual material of the physical aspects of the OPS were used to identify and present the relative impact of each of these parameters and their relationship to one another.

The initial results demonstrate that a purely quantitative approach is insufficient in describing comfort conditions outdoors, and an understanding of the dynamic human parameter is necessary in designing spaces for public use. Understanding the interrelationship between microclimatic conditions and the different factors of psychological adaptation would be important so as to assess their design role; whether design considerations would influence these parameters, or vice versa, whether they could influence design decisions.

An awareness of these issues would be valuable to architects, planners and urban designers, by way of enriching the design possibilities with more favorable outdoor comfort conditions. Refinement of OPS for design purposes is examined with investigation into modification considerations of the environmental variables that are susceptible to control by urban design for increased user comfort.

Keywords: outdoor public spaces (OPS), physical aspects, microclimatic conditions, users' psychological adaptation, users' comfort

DEDICATION

I would like to dedicate this thesis to my loving family whom without I could not achieve what I am, my father Mazen, mother Nadia and my siblings Omar, Samar, Aia and Mohamad. Not to forget a special thanks goes to my caring sister Dana for her sincere support throughout this thesis. Thanks for standing by me.

ACKNOWLEDGMENTS

“All praise and thanks are for Allah, the One who, by His blessing and favor, good works are accomplished”.

The work in this thesis was developed for the Masters of Science in Urban Planning and Design at Qatar University. The author would like to express her sincere gratitude and appreciation to Dr. Fodil Fadli for his continuous support, guidance and moral supervision during the preparation and completion of this study. The author would further express her deep appreciation to the reviewers for their comments which contributed to the improvement of this study. Finally on a personal note, I have to acknowledge that this research study wouldn’t have been achievable without my family’s enormous appreciable support, patience and encouragement.

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LIST OF ABBREVIATIONS

OPS	Outdoor Public Space
RH	Humidity (%)
°C	Air Temperature (Degrees Celsius)
km/h	Wind Speed (Kilometers per hour)
PLEA	Passive and Low Energy Architecture
AMS	Academy of Marketing Science
m2k/W	Metres Squared Kelvin per Watt
CLO	Clothing and Thermal Insulation
IRB	Institutional Review Board

CHAPTER 1: INTRODUCTION

This chapter introduces the research scope of microclimatic conditions and psychological adaptation as elements for determining physical aspects of Outdoor Public Spaces (OPS) in hot arid climates. In addition to giving a theoretical and contextual background on the topic, it states the motivation of the study and the research problem, and articulates the research questions. In addition, this chapter defines the research aims and objectives, outlines expected limitations of the study, and gives the thesis structure.

1.1 Research Scope

Design factors based on microclimatic conditions and psychological adaptation of the user are expected to form exceedingly comfortable OPS that have the capacity for expanding personal satisfaction and the quality of life in urban areas, thus decreasing the negative effect of urbanization. The functionality of OPS, such as Al-Corniche and Aspire, might also serve in being useful to reduce the impact of day to day stress on visitors. It is of utmost importance to take the microclimatic conditions throughout the year into consideration when designing an OPS in hot arid regions, such as Doha, Qatar. There is also a need to evaluate the role of the users' psychological adaption, comfort, and preferences for the physical aspects of the space in linkage with the environmental conditions (Bruse, 2009).

Qatar is a hot arid region, it is evident that the urban microclimatic condition has a direct influence on the users' psychological adaptation. This includes naturalness of the place, expectation, perception, experience, time of exposure, perceived control, and environmental stimulation in OPS (Nikolopoulou & Steemers, 2003). Town planners are responsible to design outdoor spaces while keeping in mind the most suitable microclimatic conditions; e.g. considering sufficient amounts of sunlight and/or shade, protection from strong wind breezes, etc. (Bruse, 2009). Furthermore, the satisfaction level the user experiences due to the conditions of the microclimate is a main driving force that leads them into selecting particular areas to visit. Thus, evaluations on the users' psychological adaptation for different areas is valuable in designing OPS, as it allows for interpretation of user comfort to enhance and improve capabilities of design recommendations. Such assessment on the comfort levels and preferences of the user is valuable for town planners to skillfully and precisely assign and design OPS.

In the light of the need for evaluating the perception and expectation of users', the research was initiated, and particularly aimed at understanding microclimatic conditions with consideration of physical aspects and the role of the users' psychological adaptation in enhancing the OPS and improving outdoor comfort levels.

According to Brandenberg and Arnberger (2001), microclimatic conditions like air temperature, solar radiation, humidity, and wind speed have a great impact on both outdoor activities and people's behavior. Understanding the microclimatic conditions and the users' psychological adaptation to enhance outdoor comfort, through the usage of devices and feedback forms respectively, develops a better comprehension of both the local and international tourists comfort and preferences, and their norms, standards and behaviors in OPS. This is for the ultimate purpose of allowing users' to engage with space by ensuring the development of enhanced urban, well-designed OPS for practical and recreational realms.

1.2 Theoretical and Contextual Background

Since the 1970s, the Arabian Gulf countries have experienced urbanization that has been fueled by an increase in national revenues from exporting crude oil. This has resulted in an increase in the urban population (Wiedmann, Salama, & Thierstein, 2012). Rapid urbanization in the Gulf countries is usually regarded as negative, causing poor housing conditions, poor infrastructure, environmental problems, automobiles dominance and lack of pedestrian considerations, etc. However, despite the problems arising due to urbanization, urban outdoor areas are important in a national perspective, since they are a source of both social and economic growth (Johansson E. , 2006). Urban outdoor areas act as climate regulators. The urban fabric of the urban outdoor area affects climate parameters such as air temperature, wind speed, and humidity. For example a better design of urban material with air movement can reduce the effect of thermal environment. Also constructing height, wind direction, technique-flow, urban geometry of buildings and their surroundings are all factors that could cause wind speed (Ragheb, El-Darwish, & Ahmed, 2016).

The OPS in areas that have been rapidly urbanized are generally uncomfortable. This is due to the limited and often missing knowledge about climate issues among urban planners. It is also due to the lack of suitable design tools for planners to plan effectively (Fringuello, 2008; Eliasson, 2000). Increasing the awareness of climate considerations among urban planners is essential; thus OPS can be designed effectively. Therefore, the urban designer must understand the implications of microclimatic conditions and also keep in mind the users' psychological adaptation to overall design a comfortable OPS.

This study has been carried out in a hot desert climate in the Middle East; Doha, Qatar, targeting the difficult summer season. The two selected OPS are Al-Corniche and Aspire; these OPS are an appropriate choice as they allow for a well-rounded study due to the fact that they are in two different locations in the city and thus allow for valid results when assessing the functions and workings of physical aspects of the space, microclimatic conditions and users' psychological adaption. This is justified in the next section.-

1.3 Motivation of the Study

Qatar is rapidly becoming a globalized region, thus it must develop strategies to attract more investments. Developing the tourism industry increases both the number of travelers and economic activities in the country. Thus, it is important to assess the comfort level of visitors to develop enhanced OPS for potential future varied activities.

Several parameters such as the users' psychological adaptation; that includes naturalness, expectations, experience (short and long term), time of exposure, perceived control and environmental stimulations have a significant role in designing an enhanced OPS. Nikolopoulou and Steemers (2003) claim that the psychological adaptation of the user influences the design phase of OPS by enriching design possibilities. Furthermore, the success of OPS relies on the number of users' who visit the space, and the statistics on the re-visits (Carmona, Heath, Oc, & Tiesdell, 2003). The drive of the study is to understand and improve users' comfort and psychological adaptation and its role in OPS.

Another essential parameter, as examined by Gaitani & Santamouris (2005) is the dependence of physical aspects on the changing microclimatic conditions that influences comfort in OPS. Thus, studies that focus on assessing climatic comfort levels of users' have greater suitability at various regions, such as hot arid countries. As a result, such knowledge adds to the economic development of the area and increases tourism to OPS. Therefore, these motives allow for a valid study to be initiated and have value in the research and practical fields.

1.4 Problem Statement

Despite the increasing interest among researchers to publish studies on outdoor thermal comfort, little attention is paid to hot arid regions (Pihlak, 2016). Majority of the research in hot arid regions have followed the urban climatology approach where the focal point is between the environmental elements and physical settings of the place, with minor attention given to the human factor. It is essential to obtain knowledge regarding a user's outdoor thermal comfort levels based on microclimatic conditions for designing and planning appropriate spatial qualities (Setaih, Hamza, & Townshend, 2013).

Limited literature in regards to the relationship between the microclimatic conditions and the users' psychological adaptation in OPS is a driving factor for carrying out this study. Furthermore, literature studies and research into the role of users' psychological adaptation based on the effects of both microclimatic conditions and physical aspects of the space have not been an area of focus. Microclimate and users' comfort are generally ascribed little importance in urban planning and design processes (Johansson E. , 2006).

As noted by several authors such as Fringuello (2008) and Eliasson (2000), the integration of climate measurement in the design process is missing as a consequence of poor urban design. Thus, literature has rapidly emphasized the need to translate available knowledge into design guidelines to overcome this deficit (Bitan, 1988; Golany, 1996; Mills, 1999).

Recently, the environmental quality of outdoor spaces has become a central issue. This is evident in the most recent scientific meetings such as the 2016 PLEA (Passive and Low Energy Architecture held in Los Angeles), and 2017 AMS (Academy of Marketing Science held in New Zealand) conferences; and in addition to practice-oriented literature including Herzog 1996, Hawkes & Foster 2002, Gehl 2007, Thomas 2010, Wooley 2012.

1.5 Research Questions

It is well known that microclimatic conditions, physical aspects of the OPS, and psychological adaptation influence users' thermal comfort and usage of OPS. Thus, the following are research questions based on the above statement:

(1) How do the physical aspects of the OPS impact microclimatic conditions?

(2) How does the microclimatic condition, physical aspects, and psychological adaptation influence the thermal comfort of the user and their roles in OPS?

(3) What design considerations can be recommended for the physical aspect to create a thermally comfortable OPS by considering the interrelationship between microclimate and psychological adaptation of the users?

1.6 Research Aim and Objectives

The study outlines the integrated approach for improvement of OPS conditions by extending an understanding of outdoor thermal comfort to the hot arid region, Doha, Qatar. The purpose is to understand the influence of microclimatic conditions and physical aspects and the role of psychological adaptation in enhancing the OPS and improving outdoor thermal comfort levels.

To achieve the aim of this study, the following objectives have been set:

(1) Evaluating the physical aspects of the OPS as elements affecting the microclimatic conditions

(2) Assessing the role of the users' psychological adaptation in estimating comfort levels with respect to microclimatic conditions and physical aspects of OPS

(3) Recommending design considerations for OPS with regard to the thermal comfort of users based on the roles of psychological adaptation and microclimate

1.7 Research Scope and Expected Limitations

It is prudent to make clear that the primary limitation parameter which might prevent this research to investigate and pursue further studies or even reach its fruition is time limit. Having limited amounts of time is a research limitation as it excludes the opportunity for the researcher to make additional discoveries in the research area, which influences the amount of data that can be collected and the information that can be relayed to an audience.

The research includes the study of three of the four variables of microclimatic conditions namely air temperature, relative humidity, and wind speed. It is worthwhile to note that solar radiation was not an assessment measurement considered in the research scope due to the limitation in time and need of specific measurement tools/instruments.

Microclimatic conditions were measured using data loggers. The challenge faced by the researcher was the placement of these data loggers to obtain the necessary readings.

The researcher had to use data loggers that were unnoticeable and place them strategically in order for the users' of the space to not be disturbed by their presence so that accurate readings could be taken.

Al-Corniche

Aspire

Figure 1. Installation of data loggers (source: author)

Two OPS have been selected for the purpose of this study for succinctness and to make it a focused research. For both locations (Al-Corniche and Aspire), a selected portion of the OPS was coined the central focal point for the purpose of observational mapping. It was selected based on the most active spot during both morning and evening (peak hours of the days).

Users' of both sites, Al-Corniche and Aspire, were subject to the questionnaire. Through data collection methods, it is noticeable that there is a discrepancy and unequal percentage over the types of nationalities. This would be calculated as a minor limitation affecting qualitative measurements and data collection. This factor cannot be controlled due to external circumstances, as these are the users of the space.

There are also certain hours of the day where not many people have been surveyed due to the extreme harsh microclimatic conditions (i.e. hot weather, high humidity, and lack of wind) as not many users' spend time in the OPS during these conditions.

Budgetary resources is a major parameter that is needed to pursue further studies at a doctoral level. Limited amounts of tools and instruments, such as lack of data loggers, does not allow the researcher to take multiple readings at the multiple sites, such as air temperature readings.

Other variables that can be considered to affect the quantitative aspects of this study are namely: human error, uncertainties of the machinery, tools and instruments used. These have been adjusted and minimized to an extent by standardizing the instrumentation.

Although the outdoor comfort calculator is a free online viable tool as it gives an overall feel of the temperature in regards to the three substituted measurements of air temperature, relative humidity, and wind speed; however, the outdoor comfort calculator has a limit to a maximum of 44°C, thus, sometimes providing inaccurate results. This kind of error can't be escaped.

Overall, the scope and limitations of the research have explained and justified why certain data has been excluded from the research. These factors and variables have undoubtedly been potentially minimized allowing for the research to be carried out achieving accurate, reliable and relevant results. In order to minimize the impact of the limitations on the research results, multiple research methods were used and the study was structured systematically. This allowed the researcher to study and provide valid and relevant research outcomes that have significance academically and practically.

1.8 Thesis Structure

This thesis is organized into the following chapters:

Chapter 1 introduces the research scope of microclimatic conditions and psychological adaptation as elements for determining physical aspects of Outdoor Public Spaces (OPS) in hot arid climates, and to assess the outdoor thermal comfort of the user. It states the research problem, research questions, aim and objectives. The chapter also outlines the expected limitations of the study, and gives the thesis structure.

Chapter 2 is a literature review chapter that defines OPS and looks at the inter-relation between OPS and human comfort. It also summarizes types of activity that occur in OPS and how those activities develop when the space has the right qualities. This chapter also reviews the physical aspects of OPS, users' adaptation (including both physical and psychological), and microclimatic conditions of OPS. The final section is shedding light on the thermal perception and users' outdoor thermal comfort of public spaces.

Chapter 3 explains the methodology used in this research. With the aid of a combined research method, this chapter includes a detailed overview of the selection of the study area, data collection and sorting of both quantitative and qualitative measurements for the purpose of this research.

Chapter 4 is part of the data collection obtained from the combined research method. It contains specific parameters that contribute to the improvement of OPS conditions. These parameters include physical aspects of the space, physical and psychological adaptation, microclimatic conditions, and site observations for both study areas.

Chapter 5 presents and interprets research outcomes. It discusses two major aspects including physical aspects effect on microclimate and factors influencing outdoor thermal comfort (microclimate, psychological adaptation, and physical aspects).

Finally, chapter 6 is devoted to connecting the major premises covered by the thesis to make conclusions and recommend opportunities for further development and future work.

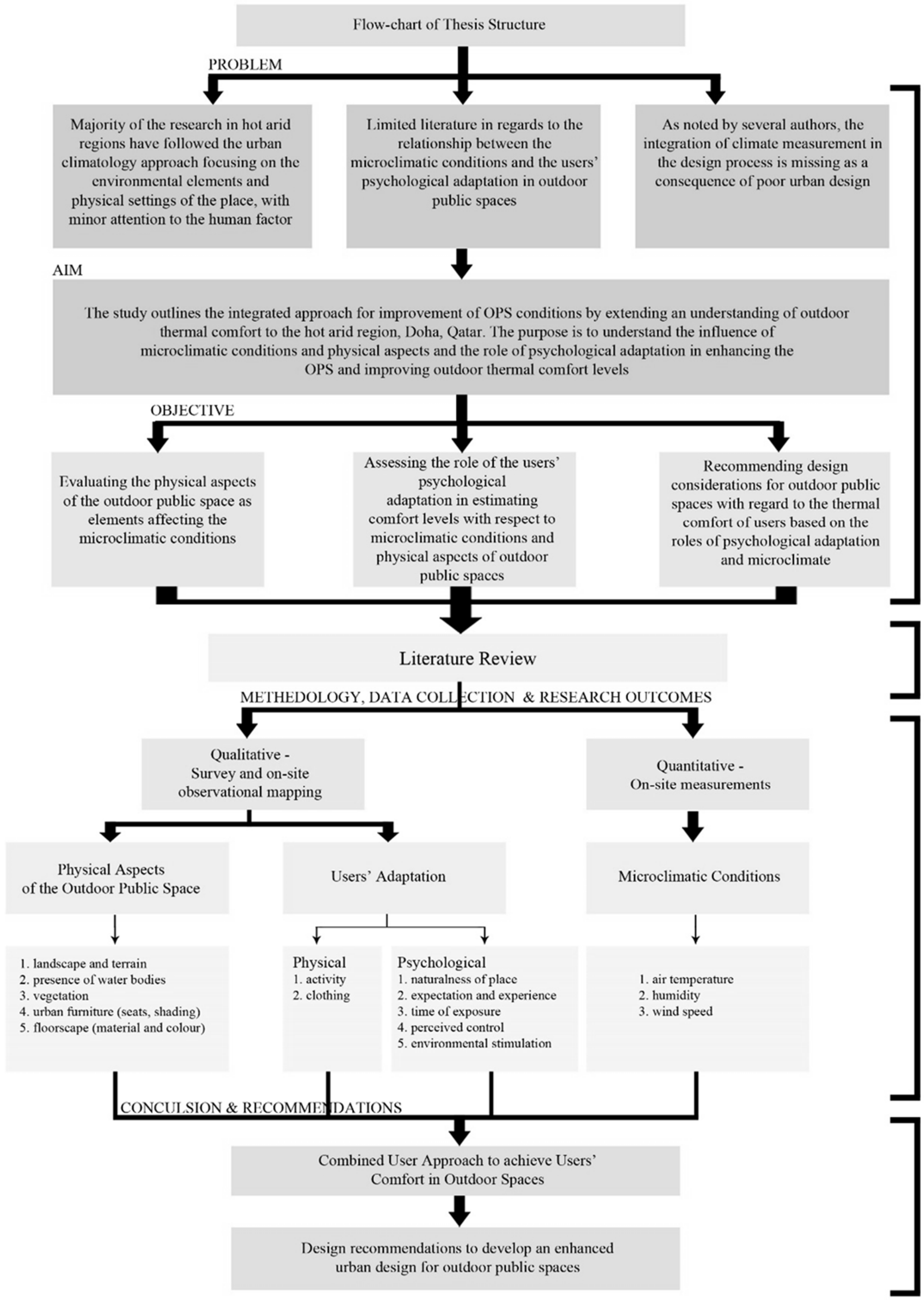


Figure 2. Thesis structure (source: developed by author)

CHAPTER 2: THE INTER-RELATION BETWEEN OPS AND HUMAN COMFORT

2.1 Introduction

This is a literature review chapter that defines OPS and looks at the inter-relation between OPS and human comfort. It also summarizes types of activity that occur in OPS and how these activities develop when the space has the right mix of qualities. This chapter also reviews the physical aspects of OPS, users' adaptation (including both physical and psychological), and microclimatic conditions of OPS. The final section is shedding light on the thermal perception and users' outdoor comfort of OPS.

2.2 Outdoor Public Space (OPS)

The functionality of urban environments depends on three elements that empower the city's enrichment and quality: physical, human, and social capital (Figure 3). The three elements incorporates infrastructure that compromise's the physical capital, the nature of knowledge correspondence that compromise's human capital, and social framework that compromise's the social capital. In this manner, urban quality is a primary variable that provides a baseline to measure the productivity and adequacy of urban environments (Federico, 2015). A main component that is crucial where urban environments are concerned is the presence of outdoor spaces.

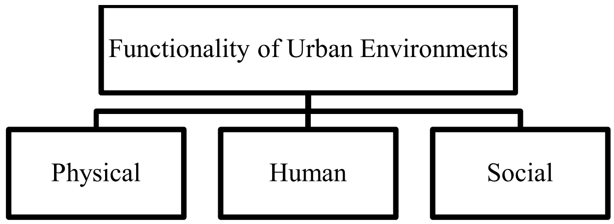


Figure 3. Functionality of urban environments (source: developed by author)

Researchers reveal that there is an agreement where urban spaces are related to OPS. This agreement of open spaces falling under the rubric of public spaces is amongst urban geography, planning, and other multi-faceted disciplines (Zaina, Zaina, AlMohannadi, & Furlan, 2015). Public spaces are freely accessible and incorporate uncovered and covered enclosed spaces such as religious structure, and civic organizations (Stanley et al., 2012).

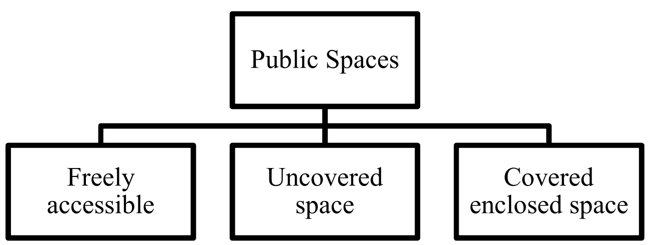


Figure 4. Public spaces (source: Stanley et al., 2012; established by author)

On the other hand, urban open spaces are characterized as any urban ground space, paying little respect to public accessibility, which is not covered by an architectural structure (Federico, 2015). Likewise, Carr (1992) characterized them as "open, publicly accessible places" that encourage the famous activities essential for community building.

Figure 5. Urban open space (source: Federico, 2015; established by author)

Outdoor spaces can be defined as public accessible outdoor areas including parks, plazas, streets, community gardens, and greenways (Lynch, 1972; Carr, 1992).

Scholars define urban spaces as being focused around qualities, values and spatial attributes that allow for 'well-designed environments' providing environmental, social, economic, and aesthetic qualities for all users' (Khan, Frank, Jan, & Konrad, 2014). The presence of good OPS is vital where it plays a significant role in communities, benefits the community both economically and environmentally, characterizes the identity of the area, and allows for the creation of cultural activities (Madden & Schwartz, 2000). Thus, OPS should inspire users to visit, allow for the interaction of people, and encourage different activities to take place.

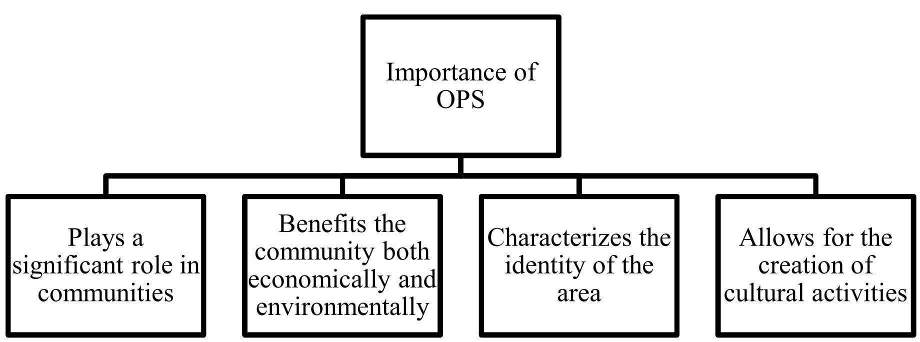


Figure 6. Importance of OPS (source: Madden & Schwartz, 2000; established by author)

In correlation, outdoor space structure can be interpreted as a multi-dimensional and complex phenomenon (Rapoport 1970; Khan, Moulaert, and Schreurs 2013). It is influenced by cultures and socio-cultural pattern that includes the cooperation between environment and users of the space. This interaction between the built environment and landscape undergoes numerous trademark, for example: human scale, comfort, variety, urbanity, complexity, inclusiveness, understand-ability, meaningfulness, congeniality, linkage and coherence, safety and security, playfulness, mystery and awe, transparency, and so on (Khan, Frank, Jan, & Konrad, 2014). Hence, it can be concluded that OPS are linked with people and their activities (Gehl & Gemzøe, 2001).

The analysis of an OPS is usually confined to its form and function by three major disciplines, urban planning, architecture and archaeology. This is despite the agreements reached amongst theorists of the casual effects between the relationship of social political outcomes to open space; a perspective that will be considered to analyze the data and reconcile the extreme quantitative and qualitative scales of this study. It is widely known that across the globe, the form and function of OPS depend on the cultural arrangement and traditional planning of each place. However, it is also evident that OPS across the globe retain a host of similar features amongst them (Stanley, Barbara, Katrina, & Michael, 2012).

The OPS, acting as an outdoor and uncovered space, is of particular interest and the fundamental focus of this examination study, for the purpose of this research. OPS are designed to be utilized throughout the entire year and achieve various urban functions, such as amenity. Alternatively, in hot dry arid regions, open spaces are hardly occupied amid summer season; consequently, to enhance their utilization and function, comfort must be presented, outlined and well designed for outdoor areas. In effect, with a well-designed urban space, the users comfort in OPS expands the human activity and enhances both urban functionality and vitality. This in return corresponds to increasing people's health, quality of life within the urban outdoor space and social interactions between visitors'. Thus, it is of cardinal significance for urban open space to incorporate both comfort and attractiveness (Gehl, 1996).

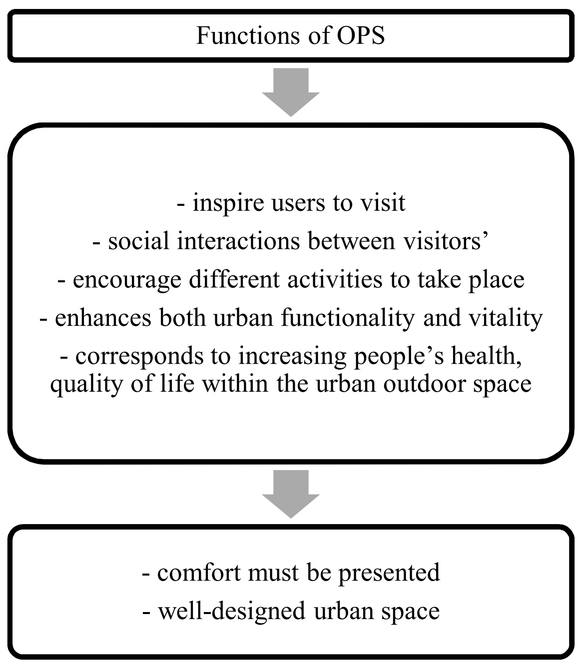


Figure 7. Functions of OPS (source: Gehl, 1996; established by author)

2.2.1 Activities in OPS

2.2.1.1 Types of Activities

OPS becomes a goal in itself (Gehl, 2007), where it hosts social, cultural, and recreational activities including exhibitions, parades, sport activities, and outdoor cafés. OPS are usually used for longer hours when the weather is tolerable; thus activities are extended to include evening hours enabling people to socialize and gather in outdoor spaces (Gehl, 2007).

Outdoor activities are divided into three types: necessary activities, optional activities, and social activities. It is worthwhile to note that each type places different demands on the physical environment (Gehl, 1996).

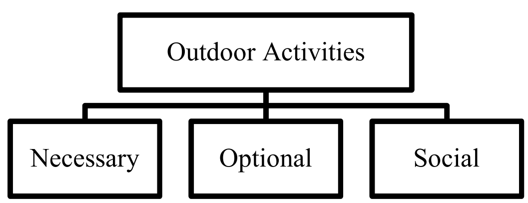


Figure 8. Types of outdoor activities (source: Gehl, 1996; established by author)

The necessary or functional activities are mainly associated with walking taking place all year round under all situations where the user has less options, for example, going to school or work, shopping, waiting for a bus. The second type is the optional or recreational activities that are mainly related to sitting; this type of activity usually happens where the place and time are convenient for it to occur. Some recreational activities that users might employ include sitting on a bench in the open space to enjoy the sun's warmth during the winter, or walking in the open space to breathe in fresh air and feel the breeze across their face. The last type is the social or resultant activities that rely on the people present in the outdoor space. It usually occurs when people meet to socialize in a certain place for chatting, greeting, children playing, and other communal activities.

2.2.1.2 Activity and Quality of OPS

A clear and evident relationship is apparent between the quality of OPS and outdoor activities, which mainly occurs in optional and social activities. If the quality of outdoor areas is poor only necessary activities occur. Necessary activities will also take place when outdoor areas are of high quality, though it will not take a long time to complete since the physical conditions is improved. Moreover, it can be reasoned and deduced that the better the physical framework the more human activities are likely to occur i.e. optional activities where the place and the circumstance allow people to sit, stop, eat, play, etc. Figure 9 illustrates a graphic representation of the relationship between the quality of OPS and the rate of occurrence of outdoor activities.

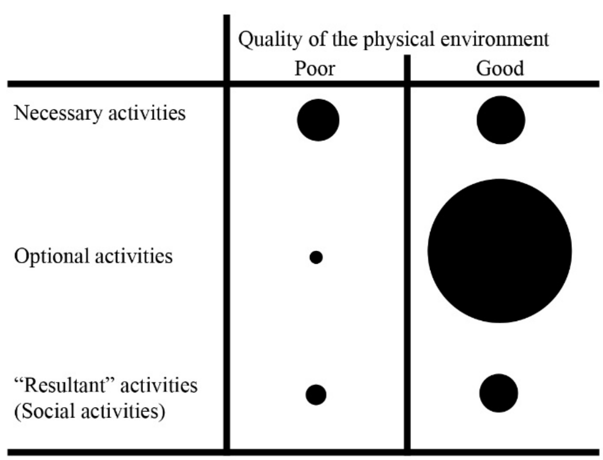


Figure 9. Relationship between the quality of OPS and the rate of outdoor activities occurrence (source: RUDI, 2016)

Another aspect to measuring the relationship between effectiveness, quality and outdoor activity is with regards to the development of activities which can occur by number of participants, duration of time and use, and scope. The success of an OPS is not determined by the quantity of users, in fact it is defined by the number of minutes spent outdoors (Gehl, 1996). Thus the more users and longer stay results in a wide range of activities in the outdoor space. Gehl (1996) also emphasized on the relationship between the level of activities in the OPS and the microclimate. This link is evident in optional and social activities where it takes place only if the external physical conditions are good to stop, sit, and stroll (Gehl, 1996). Microclimate, among other qualities and factors discussed in the next section, is one of the crucial defining points when determining the success, functionality and effectiveness of an OPS.

2.2.2 Qualities of a Successful OPS

Qualities of a successful OPS aren't just a personal taste; a well-designed outdoor space must encounter the needs for a wide range of functional criteria too. There are many qualities for an effective OPS that inspire activities and motivate the use of the area. They include a lively, social space that is used by everyone, time and use, user's needs, and users' comfort and urban microclimatic conditions. This section goes into further detail regarding these qualities and explains how they are important when used to classify an OPS as successful. These qualities can be utilized as a checklist for improving, designing and assessing outdoor spaces.

2.2.2.1 Lively and Used by Everyone

A primary quality of a successful OPS is that it needs to be vibrant, lively and used by everyone. Indicators of a healthy place include high proportions of people in groups, a higher than average proportion of women, people at a range of different ages, and variation of activities (Whyte, 1980; Madden & Schwartz, 2000). Varied activities inspire and motivate the use of outdoor space; popular places are the ones that have more things to do than less successful spaces. Francis (2003) further enhances that a good OPS is "the lively one and well-used by people".

Table 1. Qualities of a successful OPS - lively (source: established by author)

Lively	Used by everyone - High proportions in groups - Higher than average proportion of women - People at a range of different ages
	Rich, vibrant environment
	Variation of activities

2.2.2.2 Social Space

OPS are accessible for everyone regardless of race, age or gender. It is a democratic social area utilized by users' and the society. They additionally present a cultural character for the area (Soltanian, 2015). Several research projects have aimed to discover qualities that make a successful OPS discovering that sociability is one factor that achieves this.

Whyte (1980) demonstrated that a social space is what makes a successful outdoor space. The author illustrated this in the Street Life project using time-lapse cameras recording daily patterns in the open area. It was found that high proportion of people in groups are an indicator of best-uses OPS and an index for selectivity, where users' decided to visit the area by their own choice (Whyte, 1980). Madden and Schwarts (2000) supported Whyte's (1980) perception that the high proportion of people is an indication of a good utilization of OPS. At the point when individuals see and meet with friends, and feel comfortable communicating with strangers, the user of the space usually feels a stronger attachment to the place and its community (Madden & Schwartz, 2000).

Table 2. Qualities of a successful OPS - social (source: established by author)

Social	Accessible for everyone regardless of: - Race - Age - Gender
	Present a cultural character for the area
	High proportion of people in groups
	Individuals see and meet with friends
	Feel comfortable communicating with strangers Strong attachment to the place and its community

2.2.2.3 Duration of Time and Use

It can also be argued that the level of use of an OPS alone is not a reliable guide to categorize and assess the success of an outdoor space, important as it is. Time spent at an area and who is utilizing it are other signs of a successful outdoor space. Francis Tibbalds, in his work Making People-friendly Towns (1992), suggested that OPS should comprise of "a rich, vibrant, mixed-use environment that does not die at night or at weekends and is visually stimulating and attractive to residents and visitors alike". The level of use doesn't only rely on the attractiveness of the area, it's also influenced by the number of people in the space (Stiles, 2012). Gehl (1996) underlined that it is not the quantity of individuals or occasions that demonstrate the success of OPS rather it is the quantity of minutes spent outside. Thus, the more individuals and the increase in the length of time the people stay results in increased use.

Table 3. Qualities of a successful OPS - duration of time and use (source: established by author)

Duration of time and use	Time spent at an area
	Who is utilizing the space
	Does not die at night or at weekends
	Visually stimulating and attractive
	Influenced by the number of people in the space
	Increased use

2.2.2.4 Designing for User's Needs

Users' needs and requirements is an essential aspect that needs to be considered when designing for a successful outdoor space (Francis, 2003). The outdoor space must respond to the users' needs that can be identified as "if your goal is to create a place (which we think it should be), a design will not be enough… The goal is to create a place that has both a strong sense of community and a comfortable image, as well as setting and activities and uses that collectively add up to something more than the sum of its often-simple parts. This is easy to say, but difficult to accomplish…. Although design is important, these other elements tell you what 'form' you need to accomplish for the future vision for the space" (PPS, 2000).

Aspects that must be achieved in regard to the users' needs includes comfort, relaxation, passive engagement (enjoying the outdoor space without the need to participate) & active engagement (physical participation, discovery & enjoyment) (Gehl, 1996).

Table 4. Qualities of a successful OPS - designing for users' needs (source: established by author)

Designing for users' needs	Create a place that has a: - Strong sense of community - Setting, activities and uses - Comfortable image - Relaxation - Passive engagement (enjoying the space without the need to participate) - Active engagement (physical participation, discovery and enjoyment)

2.2.2.5 Users' Comfort and Urban Microclimate

Different comfort levels, needs and expectations must be considered in designing spaces to satisfy different groups of people and provide them with ample choices (Carr, 1992). Each person may experience different outdoor qualities at a particular place at a given point in time. The sense of discomfort may arise from the person's physical activity or even the state of mind (Erell, Pearlmutter, & Williamson, 2011). Comfort can be defined from one point of view as the state of mind that expresses satisfaction with the surrounding environment (ASHRAE, 2004). The level of comfort can also be used to express a feeling of satisfaction, relaxation, and a state of mental and physical prosperity.

Users' comfort is one of the main requirements that needs to be met in outdoor areas (Carr, 1992). However, it is difficult to meet other necessities without compromising the users' needs regarding their level of comfort. Most of the popular used outdoor spaces have more seats and shading devices than the less used ones; other appealing components of outdoor space can't make users' visit and sit if there is nowhere to sit (Whyte, 1980).

Users' should have the freedom to select their seating area whether in the shade or in the sun. Bosselmann (1983) considers that access to the sun or having shelter is an essential factor in outdoor spaces. Whilst Gehl (1996) described a connection between the level of activities and the urban microclimate of OPS, emphasizing that the external condition defines the type of activity to take place.

Exploring the research topic further, the following sections reveal insights on the users' comfort with regards to physical aspects, users' psychological adaptation, and the microclimatic conditions in OPS.

Table 5. Qualities of a successful OPS - users' comfort & urban microclimate (established by author)

Users' comfort and urban microclimate	Meeting expectations to satisfy different groups of people Provision of ample choices: - Urban furniture - Activities

Below is a generic summary table of the qualities of a successful OPS including all aspects and types.

Table 6. Qualities of a successful OPS (source: established by author)

Qualities of a Successful Outdoor Public Space (OPS)	
Lively	- Used by everyone - Rich and vibrant environment - Variation of activities
Social	- Accessible for everyone - Present a cultural character for the area - High proportion of people in groups - Individuals see and meet with friends - Feel comfortable communicating with strangers - Strong attachment to the place and its community
Duration of time and use	- Time spent at an area - Who is utilizing the space - Does not die and is visually stimulating & attractive - Influenced by the number of people in the space - Increased use
Designing for users' needs	Create a place that has a: - Strong sense of community - Setting, activities and uses - Comfortable image - Relaxation - Passive engagement - Active engagement
Users' comfort and urban microclimate	- Meeting expectations to satisfy different groups of people - Provision of ample choices (urban furniture, activities, etc.)

2.3 Physical Aspects of OPS

Makdii, (2011) examines the physical factors of OPS through perception and usage; his crucial criteria to the study include edges, floor-scape, and urban furniture (Madanipour, 1996). In another research Mohadesh's (2005) framework was aimed to be used in the design of the study's questionnaire and identification of physical factors; a pilot study was conducted to obtain users' viewpoint towards the identified attributes and its effect on the space.

The identified physical characteristics of an OPS defined by Mahmoudi (2015) include a defined framework: seating, paving, shelter and canopy, planting, and water features. This framework identifies physical problems as a complex measure to examine the livability and physical quality of the space.

Improving the physical environment clearly can't solve all problems of public space, yet, it may lead to the prevention of problem (Sauter & Huettenmoser, 2008). Such a case can be, providing an appropriate vegetation, presence of water bodies, floor-scape (soft landscape, hard pavement, change of material and color, and change in level), urban furniture (seating, shading devices), and a variety of other physical factors to serve the users of space (Figure 10).

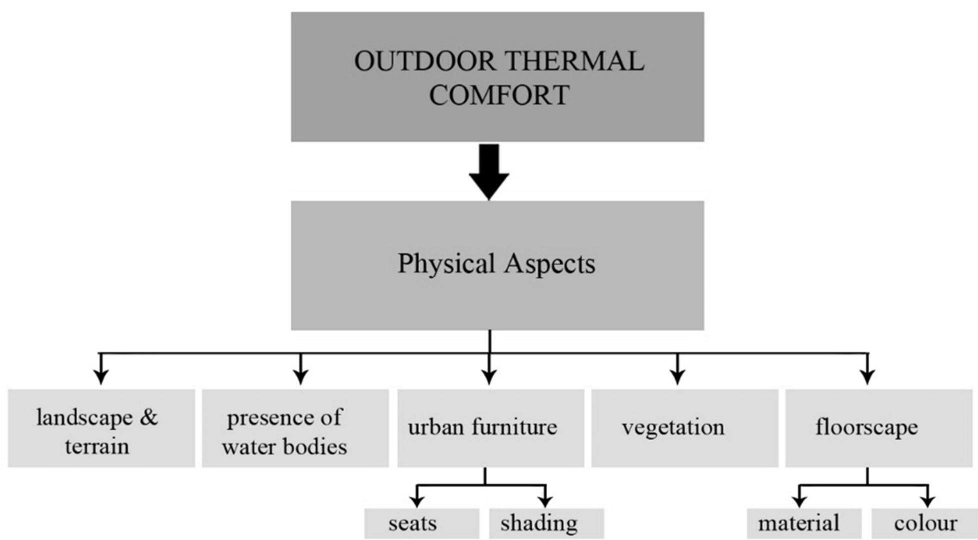


Figure 10. Physical aspects of OPS (source: developed by author)

2.4 Users' Adaptation

Nikolopoulou (2003) defines adaptation as "the gradual decrease of the organism's response to repeated exposure to a stimulus, involving all the actions that make them better suited to survive in such an environment….. This may involve all the processes which people go through to improve the fit between the environment and their requirements". The interaction with the built environment leads to the notion of "adaptive opportunity; portraying the level to which users' can adapt to the outdoor space. Discomfort is only a result when the adaptive opportunity is insufficient (Baker & Standeven, 1996).

According to Nicol (2008), many studies are interested in the adaptive approach of thermal comfort. However, there are doubts to transform results acquired under lab research setting to represent the complexity of the real world setting. The other reason finding results on this research matter is considered difficult may be constructed from other field studies carried out by Brager and de Dear (1998) and Nikolopoulou et al. (2001), in which it is demonstrated that individuals adapt to their own atmospheres and have a tendency to endure significantly more variety of atmospheric conditions than those anticipated by lab based thermal models.

The adaptive approach is broken down into three different categories including physical, physiological & psychological (Nikolopoulou & Steemers, 1999). It's important to understand the physical and psychological aspects to get a grasp of the different issues concerning the subject of the visitors' comfort level. Alternatively, the physiological adaptation is not significant in this setting since it is caused by exposure to a stimulus, leading to a gradually declining strain from such exposure (Clark & Edholm, 1985). A breakdown of the factors of physical & psychological adaptation are seen in Figure 11.

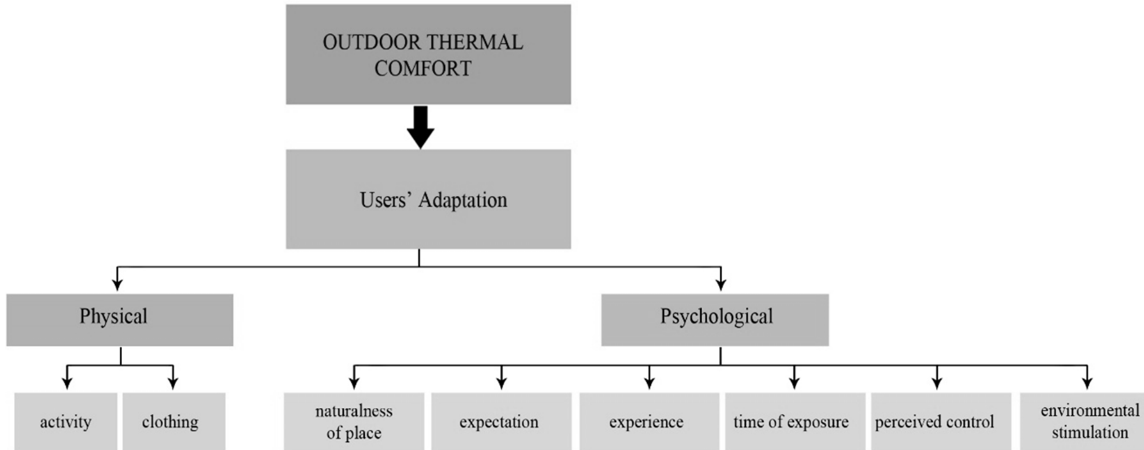


Figure 11. Users' physical and psychological adaptation (source: developed by author)

2.4.1 Physical Adaptation

Nikolopoulou (1999) refers to physical adaptation as the alterations that a person makes to adjust to the environment, or the change a person makes to the environment to meet their requirement. Physical adaptation is broken into two kinds: reactive and interactive. Reactive adaptation includes personal adjustments such as altering one's clothing level, position or activity, or even the consumption of hot or cool beverages.

Clothing influence human thermal comfort by offering thermal insulation that is suitable in an environment. It is measured in m2k/W or in CLO units. Figure 12 is of a scale using CLO units, factor evolution from 0.1 to 1.0 the amount of top and bottom clothing increases, whereas 0.3 to 0.5 shows the gradual increase of one piece clothing. In hot climates it's important for clothing to allow for air movement; e.g. a western outfit has a thermal insulation value of 0.3 CLO while a North African traditional loose dress in bright colors CLO value of up to 0.5 (Clark & Edholm, 1985). The traditional clothing in hot arid regions aids the movement of air for cooling purposes. Long open dresses increase the amount of ventilation between the body and the dress due to the air movement from the bottom upward (Zrudlo, 1988).

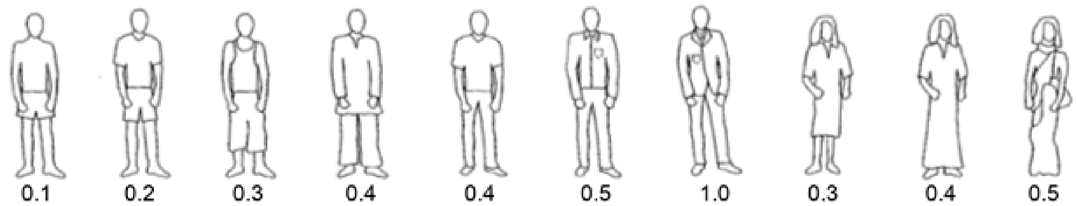


Figure 12. CLO units of various items of clothing: reactive adaptation (source: Clark & Edholm, 1985)

Alternatively, the interactive adaptation involves changes made by people to the environment to enhance their comfort conditions; this includes opening a window or closing a curtain (Nikolopoulou M. , 2003). Interactive adaptation is a limited physical adjustment in open spaces due to the environment of outdoor spaces. However, one hypothetical addition to outdoor spaces of the inclusion of moveable shading devices would be considered as an interactive adaptation that can be manipulated by the user in order to adjust their comfort.

2.4.2 Psychological Adaptation

Different visitors' perceive the environment differently, and the human reaction to a physical stimulus is not in direct relationship to its size, but it's rather determined on the available data that individuals have for a specific condition. Thus, psychological variables impact thermal perception of a space and any progressions happening within it (Nikolopoulou M. , 2003). As indicated by Nikolopoulou and Steemers (2003), different components that impact psychological adaptation and the outdoor thermal comfort levels of users' include:

- naturalness of the place
- expectations and experience
- time of exposure
- perceived control
- environmental stimulation

Figure 13 below illustrates the interrelationships between the different parameters of psychological adaptation.

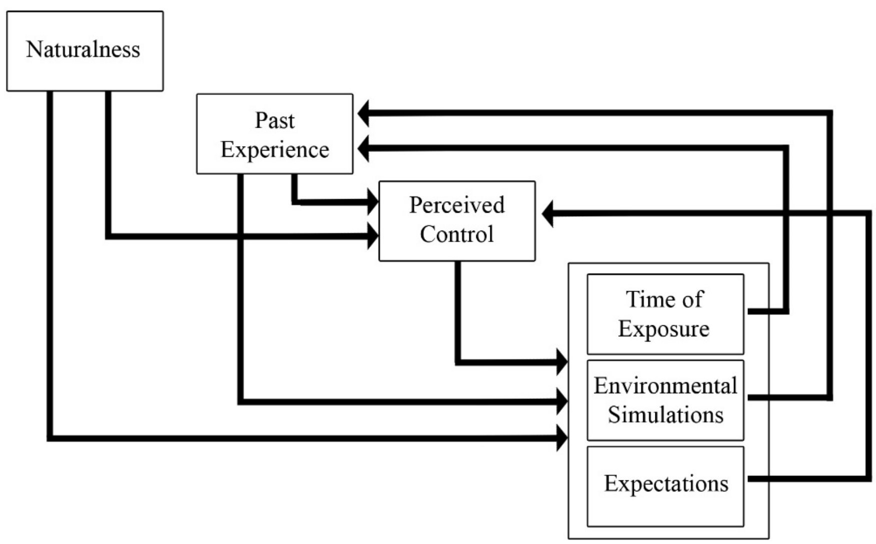


Figure 13. Network demonstrating interrelationships between the different attributes of psychological adaptation (source: Nikolopoulou M. , 2003)

Understanding the interrelationship between the attributes of psychological adaptation is important for comparison purposes, and also to assess if design considerations would impact the variables or vice versa, or if it would impact design decisions (Nikolopoulou M. , 2003). Nikolopoulou and Steemers (2003) portray in Figure 13 that some parameters only affect one other variable, however others have a two-way relationship. It is elaborated that there is no magnitude associated with the strength of relationship between the parameters of psychological adaptation; the diagrams have been developed based on the insights that the research has provided on thermal comfort and psychological adaptation as a guide for designing urban spaces (Nikolopoulou M. , 2003).

2.4.2.1 Naturalness of the Place

Individuals have a tendency to have more tolerance to non-artificial changes happen in their physical surroundings (Griffiths, Huber, & Baillie, 1987). As opposed to the interior of buildings, most changes to the physical environment happen naturally in outdoor spaces. It was found that users' of the space can tolerate a wide range of physical changes to the environment such as air temperature (Nikolopoulou & Lykoudis, 2006). This acceptance of non-modifiable environmental changes contributes to the naturalness of the place and endorses the extent of psychological adaptation of the user.

2.4.2.2 Expectations and Experience

Expectations from a users' point of view is to have prospect of what the environment should be like, rather than what it truly is; where it majorly affects users' perceptions (Nikolopoulou & Lykoudis, 2006). Experience on the other hand directly influences users' desires and expectations. One prominent example is the scenario where expectations and experience explain the difference in comfort temperature between the transitional season i.e. spring (transition from winter to summer) and autumn (transition from summer to winter). Spring is preceded by colder temperatures therefore people tend to be less tolerant to the warmth of summer, hence the temperature in which people feel comfortable is lower than that in autumn (Zrudlo, 1988).

2.4.2.3 Time of Exposure

Thermal perception of users' in outdoor spaces impacts the time of their stay outside; this refers to the intended time spent in the area (Nikolopoulou M. , 2003). Time of exposure in outdoor areas is a critical issue when discussing the level of activity in open spaces since it's influenced by both high quantities of individuals and longer individual stays (Gehl, 1996). Users' usually handle thermal discomfort well if they anticipate their exposure to be short.

2.4.2.4 Perceived Control

Perceived control is generally recognized as the state of being in control over a source of discomfort, which in return increases tolerance, reduces individual's irritation, and reduces negative emotional reactions. Additionally, the decision of sitting in the sun or the shade in outdoor spaces likewise influenced the amount of time spent outside. Nikolopoulou (2003) suggest that "this was longest in the sites that had a variety of spaces available—with 50 min average in the summer—offering both exposure to the sun and the shade, and shortest in the area where no shading was offered —16 min average in the summer". Since there is limitation in having control over thermal discomfort, perceived control is critical in outdoor spaces (Nikolopoulou M. , 2003).

2.4.2.5 Environmental Stimulation

A fundamental reason as to why people spend time outdoors is the presence of environmental stimulations. Satisfaction of the visitor in a space is influenced by outdoor motivations that break boredom. People tend to have a higher tolerance to weather conditions due to the various types of environmental stimulations offered in outdoor spaces; which leads to higher quantity of people and spending more time. Nikolopoulou (2011) views comfortable conditions as those where users' don't feel warm or cool, and it is progressively believed that a variable environment is favored where a static or fixed environment becomes unbearable.

2.5 Microclimatic Conditions Affecting Outdoor Thermal Comfort

Historically, human activity and development has been linked with the urban climate. Microclimatic elements include air temperature, solar radiation and sunshine hours, relative humidity, wind speed and direction (BojinSki & VerStraete, 2014).

Climate can be characterized into many types (hot-hot humid/hot dry, moderate-moderately dry/moderately humid, and cold-cold humid/cold dry). Climate thus needs to be scrutinized and taken into consideration during the planning and design of an outdoor site or space (Dahl, 2010). Doha is classified as hot dry with extreme heat, fierce sunlight, clear sky, rare or no precipitation and a lack of water. Major differences between day and night temperatures are also experienced in this arid environment and hot climate area (Dahl, 2010).

Wind acts as both friend and foe – as a cooling breeze, acknowledged during the summer season, or as biting cold amid winter storms (Dahl, 2010). Air temperature, humidity and wind speed are the three components of microclimatic conditions for the significance of this research (Figure 14).

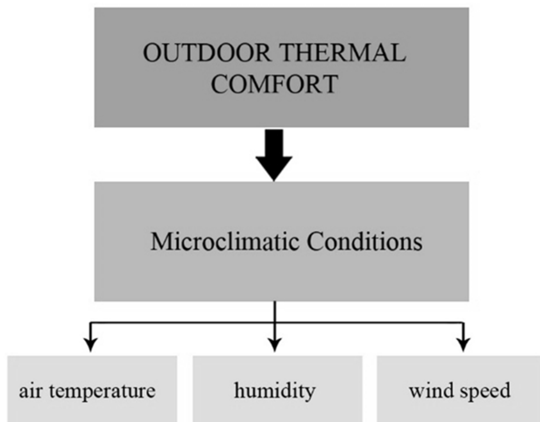


Figure 14. Microclimatic conditions (source: developed by author)

2.5.1 Air Temperature

Air temperature in a physical outdoor environment is not a sufficient indicator alone of human thermal comfort outdoors; i.e. if the air temperature is 21°C this could be perceived as uncomfortably cool in a shaded and windy area, or uncomfortably warm in a sunny and humid place but with no wind. At the same air temperature it could be perceived as comfortable or uncomfortable. Even though air temperature emphatically impacts outdoor thermal comfort, the design of outdoor spaces has minimal effect on changing air temperature (Yang, Lau, & Qian, 2011). However, there are strategies used in practical life to increase or decrease outdoor air temperature. To increase air temperature, planners may maximize solar exposure, utilizing dark materials, and minimizing the flow of cold wind through providing windbreaks. To decrease air temperature, vegetation can be used to provide shade; water features can be used for evaporative cooling in outdoor spaces. Thus, materials in the outdoor space can be manipulated and added/ removed to have an effect on air temperature in affecting the users' of the space.

2.5.2 Relative Humidity

Humidity refers to the water vapor in the air as a result of evaporation from water surface and from moist objects (Konya, 1980). Relative humidity is the ratio of the water vapor to the equilibrium vapor pressure of water at that particular temperature; it is dependent on both temperature and the pressure of the system of interest. In a hot arid climate, the low level of relative humidity and the daily wind patterns may cause a feeling of excess heat, and subsequently, discomfort (Konya, 1980). Clark and Edholm (1985) suggest that the extreme dryness in the air cause breaks in the lips and soreness in the throat. Alternatively, high levels of relative humidity can cause indirect discomfort by influencing the environmental possibility evaporation. The body reacts to high levels of relative humidity by dispersing sweat all over the skin to expand its surface to support evaporative cooling. The expanded humidity of the skin causes discomfort in certain circumstance such as wearing formal clothing.

The average relative humidity has minimal influence on thermal sensation in a steady and moderate air temperature climate. Nevertheless, the change in relative humidity can have a huge effect on thermal comfort once transferring from an indoor to an outdoor space (Nikolopoulou, 2011).

2.5.3 Wind Speed

As a microclimatic condition, wind has an indirect way of manipulating thermal conditions in outdoor spaces. Trees and vegetation can alter wind direction and decrease the wind speed when required. In addition, the form and height of buildings can change wind and increase or decrease its mechanical effect; i.e. high building structures can modify strong wind speed at the top and divert it to ground level. The wind flow in front of the structure and around its corners can evolve different shapes, where the strong wind created at the base may cause unwanted conditions for users' in outdoor spaces, and vice versa.

2.6 Thermal Perception and Users' Outdoor Comfort

Physical, environmental, physiological, and psychological elements impact the thermal perception and the users' outdoor comfort. Therefore, the users' comfort qualities are subjected to changes in relation to these variables. Air temperature, humidity, solar radiation, wind speed, metabolic rates, clothing, nature, building design and materials, vegetation, levels of shading, adaptability of individuals; are all other factors that impact users' outdoor thermal comfort levels to a substantial degree (Moreno, Labaki, & Noguchi, 2008).

In addition to the effect of urban microclimatic condition, socio economic background and cultural differences play a significant role in deciding outdoor comfort of users'. To make outdoor spaces more engaging there is need for distinguishing and assessing all the components that impact outdoor thermal comfort levels of individuals. Thus, studies that don't consider psychological adaptation and other individual variables may end up being least applicable in the outdoor practical space. Shakir (2009) pointed that the evaluations on outdoor thermal comfort levels in the light of climatic conditions alone seem, by all accounts, to be inadequate and invalid; the outdoor comfort levels do change based on the various psychological conditions users' experience.

It is from thorough research and in-depth analysis and critique of literature that varied factors have been scrutinized and categorized to allow for a comprehensive investigation of a case study and adapt it in a manner to achieve the research aim and objectives in improving OPS conditions through understanding the influence of microclimatic conditions and physical aspects on OPS and the role psychological adaptation plays.

2.6.1 Assessment Tools Review

At ground level, streets, squares and other open spaces are often exposed to the sun, causing discomfort to pedestrians or those wishing to sit outside in the warm part of the year (Yeang & Spector, 2009). Mapping of daily activity on Georgiou Square, a large public space in the center of Patras, Greece, provided starting points for a detailed study of possible microclimatic interventions (Konstantina, 2011). These included the provision of extensive shaded areas, attention to the solar-optical properties of surrounding surfaces and study of the roles of vegetation and bodies of water.

The paper by Konstantina (2011) of microclimatic interventions on the urban square in Greece focuses on urban resting areas and thermal and visual comfort and their implications on users' behavior. The assessment is based on microclimatic monitoring, on site observations and questionnaire guided interviews.

Microclimatic monitoring was achieved during the months of July and August, 2016; recording Air Temperature (^{o}C), Relative Humidity (%), Wind Speed (m/s) and Daylight levels (Illuminance Lux) four times a day (10:30am, 12:30am, 18:00pm and 20:00pm). Surface Temperatures of the urban furniture that a potential user is in direct whilst walking or in contact with when seated were also measured at the same areas. Observations and 100 interviews were achieved during the same period; special attention was given on the selection of the interviews of different age groups within the same area. Konstantina (2011) further reports on the condition and perception of the users' monitored during the period of the study. The final results were analyzed to come up with assumptions for improving the environment to enhance urban accommodation (Konstantina, 2011). Based on the results, the paper summarizes design proposals of microclimatic interventions to increase spatial diversity to enable users' to tolerate unfavorable conditions and support both formal and informal activities. This also allows for setting the ground for new user patterns, depending on the OPS architectural design and expression.

These microclimatic interventions tests included 1) benches developed in overlapping areas to offer views to the areas where activities are mainly taking place, 2) dense deciduous trees to act as a sound barrier, cast shadows during summer while also permitting solar exposure during winter, 3) green surfaces and water bodies to decrease air temperatures and surface temperatures, and 4) shelter: the use of pergola and wooden lattice as a mean to protect frequent paths of circulation, as well as the seating benches developed within the area to perform better during the year. Thus, the proposed interventions have been proven to provide comfort condition for users' performing different activities and promoting socializing and utilizing OPS to make it more useable and providing extensive opportunities to the users of the area.

This case study thus provides an opportune prime example for the purpose of this research as it deals with both quantitative and qualitative aspects of the study and gives insight into the mannerisms and ways to manipulate and adjust the methodology as is deemed necessary.

2.7 Conclusions

The main conclusion drawn from this chapter is that successful OPS is not reflected by the number of people alone. However, it is also reflected by the high number of groups and longer stay in OPS which result in high level of activities. Furthermore, studies linked that the level of activities is correlated to the microclimatic conditions of OPS; it showed that most of these activities happen when the outdoor conditions are an adequate. -

In addition, it is important to note that this chapter was the driving point to derive the research methodology, which is presented in the next chapter.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The research methodology is explained in this chapter which is based on field surveys "to understand the nature of people's interaction with their environment" (Nicol, 2008). Field survey further allows experiencing the real world settings. The study is also based on field measurements and human behavior monitoring as explained below. Thus, with the aid of a combined research method, this chapter includes a detailed overview of the selection of study area, data collection and sorting of a both quantitative and qualitative measurements for the purpose of this research.

3.2 Study Areas, Selection Criteria and Justification

The research study aims to investigate ways of enhancing thermal comfort by understanding the influence of microclimatic conditions and physical aspects and the role of psychological adaptation in OPS of Qatar, with emphasis on the summer season. Two recreational parks were selected for the purpose of this study where both local and international people visit; Al-Corniche & Aspire (Figure 15).

Table 7. Details of the selected case studies (source: developed by author)

Study area	Description	Time	Dates
Al-Corniche (Dafna)	Located along the sea front (edge of Doha)	6am, 8am, 10am, 12noon, 2pm, 4pm, 6pm, 8pm, 10pm	16-08-16; 30-08-16; 12-08-16; 26-08-16
Aspire	Located in the inner Doha	6am, 8am, 10am, 12noon, 2pm, 4pm, 6pm, 8pm, 10pm	16-08-16; 30-08-16; 12-08-16; 26-08-16

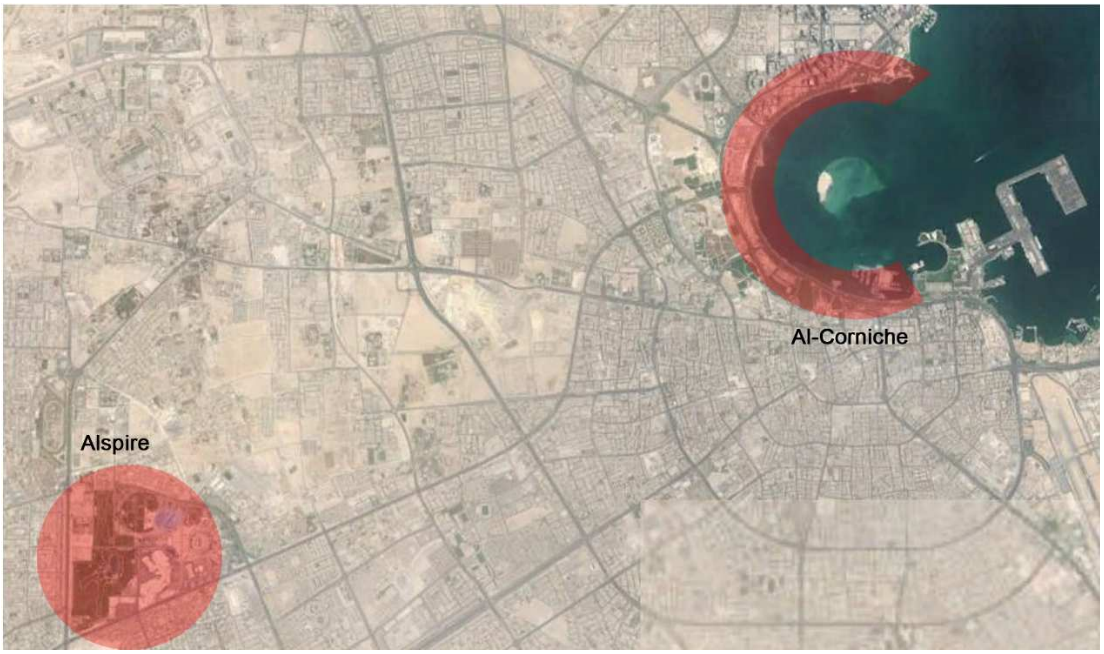


Figure 15. Location of study area (source: GoogleMaps, 2016; established by author)

Throughout the study the investigator paid close attention to the number of users' of those spaces, including their privacy, patterns of use (including time of use), activities and clothing. In addition, the selection of the different spaces enabled exploration of how design influences space utilization and thermal comfort through the in-depth analysis of different microclimates at the different sites. Furthermore, since the study aims at understanding the users' preference in relation to outdoor environmental qualities, OPS were selected based on its popularity amongst users' in Doha, crowd intensity, location, and scope. The selected parks are frequently used by different nationalities, varied age groups, and genders. Consequently, this data would have the potential to benefit planners for functionality purposes, to develop or change outdoor locations or designs, or for urban planning purposes.

3.3 Research Approach

Based on the lack in literature, majority of the research in hot arid regions have followed the urban climatology approach where the focal point is between the environmental elements and physical settings of the place, with minor attention given to the human factor. There is also missing knowledge in regards to the relationship between the microclimatic conditions parameters (quantitative) and the users' perception, and adaptation (qualitative) in OPS (Fringuello, 2008; Eliasson, 2000).

The study adopts a combined research strategy where both quantitative and qualitative research methods are used for the purpose of this study (Figure 16). Therefore, the aim of this study is to investigate ways of enhancing thermal comfort by understanding the influence of microclimatic conditions and physical aspects and the role of psychological adaptation in OPS. Thus, it is necessary for the design of this research to combine various methodologies.

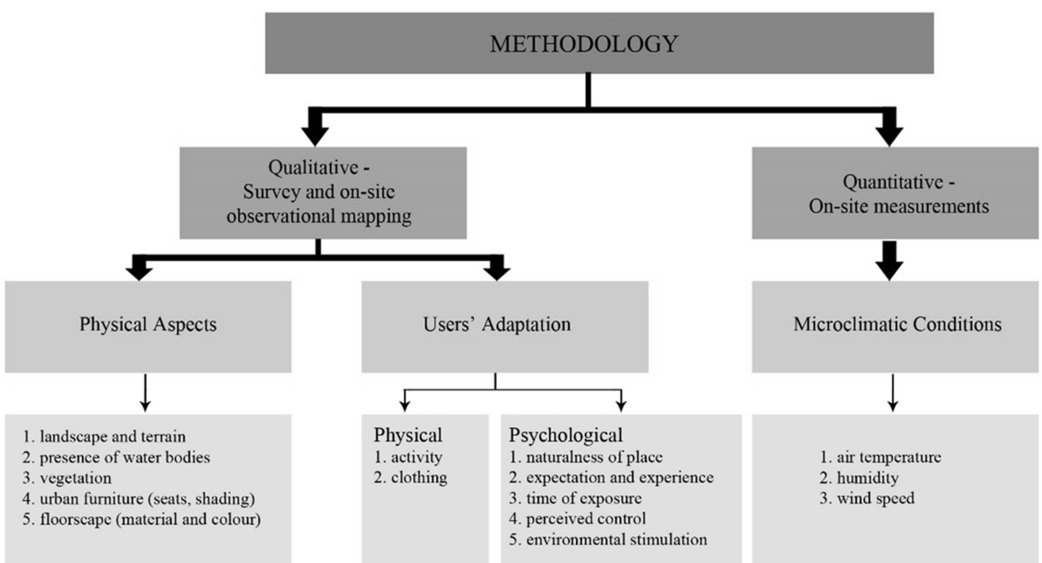


Figure 16. Combined research methods used for this study (source: developed by author)

The microclimatic conditions will be compared to the subjective physical and psychological users' adaptation obtained from questionnaire and human behavior monitoring as explained below. In addition, the microclimatic conditions together with the equipment's used to measure them throughout the study will also be described further in the next section. The data collected in the hottest peak of the year during the month of August 2016 has been graphed at 2-hour intervals from 6am to 10pm.

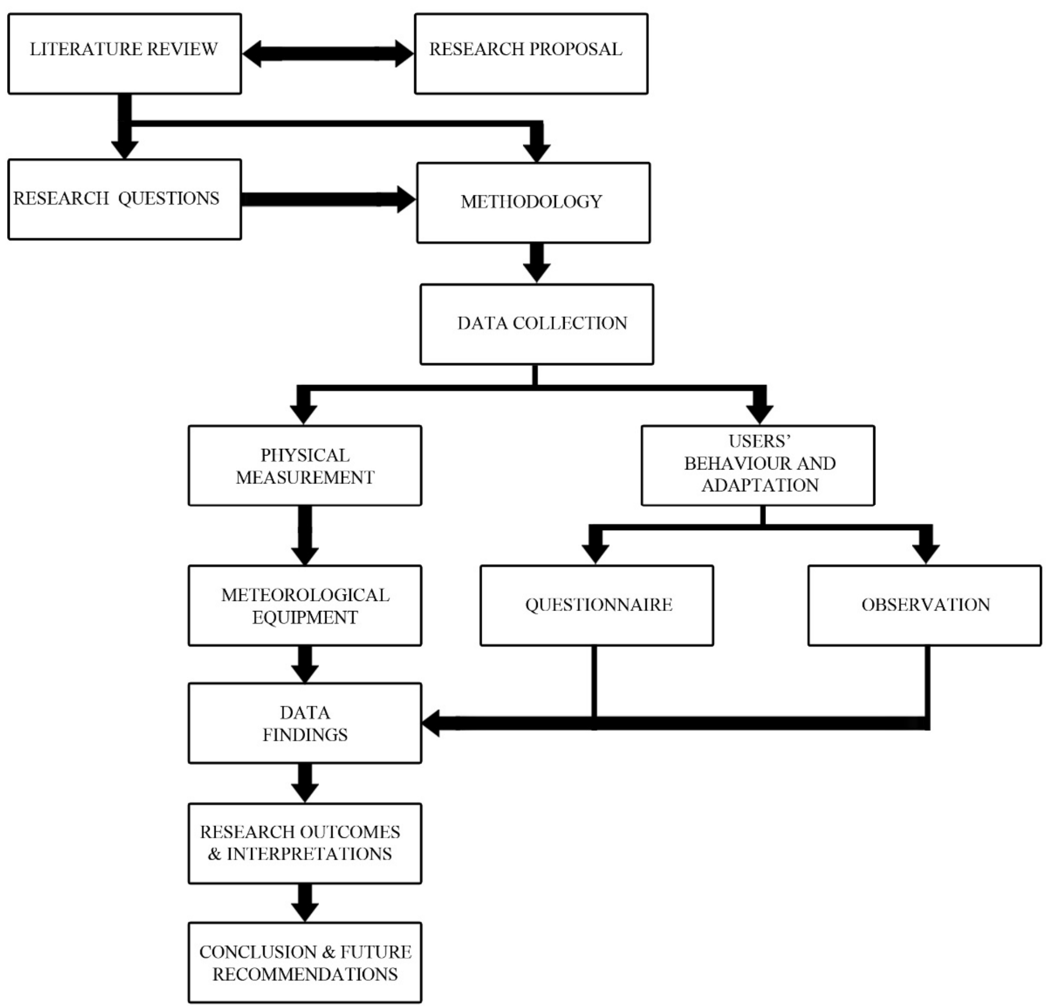


Figure 17. Research structure (source: developed by author)

3.3.1 Quantitative Measurement

Quantifiable analysis yields objective measurement; and subsequently such measurements are commonly utilized as a part of many researches that are quantitative in nature (Fan, 2002). For taking quantifiable measurements there is a requirement to clearly identify the different parameters used, and standardizing the instruments used for the purpose of the research. The objective measurements in this study are mainly used for measuring the microclimatic conditions of the OPS. The findings of these measurements are easily interpreted where it makes exceedingly relevant comparisons in relation to the outdoor thermal comfort and psychological adaptation of the user.

For outdoor thermal comfort, the understanding of the environmental conditions under which the users' are comfortable, that is when a person is not experiencing too much heat or cold in OPS, is an essence in this study. This type of methodology can be classified as quantitative experimental where on-site measurements are taken. The experimental part of the study comprised measurements of climate variables in a selected urban environment in which outdoor thermal comfort is estimated. The variables measured are: air temperature, relative humidity, and wind speed. Microclimatic monitoring for air temperature and humidity was achieved through continuous measurement to see weather patterns and give more validity to the results. The measurements were conducted with miniature data loggers. The small loggers were installed in the two parks selected recording data with a 10-minute interval during the month of August (hot season) from 6am to 10pm for four chosen days; both weekdays and weekends, as shown in Table 8. Based on the observation the measurement device has been placed in the most active point where most activities occur in the OPS; just above the pedestrian level and shielded against radiation.

The loggers are placed 2m to 2.5m above the ground, because of pedestrian traffic and the risk of theft. In addition, wind speed was measured at every one hour interval; measurements were conducted at a height of 1.2m equivalent to the pedestrian level and their interaction with the space. It is also important to note that the average of wind speed was taken as it was difficult to obtain a fixed value.

Once the measurements were obtained it was substituted into an outdoor comfort calculator to get an overall feel of the temperature in regards to the three measurements including temperature, humidity, and wind speed (TranssolarKlimaEngineering, 2016). The outdoor comfort calculator is available online, free for use and doesn't require authorization for academic and educational purposes.

Table 8. Selected days when measurements were taken (source: developed by author)

Day Number	Day Type	Date	Location
1	Weekday	16-08-2016	Al-Corniche and Aspire
2	Weekday	30-08-2016	Al-Corniche and Aspire
3	Weekend	12-08-2016	Al-Corniche and Aspire
4	Weekend	26-08-2016	Al-Corniche and Aspire

3.3.1.1 Measurement Instruments

The first instrument used for collecting the readings of the different selected microclimatic parameters is called TGP-4500 Tinytag Plus 2 Dual Channel Temperature/Relative Humidity (Figure 18). The second instrument used for measuring wind speed is called Kestrel Pocket Weather Tracker (Figure 19).

Figure 19. TGP-4500 tinytag plus 2 dual channel temperature/ relative humidity (source: author)

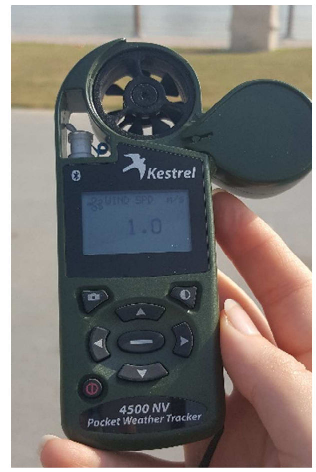


Figure 18. Kestrel pocket weather tracker (source: author)

The Tinytag Plus 2 range of data loggers have a high reading resolution and accuracy; hence the device has the capability of providing highly precise results. The instrument are housed in robust, waterproof (IP68 rated) cases that are designed for use in a wide range of outdoor applications. The TGP-4500 is a self-contained temperature and relative humidity data logger. This unit features a coated RH sensor that has good resistance to moisture and condensation, ensuring measurement reliability (Tinytag, 2011).

The Kestrel Pocket Weather Meter impeller was tested in a subsonic wind tunnel operating at approximately 300fpm (1.5m/s) and 1200fpm (6.1m/s) monitored by a Gill Instruments Model 1350 ultrasonic time-of-flight anemometer. Hence, it was of certainty that the instrument is reliable in taking wind speed measurements.

3.3.1.2 Microclimatic Conditions and Design of OPS

It is near impossible to design and develop outdoor spaces that provides comfortable environment to users' at all times (Walls, Parker, & Walliss, 2015). Studies on outdoor thermal comfort aim at identifying optimum conditions that try to satisfy the majority of users' requirements. Air temperature, humidity, and wind speed are considered as being the best indicators of the condition of the outdoor environment where it's helpful in understanding outdoor thermal comfort levels with more precision (Markov, 2002). It has been evident that the use of OPS are mainly dependent on microclimatic conditions in addition to psychological adaptation of users'. Hence, measurements of the three microclimatic parameters from the surveyed areas can provide a better understanding on outdoor conditions, thus the three parameters were selected for the study for research purposes. Based on recent studies it can be assumed that the microclimatic conditions such as temperature, humidity and wind speed have a great effect on impacting both attitude and behavior of users' in OPS (Orosa, 2009).

3.3.2 Qualitative Measurement

Qualitative analysis yields subjective measurement that is conducted to obtain more details and better insights of the real situation. Subjective measurements are made for understanding physical adaptation, perceptions, emotions, psychological adaptations and behavioral adaptations of users'. Such measurements are useful in making the translations more realistic as it enhances the applicability of the research results and their analysis. This type of measurement allows the user to express their perspective all the more intricately.

Thus, the method used for conducting such measurement can be either semi-structured or unstructured and open-ended.

It is important to note that special attention was given on the selection of the interviews of different age groups, genders and nationalities for the different site areas. In addition, secondary data will be collected using literature such as books, journal articles, online services, etc.

3.3.2.1 Questionnaire Design

To conduct a questionnaire an Institutional Review Board (IRB) approval had to be granted for the proposal by meeting all requirements. The questionnaire also had to be exempted from the full research ethics review (refer to appendix A).

Prior to being involved in the research, participants' had to give approval to become subject to the questionnaire. They were informed about the purpose, nature of the research, data collection and its confidentiality. They were informed that no information about the individuals who have participated in the survey would be disclosed to anyone at any time. Furthermore, since there is the possibility that the respondent might lose interest in answering questions, the survey clearly states that participation is voluntary and that participants can skip any question or withdraw at any time. The questions in the survey were structured in a way that will only require five minutes or less of the participant's time. The researcher had to also answer questions based on their observation of the respondent during the times when respondents were and were not taking the survey. Partial aspects of this observation includes recording amount of crowd from the different surveyed locations.

The highly structured Questionnaire was used as the primary source for collecting data; it was designed in a way so that it includes both close-ended and open-ended questions. Close-ended questions were mainly used to get a thorough understanding of the measurements conducted in relation to the outdoor thermal comfort levels. The aim of the open-ended questions was to collect more in-depth data to develop a greater understanding of the real-time situation. As a result the analysis and interpretations will be more realistic and helpful in generating high quality outcomes of the real-time situation which that assist the researcher to come up with recommendations that have higher relevance and applicability in both the practical and recreational field. The questionnaire will further assist in understanding the users' perception and adaptation of the space in regards to outdoor comfort (refer to appendix B).

3.3.2.2 Sample Size

The total sample size used for the research was 180 for Al-Corniche, and 180 for Aspire. The questionnaires were dispersed to users' belonging to different nationalities, age groups, and genders. Different nationalities have been surveyed for the purpose of the research including Arabs, Indians, Asian, European, and others. A variety of different age groups were selected ranging from 18-25; 25-30; 30-35; 35-40; and 40-50. Surveys were achieved during both weekdays and weekends at each study area. The survey questionnaires were conducted from morning hours until night time.

3.3.3 Human Behavior Monitoring

The questionnaire and the observations are two main approaches used for human behavior monitoring. The questionnaire made by the researcher through formal observations was mainly designed to explore subjective responses and attitudes of users' in the different selected areas during the summer season. In addition, the observations aimed at investigating users' behavior such as patterns of use and activities in each study area. Thus, the observation sheet was prepared and filled by the researcher during the field study period. On-site observational mapping was also employed as a technique to monitor human patterns. The following sections will give further insight and details about the questionnaire and the observation techniques used for the purpose of this research.

3.3.3.1 The Questionnaire

Prior to the four main sections in the questionnaire the first part was intended to evaluate the socio-conditions of the participants. It is called the general information inclusive of gender, age, nationality, academic qualifications, specialization, area living in, etc. to understand who uses the space.

The questionnaire is primarily designed for people utilizing OPS; it consists of four main sections including both close-ended and open-ended questions:

1. Section A seeks more data regarding the participants behavior and place perceptions by investigating various issues such as behavior, thermal history, experience of the place, expectations, time of exposure or time spent outdoor,

purpose of visit, and users' perceptions and attitude towards the space during the time of the interview

2. Section B of the survey aims at understanding the users' personal traits such as clothing, activity, and if any drinks or food were consumed
3. Section C is designed to collect information about users' perception regarding present comfort levels, preferences, and satisfaction towards the microclimatic conditions such as: air temperature, humidity, wind movement, and the overall weather condition
4. Section D is the general satisfaction of the OPS which aims to collect information about users' perception regarding the physical aspects and design features of the existing OPS: vegetation, water features, urban furniture, shaded or covered areas, flooring (pavement, concrete, etc.)

3.3.3.2 Observations

Observations were taken of the people and activities within the defined boundaries in each selected park. An observation form was prepared and filled by the researcher during the field study period at 6:00am, 8:00am, 10:00am, 12pm, 2:00pm, 4:00pm, 6:00pm, 8:00pm, and 10:00pm. The aim of the form is to provide a clear image on the nature, type and condition of the respondent. The questions in the form are structured and close-ended to make it easier in categorizing and quantifying data for more effective interpretations.

The observation form initiates with the general information consisting of site location, date, time, and weather conditions (sunny, overcast, partly cloudy, or rainy).

The questions in the observation form were aimed at understanding the gender, age group, nationality, and color and texture of clothing to define and describe the respondent more clearly. The researcher also observed and noted the estimate number of people vising each surveyed location, if users' are sitting alone or in groups, type of users' activities, whether eating or drinking (cold or warm), and respondent's sitting area whether in shade or sun. These aspects had to be observed to understand the type of preparation or protection proceeded by the user to attain optimum outdoor thermal comfort. Furthermore, during the observation phase photos were also taken at each observation phase.

The last phase of the observation form was inclusive of a site plan for one area in each of the two public spaces (Figure 20). The two areas have been chosen as they are the focal active points where all the activities and gatherings of many users' take place. The site plan was added to the form to map out people's location and movement, crowd behavior and study of users' pattern (i.e. where people are coming from, where do people sit and walk) in detail within the selected boundary. The on-site observational mapping was achieved during both weekdays and weekends for the times at 10am morning and 6pm evening (peak morning and evening hours of the day).

Figure 20. Site plan for selected boundary of OPS (source: GoogleMaps, 2016; established by author)

Based on the work of Whyte (1980) a mapping code was developed, where the following legend was used:

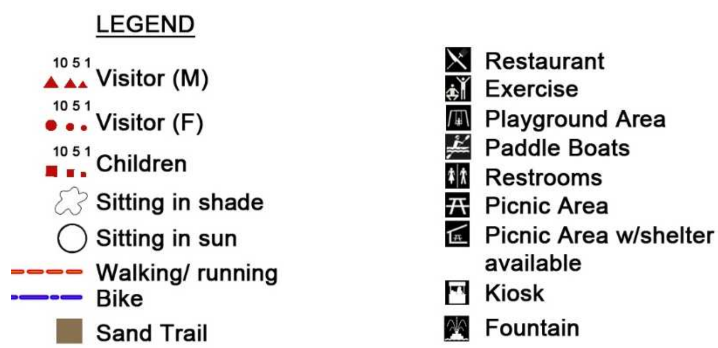


Figure 21. Legend for on-site observational mapping (source: developed by author)

This legend was very efficient and effective in assisting with the analysis of the selected outdoor areas through the observation procedure.

3.4 Conclusions

Data sources and methods have been identified in this chapter by using a combined methods approach to enhance and validate the research study. Both quantitative and qualitative techniques have been put into effect to conduct the research to understanding the relationship between environmental variables and the information gathered from the users' adaptation in the OPS to determine outdoor thermal comfort.

Moreover, the research methodology chapter serves the purpose of establishing a data collection strategy to enable the researcher to collect raw data as illustrated in the following chapter.

CHAPTER 4: DATA COLLECTION

4.1 Introduction

The study outlines the integrated approach for improvement of OPS conditions. The case study of Doha's public realm "Al-Corniche" and "Aspire" are both used as the basis of this research with emphasis on the summer season. The research study aims to investigate the role of psychological adaptation to determine thermal comfort in public outdoor spaces in Doha.

The researcher collected data through the use of survey questionnaire, microclimatic measurements and on-site observations. Data was collected during weekdays and weekends from both locations, during August in the year 2016. Presentation of the numerical and observational data was through statistical data analysis means such as graphs and tables to allow for identification of patterns and trends which enables the evaluation of thermal comfort. The collection of data has also been presented separately for both weekdays and weekends for comparative purposes.

The researcher made valid observations regarding the users' gender, clothing, activity, etc. for the purpose of developing correlations between adaptive activities and thermal comfort. The researcher observed crowd behavior and intensity to monitor and get a thorough understanding of crowd quality and quantity.

The findings highlight specific parameters that contribute to the OPS by understanding the influence of microclimatic conditions and physical aspects and the role of psychological adaptation in enhancing the OPS and improving outdoor comfort levels. The parameters include the following:

● Physical aspects – landscape and terrain (typology constructions and its topographical characterization), presence of water bodies, vegetation, urban furniture (seats, shading devices), shaded or covered areas, floor-scape (soft landscape, hard pavement, concrete, change of material and color) (Madanipour, 1996; Mahmoudi 2015)

● Psychological adaptation – naturalness of the place, expectations, experience, time of exposure, perceived control, and environmental stimulation (Nikolopoulou M. , 2003)

● Microclimatic conditions – air temperature, relative humidity, wind speed (BojinSki & VerStraete, 2014).

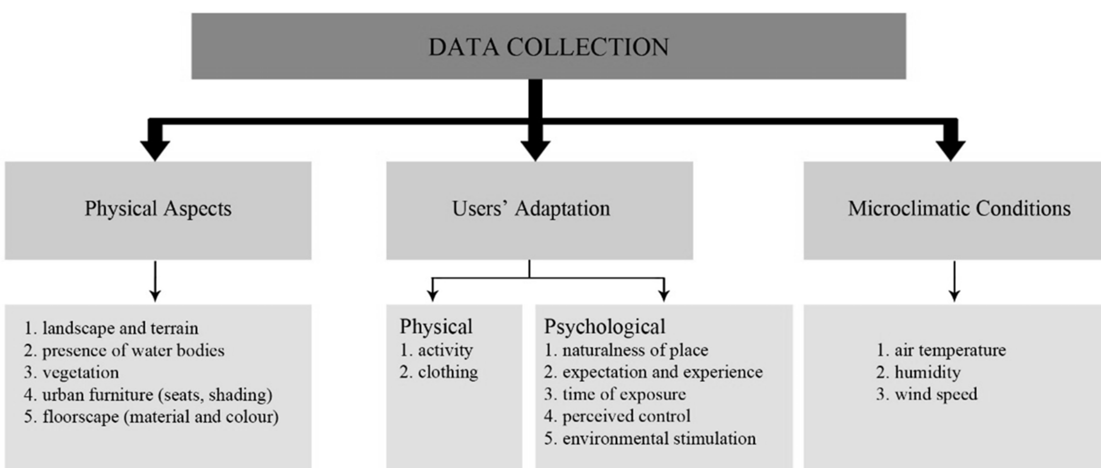


Figure 22. Data collection parameters (source: developed by author)

4.2 OPS of Al-Corniche

4.2.1 Physical Aspect of the OPS

Doha's Al-Corniche OPS is located along the sea-front which runs over 7km. It is studded with exciting green surroundings (grass, shrubs, and trees) and remarkable modern architecture. The OPS of Al-Corniche has expanded in the 21st century with many skyscrapers being built towards the north of Al-Corniche (Zaina, Zaina, AlMohannadi, & Furlan, 2015). The whole of Al-Corniche is only facilitated around one Café and one restaurant, with no kiosks being in space (Figure 23).

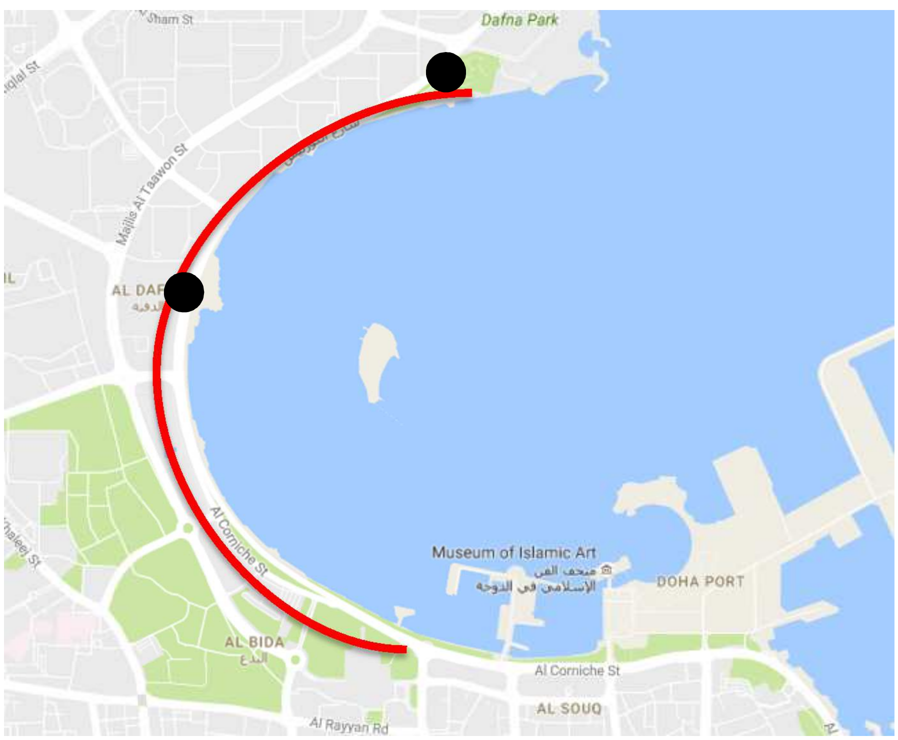


Figure 23. Cafe and restaurant around Al-Corniche (source: GoogleMaps, 2016; established by author)

The line of palm trees running the length of this public space are ultimately used as a shading device. As for the urban furniture, there is a limited amount of seating and shading devices constructed into the fabric of the space. The furniture and, more importantly, the paving were light colored. The surface of the ground in Al-Corniche is of a light hard pre-cast concrete flooring.

4.2.2 Physical Adaptation of the User

4.2.2.1 Activities in Al-Corniche

In the OPS of Al-Corniche it is seen that there are necessary activities where some users' are waiting for a bus (usually labor or workers'). However, the type of activity that is most prevalent in Al-Corniche are the optional and the social types. The optional or recreational activities that users' employ include sitting on a bench in the open space to enjoy the breeze of the ocean or the landscape, or sitting on the grass to enjoy the quietness and the peacefulness, or walking in the open space, etc. The other type is the social or resultant activities that rely on the people present in the outdoor space. It usually occurs when people meet to socialize in a certain place for chatting, greeting, children playing, and other communal activities. Figure 24 shows the percentage of different activities seen over the four days in Al-Corniche including both weekdays and weekends.

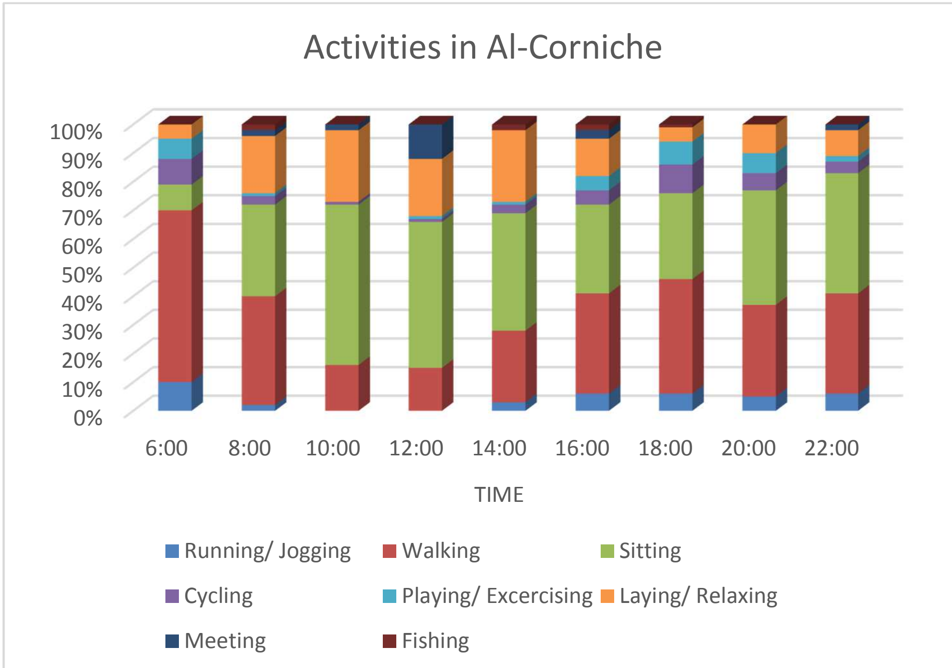


Figure 24. Activities in Al-Corniche (source: developed by author)

OPS becomes a goal in itself (Gehl, 2007), where it hosts social, cultural, and recreational activities including exhibitions, parades, sport activities, and outdoor cafés. It has been observed that over the four days Al-Corniche lacked some of these activities such as outdoor exhibitions, parades, and sport activities (soccer, etc.).

4.2.2.2 User Demographics

It has been observed that over the four days in Al-Corniche including both weekdays and weekends there were over 60% more men than women utilization of the OPS (Figure 25). It is vital to note that there are multiple hours throughout the selected days were there is no women at all occupying the space; however, this is only observed for the weekdays.

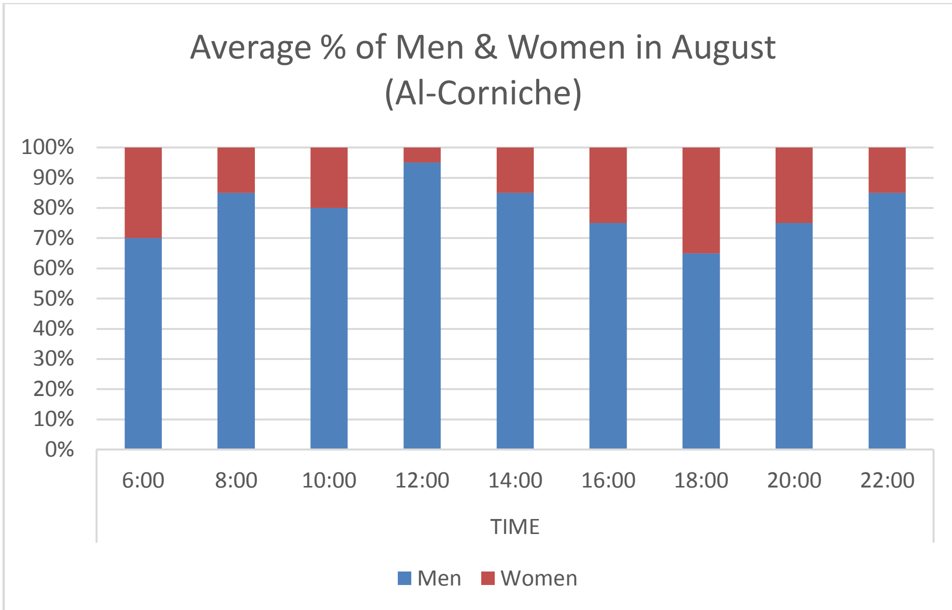


Figure 25. Average % of men and women for both weekdays & weekends in Al-Corniche (source: developed by author)

It has been visually observed and surveyed that users' of Al-Corniche spend a lot of time if they are in groups, mainly during the evening or weekends. Thus, the OPS of Al-Corniche is a rich-vibrant environment, as it does not die during the surveyed nights or weekends' in August, 2016.

4.2.2.3 Clothing, food and drinks

Majority of the people were wearing short-sleeved tops (0.2CLO), long pants (0.4CLO) or short pants (0.2CLO). Some were wearing black abayas (0.5CLO), headscarfs, and burqa; others wore white dishdasha (0.4CLO) (mainly due to culture and religion) but even this did not stop them from wanting to spend more time in the area. Some users' alternatively wore short dresses (0.3CLO), whilst some wore long dresses (0.4CLO). Whilst other users' chose to cover their faces with head shawls or even use umbrellas as a technique to protect them from direct sunlight. A lot of users' wore hats and opened shoes. However, in saying that, many also chose to wear closed shoes and socks for walking and/or jogging reasons. Over the four days it has been observed that the choice of color of cloths varied; 40% of the users' wore light colors, 35% wore mixed, and 25% wore dark colors'.

It has been observed that a variety of users' ate and drank hot and cold food and drinks; with more of cold drinks which allowed them to adapt psychologically to the environment and stay longer within the area by internally staying cool. On the other hand, some users' drank hot drinks because they didn't feel too hot, but rather felt neutral as they drank the hot drinks.

4.2.3 Psychological Adaptation

4.2.3.1 Day 1 (16-08-16) Weekday

Based on the survey, during the early morning at 6am 70% of the users' were able to enjoy and tolerate the environment with regards to both air temperature and humidity; to the extent that they were willing to revisit the area. From 8am to 12pm only 50% managed to tolerate the environment and that was primarily to the satisfaction level of both air temperature and humidity level, although 90% preferred more air movement. Amid the afternoon from 12noon to 6pm it was found that 100% of users' of the space preferred lower air temperature and 90% of the surveyed preferred less humidity level; whereas 60% were satisfied with the air movement and required no change. Thus, users' during the afternoon were not able to tolerate the environment due to the harsh weather conditions (air temperature and humidity). From 6pm to 10pm only 20% were able to tolerate the varied physical changes to the environment (Figure 26). This was mainly due to the increased temperature and humidity, and the low air movement as shown in 4.4.4.1.

It is interesting to further note that from 6am to 2pm 15% users' were not satisfied with the amount of vegetation and required more. However, from 4pm to 10pm 100% of people surveyed were satisfied with the amount of vegetation available in the environment (Figure 26).

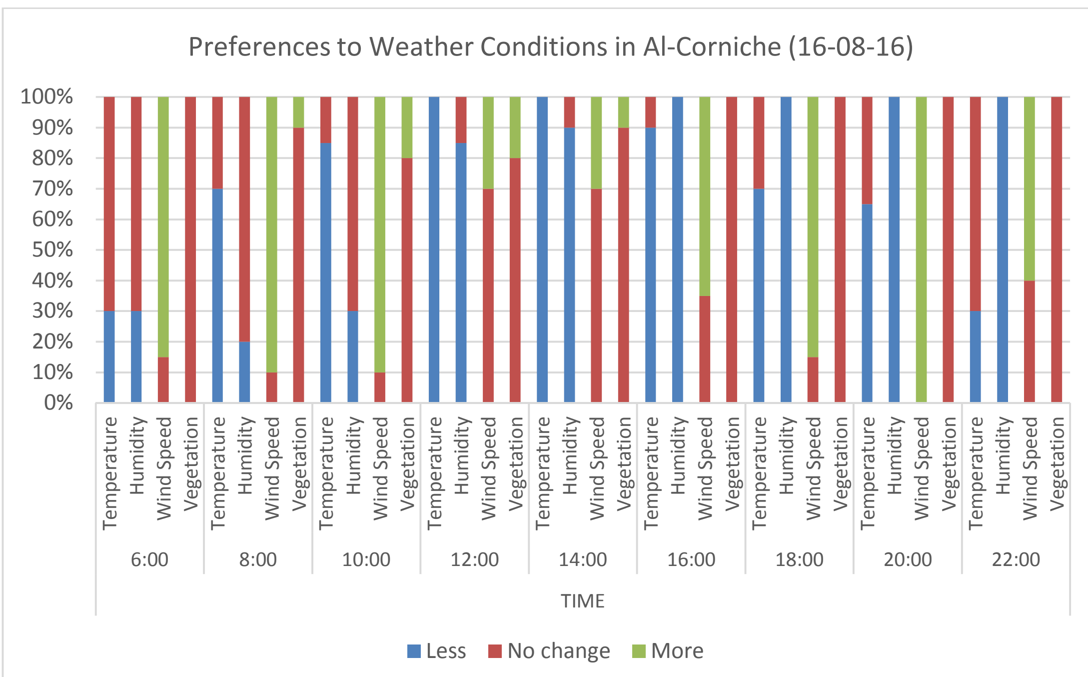


Figure 26. Preferences to weather conditions in Al-Corniche on 16-08-16 (source: developed by author)

75% of the users' didn't mind staying in the OPS of Al-Corniche throughout the day (Figure 27). However, in saying that, the time of stay was influenced on the level of activity taken in the space and the amount of weather conditions they can tolerate.

Figure 27. Users' enjoying the OPS of Al-Corniche (source: developed by author)

From 8am to 2pm there was hardly any users’ in the OPS. However, there was a rapid increase of users’ starting from 4pm to 10pm (Figure 28), however the 75% of the surveyed minded staying for long hours in Al-Corniche.

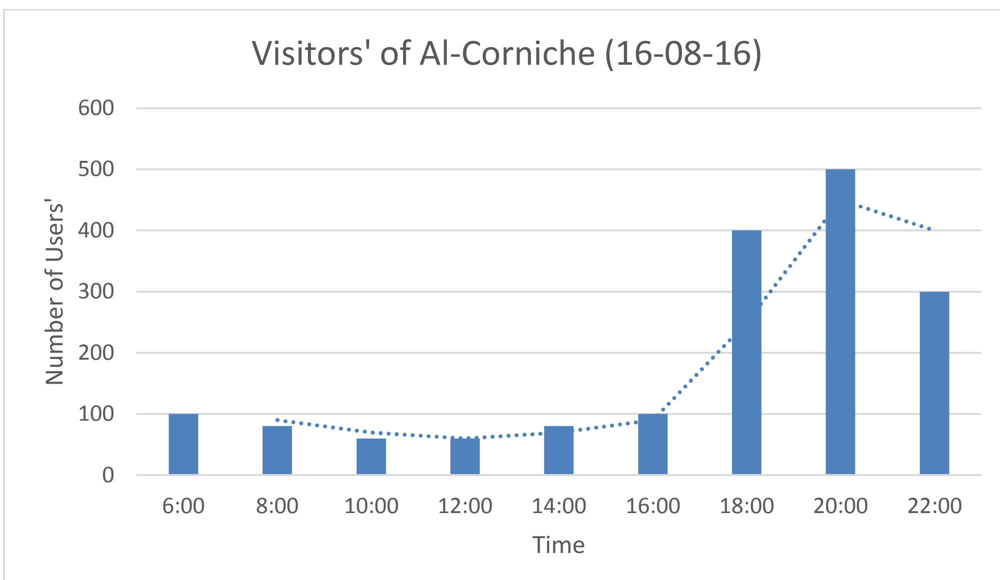


Figure 28. Number of visitors' in Al-Corniche on 16-08-16 (source: developed by author)

The anticipated time to stay for 80% of the users' during the morning was a half hour to an hour, afternoon was less than half an hour, and night time was half an hour or less.

In addition, the environmental stimulation was an attribute that brought people to the space such as the ocean, trees, and sound of the waves. Although this was the case the low wind speed, high temperature and humidity did not allow users' to enjoy the OPS of Al-Corniche on this day.

It was observed that from 6am to 12noon the OPS was used by more individuals whom happen to gather around a shaded tree, CAFÉ, and restaurant areas as shown in Figure 29. It has been observed that the rest of Al-Corniche was empty.

Figure 29. Individuals' gathering around trees and café (source: author)

As shown in Figure 30 below, from 2pm to 10pm the OPS of Al-Cornice was mainly occupied by groups and individuals.

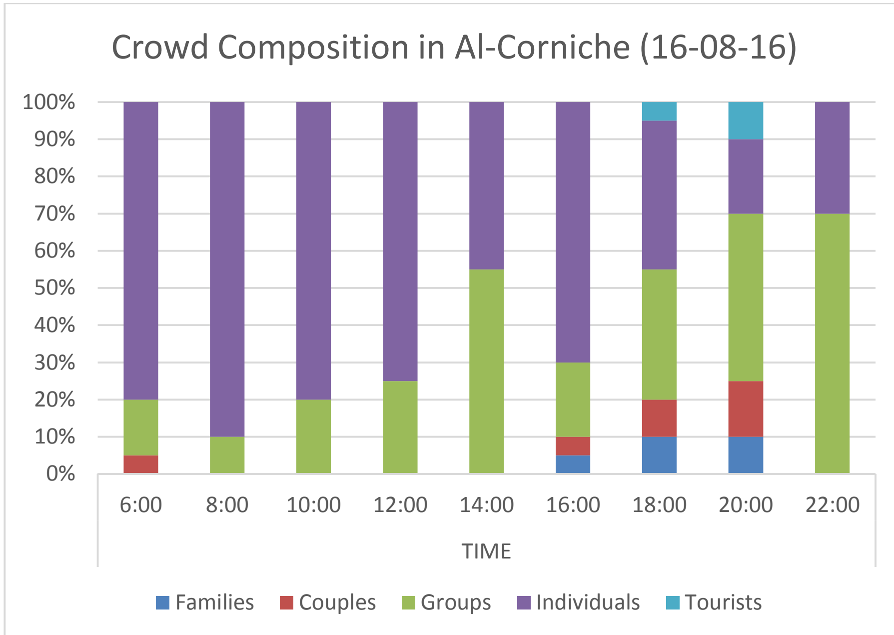


Figure 30. Crowd composition in Al-Corniche on 16-08-16 (source: developed by author)

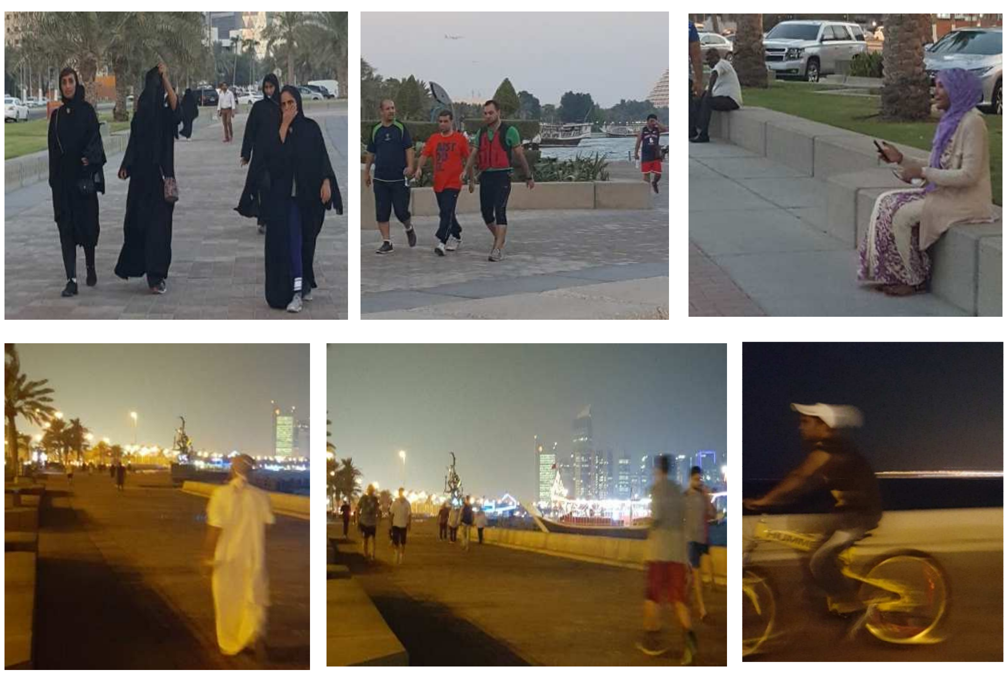


Figure 31. Al-Cornice occupied by groups and individuals (source: author)

According to the survey only 15% of the users' enjoyed the weather and didn't mind spending more time. However, 85% didn't want to spend time in the OPS of Al-Corniche due to the hot and un-suitable weather conditions.

4.2.3.2 Day 2 (30-08-16) Weekday

From 6am to 12pm only 35% of the users' were able to tolerate the air temperature where they preferred no change, 65% on the other hand preferred less temperature; 30% preferred no change in humidity level where 70% preferred less humidity. Whereas 60% preferred more air movement and 40% preferred no change in the wind speed as extracted from the survey. During the afternoon from 12noon to 6pm the survey showed that 50% of users' preferred lower air temperature and 40% of the surveyed preferred less humidity level; whereas 95% were satisfied with the air movement and required no change in wind speed. Thus, users' during the afternoon were satisfied and enjoyed the overall weather conditions.

From 6pm to 10pm 85% of the surveyed were not able to tolerate the air temperature and required less temperature; 80% preferred less humidity level; and 30% preferred more air movement, however 70% were satisfied with the air movement (Figure 32).

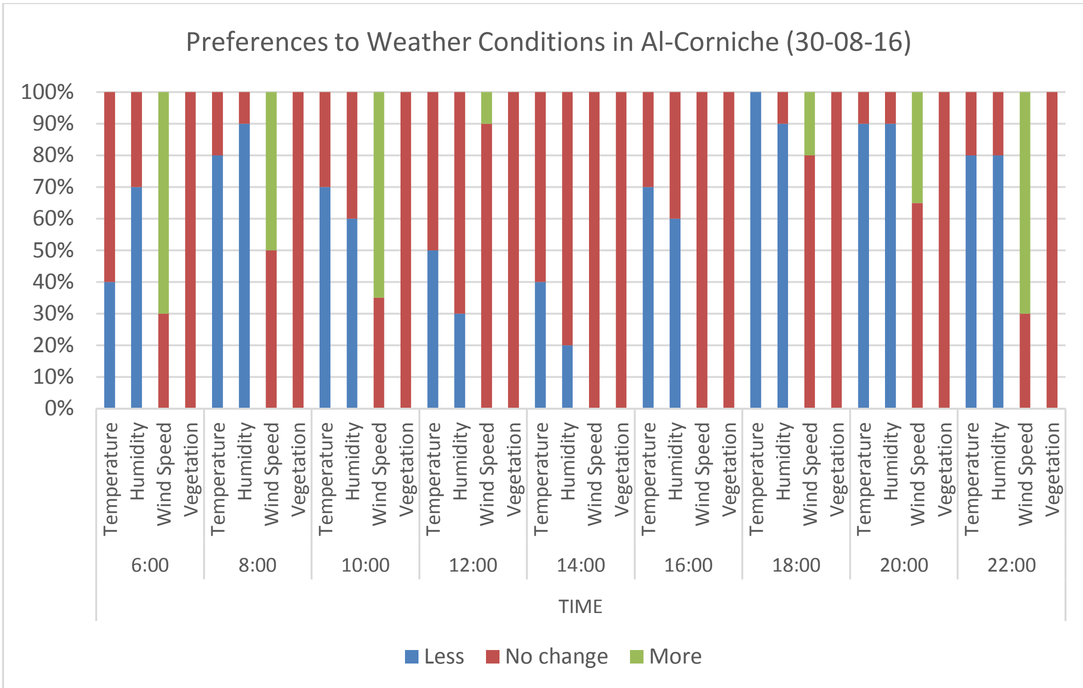


Figure 32. Preferences to weather conditions in Al-Corniche on 30-08-16 (source: developed by author)

35% of the users' didn't mind staying in the OPS of Al-Corniche throughout the morning. However, in saying that, the time of stay was influenced on the level of activity taken in the space and the amount of weather conditions they can tolerate. It was observed that after 4pm there was a rapid increase of users' (Figure 33). From 4pm to 10pm, this was the time of the day were 50% of the people surveyed did not mind to stay for long hours in the OPS of Al-Corniche.

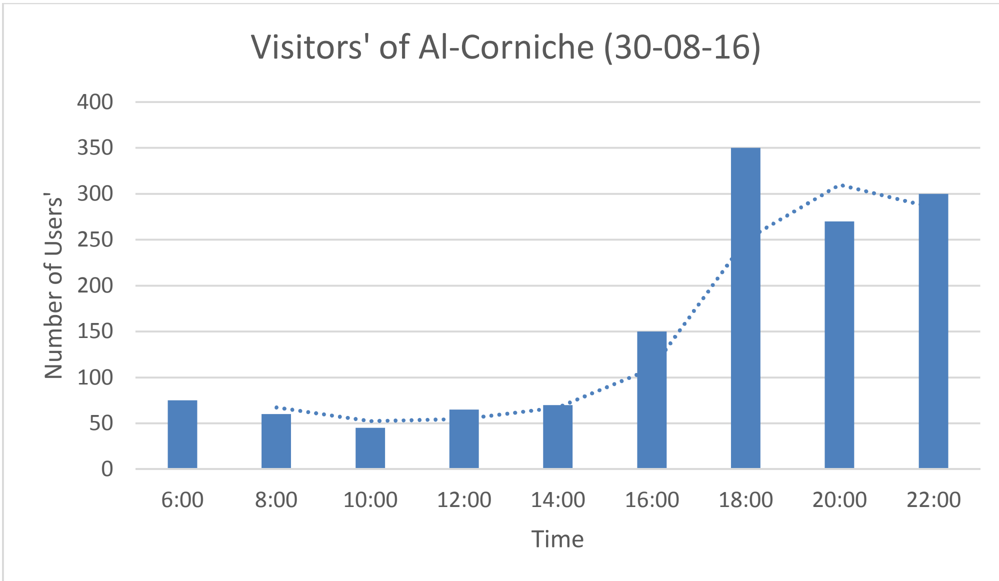


Figure 33. Number of visitors' in Al-Corniche on 30-08-16 (source: developed by author)

The anticipated time to stay for 80% of the users' during both the morning and the afternoon was half an hour to an hour, and during the night it was one to two hours.

Although majority of the visitors' described the weather to be hot during the day and very humid, with low air movement, they had control over their discomfort as many visitors' were gathered and distributed around trees to provide them with shade whilst they were sitting (Figure 34). Thus, those variables influence longer time spent outside.

Figure 34. Users' gathered around trees (source: author)

On the other hand, other people had no control over there source of discomfort including those walking as there is no mean of shading devices and some people sitting on benches as some are also un-shaded (Figure 35).

Figure 35. Lack of shading devices for users' (source: author)

As shown in Figure 36 it was observed that from 6am to 8am there was more individuals, from 10am to 10pm both groups and individuals were equally divided. Couples started coming at 6am and from 4pm to 10pm. Families also started coming from 4pm to 8pm. There were also some tourists at 8pm in the OPS of Al-Corniche.

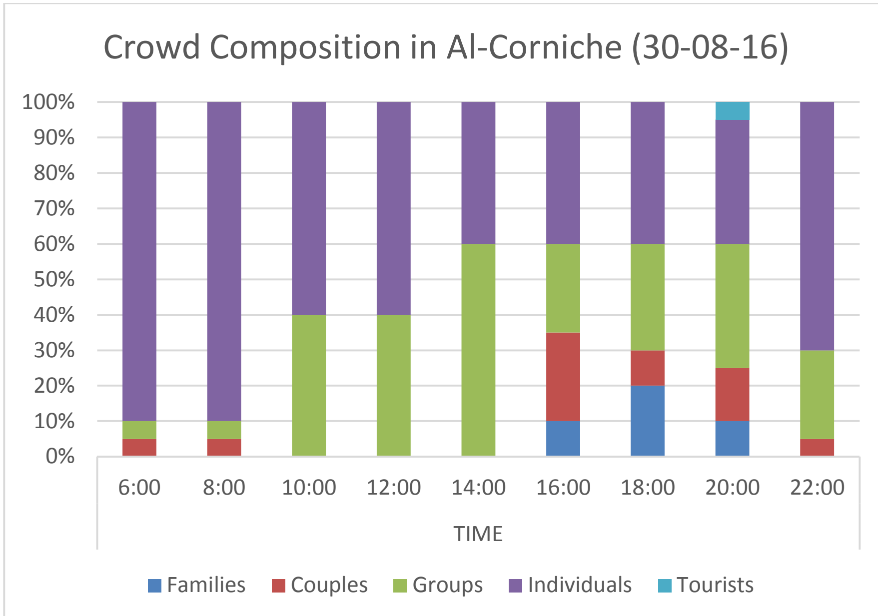


Figure 36. Crowd composition in Al-Corniche on 30-08-16 (source: developed by author)

Figure 37. Crowd composition of couples and families in Al-Corniche (source: author)

75% of the respondents' didn't mind re-visiting the OPS of Al-Corniche on similar climatic conditions and spending more time in the area.

4.2.3.3 Day 3 (12-08-16) Weekend

During the morning from 8am to 12pm 60% preferred a decrease in air temperature, and 40% preferred no change to the temperature; 50% preferred less humidity, and 90% of the surveyed wanted more air movement. Amid the afternoon from 12noon to 6pm the survey illustrated that 75% of users' of the space preferred lower air temperature and 75% of the surveyed preferred less humidity level; whereas 65% were satisfied with the air movement and required no change. From 6pm to 10pm 50% of the surveyed were not able to tolerate the air temperature and required less temperature; 40% preferred less humidity level; and 55% preferred more air movement (Figure 38). Thus, the survey showed that users' were satisfied with the overall weather conditions during night time as they can adapt physically where it meets their comfort level.

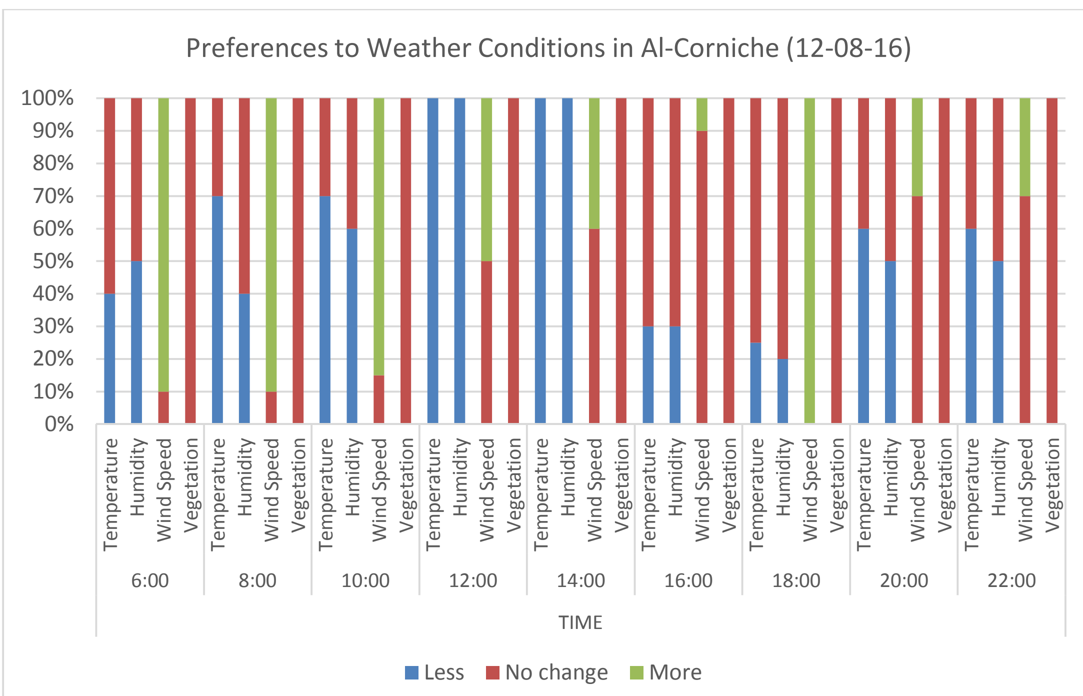


Figure 38. Preferences to weather conditions in Al-Corniche on 12-08-16 (source: developed by author)

Throughout the morning 85% of the users' didn't want to spend time in the OPS of Al-Corniche. It was observed that after 2pm there was a rapid increase of users', which slowly started decreasing after 6pm (Figure 39). From 2pm to 10pm, this was the time of the day were 55% of the people surveyed didn't mind to stay for long hours in the OPS of Al-Corniche.

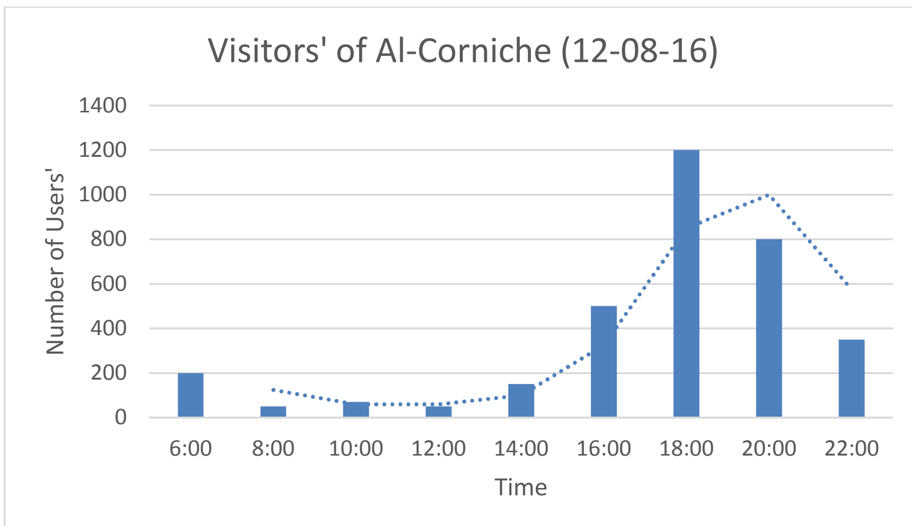


Figure 39. Number of visitors' in Al-Corniche on 12-08-16 (source: developed by author)

The anticipated time to stay for 75% of the users' during the morning was a half an hour to two hours, afternoon was two to three hours, and evening and night time was an hour to three hours.

It was observed that the crowd was mainly composed from individuals and groups. Both families and couples were also found across the entire day. Tourists, on the other hand, were few and seen at 8am, 10am, 6pm, and 10pm (Figure 40).

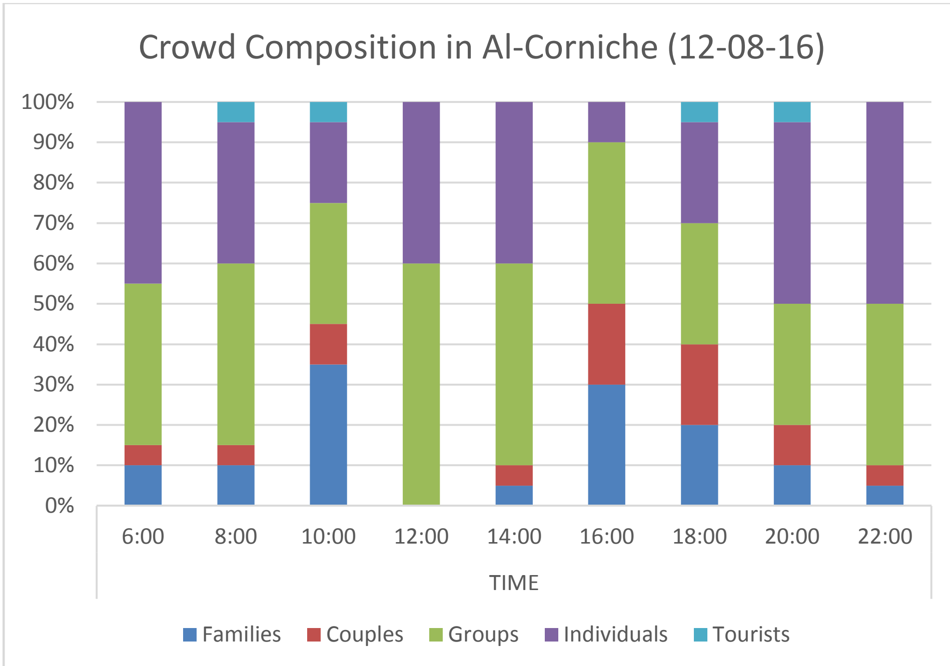


Figure 40. Crowd composition in Al-Corniche on 12-08-16 (source: developed by author)

Based on the survey 85% of the visitors' said that they would come to re-visit Al-Corniche but only spend little time in the OPS unless the climatic conditions are more tolerable and bearable.

4.2.3.4 Day 4 (26-08-16) Weekend

Based on the survey and shown in Figure 41, 55% of the users' during the morning managed to tolerate the environment despite the high humidity; to the extent that many users' were willing to revisit Al-Corniche. Amid the afternoon it was found that 35% of users' of the space can tolerate the physical change of the environment such as the increase in temperature. During this time a high percentage of users' were sitting under the shaded area or sitting on the cool grass. When the sun began to set and the night approached, 40%

of users' were able to tolerate the varied physical changes to the environment such as the decrease in temperature, increased humidity and reduced air movement.

Figure 41 illustrates that 50% of the users' on this day were satisfied with the wind condition, however 50% had expected and preferred that there should be more air movement. Majority of the users' surveyed felt warm to hot and noted that it would be more preferable to have more shaded areas due to the direct sunlight as it affects their experience. On the other hand, another significant percentage of the surveyed accepted the humidity level and the overall weather conditions with an average ranking of 4 out of 6 for their comfort level.

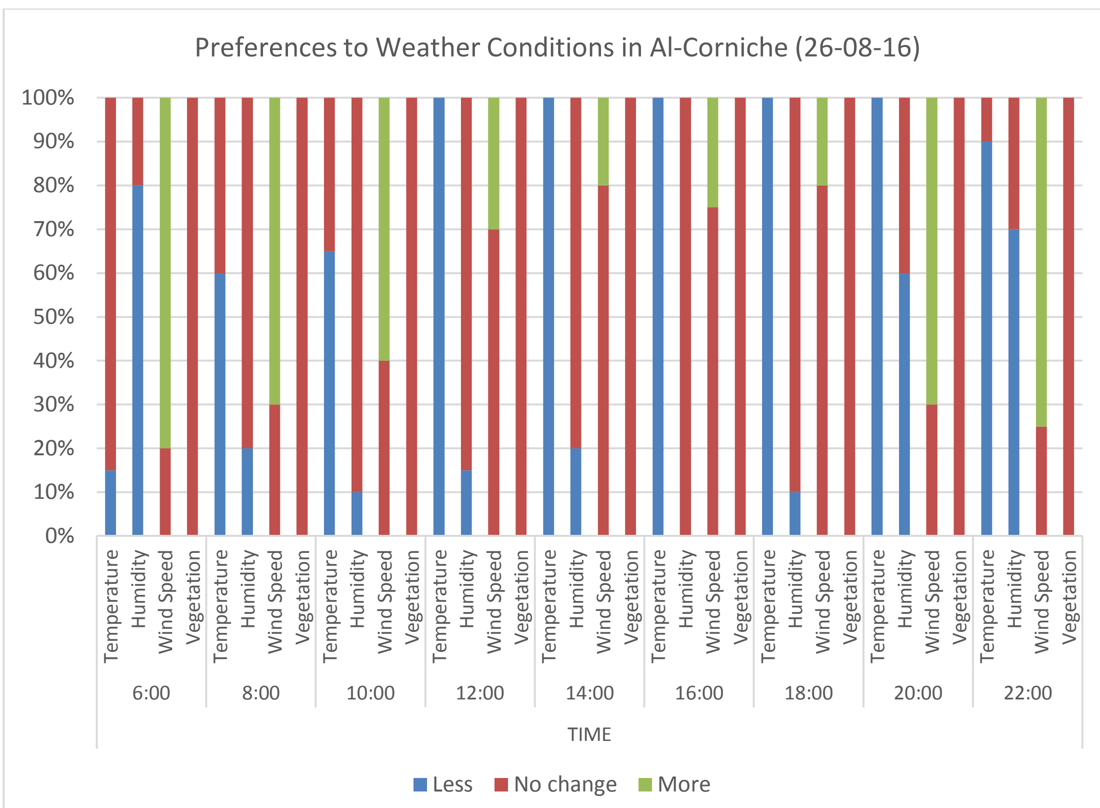


Figure 41. Preferences to weather conditions in Al-Corniche on 26-08-16 (source: developed by author)

85% of the users' didn't mind staying in the OPS of Al-Corniche throughout the day. However, in saying that, the time of stay was influenced on the level of activity taken in the space and the amount of weather conditions they can tolerate (Figure 42). Thus, expectation preceded experience in this instance.

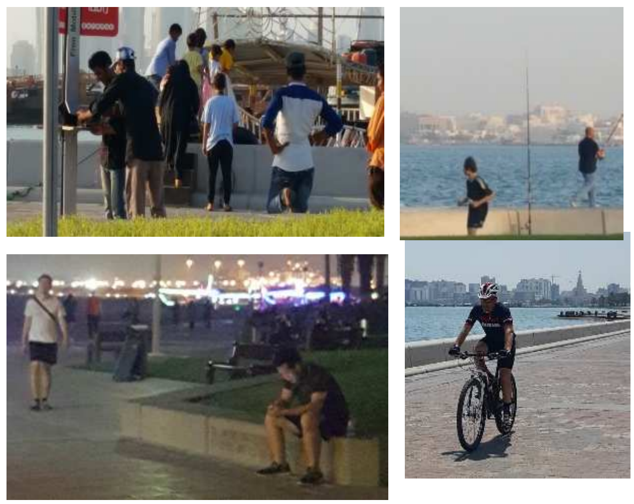


Figure 42. Activities of the OPS (source: author)

It was observed that after 2pm there was a rapid increase of users' which slowly started decreasing after 6pm as shown in Figure 43 below. From 2pm to 10pm 80% of the surveyed users' didn't mind to stay for long hours in the OPS of Al-Corniche.

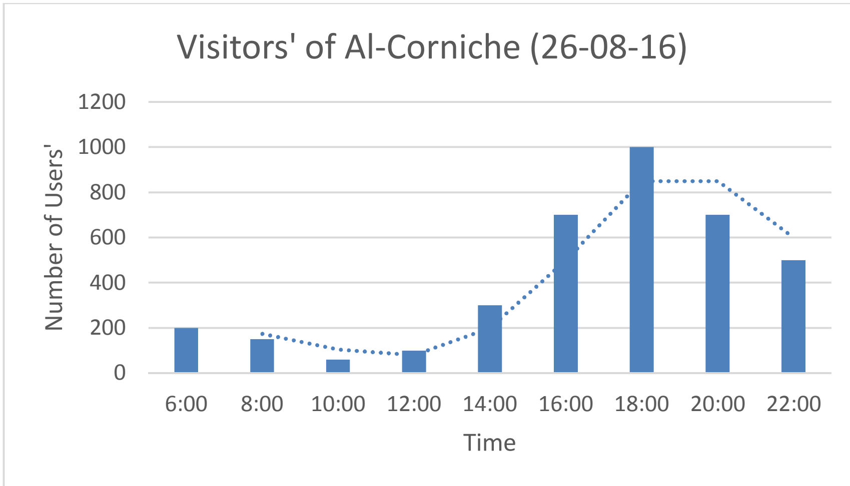


Figure 43. Number of visitors' of Al-Corniche on 26-08-16 (source: developed by author)

The anticipated time to stay for 70% of the users' during the morning was an hour to two hours, and both afternoon and evening two to four hours.

Although majority of the visitors' described the weather to be hot during the day, they had perceived control over their discomfort as many visitors' were gathered and distributed around trees to provide them with shade whilst they were sitting (Figure 44). Thus, those variables influence longer time spent outside.

Figure 44. Users' gathered around trees (source: author)

On the other hand, other people had no control over there source of discomfort including; those walking as there are no means of shading devices, some people sitting on benches as they are also un-shaded, and even the same applies for those exercising (Figure 45).

Figure 45. Lack of shading devices (source: author)

Another factor that influenced the users' length of stay to increase over the day was the good weather, greenery, beautiful landscape and nature, and the sea breeze. The environmental stimulation is an important attribute that brings people to the space such as the ocean, trees, sound of the waves, sounds of the pigeons.

The time of exposure was dependent if the users' were alone, in groups, came as families, or were in couples. It was observed that on this day users' spent more time throughout the day if they were in groups or families. As shown in Figure 46 more individuals are found in the morning, whilst in the afternoon people are usually not alone (i.e. in groups, with family or couples). Based on the survey findings, tourists were seen at 4pm and 6pm (Figure 47).

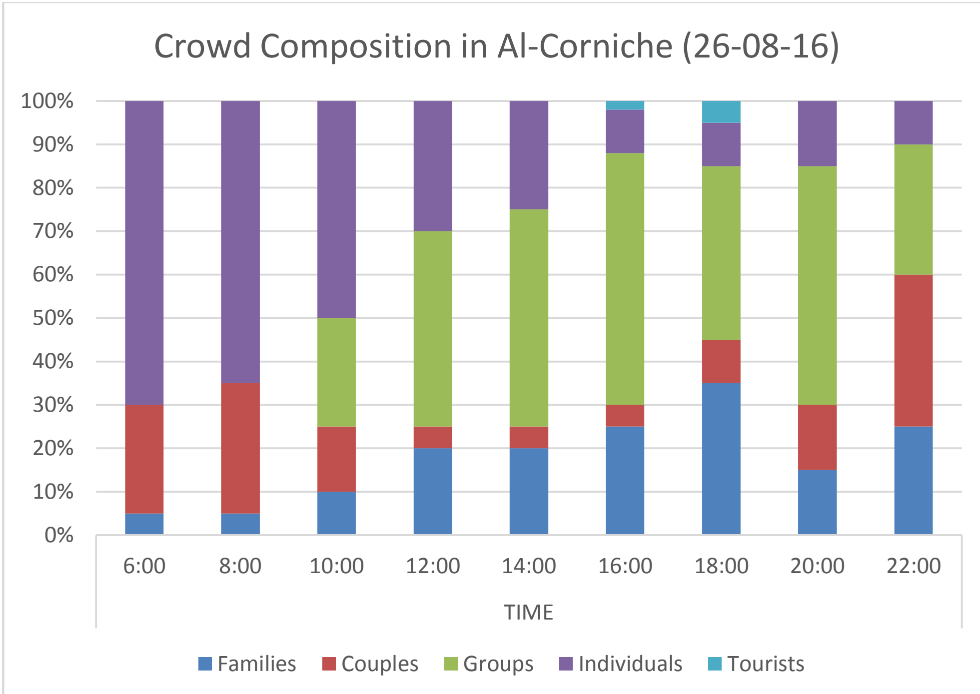


Figure 46. Crowd composition in Al-Corniche on 26-08-16 (source: developed by author)

Figure 47. Tourists (source: author)

It is important to note that 80% of the visitors' surveyed on this day said that they would come to re-visit and spend more time at Al-Corniche.

4.2.4 Microclimatic Conditions

4.2.4.1 Day 1 (16-08-16) Weekday

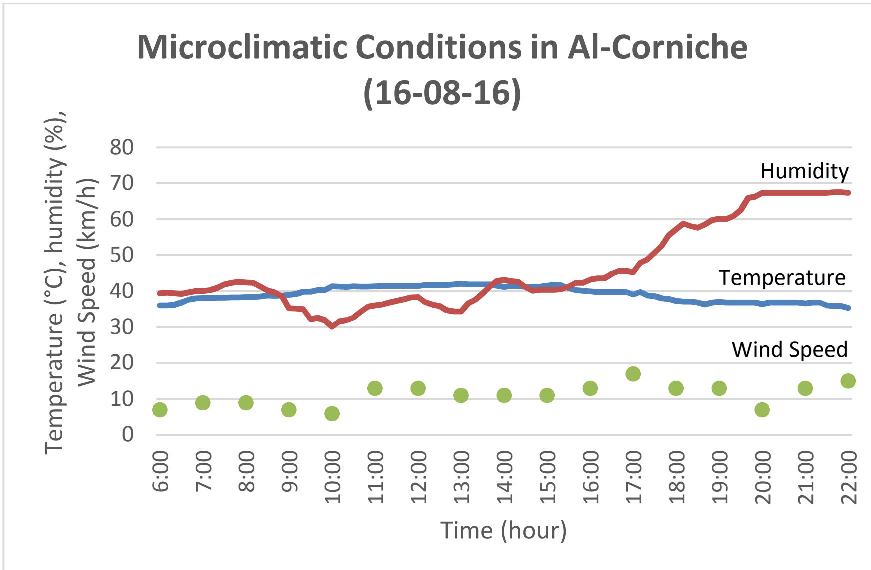


Figure 48. Microclimatic conditions in Al-Corniche on 16-08-16 (source: developed by author)

The hottest peak of the day is at 1pm (42°C), with one of the lowest humidity level (34%) and moderate wind speed (11km/h). Based on the outdoor comfort calculator it sums to a total of 40°C as shown in Figure 49 below.

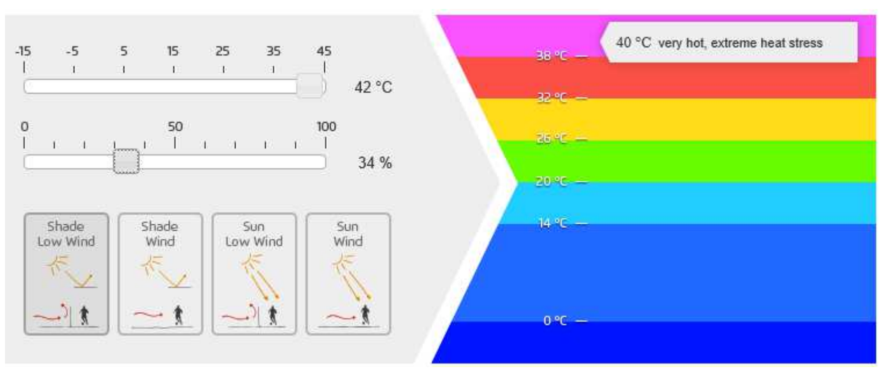


Figure 49. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

The timing between 6am to 5pm lies within approximately the same outdoor comfort range. On the other hand, the coolest peak of the day is at 6am and 10pm (36°C and 35°C, respectively). 6am has one of the lowest humidity level (39%) and lowest wind speed (7km/h). Based on the outdoor comfort calculator it sums to a total of 35°C (hot, great heat stress) as shown in Figure 50 below.

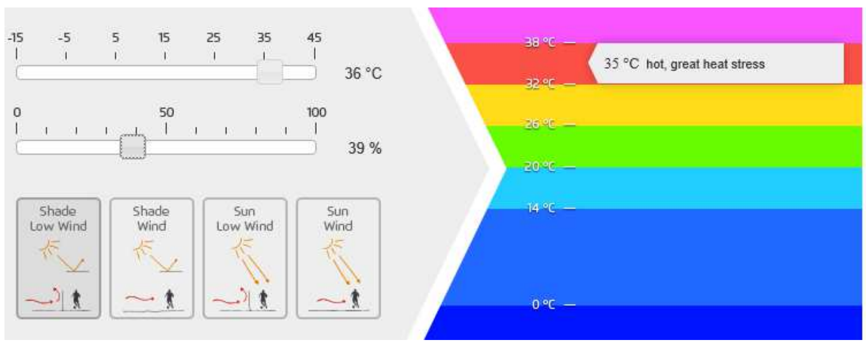


Figure 50. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

Whereas, 10pm has one of the highest humidity level (67%) and highest wind speed (15km/h). Based on the outdoor comfort calculator it sums to a total of 43°C (very hot, extreme heat stress).

4.2.4.2 Day 2 (30-08-16) Weekday

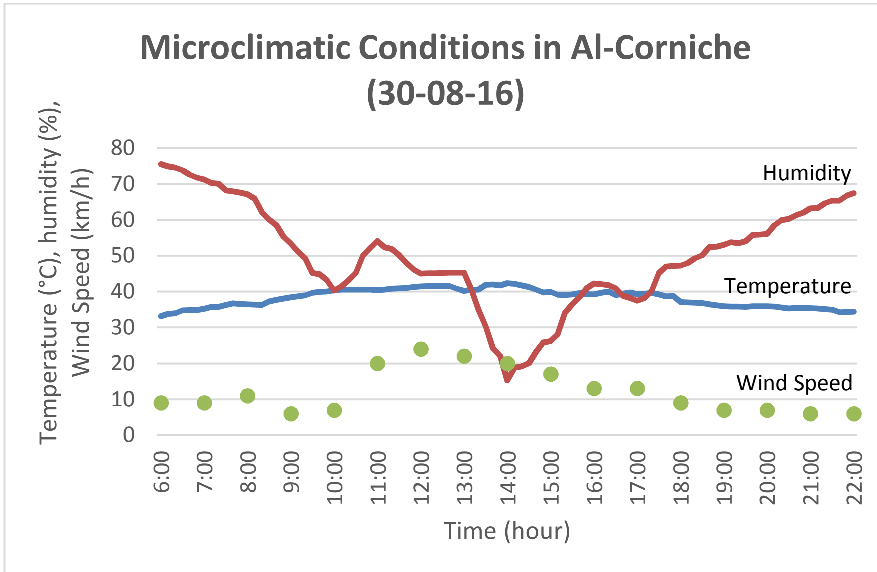


Figure 51. Microclimatic conditions in Al-Corniche on 30-08-16 (source: developed by author)

The hottest peak of the day is at 2pm (42°C), with one of the lowest humidity levels (15%) and highest wind speed (20km/h). Based on the outdoor comfort calculator it sums to a total of 32°C (hot, great heat stress).

Alternatively, the coolest peak of the day is at 6am and 10pm (33°C and 34°C, respectively). Both 6am and 10pm have one of the highest humidity levels (75% and 67%, respectively) with the lowest wind speeds (9km/h and 6km/h, respectively). Based on the outdoor comfort calculator both readings above sum to a total of 41°C (very hot, extreme heat stress).

4.2.4.3 Day 3 (12-08-16) Weekend

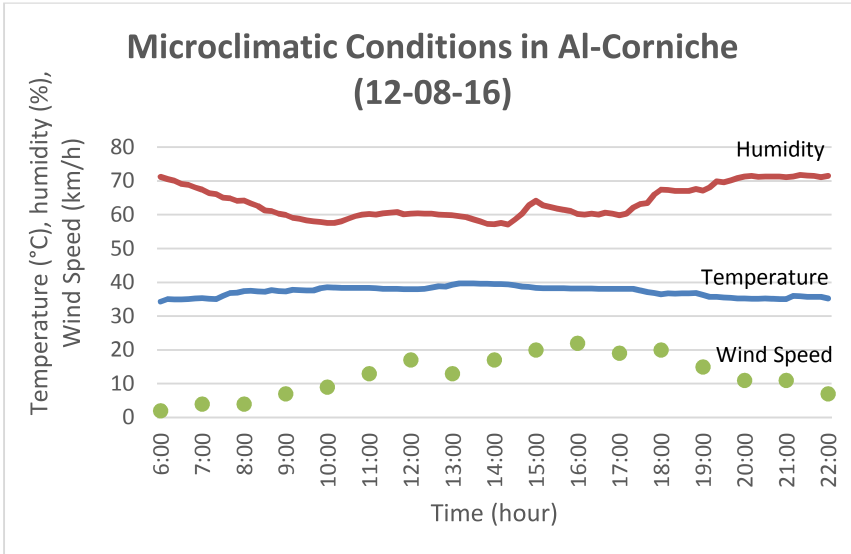


Figure 52. Microclimatic conditions in Al-Corniche on 12-08-16 (source: developed by author)

The hottest peak of the day is at 2pm (39°C), with one of the lowest humidity levels (57%) and highest wind speeds (17km/h). Based on the outdoor comfort calculator it sums to a total of 44°C (very hot, extreme heat stress) as shown in Figure 53 below. The timing between 10am to 5pm lies within approximately the same outdoor comfort range.

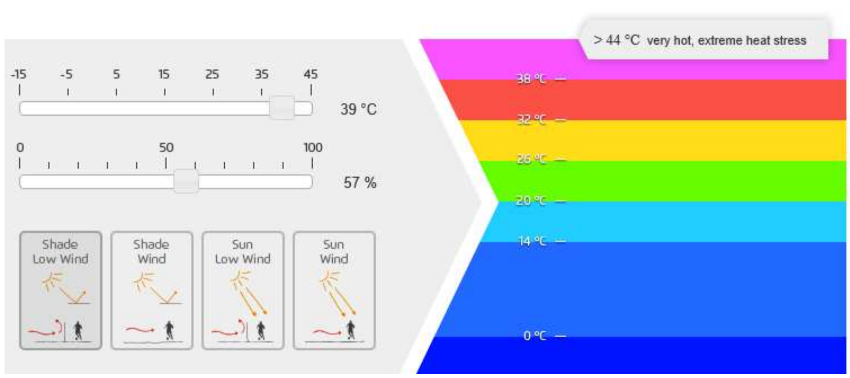


Figure 53. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

With a similar outdoor comfort temperature calculated, the coolest peak of the day is at 6am (35°C, respectively). It has one of the highest humidity level (71%) and very low wind speed (2km/h). Based on the outdoor comfort calculator it sums to a total of 44°C (very hot, extreme heat stress).

4.1.4.4 Day 4 (26-08-16) Weekend

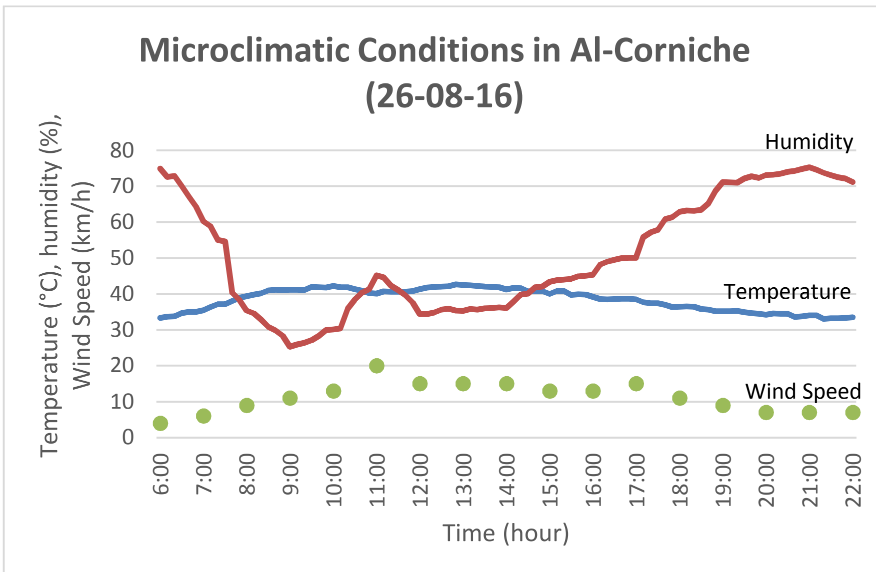


Figure 54. Microclimatic conditions in Al-Corniche on 26-08-16 (source: developed by author)

The hottest peak of the day is at 10am (42°C), with one of the lowest humidity level (30%) and moderate wind speed (13km/h). Based on the outdoor comfort calculator it sums to a total of 38°C (Figure 55).

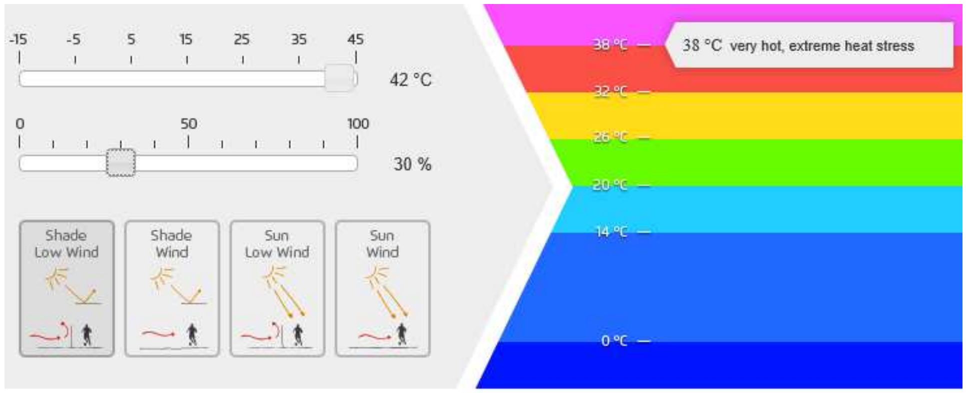


Figure 55. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

Thus, the timing between 9am to 3pm lies within approximately the same outdoor comfort range. On the other hand, the coolest times of the day were at 6am and 10pm (33°C) with one of the highest humidity levels (71% and 75%, respectively) and lowest wind speed (4km/h and 7km/h, respectively). Therefore, according to the outdoor comfort calculator both readings above sum to a total of 41°C (very hot, extreme heat stress) as shown in Figure 56.

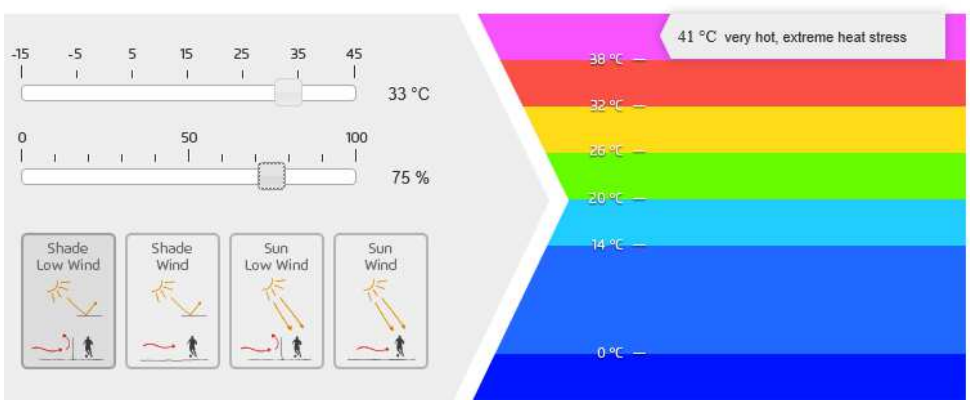


Figure 56. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

4.2.5 Site Observation of Al-Corniche

4.2.5.1 Day 1 (16-08-16) at 10am Weekday

Due to limitations of the study, the researcher could only present a geographical perspective of the focal point of the OPS in question for two main time periods, 10am and 6pm for both one weekday and one weekend. Looking at Figure 57, which is a site plan of the OPS, it can be seen that there were only 15 people who were using the central focal space of Al-Corniche, which has been noted to be the largest free space in terms of surface area where the 30-foot Oryx statue and the main restaurant (Al Mourjan) are located. On the 16th of August, 2016 at 10am, the temperature was recorded at 41°C, humidity at 30%, and wind speed measured at 6km/h. The users of the space were either walking, around the water drinking area/fountain, or sitting and relaxing under the shaded areas of trees. It can be seen that there were no individuals who were sitting by the seaside water. There were no children or groups or families spotted at this time on this weekday. There were no users observed to be exercising at this hour of the weekday mainly due to the fact that the adult population of Qatar were in their offices.

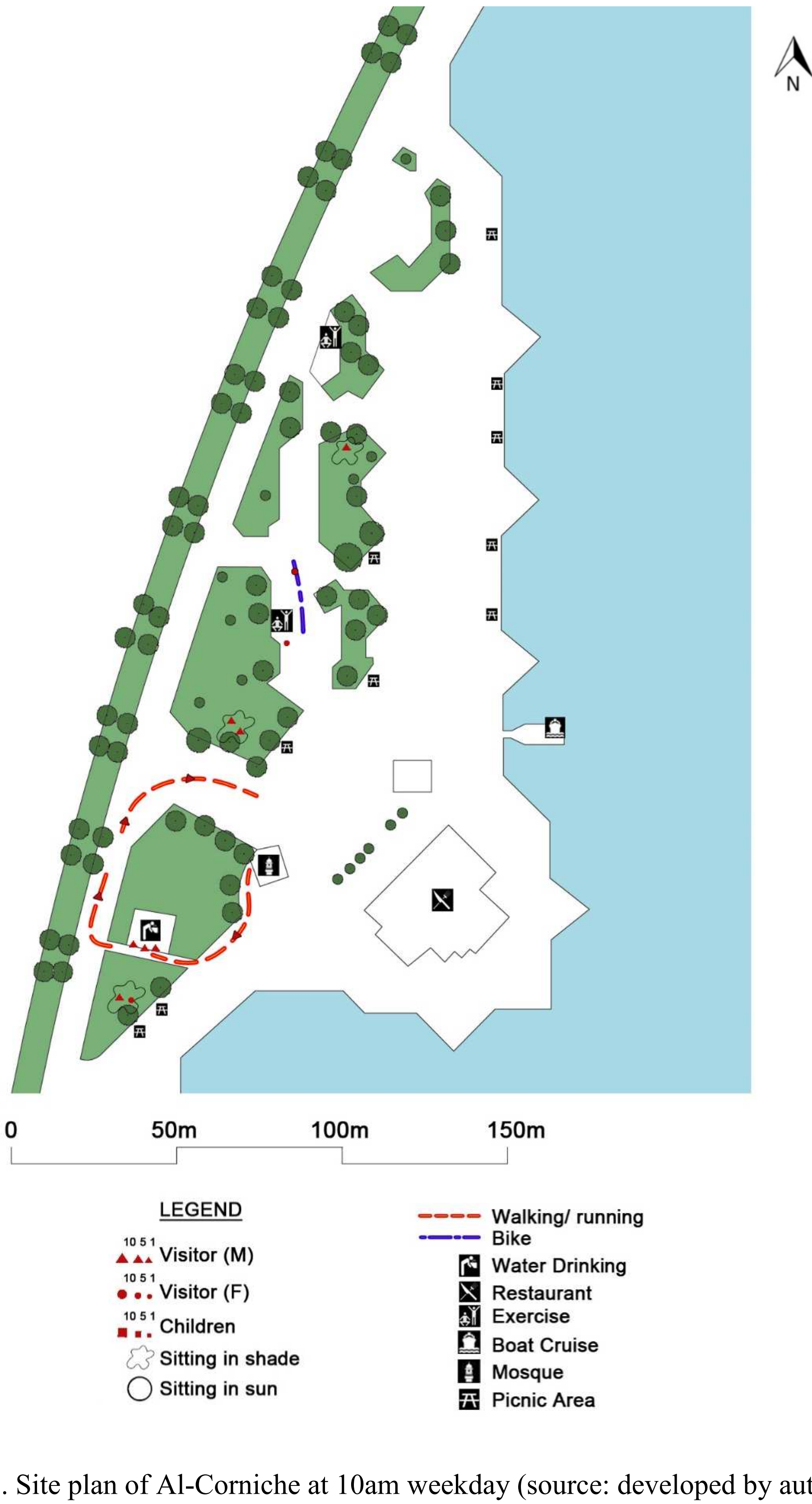


Figure 57. Site plan of Al-Corniche at 10am weekday (source: developed by author)

4.2.5.2 Day 1 (16-08-16) at 6pm Weekday

Figure 58 is a site plan of the OPS of Al-Corniche where there have been 135 people using the space on the 16th of August at 6pm. The measured temperature was 37°C, humidity at 57%, and wind speed at 13 km/h. The temperature measured at this time was lower than what was measured at 10am on this weekday, while the humidity increased and wind speed increased two-fold. Majority of the users at this time were mostly walking and not sitting, many were observed to be exercising even near the waterfront. There is a fair distribution of the users around this central focal point. It is clear in Figure 58 that there were no people sitting in the shaded areas most probably because the sun was about to set and they wanted to take advantage of the last light of the day. There were a few children accompanied by their parents. Many of the users were sitting on the grass or on the pavement near the picnic areas.

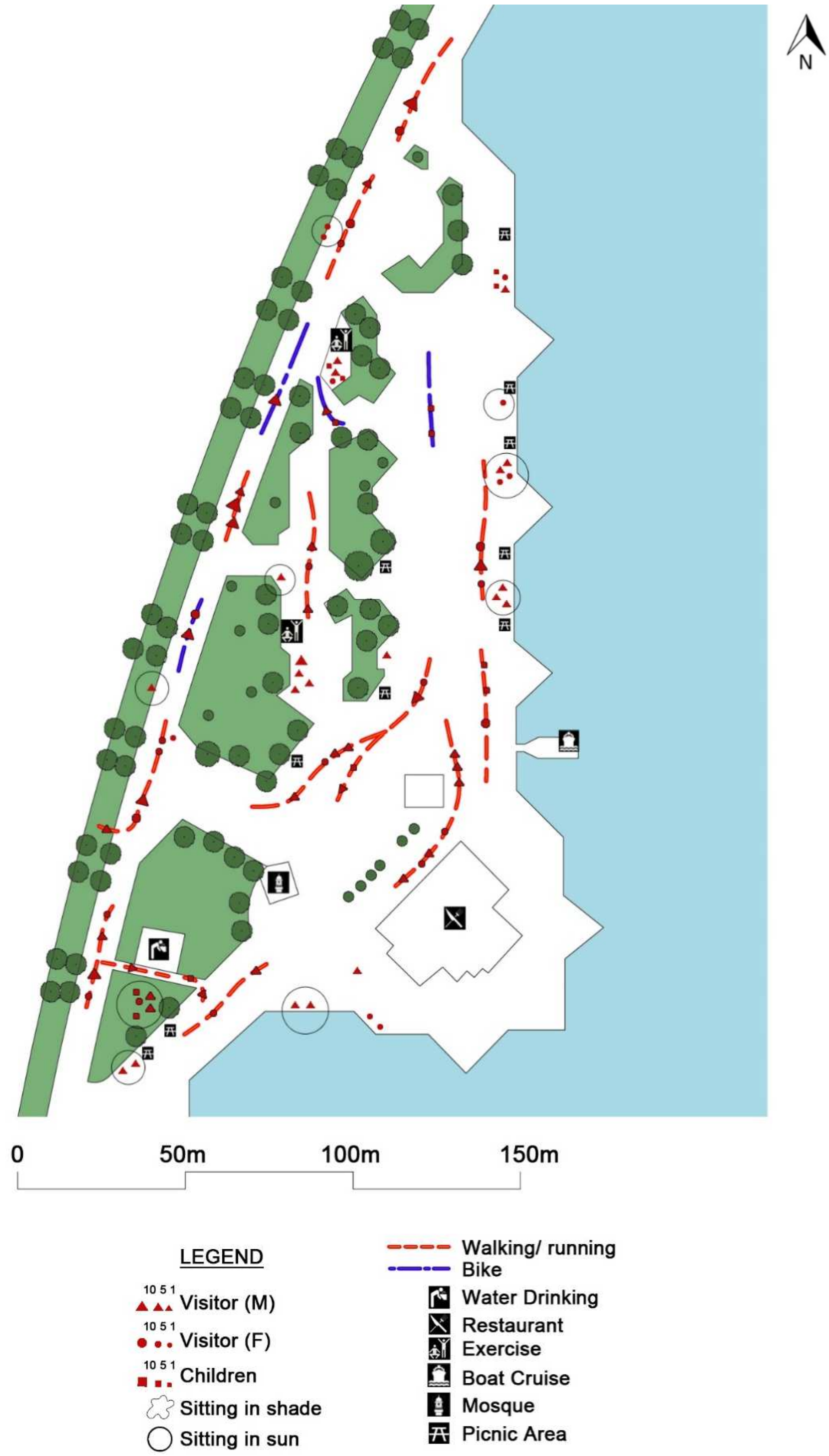


Figure 58. Site plan of Al-Corniche at 6pm weekday (source: developed by author)

4.2.5.3 Day 3 (12-08-16) at 10am Weekend

Figure 59 shows a site plan of the outdoor public space of Al-Corniche at 10am on the 12th of August, 2016, a weekend with readings of 38°C (temperature), 57% (humidity), and 9km/h (wind speed). Referring back to Figure 57, which showed a map of the OPS at 10am on a weekday with 15 users, Figure 59 presents information that there were 30 users of the space on this weekend at 10am. Majority of the users were relaxing in the morning and sitting under the shaded areas (trees), however, it was observed that there weren't enough seats under the trees for the amount of users. People were not exercising this early in the morning on the weekend because the exercising areas were not shaded by any means. And even the walkways and the bike paths had no shading devices employed for the users to walk/bike under. However, the microclimatic conditions were tolerable and comfortable enough for the users to walk rather than sit.

Figure 59. Site plan of Al-Corniche at 10am weekend (source: developed by author)

4.2.5.4 Day 3 (12-08-16) at 6pm Weekend

The site plan of Al-Corniche at 6pm on the weekend of the 12th of August, 2016, had microclimatic condition readings of temperature at 36°C, humidity at 67%, and wind speed at 20km/h. From 10am to 6pm on this weekend, there has been a large flood of people who came to use the OPS of Al-Corniche, from 30 users to 460 individuals, respectively. Because 6pm was about the time when the sun was about to set, none of the 460 users were sitting under the shade. People were mainly sitting on the grass, near the water, or near the picnic areas; there were not enough benches/seats to accommodate all of the users. Many of the male visitors were clustered around the mosque as it was almost time for Maghrib prayer. Few people were riding their bikes and most of the children were around the exercising areas. Many of the single individuals were sitting under/near the trees for privacy and away from the other users. There were almost no users who were using the boat cruise activity. Overall, there was an equal amount of users sitting and walking distributed over the entire central focal space of Al-Corniche.

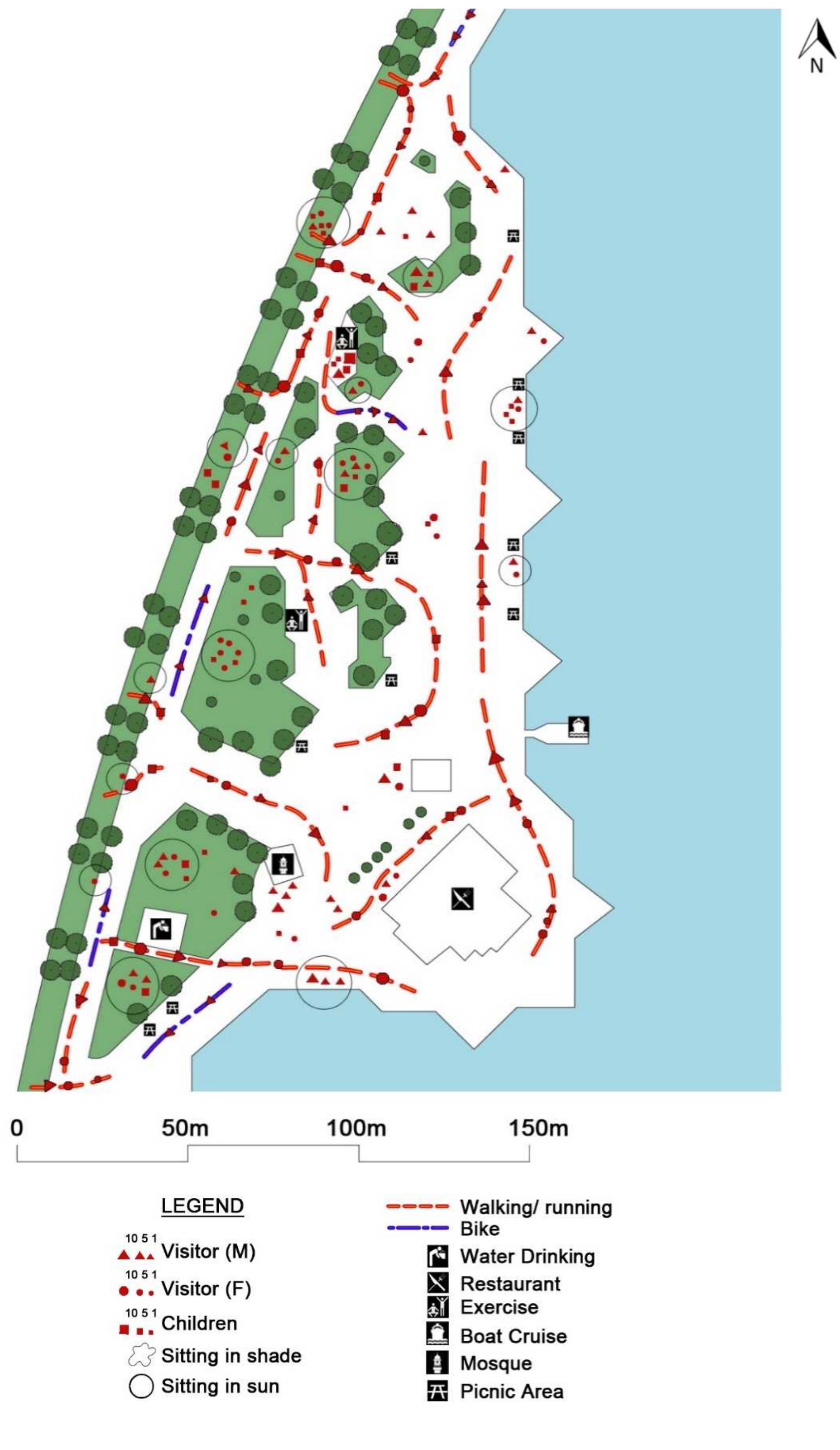


Figure 60. Site plan of Al-Corniche at 6pm weekend (source: developed by author)

4.2.6 Cumulative Al-Corniche Weekday Results

The relationship between crowd volume, temperature, humidity, wind speed and outdoor comfort temperature for the two weekdays that were studied at the various time intervals is given in Figure 61. The Y axes represents the values for temperature (in degrees Celsius), humidity (as a percentage), wind speed (in km/h), outdoor comfort temperature (in degrees Celsius) and the number of visitors; while the X axis shows the independent variables occurring over time. It is temperature, humidity and wind speed readings that are used to measure the outdoor comfort temperature. Taking this into account, the coolest outdoor comfort temperature in Figure 61 is observed at 2pm at 37 degrees Celsius with the lowest humidity at 30% and the second highest wind speed reading of 17km/h. it is at 2pm that the number of visitors began to increase at an exponential rate. The number of users of the space at Al-Corniche began to decrease starting 8pm. Perhaps this change in the crowd volume had some relation to office timings. It is also feasible that the crowd behavior and volume might not be greatly influenced by temperature, humidity or wind speed, but time might be a major factor that impacts the crowd intensity.

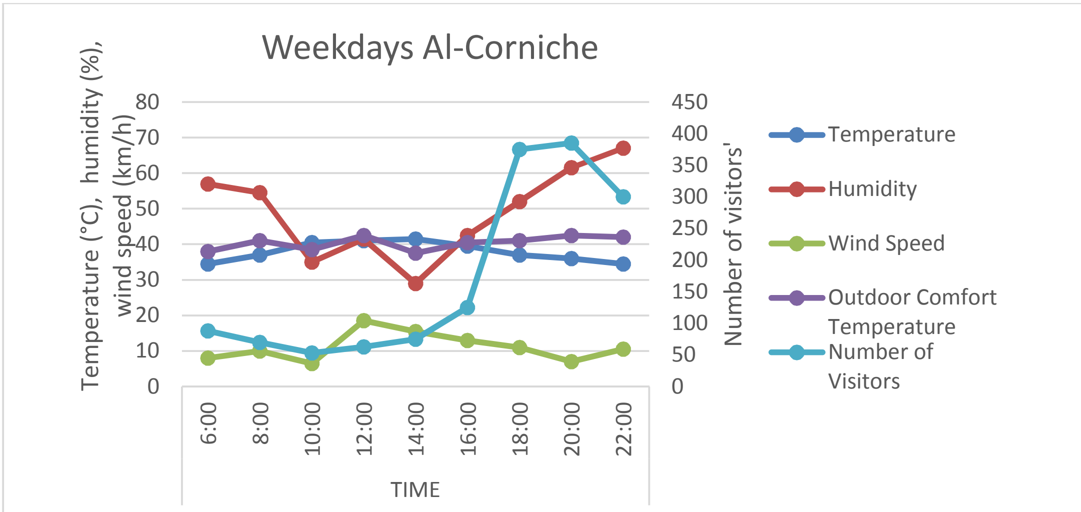


Figure 61. Cumulative Al-Corniche weekday results (source: developed by author)

Comparisons between the preferences of the visitors at Al-Corniche for the weekdays in relation to the four physical parameters from 6am to 10pm are depicted in Figure 62. The x-axis represents the physical parameters (temperature, humidity, wind speed, and vegetation), and the y-axis gives the percentages based on the visitors' responses. Many of the visitors preferred no change to the vegetation at most hours of the day. While at 8am, 10am, 12pm, and 2pm, a very minute percentage of the visitors required more vegetation; but there was an overall satisfaction with regard to the present vegetation in Al-Corniche. When analyzing the changes in the perceptions of the visitors with regards to the prevailing thermal comfort conditions from 6am to 10pm, it was observed that there was a gradual increase over the day in the percentage of the surveyed individuals who wanted lower humidity levels. Majority of the visitors preferred more wind movement; it was only at 12pm, 2pm, and 4pm, which 80%, 85%, and 70% of the visitors, respectively, were satisfied with the current conditions and required no change in the wind speed.

Majority of the visitors would have preferred lower temperatures throughout the whole day. Even though there was an increase in the number of visitors starting from 4pm (Figure 61), and even with the prevailing thermal comfort conditions experienced by the visitors that were not all tolerable or comfortable, it seems that location, greenery, vegetation, etc. were the driving force for attracting people to Al-Corniche on the weekdays.

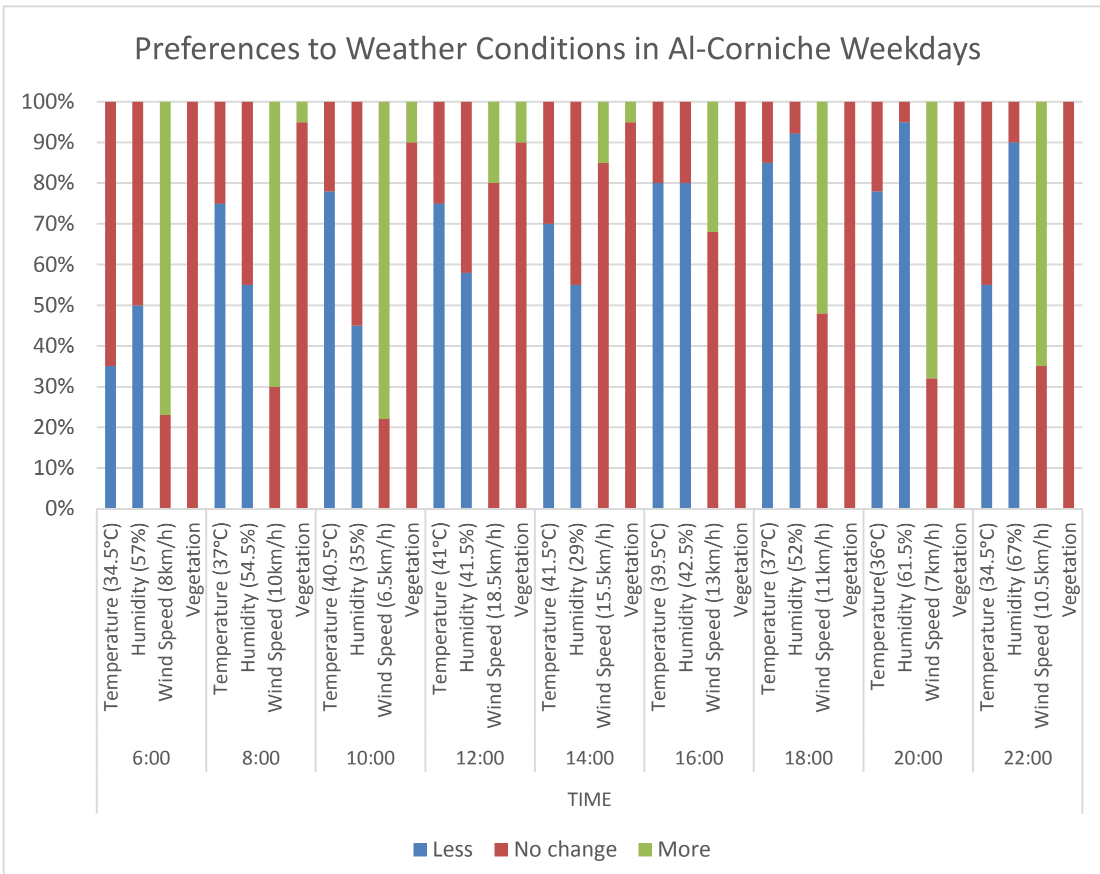


Figure 62. Preferences to weather conditions in Al-Corniche weekdays (source: developed by author)

4.2.7 Cumulative Al-Corniche Weekend Results

The relationship between crowd intensity, temperature, humidity, wind speed and outdoor comfort temperature during both weekends at various time intervals is given in Figure 63. The Y axes represents the values for temperature (in degrees Celsius), humidity (as a percentage), wind speed (in km/h), outdoor comfort temperature (in degrees Celsius) and the number of visitors; while the X axis shows the time periods in which the dependent variables were taken. It is abundantly clear throughout the entirety of the weekend that the outdoor comfort temperature readings were higher than the actual temperature recorded due to the high humidity, specifically observed between 6-8am and 4pm-10pm. It can also be observed that the humidity, which reaches beyond 70% is much higher in the weekend than the weekday at Al-Corniche. It seems that the outdoor comfort temperature was more tolerable taking into account the increased wind speed during the afternoon. Despite this, Figure 63 shows that the number of visitors began to rise mostly after 2pm and the crowd volume was at its peak at sunset, around 6pm; the number of users of the space at Al-Corniche began to dissipate starting 8pm. During the weekend, compared to the weekday, it can be seen that Al-Corniche was more crowded as parents weren't at work.

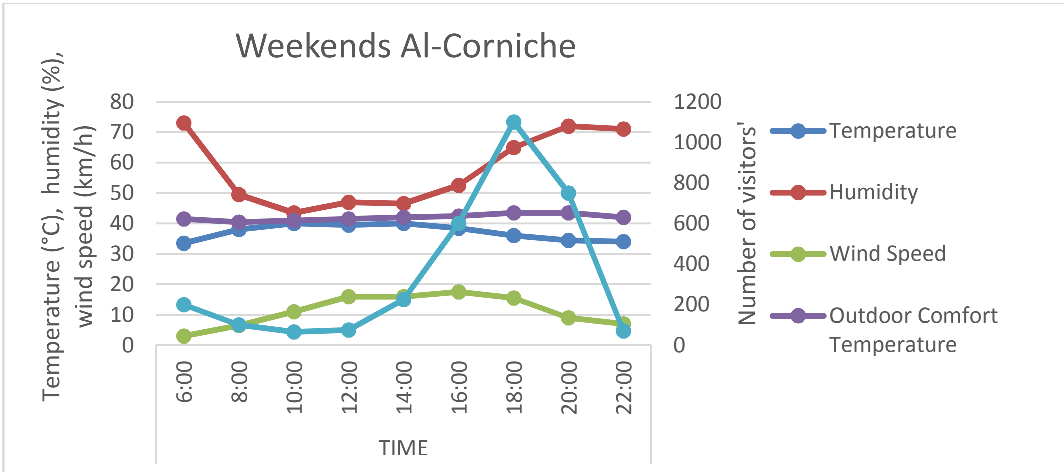


Figure 63. Cumulative Al-Corniche weekend results (source: developed by author)

Assessments on the perceptions of the visitors at Al-Corniche with regard to the prevailing physical conditions during the weekend indicate that at all hours of the two weekends that were studied, 100% of the surveyed visitors were satisfied with the amount of vegetation present in the OPS (Figure 64). It is also strikingly clear that at 12pm and 2pm, 100% of the visitors preferred lower temperature values; this is in conjunction with Figure 63, which shows that the highest temperature readings were recorded at 12pm and 2pm of 40 degrees Celsius. The visitors throughout the weekends preferred more wind movement. Humidity was tolerable in the evening hours and preferred to be less during the morning and afternoon hours.

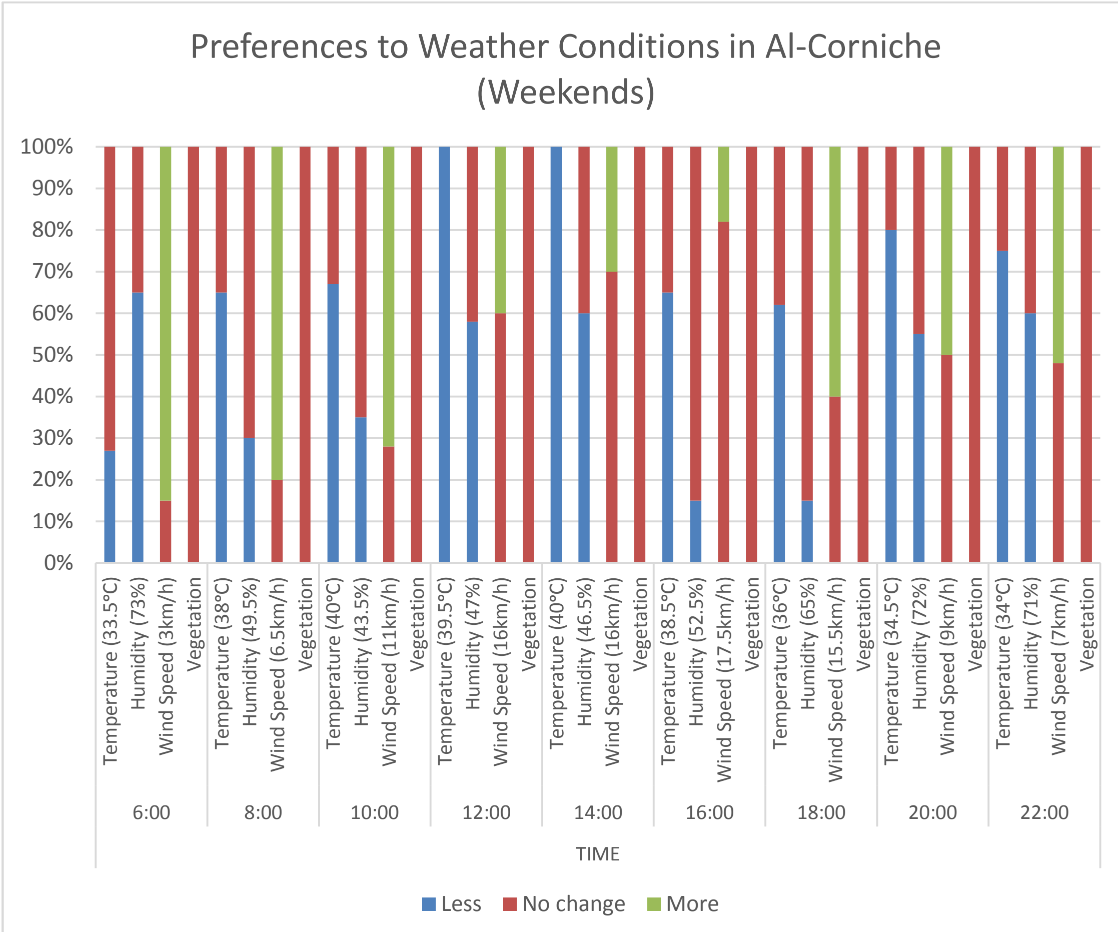


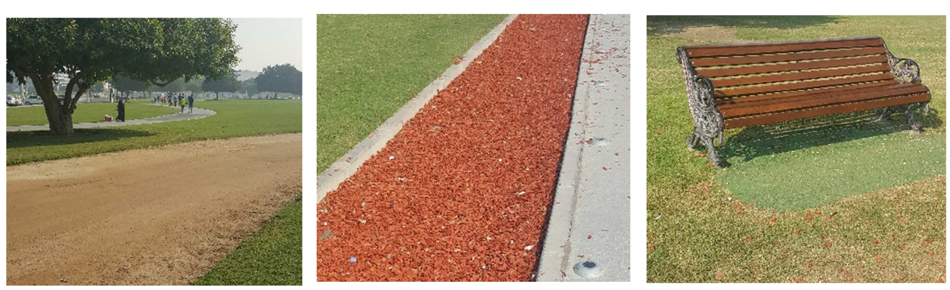
Figure 64. Preferences to weather conditions in Al-Corniche weekends (source: developed by author)

4.3 OPS of Aspire

4.3.1 Physical Aspect of the OPS

Aspire is located on a high topographical point where the space has been planned to be above the average ground level. It is surrounded by medium rise buildings, Café and restaurant, and operational kiosks. It is scattered with lots of vegetation all around such as trees, shrubs, and grass. The presence of some water features such as the pond and the fountain adds to the beautifully landscaped environment. Aspire has seats both with and without shading devices such as a pergola or a tree to allow the user to select from a variety of different choices which suits their preferences (Figure 65). In saying that some walking routes don’t have enough shading device. Aspire has the soft walking mat (rubber), wood chips mulch, sand trail, route for cycling, and light concrete ground surface pavement. The existing urban furniture is also light in color adding a peaceful and relaxing atmosphere to the outdoor public area.

Variety of seating arrangements



Variety of floor surfaces

Figure 65. Physical elements of the space (source: author)

Furthermore, Aspire has evaporative cooling device around the central pond to provide a thermal comfortable environment for the user of the OPS (Figure 66). It is also crucial to take note that Al-Corniche doesn't have any cooling devices in its OPS.

Figure 66. Evaporative cooling device in Aspire (source: author)

4.3.2 Physical Adaptation of the User

4.3.2.1 Activities in Aspire

The varieties of activity that are current in Aspire include both optional and social types. The optional or recreational activities that users' employ include sitting on a bench in the open space to enjoy the pond or the landscape, or walking in the open space, etc. The other type is the social or resultant activities that rely on the people present in the outdoor space. It usually occurs when people meet to socialize in a certain place for chatting, greeting, children playing, and other communal activities. Figure 67 shows the percentage of different activities observed over the four days in Aspire including both weekdays and weekends.

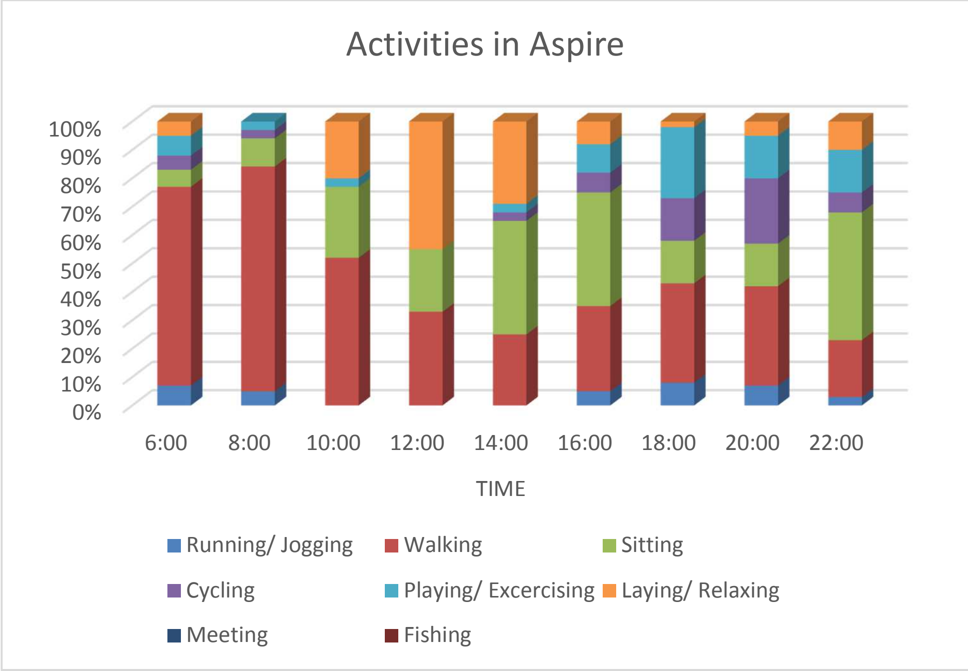


Figure 67. Activities in Aspire (source: developed by author)

OPS becomes a goal in itself (Gehl, 2007), where it hosts social, cultural, and recreational activities including exhibitions, parades, sport activities, and outdoor cafés. It has been observed that Aspire doesn’t lack any of those other than the outdoor exhibitions.

4.3.2.2 User Demographics

It has been observed that over the four days in Aspire including both weekdays and weekends there were over 40% more men than women utilizing the OPS (Figure 68). It is vital to note that from 6pm to 8pm there are 50% more women than men.

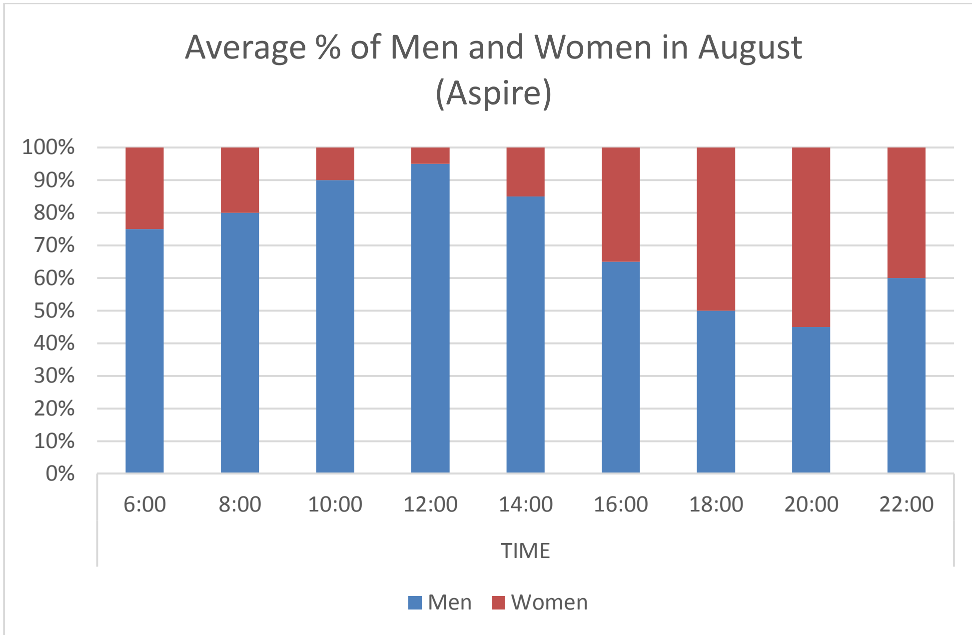


Figure 68. Average % of men & women for weekdays & weekends in Aspire (source: developed by author)

The length of stay varies from one user to the other. The duration of time and use is dependent on many variables such as the microclimatic conditions and other factors. The OPS of Aspire is usually used for longer hours when the weather is tolerable; thus activities are extended to include evening hours enabling people to socialize and gather in outdoor spaces. Users' of Aspire spend a lot of time if they are usually with family, during the evening or weekends. Thus, the OPS of Aspire is a rich-vibrant environment full of people and different activities.

4.3.2.3 Clothing, food and drinks

Majority of the people were wearing short-sleeved tops (0.2CLO) and long pants (0.4CLO), while others were wearing shorts (0.2CLO). There was a significant number of users' who wore black abayazs (0.5CLO), headscarfs, and burqa; whilst some chose to wear white dishdasha (0.4CLO) (mainly due to culture and religion). Many users' wore hats and opened shoes. However, in saying that, many also chose to wear closed shoes with socks. Over the four days observed, the choice of color of cloths varied; 25% of the users' wore light colors, 50% wore mixed, and 25% wore dark colors.

It has been observed that a variety of users' ate and drank hot and cold food and drinks; with more of cold drinks.

4.3.3 Psychological Adaptation

4.3.3.1 Day 1 (16-08-16) Weekday

75% of the users' surveyed from 6am to 12pm were able to tolerate both air temperature and humidity level where they preferred no-change in the air temperature and humidity. However, many users' were not satisfied with the wind speed where 85% preferred more air movement. From 12noon to 6pm, 95% of users' preferred lower air temperature and 85% preferred less humidity, whereas 80% were not satisfied with the wind speed where they required more air movement. During the evening from 6pm to 10pm, 70% of the surveyed were not able to tolerate the air temperature and required less temperature; 80% preferred a lower humidity level; and 85% preferred more air movement (Figure 69). Thus, users' during both afternoon and evening were not able to tolerate the overall weather conditions. Based on the survey 55% of the visitors' said that they would come to re-visit Aspire but only spend little time in the OPS.

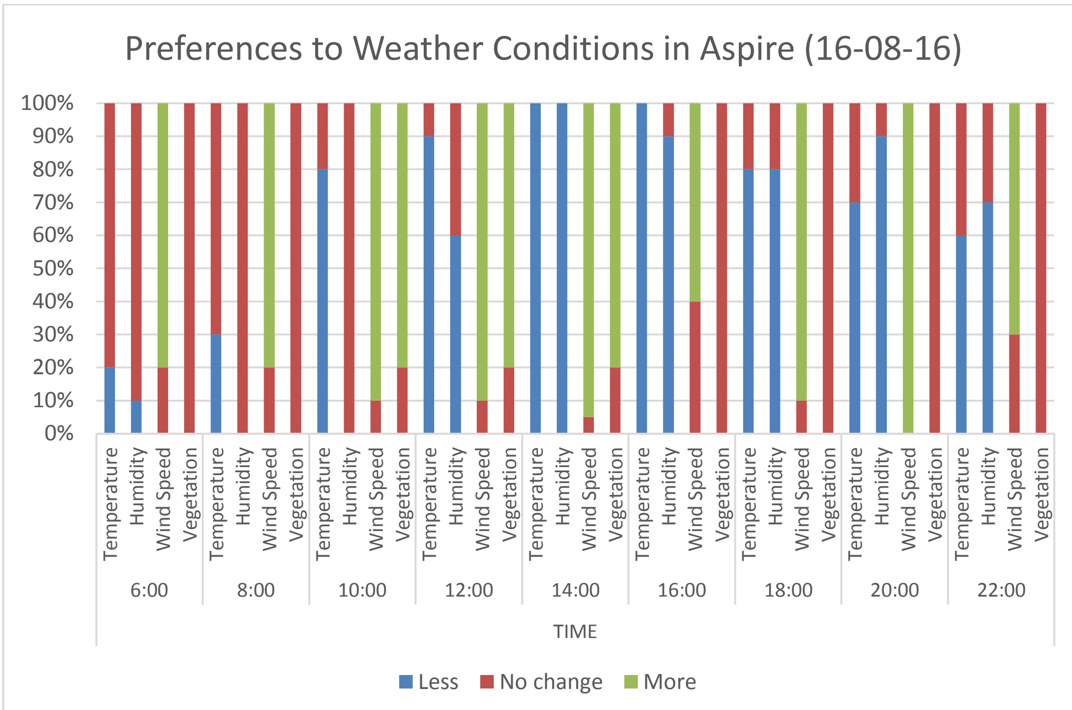


Figure 69. Preferences to weather conditions in Aspire on 16-08-16 (source: developed by author)

It was observed that from 4pm to 8pm users' rapidly increased reaching 200 persons. After 8pm users' started slowly decreasing (Figure 70). 70% of users' were not able to tolerate the weather conditions, therefore, they were not able to stay for long hours in the OPS of Aspire.

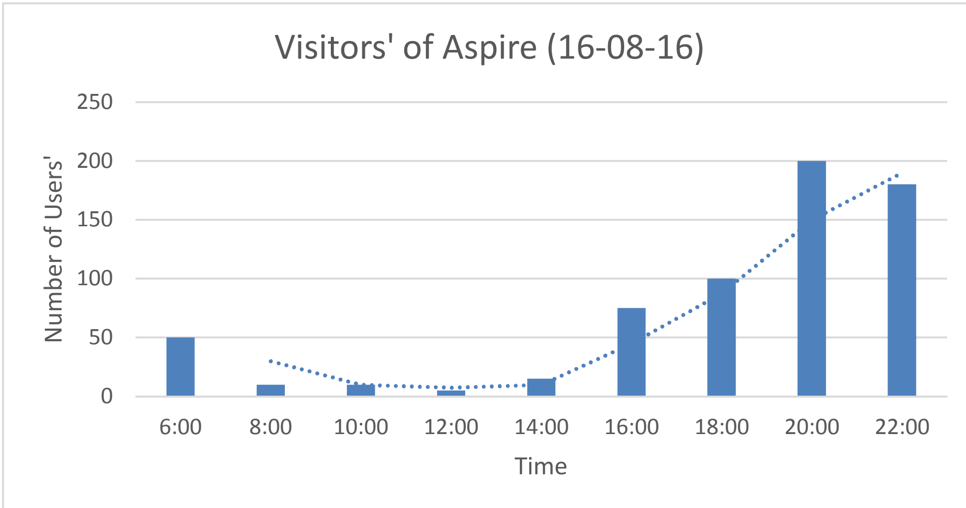


Figure 70. Number of visitors' in Aspire on 16-08-16 (source: developed by author)

As illustrated in Figure 71, more individuals are found from 6am to 4pm (Figure 72), whilst from 4pm to 10pm at night there was a variety of crowd composition in the OPS ranging from families, groups, individuals, and couples. However the most percentage was composed of families during these hours.

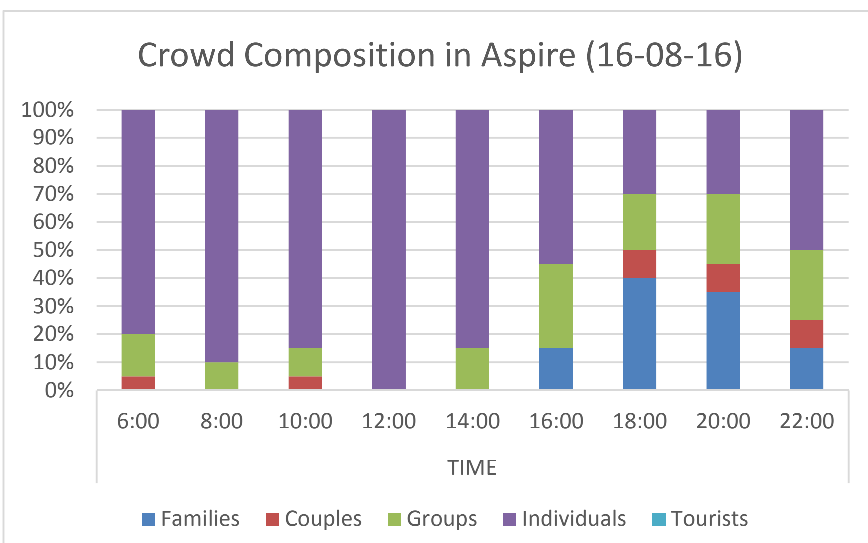


Figure 71. Crowd composition in Aspire on 16-08-16 (source: developed by author)

Figure 72. Individuals in the OPS of Aspire (source: author)

4.3.3.2 Day 2 (30-08-16) Weekday

The survey illustrated that from 6am to 12pm 60% of the users' were not able to tolerate the air temperature as they preferred less air temperature, and 90% preferred more air movement. On the other hand, 40% preferred less humidity while 60% didn't mind the humidity level and required no change. During the afternoon from 12pm to 6pm 90% of users' preferred lower air temperature and only 40% preferred a lower humidity level. Based on the survey from 12pm to 6pm 95% were satisfied with the wind speed and required no change in the air movement. Thus, users' during the afternoon were able to tolerate the overall weather conditions. During the evening from 6pm to 10pm 50% of the surveyed were not able to tolerate the air temperature and required less temperature; 75% preferred less humidity; and 55% preferred more air movement (Figure 73).

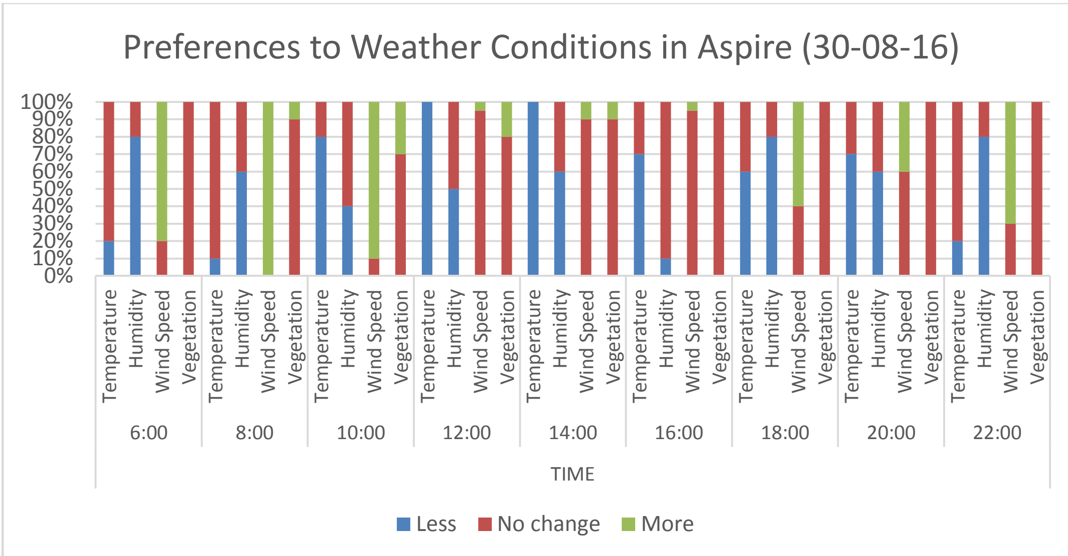


Figure 73. Preferences to Weather conditions in Aspire on 30-08-16 (source: developed by author)

It was observed that from 4pm to 10pm there was a fast increase of users' reaching to a number of 500 persons (Figure 74). As an overall, users' were able to tolerate the weather conditions of the day as 75% of the surveyed did not mind staying for long hours in the OPS of Aspire.

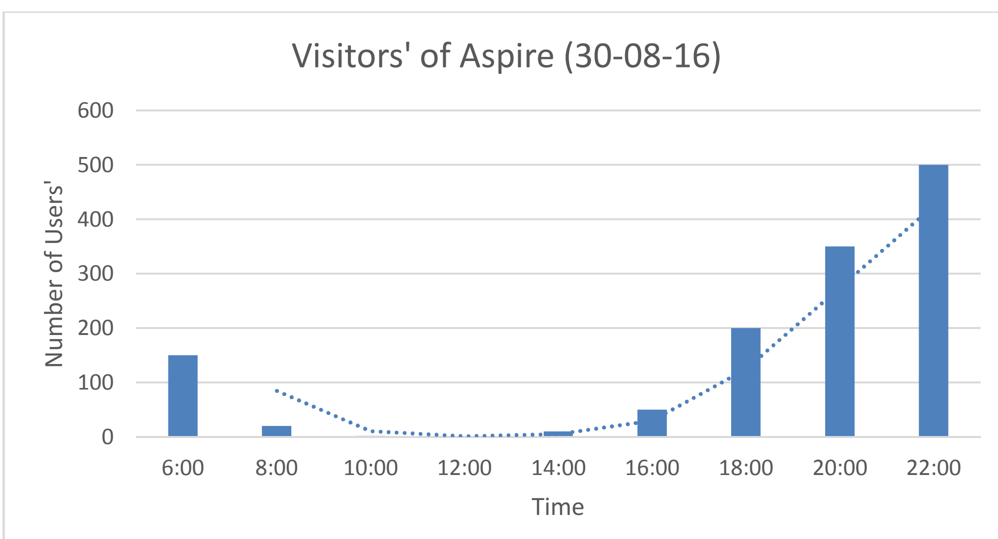


Figure 74. Number of visitors'' in Aspire on 30-08-16 (source: developed by author)

Figure 75. Users' enjoying the OPS in Aspire (source: author)

The anticipated time to stay for 85% of the users' during the morning was half an hour to an hour, and both afternoon and evening one to four hours depending on both the activity level and if they were alone, in groups, families, couples, etc. Based on the survey 70% of the visitors' said that they would come to re-visit Aspire and spend more time in the OPS.

As illustrated in Figure 76, more individuals are found from 6am to 6pm, whilst from 4pm to 10pm at night there was a variety of crowd composition in the OPS ranging from families, groups, individuals, and couples. However, the highest percentage was composed of families during these hours. According to the survey tourists were also noted from 6pm to 8pm.

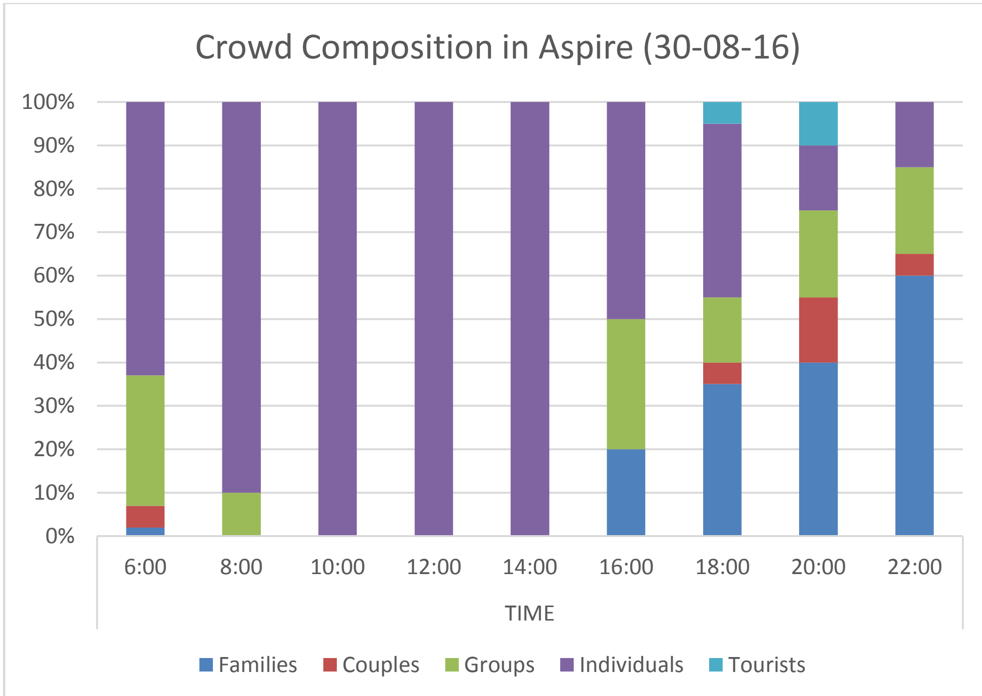


Figure 76. Crowd composition in Aspire on 30-08-16 (source: developed by author)

4.3.3.3 Day 3 (12-08-16) Weekend

The survey illustrated that from 6am to 12pm 90% of the users' were not able to tolerate the air temperature where they preferred less air temperature; 95% preferred less humidity, and 100% preferred more air movement. During the afternoon from 12noon to 6pm 100% of users' preferred lower air temperature and less humidity level, and 75% were not satisfied with the wind speed where they required more air movement. Thus, users' during both morning and afternoon were not able to tolerate the overall weather conditions. During the evening from 6pm to 10pm 80% of the surveyed were not able to tolerate the air temperature and required less temperature; 75% preferred less humidity level; and 85% preferred more air movement (Figure 77).

It is interesting to further note that from 10am to 12noon 15% of the users' were not satisfied with the amount of vegetation and required more. However, throughout the rest of the day 100% of the respondents were satisfied with the amount of vegetation provided (Figure 77).

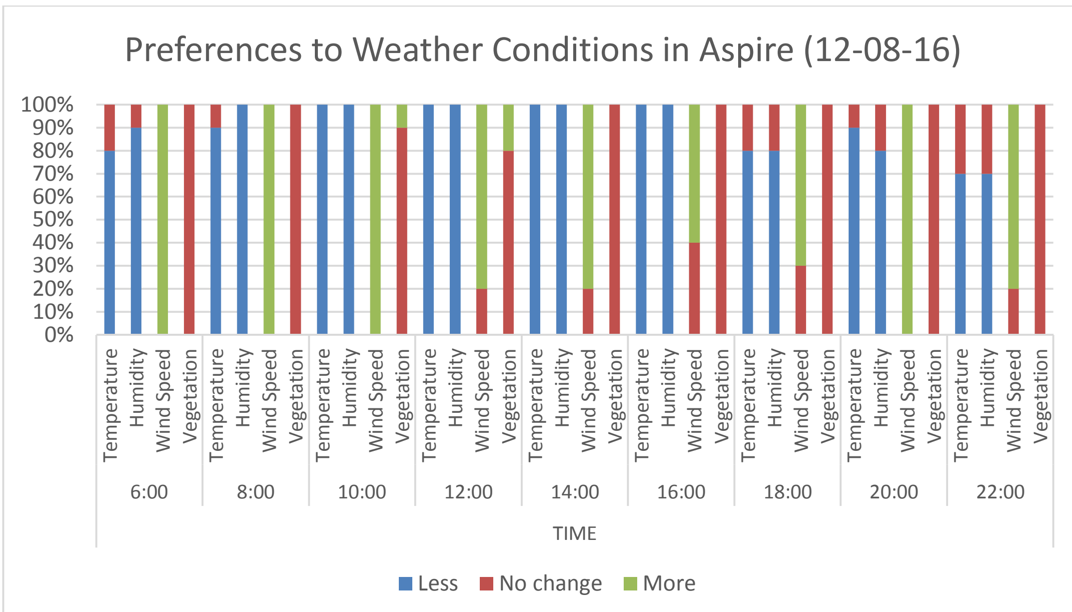


Figure 77. Preferences to weather conditions in Aspire on 12-08-16 (source: developed by author)

It was observed that after 4pm there was a rapid increase of users' which slowly started decreasing after 8pm (Figure 78). Although a high percentage of users' were not able to tolerate the weather conditions, 60% of the surveyed did not mind staying for long hours in the OPS of Aspire from 6pm to 10pm. Although this is the case, the time spent outdoor was rather influenced on the level of activity by the visitors' and the weather conditions they can handle.

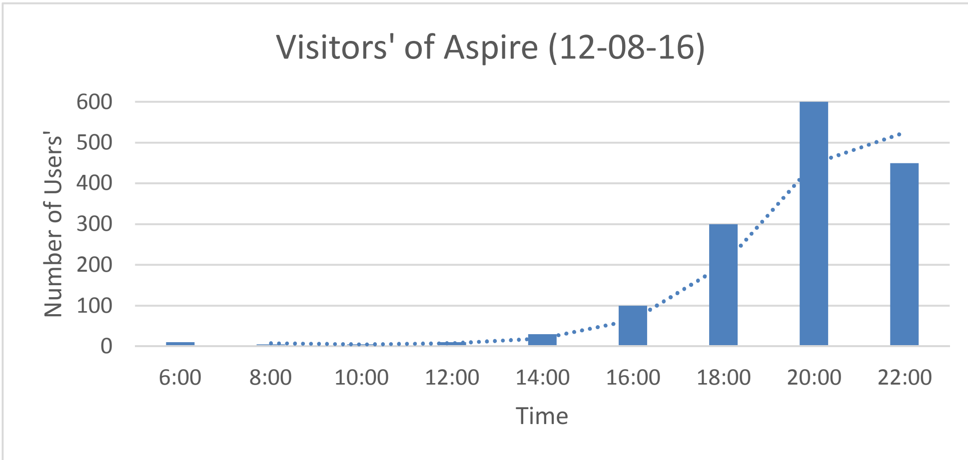


Figure 78. Number of visitors' in Aspire on 12-08-16 (source: developed by author)

The anticipated time to stay for 90% of the users' during the morning was fifteen minutes to less than half an hour, and both afternoon and evening one to two hours.

Although majority of the visitors' described the weather to be hot during the day, they had control over their discomfort as many visitors' were seated under shaded trees and pergolas/canopies. Thus, the provision of proper shading devices encouraged longer time to be spent outside.

On the other hand other, users' whom were walking, exercising or cycling had no control over their source of discomfort in regards to availability of shading. However, in saying that, they had perceived control over the dress code, choice of color for their clothing, and choice of drink and food.

In addition, the environmental stimulation was another attribute that brings people to the space and influence the users' to stay for longer hours throughout the day. These factors include the greenery, beautiful landscape and nature, sounds of the aquatic animals, pond and the walking fountain.

The time of exposure is a variable that is dependent if the users' were alone, in groups, families, couples. Based on the respondents' surveyed and observations made, it is seen that users' spent more time if they were with family or groups. As illustrated in Figure 79, more individuals are found in the morning from 6am to 12noon, whilst from 12noon to 10pm at night there was a varied crowd composition in the OPS ranging from families, groups, individuals, and couples. However, the most percentage was composed of families during these hours. According to the survey tourists also used the space from 6pm to 8pm.

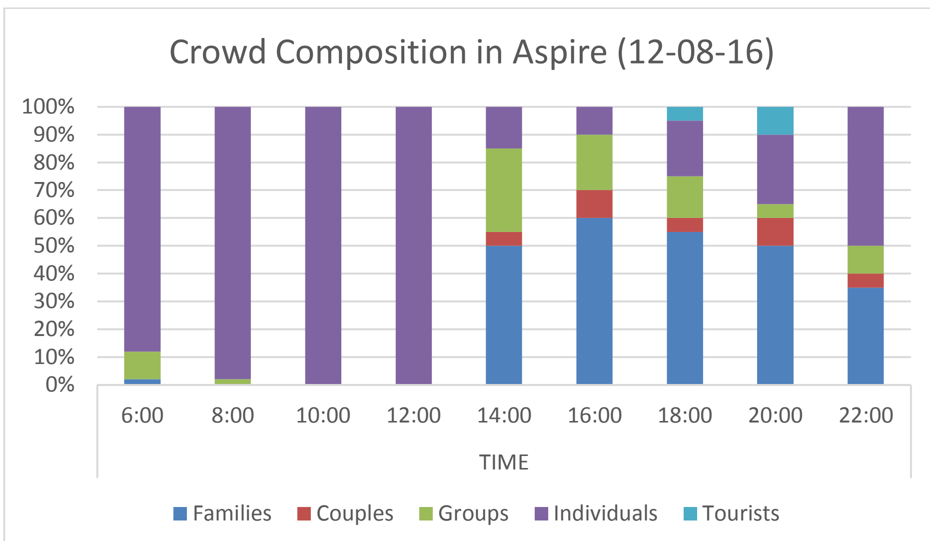


Figure 79. Crowd composition in Aspire on 12-08-16 (source: developed by author)

Based on the survey 70% of the visitors' said that they would come to re-visit Aspire but only spend little time in the OPS.

4.3.3.4 Day 4 (26-08-16) Weekend

The survey illustrated that from 6am to 12pm 50% of the users' were not able to tolerate the air temperature as they preferred a lower air temperature, 25% preferred less humidity, and 55% preferred more air movement. During the afternoon from 12pm to 6pm, 95% of users' preferred lower air temperature, 75% preferred less humidity level, and 65% preferred more air movement. During the evening from 6pm to 10pm, 60% of the surveyed were not able to tolerate the air temperature; 45% preferred less humidity level; and 85% preferred more air movement (Figure 80). However, in saying that, users' were able to tolerate the environment during the night time due to the overall moderate weather conditions.

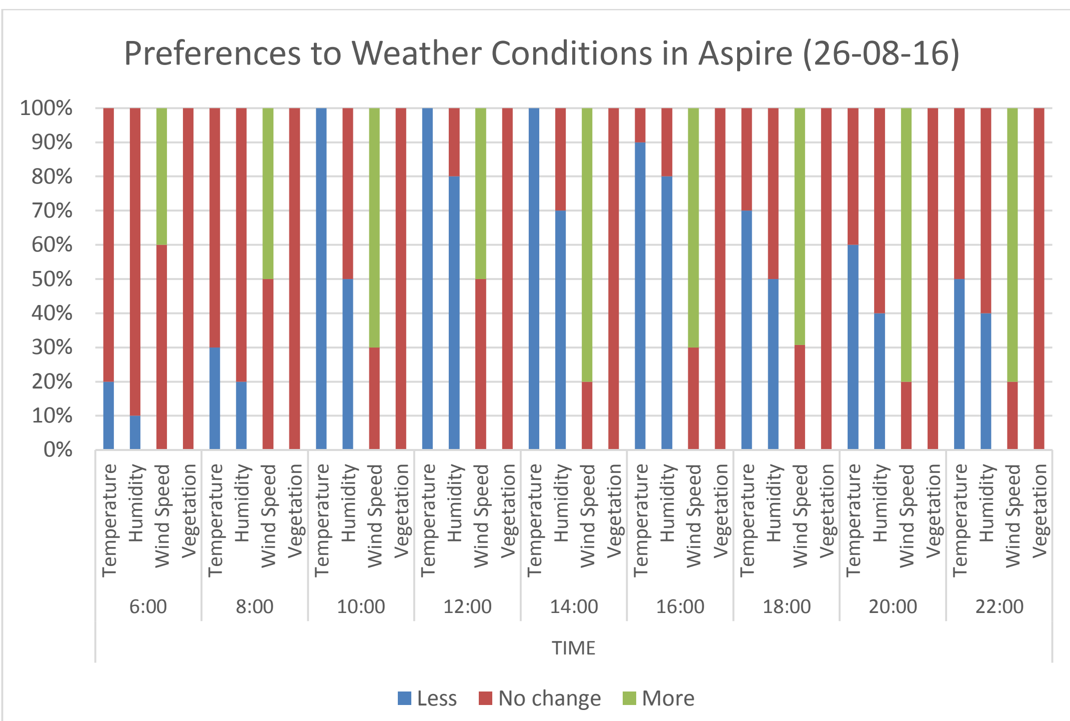


Figure 80. Preferences to weather conditions in Aspire on 26-08-16 (source: developed by author)

It was observed that at 6am there was a good number of users' in the OPS of Aspire (200 person), which rapidly decreased after 8am to the extent that there was hardly any users' seen. After 6pm there was a rapid increase of users' (400 persons) which slowly started decreasing after 8pm (Figure 81).

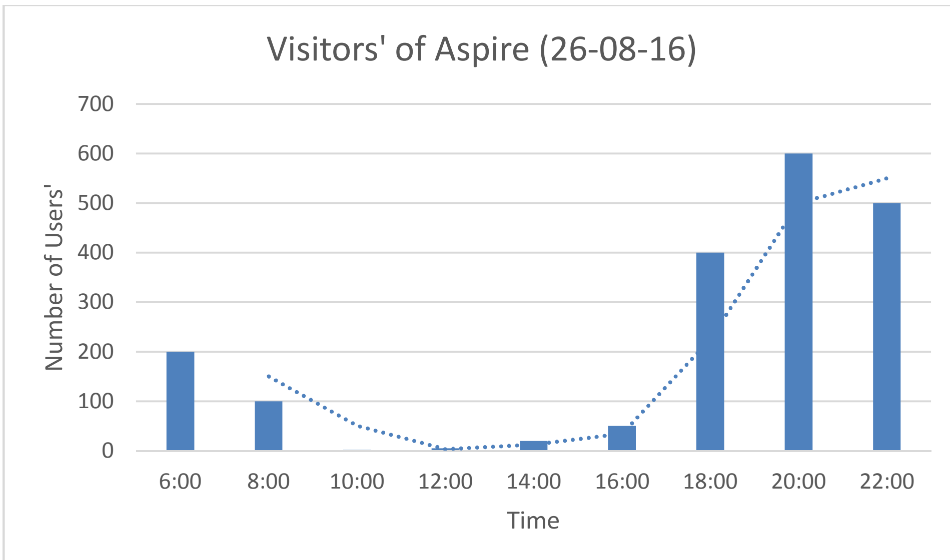


Figure 81. Number of visitors' in Aspire on 26-08-16 (source: developed by author)

Based on the survey 85% of users' from 10am to 6pm were not able to tolerate the overall weather conditions and thus were not able to stay outdoors for long hours. Alternatively, 75% of the respondents' from 6pm to 10pm didn't mind staying for long hours in the OPS of Aspire, although the weather conditions were not great. However, the time of stay was massively influenced on the level of activity taken in the space and the amount of weather conditions they can tolerate.

The anticipated time to stay for 60% of the users' during the morning was less than half an hour (where it shows that visitors' want to come but don't want to spend more time), afternoon no-one was able to stay (users' don't want to come and don't want to spend time), and evening two to four hours (people want to come and spend more time).

The time of exposure was dependent if the users' were alone, in groups, families, couples. It was observed that on this day users' spent more time throughout the day if they were in groups or families. As illustrated in Figure 82, more individuals are found in the morning (6am to 8am) with little amount of couples. From 10am to 12pm it is mainly individuals, whereas starting from 4pm to 10pm it is mostly families, then individuals and groups, then couples (Figure 83). It is critical to highlight that Aspire is mainly inclusive of families and sports on all days of the week.

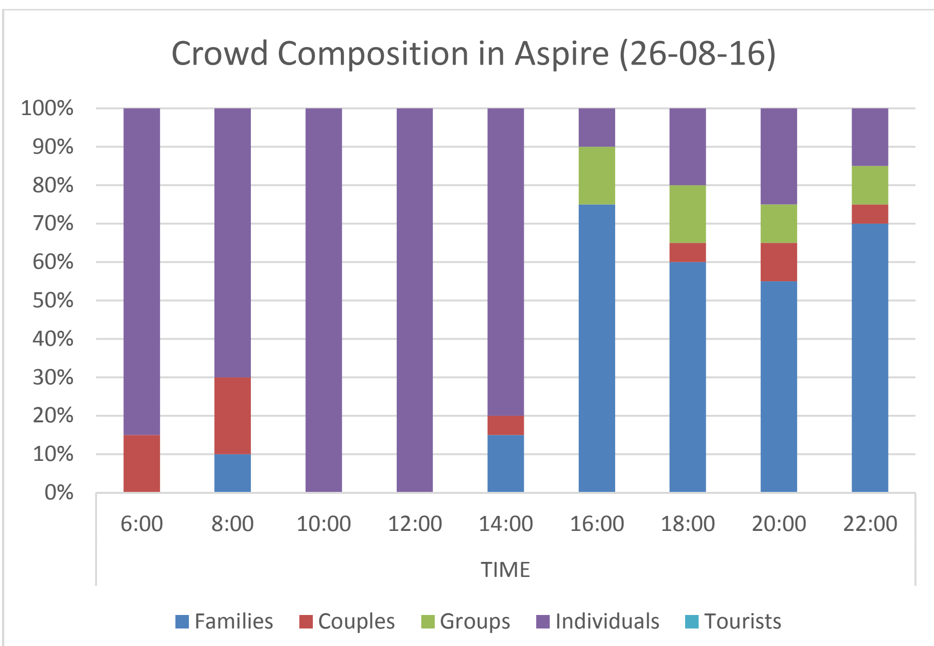


Figure 82. Crowd composition in Aspire on 26-08-16 (source: developed by author)

Figure 83. Users' of OPS (source: author)

It is vital to note that according to the survey 65% of the visitors' said that they would come to re-visit Aspire but not spend a lot of time in the OPS.

4.3.4 Microclimatic Conditions

4.3.4.1 Day 1 (16-08-16) Weekday

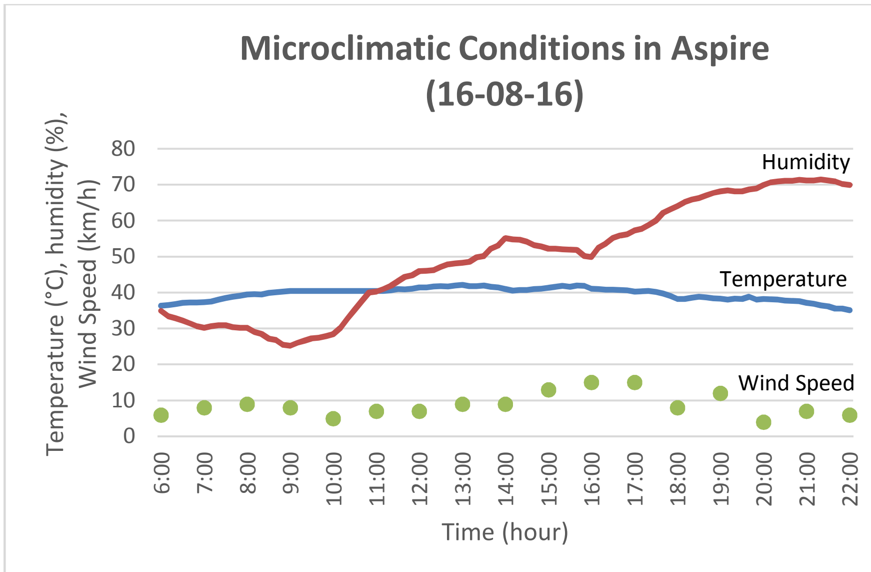


Figure 84. Microclimatic conditions in Aspire on 16-08-16 (source: developed by author)

The hottest peak of the day is at 1pm (42°C), with a humidity level of (48%) and moderate wind speed of (9km/h). Based on the outdoor comfort calculator it sums to a total of 44°C (very hot, extreme heat stress) as shown in Figure 85 below.

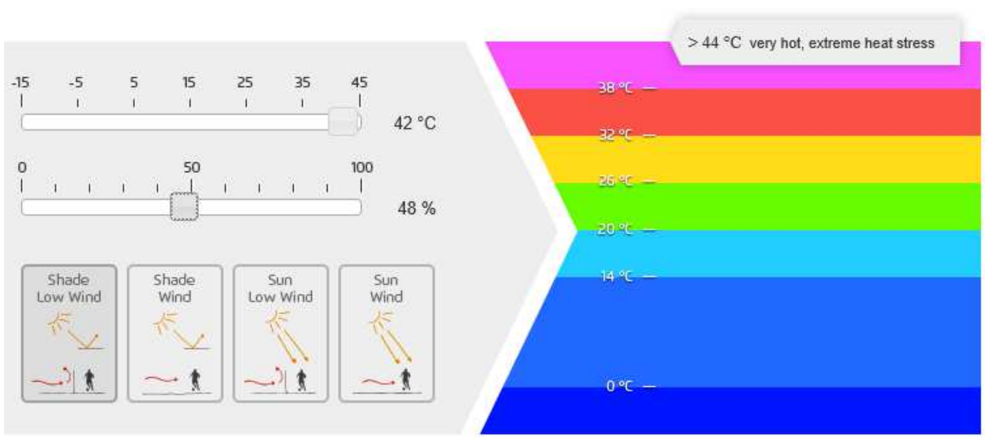


Figure 85. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

On the other hand, the coolest peak of the day is at 6am and 10pm (36 and 35°C, respectively). 6am has one of the lowest humidity level (35%) and lowest wind speed (6km/h). Based on the outdoor comfort calculator it sums to a total of 33°C (hot, great heat stress) as shown in Figure 86 below.

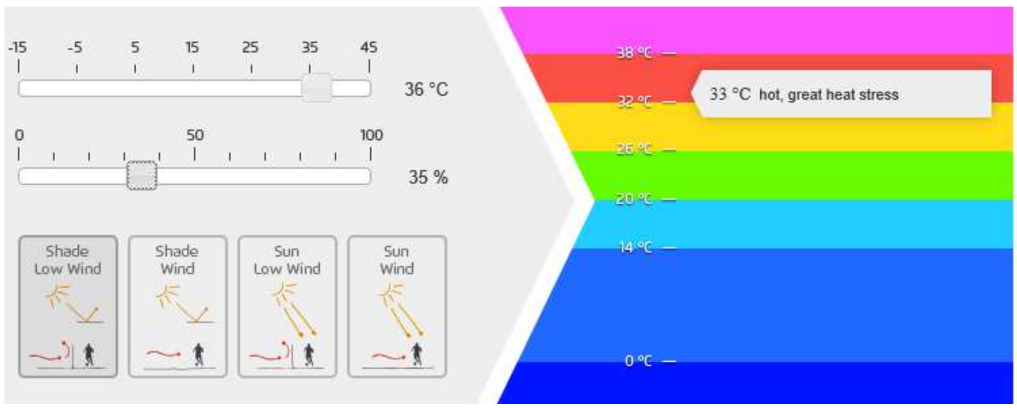


Figure 86. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

Whereas, 10pm, with the coolest air temperature measured on this day has one of the highest humidity level (70%) and lowest wind speed (6km/h). Based on the outdoor comfort calculator it sums to a total of 44°C (very hot, extreme heat stress).

4.3.4.2 Day 2 (30-08-16) Weekday

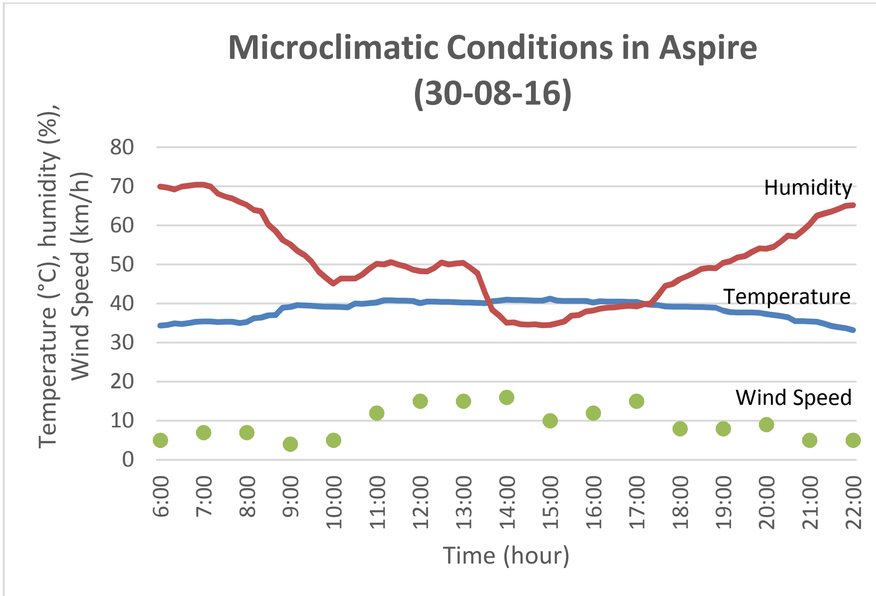


Figure 87. Microclimatic conditions in Aspire on 30-08-16 (source: developed by author)

The hottest peak of the day is at 2pm and 3pm (41°C), with one of the lowest humidity level (35% and 34%, respectively) and wind speed (16km/h and 10km/h, respectively). Based on the outdoor comfort calculator both readings sum to a total of 39°C (Figure 88).

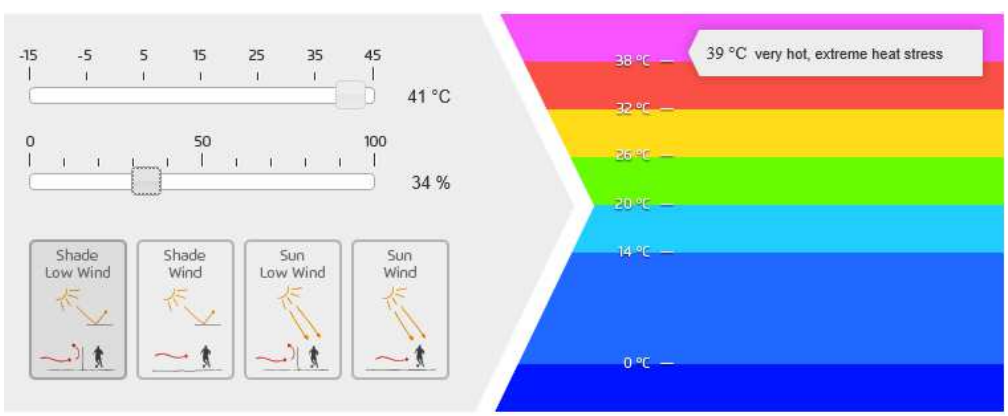


Figure 88. Outdoor comfort calculator (source: TranssolarKlimaEngineering, 2016; established by author)

On the other hand, there were two cool peaks measured on this day. The first was at 6am, temperature of 34°C with one of the highest humidity of 70%, and one of the lowest wind speed of 5km/h. The second was at 10pm, temperature of 33°C with a humidity of 65% and wind speed of 5km/h. Based on the outdoor comfort calculator the 6am timing sums to a total of 42°C, and the 10pm sums to 38°C.

4.3.4.3 Day 3 (12-08-16) Weekend

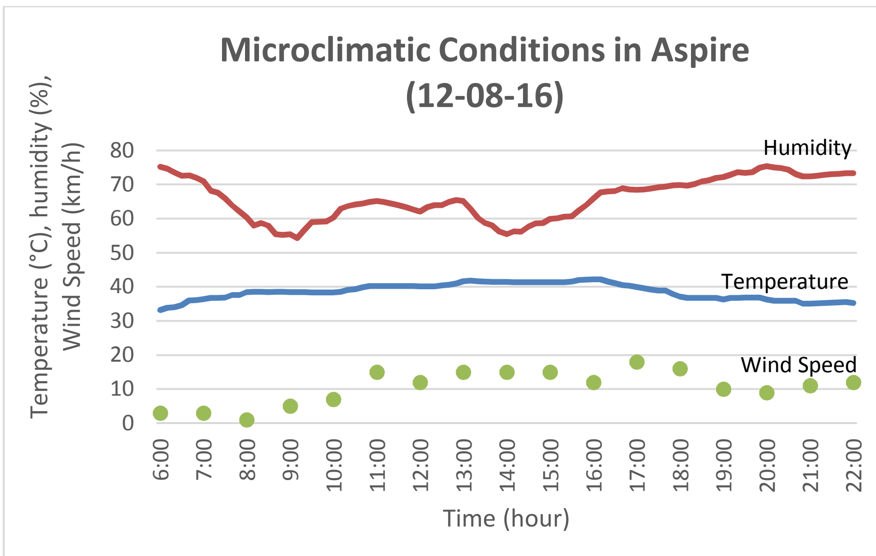


Figure 89. Microclimatic conditions in Aspire on 12-08-16 (source: developed by author)

The hottest peak of the day is at 4pm (42°C), with high humidity level (66%) and moderate wind speed (12km/h). Based on the outdoor comfort calculator it sums to a total of 44°C (very hot, extreme heat stress).

The timing between 8am to 6pm lies within approximately the same outdoor comfort range. Alternatively, the coolest peak of the day is at 6am (33°C), with one of the highest humidity level (75%) and lowest wind speed (3km/h). Based on the outdoor comfort calculator it sums to a total of 41°C.

4.3.4.4 Day 4 (26-08-16) Weekend

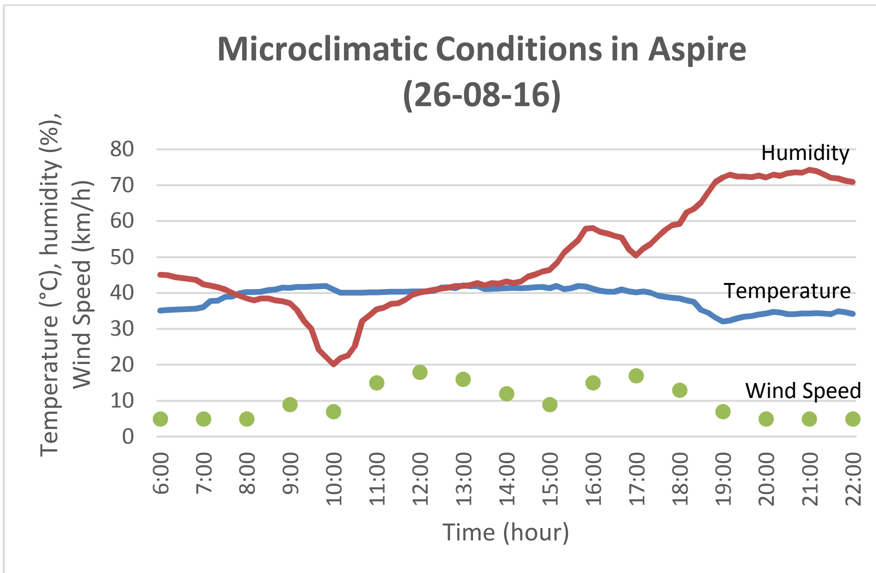


Figure 90. Microclimatic conditions in Aspire on 26-08-16 (source: developed by author)

The hottest peak of the day is at 1pm (42°C), with a humidity level of 42% and moderate wind speed of 16km/h. Based on the outdoor comfort calculator analysis, it calculates to a total of 44°C (very hot, extreme heat stress).

The timing between 8am to 6pm lies within approximately the same outdoor comfort range. On the other hand, the coolest peak of the day is at 7pm (32°C), with one of the highest humidity level (72%) and lowest wind speed (7km/h). Based on the outdoor comfort calculator it sums to a total of 38°C (very hot, extreme heat stress).

4.3.5 Site Observation of Aspire

4.3.5.1 Day 1 (16-08-16) at 10am Weekday

The site plan of Aspire OPS (Figure 91) shows the central focal space, which has been designated to be the area including and around the man-made pond (water body). On the 16th of August, 2016, a recorded weekday at 10am, there were 10 people observed using the space that were comfortable with the present prevailing conditions of 40°C (temperature), 28% (humidity) and a wind speed of 5km/h. These 10 users could be categorized into using two main walking paths, near the restaurants (which is an entrance point) and near the pond and fountain. There was a miniscule amount of visitors who were sitting in the shade relaxing, and none sitting in the sun. It is crucial to note that the areas where there are exercising equipment placed have no shading devices, and thus no users were observed near that area. This could also be due to the fact that adults were at work at 10am on a weekday.

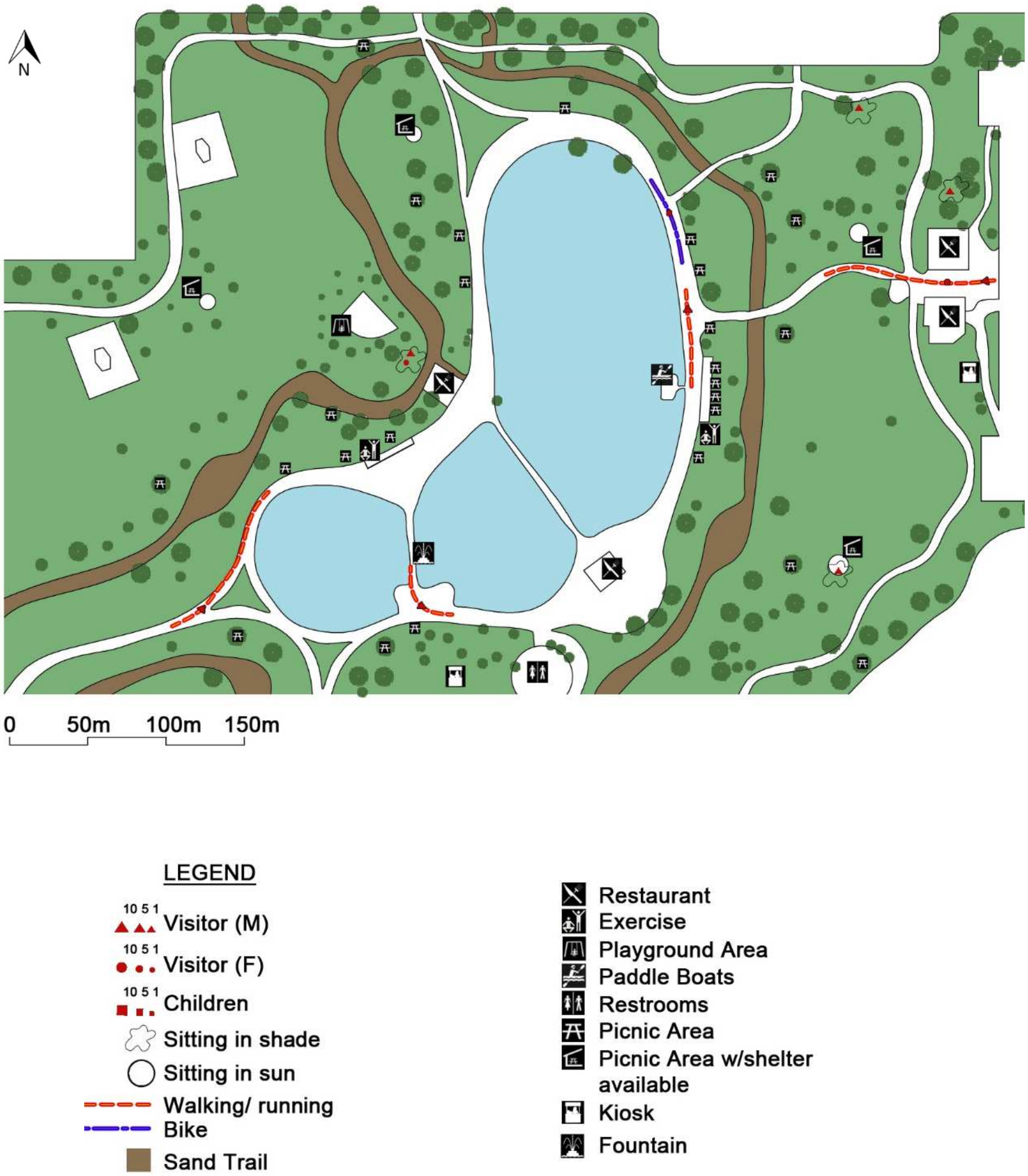


Figure 91. Site plan of Aspire at 10am weekday (source: developed by author)

4.3.5.2 Day 1 (16-08-16) at 6pm Weekday

Figure 92 represents the site plan of Aspire plotting 45 users. On the 16th of August, 2016 at 6pm, the temperature readings was at 38°C, humidity level at 64%, and wind speed measurement at 8km/h. Users were both walking and sitting. Walking mainly around the man-made pond, under the shaded areas of the walkway routes, while some were using the exercising equipment. Those who were sitting, were mainly gathered around the pond, children were huddled around the playground, and friends and families were drinking cold and warm beverages in the café. There were no users observed to have been sitting on the grass in the shade, they were sitting on the grass in the sun enjoying the last minutes of light before sunset.

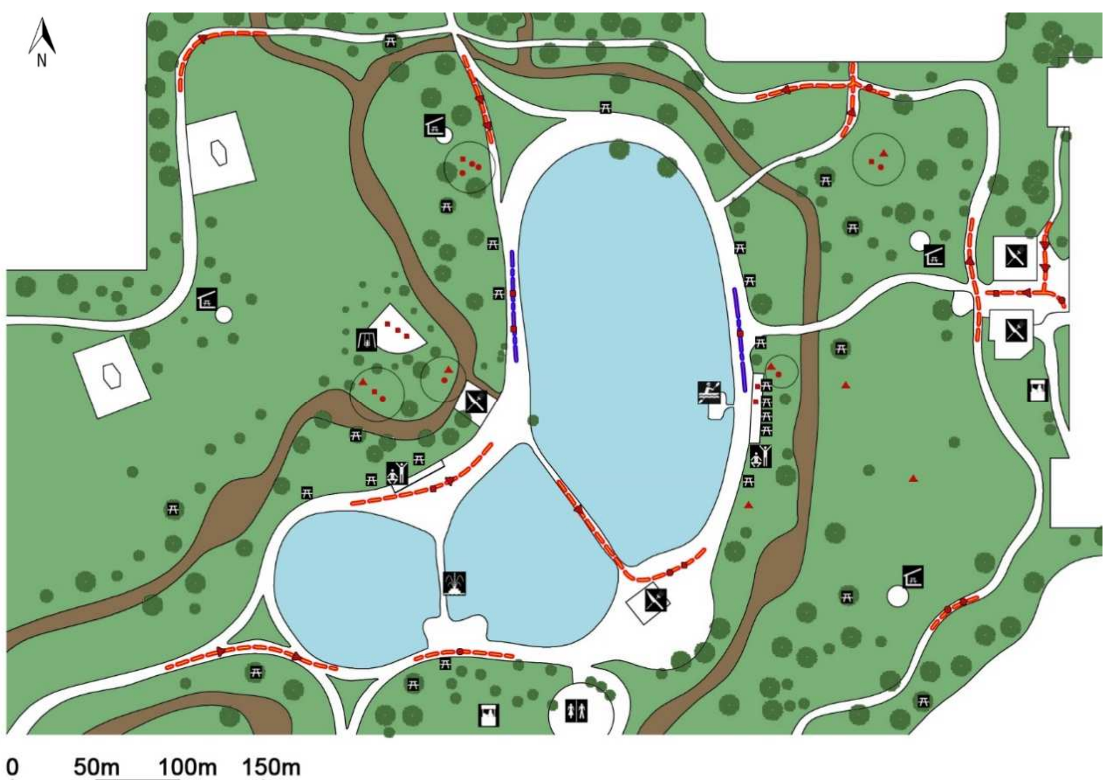


Figure 92. Site plan of Aspire at 6pm weekday (source: developed by author)

4.3.5.3 Day 3 (12-08-16) at 10am Weekend

Figure 93 is a depiction of the site plan of Aspire on the weekend of the 12th of August, 2016 at 10am in the morning. 4 people were experiencing a temperature of 38°C, humidity levels reached 60%, and wind speed at 7km/h. One user was sitting under the shaded area by the tree, another user was entering the OPS from the restaurant side, yet another individual was arriving at Aspire at 10am on a weekend from another entry point from the North, and the fourth user was walking using the path that was shaded by presence of trees and was relaxed by the amount of vegetation.

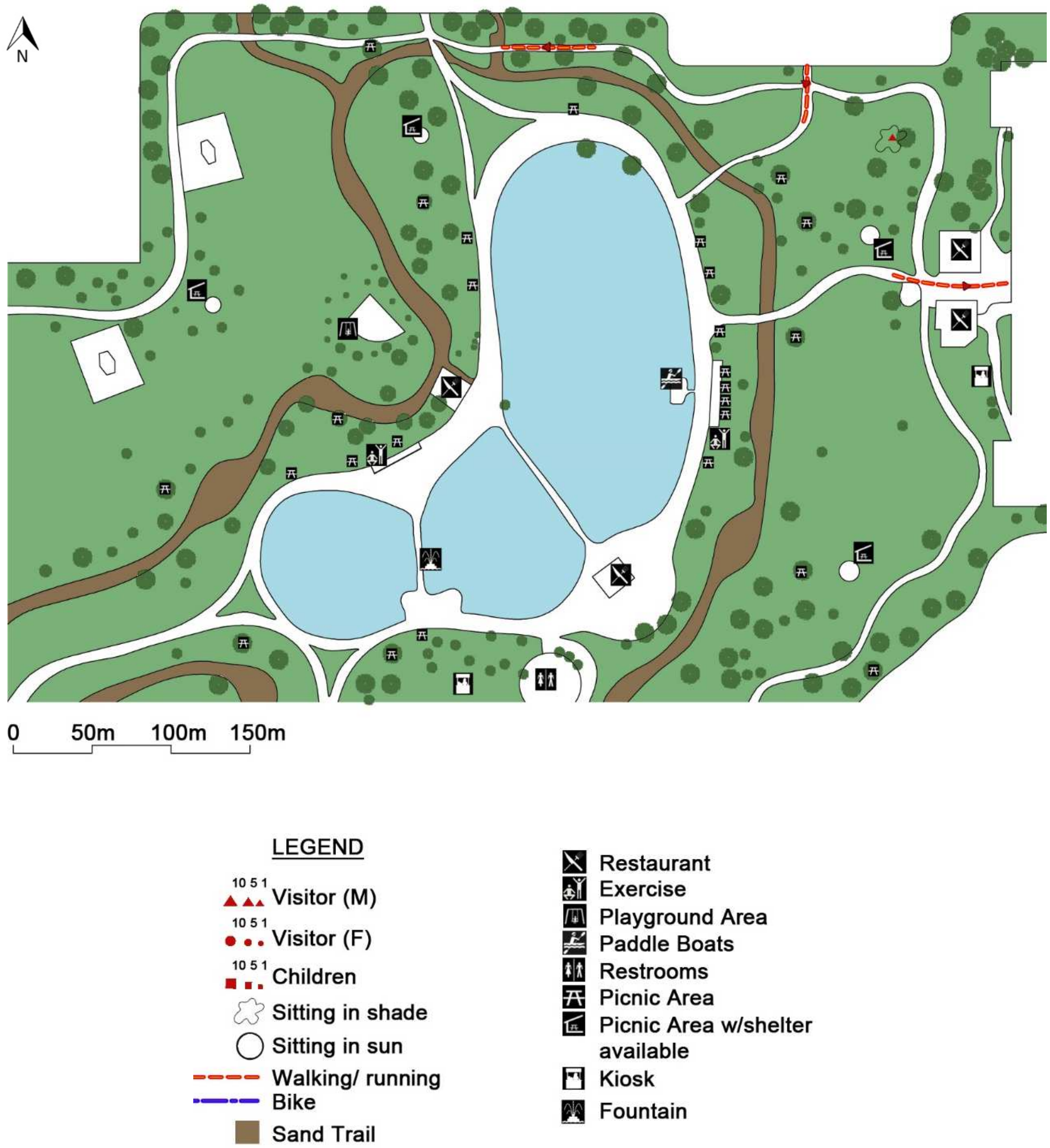


Figure 93. Site plan of Aspire at 10am weekend (source: developed by author)

4.3.5.4 Day 3 (12-08-16) at 6pm Weekend

The Aspire OPS on the 12th of August, 2016, had a measured temperature reading at 37°C, a high humidity at 70%, and relatively high wind speed measuring at 16km/h. On this weekend at 6pm, there were 170 users of the space. This was the highest recorded number of visitors from the four site plans of Aspire (refer to Figure 91, Figure 92 and Figure 93). This observed high number of visitors seems to be in relation to the fact that it was a weekend at 6pm, and not directly influenced by the exiting microclimatic conditions. The northern part of the site plan shows a clustering of women and children in groups, while everywhere else, the distribution between men and women users of the space is quite even. A large percentage of the children were utilizing the playground. There is also an equal amount of users sitting and moving around. Majority of them were sitting and walking in the unshaded areas enjoying the last hour before sunset. A larger number of men more than women were walking. The picnic areas with sheltering available were almost deserted. It is interesting to note that for all of the four site plans of Aspire, no users were utilizing the sand trail; the reason for this is unknown.

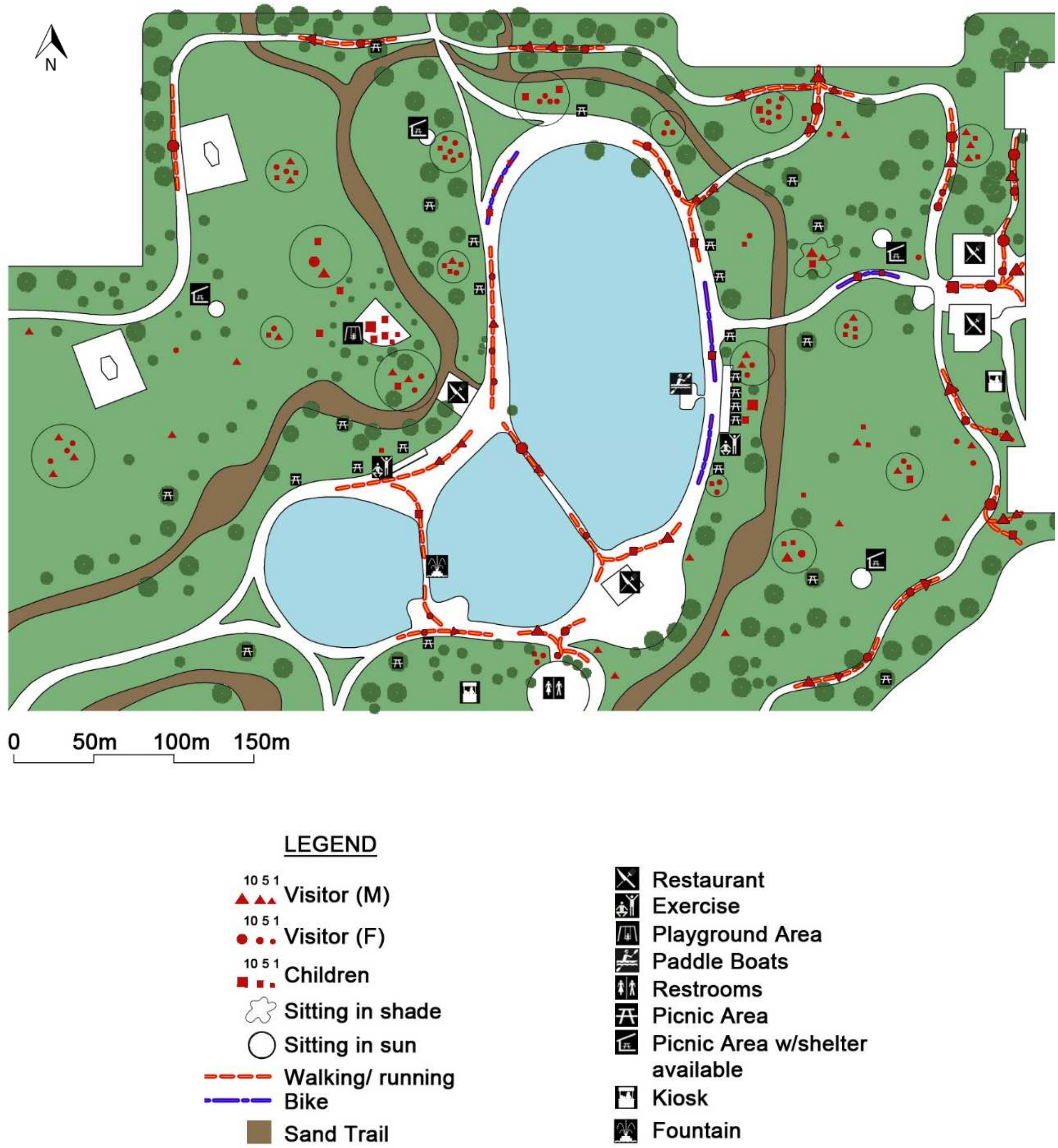


Figure 94. Site plan of Aspire at 6pm weekend (source: developed by author)

4.3.6 Cumulative Aspire Weekday Results

Assessments on the crowd intensity and its relation to temperature, humidity, wind speed and outdoor comfort temperature for the two weekdays that were studied at the various time intervals in Aspire is given in Figure 95. It is temperature, humidity and wind speed readings that are used to measure the outdoor comfort temperature. Taking this into account, there seems to be a direct correlation with the outdoor comfort temperature and the number of visitors. It is observed that the highest outdoor comfort temperature (44 degrees Celsius) and the least amount of visitors (almost zero) were recorded at 12pm. In contrast to what was observed in Figure 61, the cumulative weekday results of Al-Corniche, the number of visitors did not begin to diminish at 8pm, even though it was a work day. In fact, the crowd volume was maximum between 8pm to 10pm, with about 300 visitors tolerating the temperature, humidity and wind speed levels.

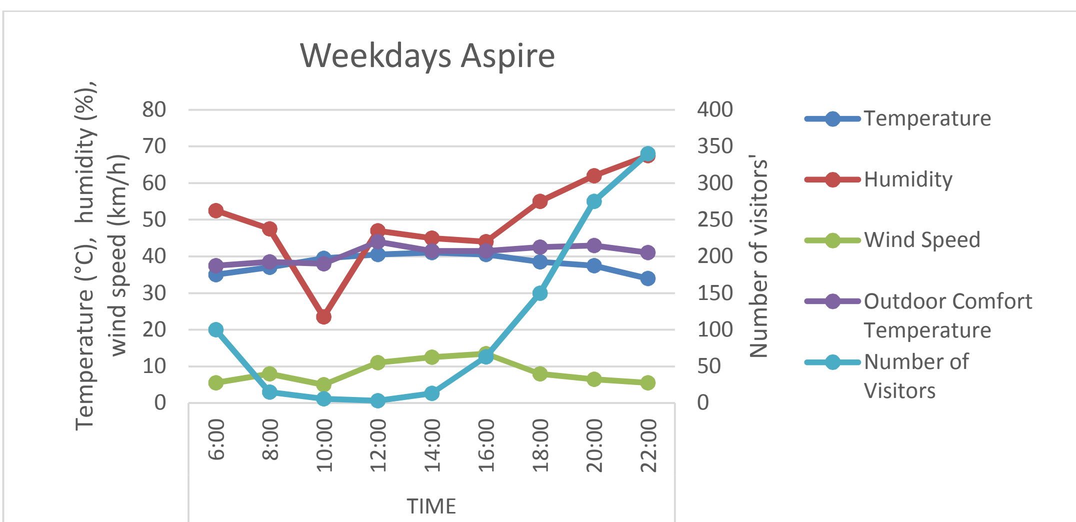


Figure 95. Cumulative Aspire weekday results (source: developed by author)

Assessments were made for understanding the perceptions of the individuals in relation to the different physical parameters at Aspire during the weekdays at various time intervals is shown in Figure 96. At most hours of the day, visitors were satisfied with the level of vegetation, however, at 10am, 12pm, and 2pm, there was a significant percentage (about 50%) of the visitors who wanted more vegetation. With regards to the temperature, visitors were thermally comfortable from 6-8am, but at 10am, a large number of the visitors felt warm or hot and immediately preferred lower temperature values. Similarly, there was a gradual increase over time of the number of visitors who preferred lower humidity levels and wanted more wind movement. Additionally, most of the visitors were in groups and so Aspire seems like a family-oriented OPS.

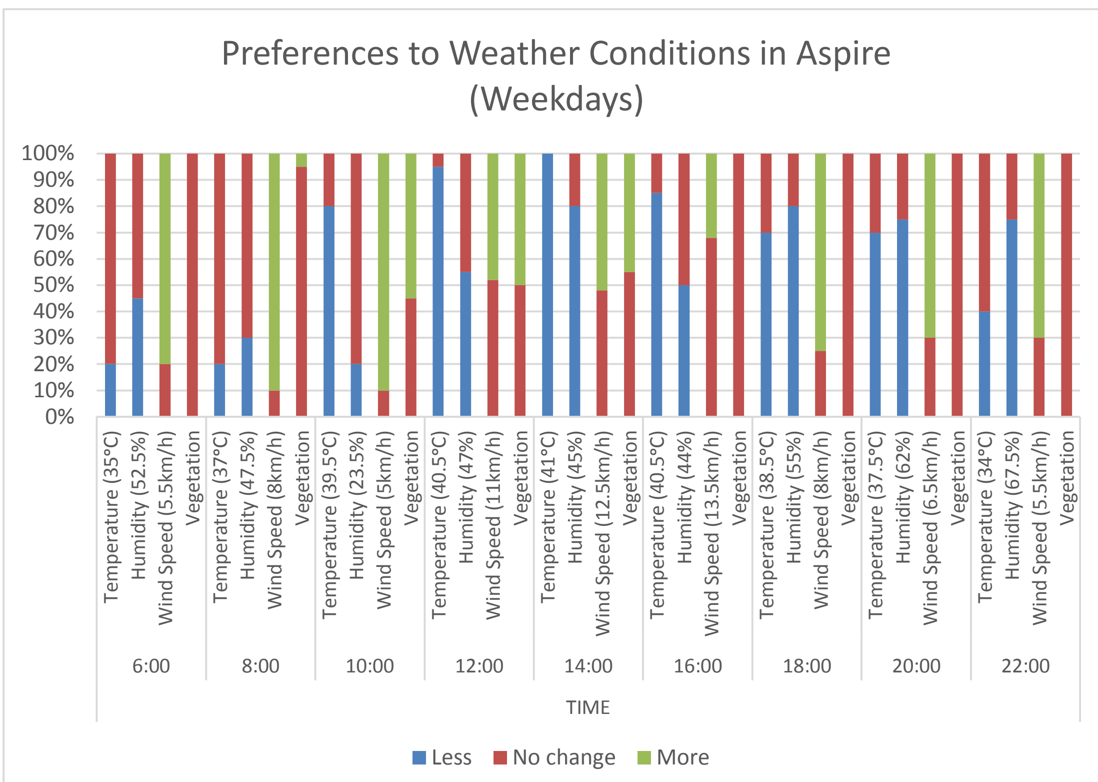


Figure 96. Preferences to weather conditions in Aspire weekdays (source: developed by author)

4.3.7 Cumulative Aspire Weekend Results

Evaluations on the crowd volume in relation to temperature, humidity and wind speed during the weekend at Aspire reveals that there were marked changes in the number of visitors during different times, as shown in Figure 97. It is odd to note that at 10am, when the most comfortable outdoor temperature was calculated, the least number of visitors was recorded. However, when the actual temperature readings were taken, and began to drop starting 4pm to 10pm from 41 degrees Celsius to 33 degrees Celsius, there was an increase in the number of visitors from about 100 to approximately 600 individuals. This was despite the increase in humidity from 60% to 70% during that time period, and the minute decrease in wind movement. During the weekend, compared to the weekday, it can be seen that Aspire was more crowded due to the fact that there was no work obligations. Family crowds were more dominant in Aspire than Al-Corniche during the weekend more than the weekday.

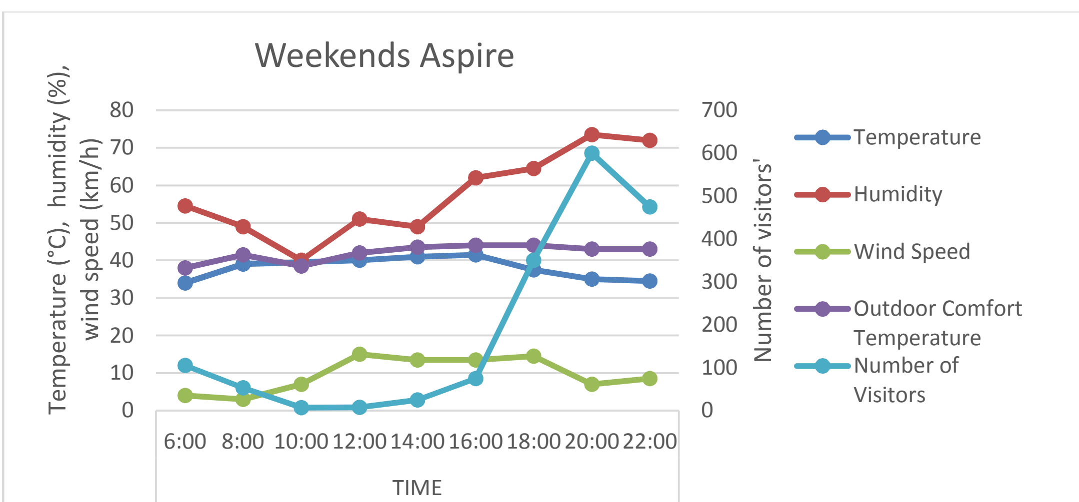


Figure 97. Cumulative Aspire weekend results (source: developed by author)

Comparisons between the preferences of the visitors of Aspire in relation to the existing physical parameters for the weekends are presented in Figure 98. The analysis made of the weekend data reveals that people were quite happy with the vegetation that was present in the OPS of Aspire. Although, there was a range from 65% to 90% of the visitors who preferred more wind movement throughout the day. Based on the responses, it is noticed that people preferred lower temperatures, especially at the hours of 10am, 12pm, 2pm, when 100% of the surveyed were not at all satisfied with the prevailing temperature levels, which varied between 39.5-41 degrees Celsius, the hottest temperature readings recorded during the weekend. Humidity levels were preferred to be less during all hours of the weekend. It was observed that most of the respondents, irrespective of the time during the weekend, expressed that they were willing to remain in the OPS of Aspire for another hour or more despite slight dissatisfaction of the existing climatic conditions.

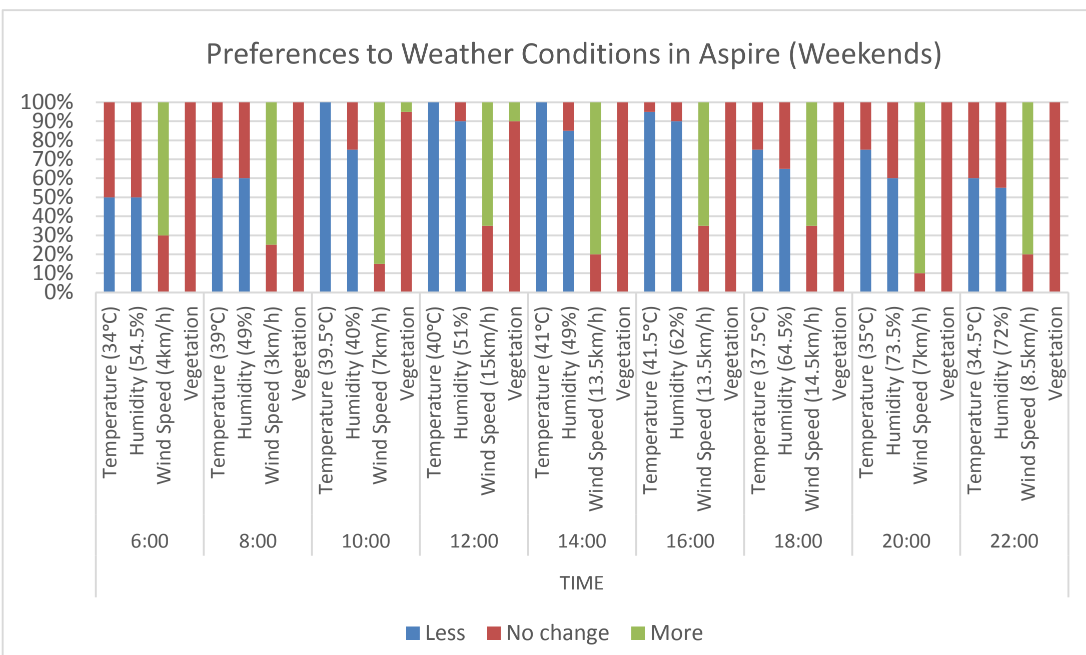


Figure 98. Preferences to weather conditions in Aspire weekends (source: developed by author)

4.4 Conclusions

The results presented in this chapter help in understanding outdoor thermal comfort of users' in the hot arid region, Doha, Qatar. Furthermore, it aids to understand the influence of microclimatic conditions and physical aspects and the role of psychological adaptation in enhancing the OPS and improving outdoor thermal comfort levels. This is discussed in the next chapter with regards to research outcomes and interpretations.

CHAPTER 5: RESEARCH OUTCOMES AND INTERPRETATIONS

5.1 Introduction

This thesis is a research study that chiefly investigated the role of psychological adaptation in evaluating thermal comfort of users in OPS. It also assessed the various factors that impact thermal comfort in Qatar, including mainly microclimatic conditions and physical aspects. In this regard, qualitative and quantitative research methods were employed for this study. The primary (raw) data was primarily collected from two selected OPS locations (Al-Corniche and Aspire) in Doha, Qatar and were analyzed.

It is true that the myriad of microclimatic conditions (temperature, humidity and wind speed) in outdoor spaces strengthens the notion that a sole physiological approach is insufficient to depict thermal comfort conditions outdoors, and thus taking into account psychological adaptation (naturalness, expectations, experience, time of exposure, perceived control, and environmental stimulation) becomes important. The research study also confirmed that the research must also delve into the physical aspects of OPS (vegetation, floor-scape, presence of water bodies, etc.), as it is a major factor in influencing the thermal comfort of individuals.

The methodology of the research employed the following to record raw data:

- Questionnaires: users were surveyed from 6am to 10pm, and a need was discovered to design these locations for catering to the needs, demands and expectations of the visitors
- Microclimatic measurements such as data loggers
- Visual observation techniques and mapping

Thus, this study would be beneficial to provide better insights and useful tips for recommending design considerations in order to create an ambience for users in harmony with the environment. This results interpretation chapter will discuss the important analytical findings of the present research study and critically evaluate the findings in light of previous and relevant literatures.

Major limitations of this research were time and resources, which in fact prevented the researcher from delving into the study and conducting in depth analysis in this regard. In order to minimize the impact of the limitations on the research results, multiple adequate research methods were utilized in this work. Furthermore, the study was structured systematically to allow the researcher to study and provide valid and relevant research outcomes that have significance academically and practically.

5.2 Major Findings and Discussion

The highlight of the findings of this research based thesis is to provide a clearer understanding of the multiple factors that impacts thermal comfort of a user. The role of psychological adaptation, microclimatic conditions, and physical aspects of OPS in affecting thermal comfort in Qatar is also discussed. Majority of the findings of this study are in agreement with the research statement and the research found in the literature. Regardless of the above stated limitations, this investigation showed interesting findings that have important scientific value and practical significance presented in the next section.

5.2.1 Physical Aspects effect on Microclimate

The physical aspects of OPS, characterized by various elements, can make shifts in the urban climatic profile, influencing the climatic elements and contributing for unfavorable or favorable microclimates to human thermal comfort conditions. Microclimatic condition parameters including air temperature, relative humidity, and wind speed may be altered by the impact of physical interventions, which in turn might enhance the outdoor thermal comfort situations experienced by a user.

5.2.1.1 Urban Furniture

Urban furniture as a physical aspect has a direct effect on the microclimate. Seating, public facilities and shading elements are crucial in OPS to facilitate and enhance the comfort of visitors:

- The usage of seats: Although Al-Corniche is one of the most popular outdoor spaces in Doha, a significant amount of the visitors responded negatively when asked if they were satisfied with the amounts of seats available in the space. Availability of seats in Aspire was not as significant in comparison; more than half of the seats in Aspire employed shading devices, such as a pergola or used trees for cover.
- Shading devices: Physical elements (trees and artificial shading devices) provide shading by blocking the incident solar radiation, which influences outdoor thermal atmospheres and ultimately affects the thermal comfort of users' in OPS (Lin, Matzarakis, & Hwang, 2010). The research study on individual's behavior portrayed that a large percentage of both of the OPS users in August 2016 (during

the summer season) prefer to stay under the shade of trees, and because of the lack of the required amount of shading devices, some individuals' immediate behavior was to cover their faces with head-scarves or even use umbrellas to protect them from the solar radiation. On an adjoining note, Hwang et al. (2011) claims that highly shaded locations in winter tend to have uncomfortable cool surface temperature. In fact, in all matters, there must be balance.

5.2.1.2 Water Features

Setaih et al. (2013) are of the opinion that the use of water features (such as the fountains and water ponds present in Aspire) in OPS can dissipate part of the heat through evaporative cooling system. "Evaporation and evapotranspiration are always associated to the heat transfer between water, vegetation and air", as their presence improve the thermal environment in the summer seasons by cooling the air (Robitu et al. 2006). It is thus clear that the location of Al-Corniche along the waterfront helps cool down the outdoor space through the cool, sea breeze. As a result the microclimate has a great effect on OPS impacting the variables associated to human comfort (Reiter & DeHerde, 2003). The OPS of Aspire has also incorporated the use of a limited amount of evaporative cooling devices located around the central pond. Moreover, on a contrary note, Aspire also has sand trail pathways located in the central focal point of the OPS. This is a negative feature for the summer season, as sand gets hotter faster because the specific heat of sand is lower in comparison to the specific heat of water. However, for the winter season, sand takes less light energy to change its temperature, which would be beneficial for the users of the space at that time.

5.2.1.3 Vegetation

It is Ragheb et al. (2016) who pointed that elements of the environment must be incorporated within a space to preserve and complement the livability of a public outdoor space (e.g. by incorporating extra vegetation). Nasir et al. (2012) went on to reveal that a forested area in Singapore had a cooling effect to its environment compared with the dense city area. The study showed that "grassy surfaces had a potential role for the cooling effect". Moreover, Wong and Yu (2005) have also expressed that the cooling effects of the green areas were reflected in both the vegetated and in the surrounding areas (by releasing moisture through a process known as evapotranspiration). On a similar note, from a different approach, Johansson and Emmanuel's (2006) study in Sri Lanka discovered that the land of the city center had a hard cover, which brought thermal discomfort when compared to rural areas. In agreement with these views, the current research study also showed that Aspire OPS had more condensed tree areas than Al-Corniche area. It is the studding of green surroundings (grass, shrubs, and trees) in Aspire that stimulated a larger percentage of the respondents, in relation to Al-Corniche, that felt more comfortable with the prevailing microclimatic conditions. According to Huang et al. (2009), places with minimal canopy shading might have shorter thermal comfort periods and thus there arises a need for enhancing the vegetative cover for the areas. It has also been recorded that trees and vegetation play a role in altering wind direction. Another factor that influences wind speed and increases the amount of wind movement is the fact that Aspire is on a high topographical point, above the average ground level.

5.2.1.4 Surfaces

In addition to the impact of the above physical aspects as factors on microclimatic conditions, researches by Levinson et al. (2007) and Synnefa et al. (2008) indicate the effect white and light colored surfaces have on considerably improving thermal comfort due to their ability in reducing the ambient temperature. Ragheb et al. (2016) confirm that the use of high albedo materials (i.e. excessive reflective material) have the potential to reflect incoming solar radiation in urban environments and consequently effectively reduce the effects of the thermal environment on user comfort. Both Al-Corniche and Aspire were observed to have a light concrete ground surface pavement. The research finding of the study thus agrees to what is presented in the evidence-based literature. Moreover, Aspire also has soft rubber walking mat pathways adjacent to the concrete pavement to encourage movement for the health and wellbeing of the users'.

5.2.1.5 Summary

Modifying the physical aspects of OPS to influence microclimatic conditions may serve the users of the space or can become elements that cause discomfort and inconvenience for the user of the space. Thus, some interventions may give promising results in terms of thermal comfort enhancement, particularly in hot dry climates (Setaih et al., 2013).

5.2.2 Factors Influencing Outdoor Thermal Comfort

It has been observed in this research paper that there are three main factors that influence outdoor thermal comfort. Namely, these are microclimate, physical aspects, and psychological adaptation. Each have a role in affecting the OPS and ultimately thermal comfort of a user.

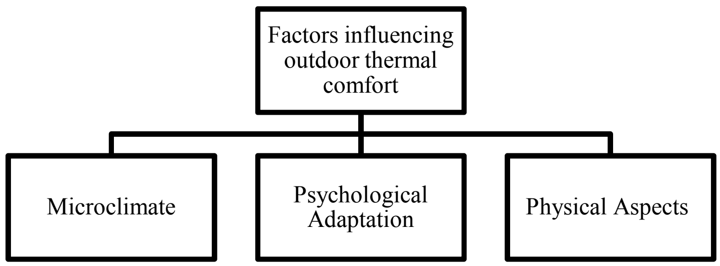


Figure 99. Factors influencing outdoor thermal comfort (source: developed by author)

5.2.2.1 Microclimate as a Factor Influencing Thermal Comfort

Erell et al. (2011) defined microclimate as a local atmospheric region where the climate (with features such as temperature, wind, precipitation, cloud coverage, and humidity) differs from the encircling area. Multiple studies have suggested that microclimate can characterize thermal comfort conditions outdoors. As early as 1977, Herrington and Vittum coined human thermal comfort to be a "psychological interpretation of the physiological state of the body". In recent studies, Staiger et al. (2012) defined thermal comfort as "the state of mind that expresses satisfaction with the surrounding environment". Developing it further, Setaih et al. (2013) claim that there are six key factors to human thermal comfort: environmental factors (air temperature, humidity, wind speed, mean radiant temperature) and personal factors (clothing insulation and activity). Nikolopoulou et al. (2001) are of a similar viewpoint, stating that thermal comfort depends mainly upon the activity level of an individual and their clothing level.

This work aims to identify, assess and evaluate the factors that influence thermal comfort in the two selected OPS. Al-Corniche has average air temperature of 37.5°C, average relative humidity levels of 53.3%, and average wind speed of 11.2 km/h. On the other hand, Aspire has average air temperature of 38.1°C, average relative humidity levels of 53.3%, and average wind speed of 9.0 km/h. The microclimatic measurements of air temperature, relative humidity and wind speed were conducted over a period of a month in August of 2016, and were graphed every two hours from 6am to 10pm, for both selected locations. The outdoor comfort temperature was calculated using these three microclimatic variables and recorded as 41.2°C for Al-Corniche and 41.4°C for Aspire (Table 9).

Table 9. Average microclimatic measurements of Al-Corniche and Aspire OPS (source: developed by author)

Location	Average Air Temperature (°C)	Average Relative Humidity (%)	Average Wind Speed (km/h)	Average Outdoor Comfort Temperature (°C)
Al-Corniche	37.5	53.3	11.2	41.2
Aspire	38.1	53.3	9	41.4

According to Moreno et al. (2008), microclimatic conditions, clothing, environment and nature, activity levels, vegetation, psychological adaptability of individuals, etc. do impact the human thermal comfort levels to a significant extent (Figure 100). In conformity with this research, the outcomes of this study also illustrated that a combination of these variables caused a variation of user comfort level. Observations obtained from the two surveyed locations during both the weekday and weekend showed that at times, people were comfortable at higher temperatures during the afternoon hours, while during the evening and even after sunset, even at lower temperatures, other users' stated they were uncomfortable with the prevailing conditions. This dissimilarity in the thermal comfort of visitors might be due to changes in multiple parameters like amount of physical activities, humidity, expectations, psychological adaptation factors, which corroborates that the thermal comfort of users in an OPS might depend on different factors.

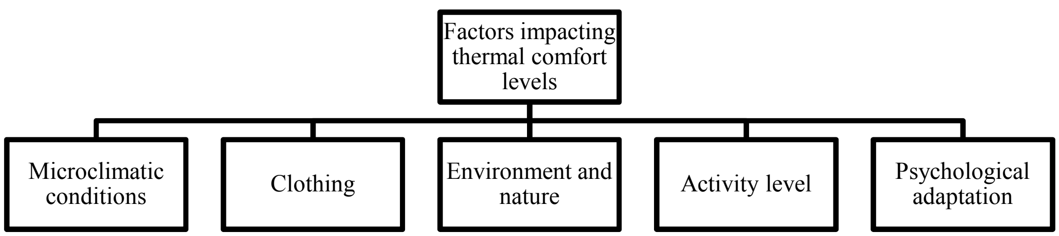


Figure 100. Factors impacting human thermal comfort levels (source: Moreno, Labaki, & Noguchi, 2008; established by author)

Ragheb et al. (2016) are of the opinion that a place should be designed to stimulate public activity. The work by Zacharias et al. (2001) discovered the relationship between microclimate and usage level of three types of activities (sitting, standing, and smoking). The authors validated that there was a strong linear relationship between air temperature and sitting behavior (Figure 101). Based on this research study, it was observed that a majority of users were mainly sitting in the shade or walking. It was only mainly during the weekend, that a large percentage of children visited the OPS of Aspire and were playing (Figure 94). The findings revealed that the amount of physical activities decreased when the microclimatic conditions were not tolerable or comfortable. According to Nasir et al. (2012), the optimization of outdoor thermal comfort ensures better tolerance to outdoor conditions of a public space, which in turn encourages more effective usage of outdoor recreational areas.

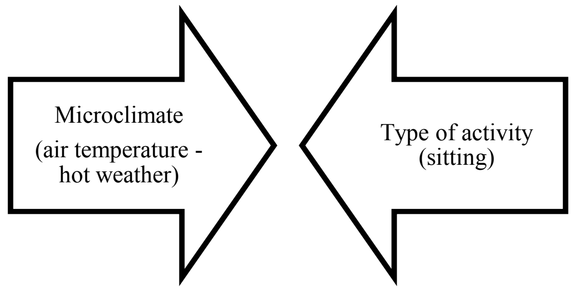


Figure 101. Relationship between microclimate and type of activity (source: developed by author)

Chen and Ng (2012) are of the viewpoint and belief that microclimatic variables, including temperature and sun, are responsible for about 12% of the presence of visitors, while place and time account for 38% and 7%, respectively. Nikolopoulou and Steemer's (2003) perspective is that the "satisfaction with the thermal environment of the space will depend as much on the space itself, as it will on personal variables people bring to the area with them, and the former will affect the latter, whereas the latter will affect the perception of the former". This was observed in Aspire, where it is considered a family-oriented and sports space, as there was a large turnout of children compared to Al-Corniche. However, there were more people in Al-Corniche in terms of the total number, with average air temperature of 37.5°C and wind velocity of 11.2km/h, compared to 38.1°C and 9km/h, respectively, measured in Aspire.

5.2.2.2 Physical Aspects as a Factor Influencing Thermal Comfort

It is undoubtedly clear from the research findings that shading is integral to user satisfaction and would be helpful in the successful development of the outdoor spaces. The presence of high crowd intensity at Aspire throughout the afternoon hours during the weekdays might be due to the greater availability of the required shaded areas in the space, which may have ultimately allowed the user to be more thermally comfortable in the space. There were both natural (trees) and created (pergolas) shaded areas in Aspire; users were satisfied with the amount of vegetation, but preferred more shaded areas, benches/seats or resting places in Al-Corniche. A significant number of the respondents agreed with the need of more trees to provide shaded areas to cool the space for thermal comfort. The field survey conducted by Lin (2009) showed that over 90% of the users of a public space in the summer chose to stay under shade trees, suggesting the importance of shade in outdoor environments to achieve a higher level of outdoor thermal comfort. Moreover, some studies confirmed the importance of shaded areas when designing outdoor spaces (Hwang et al., 2010).

Even though the responses of users from both Al-Corniche and Aspire showed that despite their preferences for lower temperature, lower humidity, and increased wind speed, they expressed their willingness and interest to re-visit the locations as they were moderately comfortable to enjoy their surroundings. This discovery indicates that the choice to return to an OPS might be influenced by the need (e.g. fitness), convenience (e.g. timing), and in effect thermal comfort of individuals (Figure 102). It was noticed that kids with their parents/mothers were present in the outdoor environment in the range beginning from 4pm until 8pm during the weekday in both surveyed locations, even at relatively hot and humid conditions. The presence of these types of individuals at this time might be the case because of office timings during the weekdays. This might be slightly contradicting to the research done by Nicol et al. (2008), which suggested that there is a limitation to the extent individuals can adapt psychologically to thermal conditions.

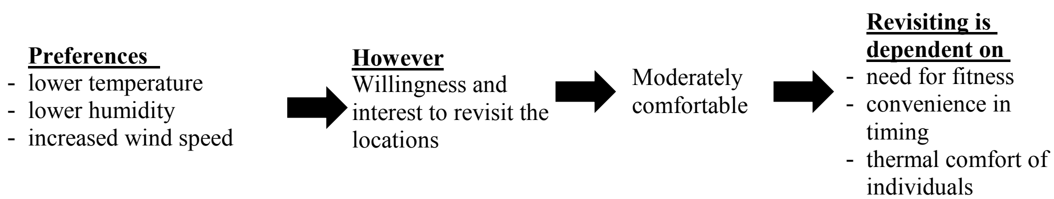


Figure 102. Responses of people in Al-Corniche and Aspire OPS (source: developed by author)

5.2.2.3 Psychological Adaptation as a Factor Influencing Thermal Comfort

According to Lin (2009), the differences in tolerance levels and thermal comfort in OPS are influenced by the mental and behavioral aspects of individuals. Reiter and de Herde (2003) define psychological adaptation as a “modification of the perception of sensory information. This notion corresponds to reduction of the intensity feeling, in the event of repeated exposures to the same environmental stress”. In relation to the literature, this study also explores the major role psychological adaptation has in determining thermal comfort levels of users in OPS. Psychological adaptation is one of the essential elements that define outdoor comfort, and in turn might impact the usage of outdoor spaces.

Nikolopoulou and Steemers (2003) illustrate psychological adaptation factors to include naturalness of the place, expectations, experience, time of exposure, perceived control, and environmental stimulation; these factors influence thermal perception of a place. The authors of the study state that there are interrelationships between the various parameters of psychological adaptation in outdoor thermal comfort studies. The findings of this study are in agreement with the literature, as it was observed and measured that in both surveyed spaces (Al-Corniche and Aspire), around 40% of the visitors tolerated high temperatures reaching about 39°C. Users of the space tolerated this increase in temperature of the physical environment as it was produced naturally.

Previous studies also established a link between people's adaptation to varying outdoor changes and behavioral changes, and their perception of the outdoor conditions (deDear & Brager, 2001). This finding is generally in accordance with the study by Thorsson et al. (2004) who justified that people's behavior depends on outdoor thermal microclimatic conditions, but is also greatly influenced by individual's expectations. For example, this was recorded in the research study, people who were exiting an air-conditioned car sought sunshine and heat even when the microclimatic conditions exceeded neutral conditions and were not tolerable or comfortable for the existing users of the space. It was also noted that the users of the OPS, from their experience, preferred to remain in hot conditions rather than highly humid conditions, and were more comfortable in comparison.

In addition to the impact of microclimatic conditions, adaptive behavior seems to influence thermal comfort of individuals. Nicol and Pagliano (2008) indicated that people make changes (or adaptations) to their clothing, beverage choice and movement in order to make themselves comfortable in a particular condition. Comfort preferences of individuals normally fluctuate within a range of values as there is no specific value at which a person is thermally comfortable at all times (Khodakarami, 2006); depending on the time of the day, expectations, purpose of time, etc. This study showed that people took action to improve their comfort conditions by wearing light colored clothing, increasing their consumption of cold drinks and decreasing their amount of activity. People were making appropriate adaptive responses in view to adjust in proportion with the current microclimate (Figure 103). Nikolopoulou et al. (2001) noted that a seasonal variation of clothing and consuming more cold drinks was noticed with increasing temperatures and presence of sunlight, as this is important for individuals' satisfaction with the space. Visitors from societies including the Middle East, Pakistan and Indians wore head covers and traditional clothing to adhere to their traditions despite the unpleasant microclimate; these individuals were able to adapt psychologically as they were constrained in making any physical modifications.

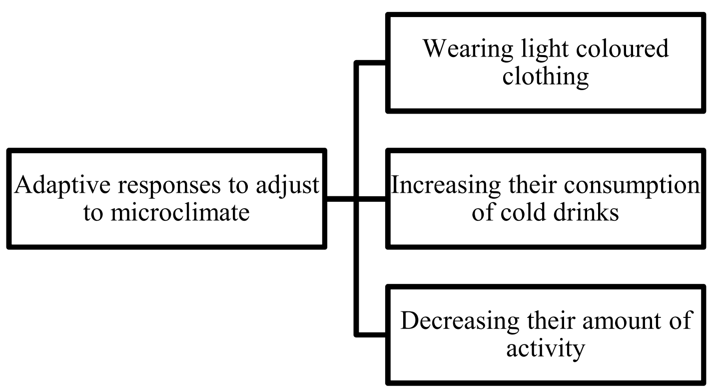


Figure 103. Users' adaptive responses to adjust to microclimate in studied areas (source: developed by author).

Thermal perception of the environment is an important factor that influences people's decisions on the amount of time to spend in an area (Nikolopoulou & Steemers, 2003). Literature studies also show that time of exposure is a significant tool that may modify a person's expectation with regard to thermal comfort, which may vary from one individual to another. Users' who visit the OPS of Al-Corniche and Aspire during the evening or night would mainly expect lower temperatures than what is recorded and hence their tolerance to such an environment would be minimal.

Similar to the studies done by Nikolopoulou et al. (2001), Thorsson et al. (2004) studied the subjective thermal comfort and human activity of OPS users and discovered that people tended to stay on average 20 mins longer when their perception of thermal conditions was within the acceptable comfort zone. The findings of this study confirmed that people who visited the space and knew they were spending a short amount of time could tolerate the microclimatic conditions. While other users who were spending an indefinite amount of time and were unaware of the time they will be exposed to the microclimate, would adapt by sitting under the shade and reduce their physical activities. Green and vegetative spaces also enhance the microclimate in the area and encourage people to stay for longer durations in comfortable atmospheres.

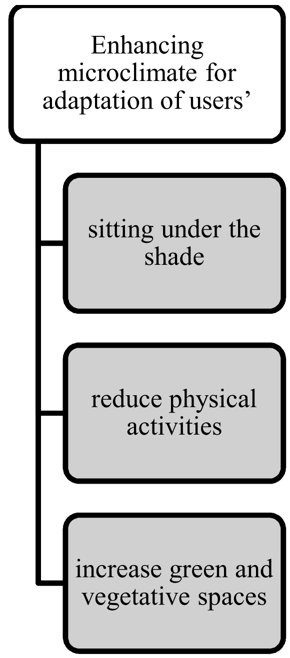


Figure 104. Enhancing microclimate for adaptation of users' (source: developed by author)

It is the results of Yao (2007) that proves that individuals make use of psychological adaptation at differing levels to acclimatize to the existing OPS thermal conditions in order to finally remain comfortable within a certain range of the microclimate. The research findings of this thesis found that people were not entirely selective of the outdoor microclimatic conditions and they seem to adapt considerably to make themselves comfortable in the prevailing conditions. The reason behind this is thought to be because users consider it essential to remain outdoors at least once a week for fitness and health related activities. Thus, users were found to be more adaptive to the microclimatic conditions of wind, heat, and humidity. Similarly, a study done by Nasir et al. (2012) proved that the respondents expressed their thermal sensation as comfortable and almost 70% of the subjects confirmed that they psychologically perceived and adapted better to the outdoor thermal conditions. Furthermore, the authors discovered that the users' perceptions on the microclimate varied according to factors such as age, gender, race, and level of activities (Nasir et al., 2012).

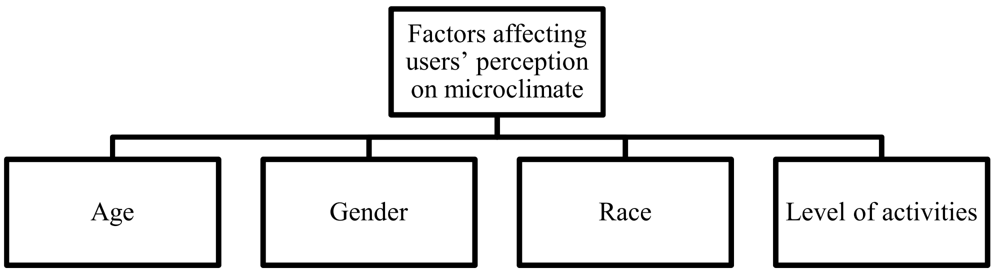


Figure 105. Factors affecting users' perception on microclimate (source: Nasir et al., 2012; established by author)

Environmental stimulation is also considered as a factor that might influence the degree of thermal comfort of the user of a space (Nikolopoulou & Steemers, 2003). Environmental stimulation is one of the reasons why people go outside (Reiter & DeHerde, 2003). It was observed that a large number of people that were found to have been in the area primarily due to the environmental stimulation provided; it was also their response to what they liked most about the area. On a similar note, the green surroundings and the view of the water (in both Al-Corniche and Aspire) enriched the spaces and created psychological satisfaction; in which it offered opportunities to relax, refresh, and secure a sense of balance (Figure 106).

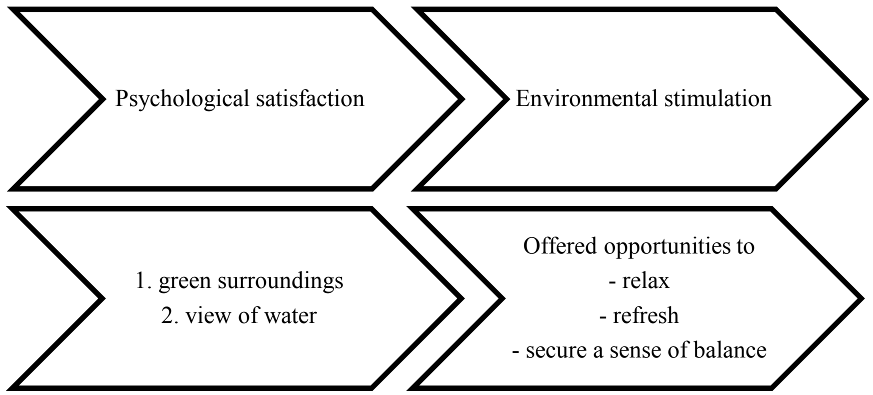


Figure 106. Psychological satisfaction of studied OPS (source: developed by author)

5.3 Conclusions

This chapter is significant for improvement of OPS conditions in hot arid regions. The next step is crucial in translating the research thesis's valuable results to conclude and recommend further design improvements for OPS. This is shown in the following chapter.

CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1 Conclusion

This thesis reviews the potentials and limitations of using three factors (microclimate, psychological adaptation, and physical aspects of OPS in Doha) to underpin our understanding and to improve outdoor human thermal comfort.

This work has thrown some light on the complexity of the interrelationships of a mix of parameters. This thesis has emphasized that a quantitative approach to the physical aspects and microclimate does not suffice, but psychological adaptation has become crucial in strongly influencing users' thermal comfort. Data was gathered from 2 different outdoor locations in Doha, Qatar, via the methods: questionnaires, microclimate measurements, and on-site observational mapping. Based on the analysis, thermal comfort of users in the space was influenced by varying factors, including air temperature, humidity, wind speed and the psychological adaptation parameters. Majority of the findings of this study are in accordance with the previous works.

The study revealed that the users of the OPS, Al Corniche and Aspire, are more tolerant of higher temperatures and of moderate levels of humidity. This is possibly due to the fact that the region experiences relatively higher temperatures throughout most of the year, being a hot and humid desert region. Thus, experience supersedes and users adapt to make themselves more comfortable. The visitors were found to adjust with the microclimate by remaining in shaded areas, consuming cold drinks or snacks, altering their clothing, reducing their activity levels, etc (Figure 107). It was observed that there is no definite values of microclimate conditions under which the user is comfortable at all time and thus the comfort preferences vary within a range of values. These variations were deduced to be dependent on the time of day, purpose of visit, individual preferences, activity, cultural status, and psychological adaptation parameters (Figure 108). Furthermore, since Qatar is known as a multicultural society, some users' thermal comfort might be affected due to cultural diversities.

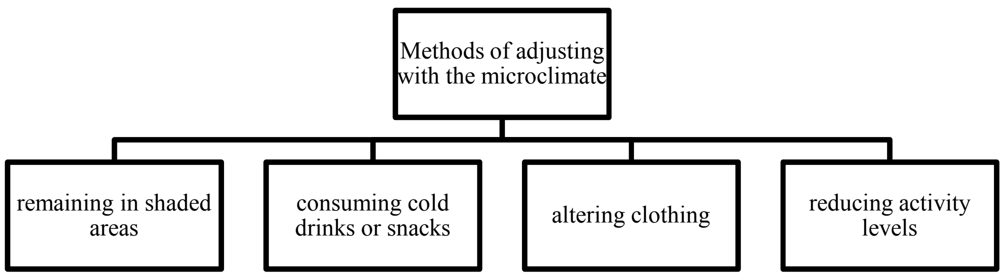


Figure 107. Methods of adjusting with the microclimate (source: developed by author)

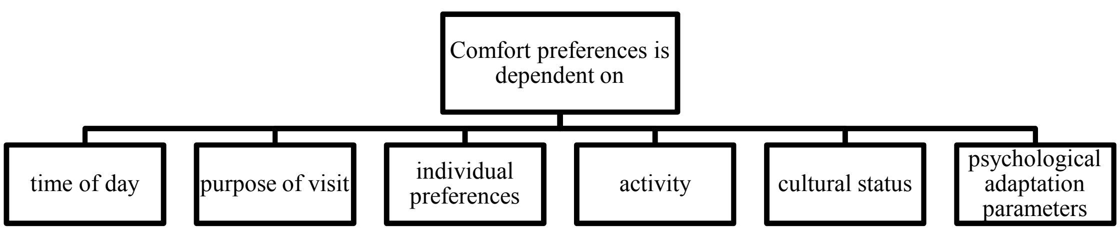


Figure 108. Comfort preferences variables (source: developed by author)

The presence of vegetation and trees acting as a canopy was seen to act a major role in influencing thermal comfort considerably. However, despite many of the respondents were satisfied with the level of vegetation, it was the type of vegetation (such as palm trees instead of deciduous trees) that did not play in favor of satisfying their comfort levels. The choice to spend time outdoors in public spaces also plays a role in individuals and groups thermal comfort. Crowd intensity and composition affected by office timings might have also affected thermal comfort.

Psychological adaptation parameters, including naturalness of the place, expectations, experience, time of exposure, perceived control, and environmental stimulation have been found to significantly affect human thermal comfort situations experienced in OPS by the users. People were found to be generally adaptive and modified their outlook to make themselves more comfortable in the existing microclimatic conditions as they prefer to spend time outdoors at least once during the weekend or weekday. It was also recorded that the presence of more users, longer stay, and higher chance of re-visitation would also result in a wider range of activities in the outdoor space; and thus, undoubtedly a higher tolerance to weather conditions would be developed (Figure 109). This was found out by studying the influence of microclimatic conditions on the behavioral patterns of people in OPS. Personal choice, emotions, perceptions, attitudes, memory and expectations prove to be a critical parameter for satisfaction with the thermal environment, psychologically.

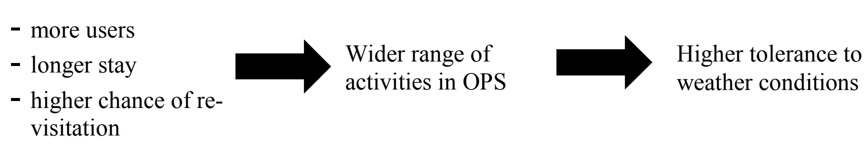


Figure 109. Development of a higher tolerance to weather conditions (source: developed by author)

There have been many noteworthy published literature works that exemplify the effect of outdoor thermal comfort on outdoor activities. Many of them have illustrated methods of adopting physical, physiological and psychological measures to combat heat.

However, limited researches have established a direct link between physical aspects, microclimatic conditions, and psychological adaptation parameters to determine and ultimately improve human thermal comfort situations in the OPS.

The analysis concluded in this research would be of value to designers and planners of the urban environment, as design guidelines based of understanding the thermal comfort levels of the users' are useful in rightly transforming OPS as well as for increasing the recreational vale of the region and attracting more users by enhancing thermal comfort conditions. The importance of microclimate-sensitive and psychological adaptation-sensitive planning in urban design was substantially confirmed by this research study, and can be applied practically at different times of the year.

6.2 Recommendations – Design Considerations for Spatial Quality of OPS

The findings and literature prove without a doubt that microclimatic conditions and psychological adaptation are crucial aspects to consider for improving human thermal comfort in an OPS, and further, that they can be controlled through site design of the physical aspects to some extent. There have been many agreed views and opinions by experts that the visitors experience and comfort is highly linked to the temperature and heat of OPS during summer.

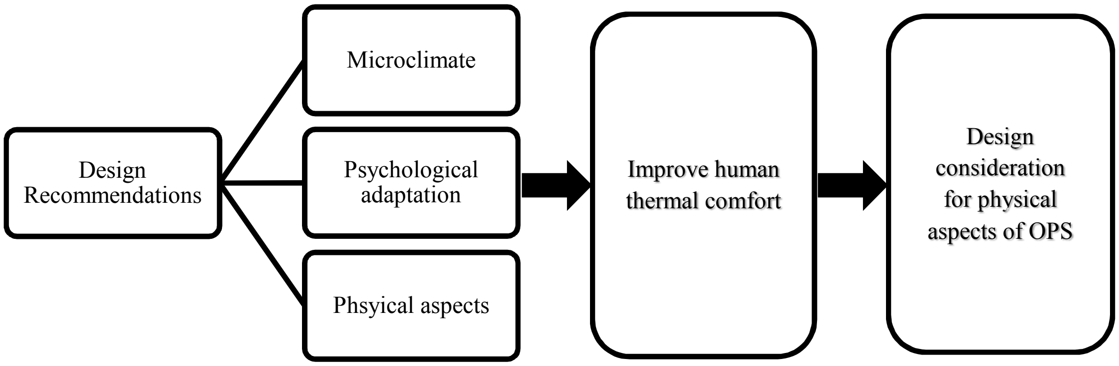


Figure 110. Design recommendations structure (source: developed by author)

6.2.1 Design Considerations from the Microclimate Perspective

Edwards (2014) suggests that based on the urban microclimatic design principles, the following must be achieved to enhance users' outdoor comfort: forging of social spaces, enhancement of urban microclimate, inclusion of nature in urban layouts, and creation of place.

The urban microclimate of any site is influenced by many parameters which may not always be controlled by the designer including "the prevailing climate, the choice of the site, the form of the site, the surrounding land, any retained buildings, the established road network or any planning restriction" (Bougdah & Sharples, 2010).

6.2.2 Design Considerations from the Psychological Adaptation Perspective

An awareness of design issues that would affect the interrelationship of psychological adaptation parameters would be valuable to urban planners, architects, and urban designers by enriching the design opportunities.

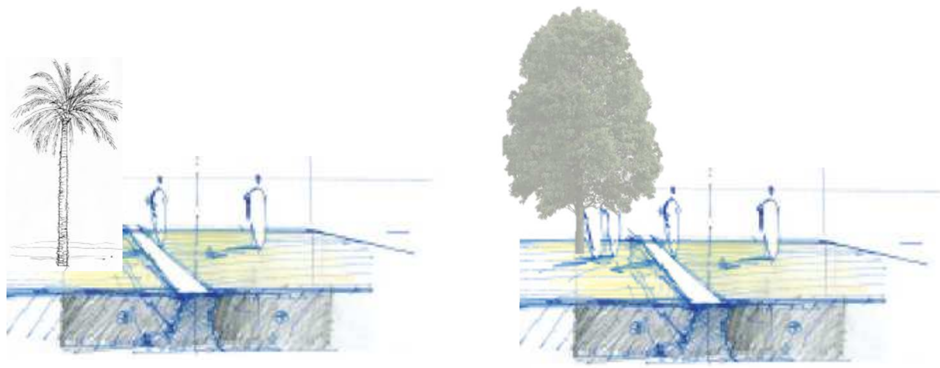
It is naturalness, experience and perceived control variables that can be influenced from the design perspective (Nikolopoulou and Steemers, 2003). Time of exposure is a personal variable. Naturalness is a prominent parameter that can be significantly increased by adding vegetation, a sort of green façade, to an area (Figure 111). The study done by Hesselgren (1987) verified that increasing natural instead of built characteristics has neutralized the negative evaluation of an empty space. Attia and Duchhart (2011) consider the point that the type of vegetation added affects the space in different ways. For example, they argue that deciduous trees have dense foliage and can thus be used to provide solar protection and retention of heat (Figure 113). Palm trees that are currently in effect in Corniche do not provide enough shade and thus the input of solar energy to the users' body is of great proportions (Figure 114). Avoiding this would encourage a higher usage rate of outdoor spaces in hot and humid regions in the summer season. In addition, Bougdah and Sharples (2010) state that trees also provide shelter from the wind during the cold season.

Figure 111. Bio-façade project at Qatar University (source: author)

Figure 112. Bio-façade freestanding structures (source: developed by author)

Current Future Design Recommendation

Figure 113. Deciduous trees providing solar protection and comfort for users' (source: developed by author)



Current – Palm Trees Future Design Recommendation – Deciduous Trees

Figure 114. Design recommendation for provision of more shade (source: developed by author)

6.2.3 Design Considerations from the Physical Aspects Perspective

Nikolopoulou and Steemers (2003) are of the opinion that increasing the opportunities for physical aspects to take place may affect perceived control. This can be accomplished by providing a myriad of sub-spaces within the same area. To do this, the planner/designer can employ transition spaces, such as arcades, or incorporate manoeuvring bio-façade elements within the space that can act as parasols or awnings shown in Figure 115 and Figure 116 below. Doing this will allow for access to the sun or rain as well as the shade, exposure to breezes as well as protection from harsh winds; this would be appreciated by the user.

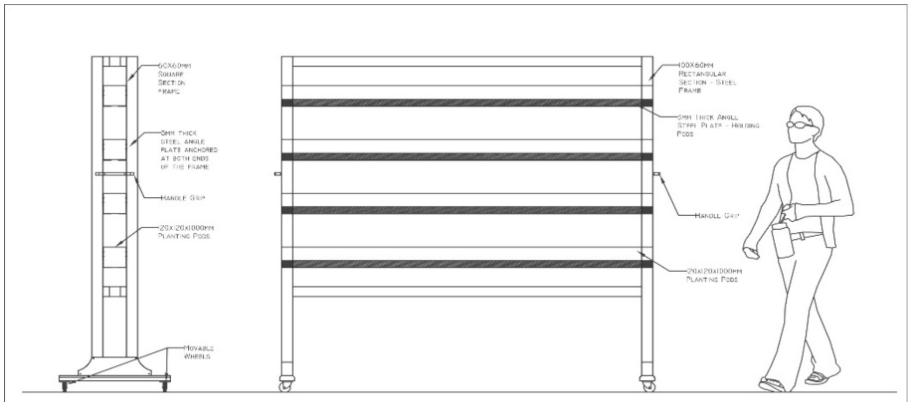
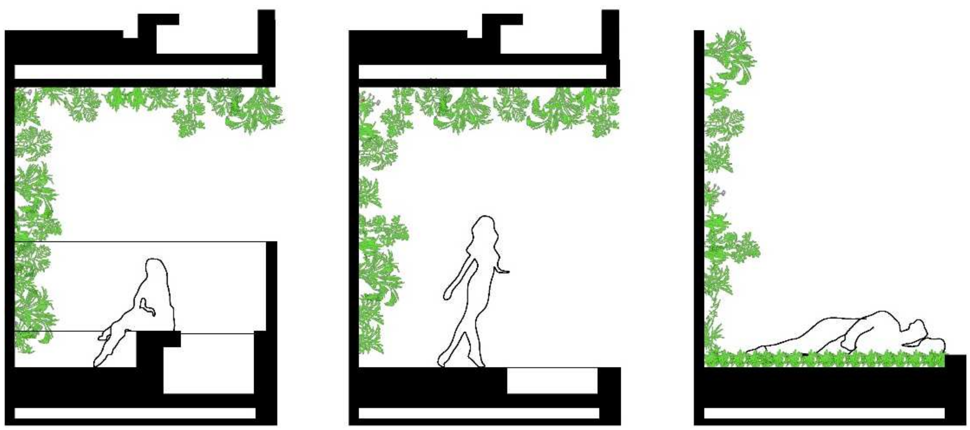


Figure 115. Mobile POD structure (source: developed by author)



Awning (shaded sitting area) Awning (walking area) Sun exposure (walking and relaxing area)

Figure 116. Freestanding transitional bio-façade structural spaces (source: developed by author)

Microclimatic control is also feasible, in which it might enhance the outdoor thermal comfort situations. Mirzaei and Haghighat (2010) are of the opinion that soft and hard landscaping, using cool reflective materials, and increasing water features are effective mitigation measures to reduce thermal discomfort. Soft landscaping, such as trees, offers solar control during summer and cools the air through evaporation from their leaves. Hard landscaping elements, including stone, paving slabs, wood chip mulch and rubber material of a light density mass. Light density mass materials minimize the amount of heat stored during the day and thus enhance the air temperature in outdoor sitting areas during the day and night avoiding thermal stress in urban environment.

Figure 117. Design recommendations for soft and hard landscaping elements (source: GoogleImages, 2016; estblished by author)

Researches by Levinson et al. (2007) and Synnefa et al. (2008) indicate the effect white and light colored surfaces have on considerably improving thermal comfort due to their ability in reducing the ambient temperature. Ragheb et al. (2016) confirm that the use of high albedo materials (i.e. excessive reflective material) have the potential to reflect incoming solar radiation in urban environments and consequently effectively reduce the effects of the thermal environment on user comfort.

According to Moonen et al. (2012), including ground-level ponds as a water feature are an effective mitigation measure and can provide a natural cooling mechanism to reduce ambient temperatures in an urban area through the process of evaporation. The usage of evaporative cooling devices and fountains would also be an asset in improving thermal comfort conditions.

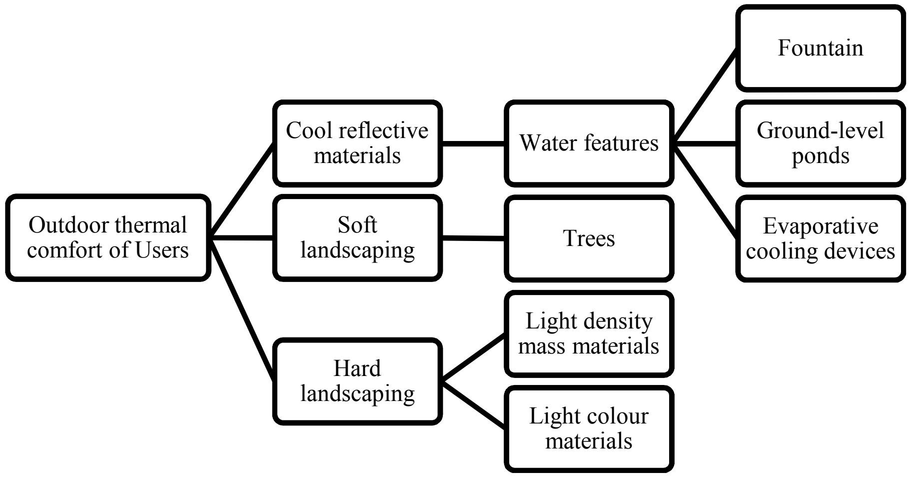


Figure 118. Design recommendations for outdoor thermal comfort of users' (source: developed by author)

The arrangement of urban furniture to influence wind movement is yet another means for maximizing thermal comfort of users. The patterns of trees, hedge plantings and landscaping can often be controlled and can influence wind speed and direction (Edwards, 2014). Other urban environmental factors that wind distribution depends on are constructing height, technique-flow, wind direction, urban geometry of buildings and their surroundings (Ragheb, El-Darwish, & Ahmed, 2016).

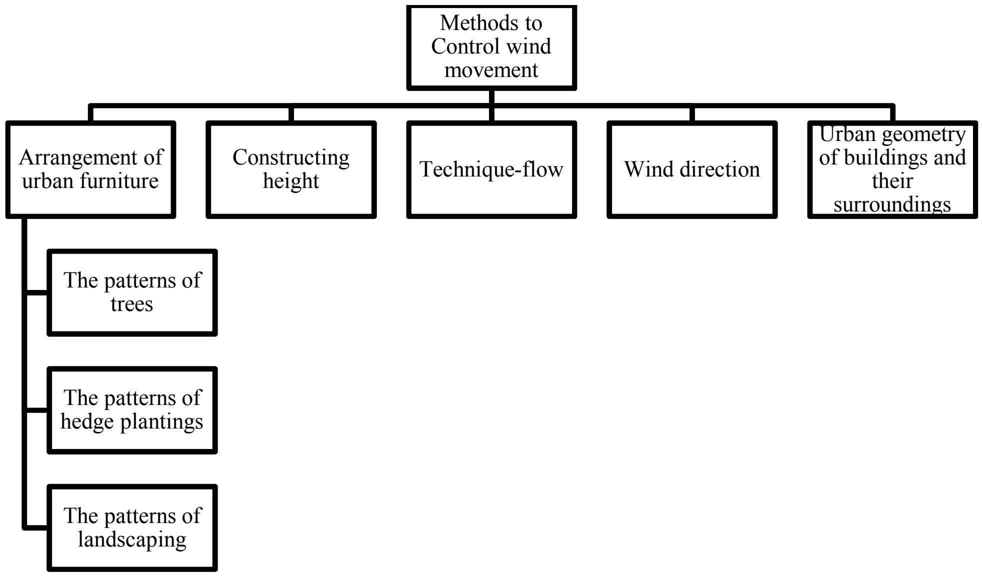


Figure 119. Techniques to control wind movement (source: developed by author)

To further increase the crowd intensity and volume, and to attract more users to the OPS, there is an urgent need of more seating and benches. An innovative idea would also be to open a stand and rent out umbrellas for rain or shine, thus accommodating both times of the year. It was also noticed that there was a large percentage of the users whose main purpose of visit was entertainment, fitness, health or sports related. Creating a space where more social activities can take place would cater to the needs and preferences of a multitude of people.

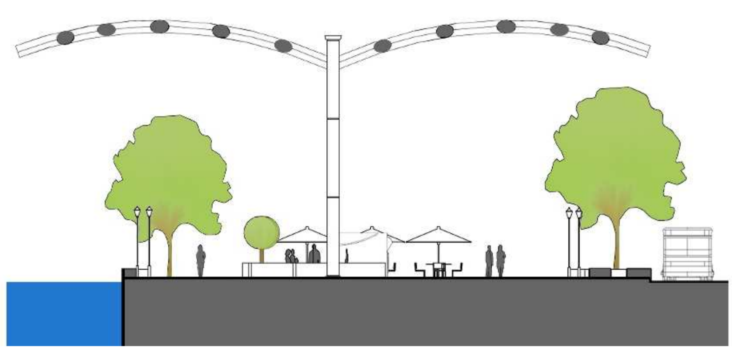


Figure 120. Typical section encouraging socialising (source: developed by author)

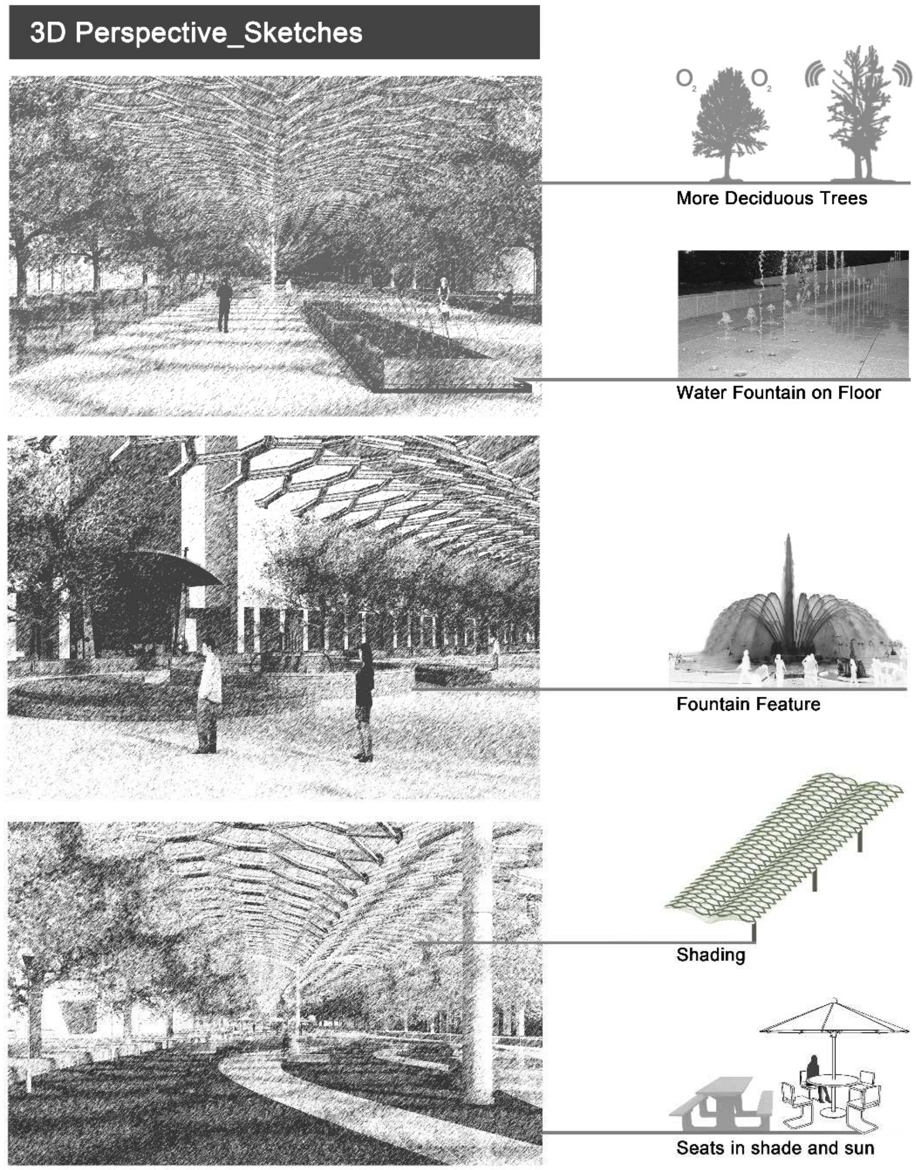


Figure 121. Design recommendations for outdoor thermal comfort (source: developed by author)

The obtainment of microclimatic data and behavioral data of users aided in concluding and making recommendations for Doha's microclimate scheme by modifying design aspects; the main aims are to reduce solar radiation, humidity and air temperature on the site and to increase the wind flow (Figure 122).

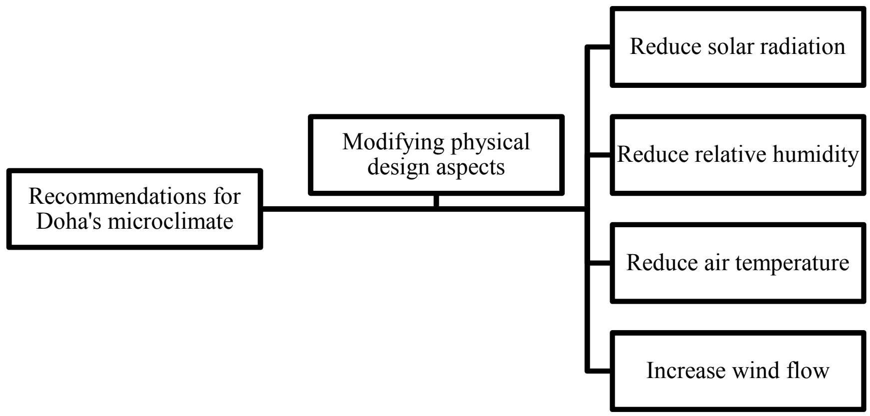


Figure 122. Recommendations for Doha's microclimate (source: developed by author)

In analyzing the microclimate and psychological adaptation, it is not always possible to incorporate all causative variables accurately and therefore a planner must use assumption and simplification techniques in the analysis process and construction of a design guideline, which might make the consequences less effective. Simulation methods (e.g. Computational Fluid Dynamics), according to Mirzaei and Haghighat (2010), can thus be used to analyze the microclimate and to enable the design of adaptive thermal comfort.

6.3 Opportunities for Further Development and Future Work

Studies revolving around thermal comfort in an OPS are fundamental for the design and development of these spaces. Further to the research conducted in this thesis, the primary approach to retrieve excruciatingly valid findings would be to assess thermal comfort over the two seasons experienced by the population of Qatar, namely summer and winter. There is still room for further research with wider sampling of more OPS in the geographical area within the hot arid climate (e.g. Museum of Islamic Art Park) to determine the adaptations of individuals to the microclimate in different environments. If ample time were available, it would be interesting to study the impact of seating placement on (1) the changes of social activities in public spaces; and (2) outdoor environment comfort with regards to psychological adaptation. Furthermore, it would be wise to measure other microclimatic parameters, such as surface temperature of different physical aspects of the space (an example would be to measure the surface temperature of seats, benches, water surfaces, vegetation, etc.) and observe and question the users of the OPS. Such studies might appear more effective and have greater practical applicability in understanding the relationship between comfort, design and social interaction in OPS. Examination of the outdoor thermal comfort using a Computational Fluid Dynamics (CFD) analysis by testing the different microclimate parameters related to the site may allow for an extensive understanding of the thermal comfort and behavioral patterns of the users of the space.

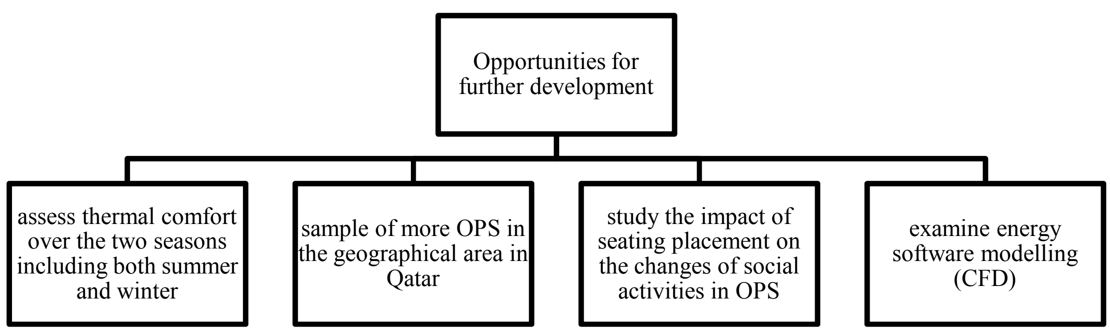


Figure 123. Opportunities for further development (source: developed by author)

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APPENDIX

Appendix A: QU-IRB Research Ethics Approval

جامعة قطر
QATAR UNIVERSITY

Qatar University Institutional Review Board
QU-IRB

June 15, 2016

Ms. Sara Zaina
Dept. of Architecture and Urban Planning
College of Engineering
Qatar University
Tel.: 50288208
Email: sara_m_zaina@hotmail.com
Email: sz1401525@qu.edu.qa

Dear Ms. Sara Zaina,

Sub.: Research Ethics Review Exemption / Graduate Student Project
Ref.: Project titled, "Assessment of Physical Environmental Parameters and Psychological Adaptation as an Element for determining Outdoor Spatial Quality in Qatar University Campus"

We would like to inform you that your application along with the supporting documents provided for the above proposal, is reviewed and having met all the requirements, has been exempted from the full ethics review.

Please note that any changes/modification or additions to the original submitted protocol should be reported to the committee to seek approval prior to continuation.

Your Research Ethics Approval No. is: **QU-IRB 625-E/16**

Kindly refer to this number in all your future correspondence pertaining to this project.

Best wishes,

K. Alali

Dr. Khalid Al-Ali
Chairperson, QU-IRB

جامعة قطر
QATAR UNIVERSITY
Institutional Review Board
(IRB)
Office Of Academic Research

Qatar University-Institutional Review Board (QU-IRB), P.O. Box 2713 Doha, Qatar
Tel +974 4403-5307 (GMT +3hrs) email: QU-IRB@qu.edu.qa

Appendix B: Questionnaire

Qatar University
College of Engineering
Department of Architecture & Urban Planning (DAUP)
Master of Urban Planning and Design Program

THESIS FOCUSES ON URBAN DESIGN L01 (MUPD 760)

Assessment of Micro-climatic Conditions and Psychological Adaptation as Elements for Determining Outdoor Spatial Quality in Outdoor Public Spaces

Supervisor: Dr. Fodil Fadli

This survey is being undertaken as part of a research project on the "User adaptation – approach towards enhancing spatial quality of outdoor public spaces in Doha (Al-Corniche and Aspire)". The objective is to understand the influence of micro-climatic conditions and urban design and the role of psychological adaptation in outdoor public spaces.

The survey results will examine physical and environmental attributes and psychological adaptation of the user to evaluate, discover issues and provide solutions to enhance the outdoor public space, which will assist urban planners in their future decisions and planning vision for outdoor public spaces in Qatar.

Kindly be informed that all information collected through this survey will be treated as strictly confidential and will be used only for research purposes. No information about the individuals who have participated in this survey will be disclosed to anyone at any time. (This questionnaire has been tested and will require 5 minutes of your time). Please note that participation is voluntary, you can skip any question or withdraw at any time.

1. General Information						
1.1.	Gender:	**A.** Male	**B.** Female			
1.2.	Age:	**A.** 18 – 25	**B.** 25 – 30	**C.** 30 – 35	**D.** 35 – 40	**E.** 40 – 50
1.3.	Academic Qualification:	**A.** High School	**B.** Diploma	**C.** Bachelor Degree	**D.** Master Degree	**E.** Ph.D
1.4.	Ethnicity:	**A.** Arab	**B.** Indian	**C.** Asian	**D.** European	**E.** Other
1.5.	Specialization:	**A.** Architecture and Engineering	**B.** Medical Sciences	**C.** Arts and Humanities	**D.** Business Management Studies	**E.** Other
1.6.	Area Living in:	______________________________				
1.7.	Frequently Used Mode of Travel:	**A.** Car	**B.** Bus	**C.** Bicycle	**D.** Walking	**E.** All
1.8.	Years living in Doha:	**A.** 1 – 5 yrs	**B.** 6 – 10 yrs	**C.** 11–20 yrs	**D.** 21–30 yrs	**E.** 31 yrs and more

No…… Date ………… Time………… Site Location………………

1

The questionnaire form (circle suitable answer)

- A - Social Visit

1. Where do you spend most of your time during the weekdays?

A. indoors **B.** outdoors **C.** both

2. a) Do you think that today's weather is typical for this time of the year?

A. yes **B.** no **C.** don't know

b) If no, what do you think it should be like?

A. cooler/ colder **B.** warmer/ hotter

3. Does temperature influence your visit time?

A. agree **B.** often **C.** disagree

4. How often do you use this place?

A. more than once every day **B.** at least once every day **C.** every week
D. every month **E.** rarely **F.** first time

5. What is the fundamental purpose you are in this place?

A. meeting **B.** relaxing/ break **C.** passing by **D.** enjoying the place
E. walking **F.** studying **G.** reading **E.** other………………

6. Are you here?

A. alone **B.** with family **C.** with a friend/ group of people

7. Would you like to spend more time considering current conditions of the area?

A. yes **B.** no

8. Why did you choose this area?

A. sun **B.** shade **C.** accessibility **D.** availability **E.** landscape
F. other………………………………………………………………………………..

9. How would you like this place to be in terms of vegetation?

A. more greenery **B.** no change **C.** less greenery

10. When did you arrive to this area?

A. <30 min ago **B.** 30-60 min **C.** 60-90 min

D. 90-120 min **E.** 120-150 min **F.** >150 min

11. How long do you think you will stay?

A. <30 min ago **B.** 30-60 min **C.** 60-90 min

D. 90-120 min **E.** 120-150 min **F.** >150 min

12. Where were you just before coming here?

A. Indoors **B.** Outdoors

13. How long ago were you in an air-conditioned space (including vehicles)?

A. <30 min ago **B.** 30-60 min **C.** 60-90 min

D. 90-120 min **E.** 120-150 min **F.** >150 min

14. a) How is your current experience/ perception of this place?

A. 1 - boring **B.** 2 **C.** 3 **D.** 4 **E.** 5 - interesting

A. 1 - attractive **B.** 2 **C.** 3 **D.** 4 **E.** 5 - unattractive

b) What is your perception about a good outdoor space?

……………………………………………………………………………………..…………

…………………………………………………………….……………………………...…

15. What do you like about this place?

……………………………………………………………………………………...…………………

…………………………………………………………..………………………...…………

16. What don't you like about this place?

……………………………………………………………………………………...…………………

…………………………………………………………..………………………...…………

17. a) Do you prefer to change your position in this place?

A. yes **B.** doesn't matter **C.** no

b) If yes, what is the reason?

…………………………………………………………………………………..…………

……………………………………………………………..…………………………..…

- B -

Surface temperature ………

18. a) Where are you sitting?

A. shade **B.** sun **C.** overcast

b) What are you sitting on?

A. bench **B.** ground **C.** grass **D.** other

19. Circle all items closest to type of clothes you are wearing now:

A. abaya **B.** dishdasha **C.** head scarf **D.** burqa **E.** shawl

F. cap **G.** tie **H.** long dress **I.** short dress **J.** long skirt

K. short skirt **L.** long pants **M.** short pants **N.** jeans **O.** closed shoes

P. opened shoes **Q.** socks **R.** sandals **S.** jacket **T.** coat

U. sleeved less Shirt **V.** short sleeved shirt **W.** long sleeved shirt **X.** hats

20. What do you classify the colours of your clothes to be?

A. dark **B.** mixed **C.** light

21. What have you been eating/ drinking in the last 10 minutes?

A. only drinking cold **B.** only drinking hot **C.** hot drink with food

D. cold drink with food **E.** only eating warm food **F.** only eating cold snack

G. eating neutral food **H.** none

22. What type of activity have you been doing in the last 10 minutes?

A. sitting **B.** standing **C.** walking **D.** playing physical game **E.** lying

F. running **G.** cycling

23. a) How would you react if it gets warmer?

A. change place **B.** clothes on **C.** clothes off **D.** hot drink **E.** cold drink

F. other ………….……………………..…………..………..…………..…………..……..….

b) How would you react if it gets colder?

A. change place **B.** clothes on **C.** clothes off **D.** hot drink **E.** cold drink

F. other ………….……………………..…………..………..…………..…………..……..….

- C -

24. a) How do you feel at the moment?

A. hot **B.** warm **C.** slightly warm **D.** neutral

E. slightly cool **F.** cool **G.** cold

25. a) What is your sun preference at this moment?

A. more sun **B.** no change **C.** more shade **D.** N/A

b) During summer does direct sunlight affect your experience?

A. agree **B.** often **C.** disagree

26. a) At the moment, how would you describe the wind situation?

A. very calm **B.** calm **C.** windy **D.** very windy

b) How would you prefer the wind situation to be at the moment?

A. more air movement **B.** no change in air movement **C.** less air movement

c) Are you satisfied with the air movement?

A. yes **B.** no

27. a) What do you think of humidity at the time being?

A. very humid/ wet **B.** Humid **C.** slightly humid

D. neither humid nor dry **E.** slightly dry **F.** dry **G.** very dry

b) How would you prefer the humidity to be at the moment?

A. much more humid **B.** a little more humid **C.** no change

D. a little drier **E.** much more drier

28. a) How would you describe the weather at the moment?

A. cold **B.** cool **C.** neutral **D.** warm **E.** hot

b) How would you prefer the weather to be at the moment?

A. cooler temperature **B.** no change in temperature **C.** warmer temperature

29. a) Do you feel comfortable in regards to the overall weather conditions?

A. yes **B.** no

b) How would you rate the overall comfort level?

A. very comfortable **B.** moderately comfortable **C.** slightly comfortable

D. slightly uncomfortable **E.** moderately uncomfortable **F.** very uncomfortable

c) How do you feel right now?

A. cool **B.** slightly cool **C.** neutral **D.** slightly warm **E.** warm **F.** hot **G.** hazardously hot

d) Do you accept the present outdoor conditions as a whole?

A. yes **B.** no

- D - General Satisfaction

30. Does the presence of water bodies cool down the place and reduce temperature?

A. agree **B.** often **C.** disagree

31. Do the high rise buildings affect the wind flow?

A. agree **B.** often **C.** disagree

32. Is there enough trees & vegetation to provide cooler spaces for thermal comfort?

A. agree **B.** often **C.** disagree

33. Which of the following parameters discourage you from visiting this park?

A. lack of activities **B.** heat **C.** lack of shaded areas **D.** lack of sitting areas i.e. children's play area, café, and shops

34. Do you find that this park is an ideal place for all family members?

A. strongly agree **B.** agree **C.** disagree **D.** strongly disagree

35. Would you like to visit this park more often than other public spaces in Doha?

A. strongly agree **B.** agree **C.** disagree **D.** strongly disagree

Signature:

Date:

THANK YOU FOR YOUR TIME AND PATIENCE

Appendix C: Summary Table of Weekdays and Weekends of the OPS in Al-Corniche

Day	Date	Time	Time (hour)	Weather	Number of Users'	Crowd diversity (Mainly)	% of users tolerating weather conditions	Didn't mind staying outdoors	Revisit	Time of stay for		Un-satisfied with amount of vegetation
Weekdays (Al-Corniche)	**16-08-16**	Morning	06am-08am 08am-10am 10am-12pm	39°C 37% 9km/h	240	Mainly individuals	60%	75% but minded staying for long hours.	85% would revisit but only spend little time.	80%	30min-1hour	15%
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	41°C 41% 13km/h	240	Mainly groups and individuals	23%				>30min	0%
		Night	06pm-08pm 08pm-10pm	35°C 64% 12km/h	1200	Mainly groups, individuals, families and couples (some tourists)	20%				30min or less	
	30-08-16	Morning	06am-08am 08am-10am 10am-12pm	37°C 60% 10km/h	60	Mainly individuals	35%	45% didn't mind staying outdoors and for long hours.	75% would revisit and spend more time.	80%	30min-1.5hours	Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	40°C 35% 18km/h	95	Mainly individuals and groups	68%				30min-1.5hours	
		Night	06pm-08pm 08pm-10pm	35°C 57% 7km/h	305	Mainly groups, individuals, families and couples (some tourists)	35%				1hour-2hours	

Weekends (Al-Corniche)	**12-08-16**	Morning	06am-08am 08am-10am 10am-12pm	36oC 63% 7km/h	106	Mainly individuals, groups, families (some couples and tourists)	33%	15% didn't mind staying outdoors	85% would revisit but only spend little time.	75%	30min-2hours	Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	38oC 60% 18km/h	233	Mainly individuals, groups, families (some couples)	38%	55% didn't mind staying outdoors and for long hours.			2hours-3hours	
		Night	06pm-08pm 08pm-10pm	35oC 70% 13km/h	783	Mainly individuals, groups, couples, families (some tourists)	52%				1hour-3hours	
	26-08-16	Morning	06am-08am 08am-10am 10am-12pm	38oC 45% 11km/h	136	Mainly individuals, couples (some groups and families)	55%	85% didn't mind staying outdoors and for long hours.	80% would revisit and spend more time.	70%	1hour-2hours	Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	40oC 40% 14km/h	367	Mainly individuals, groups, families (some couples and tourists)	35%				2hours-4hours	
		Night	06pm-08pm 08pm-10pm	34oC 70% 8km/h	734	Mainly individuals, groups, families, couples (some tourists)	40%				2hours-4hours	

Note: figures in this table is based on the questionnaire

Appendix D: Summary Table of Weekdays and Weekends of the OPS in Aspire

Day	Date	Time	Time (hour)	Weather	Number of Users'	Crowd diversity (Mainly)	% of users tolerating weather conditions	Didn't mind staying outdoors	Revisit	Time of stay for	Un-satisfied with amount of vegetation
Weekdays (Aspire)	**16-08-16**	Morning	06am-08am 08am-10am 10am-12pm	39°C 31% 7km/h	23	Mainly individuals (some groups and couples)	55%	70% of users were not able to tolerate the weather and didn't stay for long hours	55% would revisit but only spend little time.		Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	41°C 51% 11km/h	32	Mainly individuals and groups (some families)	13%				
		Night	06pm-08pm 08pm-10pm	37°C 69% 7km/h	160	Mainly individuals, groups, families (some couples)	22%				
	30-08-16	Morning	06am-08am 08am-10am 10am-12pm	37°C 59% 6km/h	58	Mainly individuals (some groups and couples)	37%	75% didn't mind staying outdoors and for long hours.	70% would revisit and spend more time	85% 30min-1hour	Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	40°C 41% 14km/h	20	Mainly individuals (some groups and families)	55%			1hour-4hours	
		Night	06pm-08pm 08pm-10pm	37°C 55% 7km/h	350	Mainly individuals, families, groups (some couples and tourists)	40%			1hour-4hours	

Weekends (Aspire)	**12-08-16**	Morning	06am-08am 08am-10am 10am-12pm	37°C 64% 6km/h	7	Mainly individual (some groups and families)	5%		70% would revisit but spend little time	90%	15min-30min	0% 15%
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	41°C 63% 15km/h	47	Mainly individuals, families, groups (some couples)	5%				1hour-2hours	0%
		Night	06pm-08pm 08pm-10pm	36°C 72% 12km/h	450	Mainly families, individuals, groups, couples (some tourists)	20%	60% didn't mind staying outdoors and for long hours.			1hour-2hours	
	26-08-16	Morning	06am-08am 08am-10am 10am-12pm	39°C 36% 8km/h	101	Mainly individuals, groups (some families)	57%	80% didn't mind staying outdoors and for long hours.	Visitors want to come but not spend a lot of time	60	>30min	Nil
		Afternoon	12pm-02pm 02pm-04pm 04pm-06pm	41°C 47% 15km/h	9	Mainly individuals, groups, families (some couples)	22%		Users don't want to come and don't want to spend time		Nill	
		Night	06pm-08pm 08pm-10pm	34°C 70% 7km/h	500	Mainly families, individuals, groups, and couples	37%		65% would revisit and not spend a lot of time		1hour-4hours	

Note: figures in this table is based on the questionnaire