



# **Critical Evaluation of Psychological Adaptation as a Factor for Determining Thermal Comfort in Public Outdoor Spaces in Dubai**

دراسة أزمة التطابق النفسي  
كعامل لتحديد الراحة من حيث درجة الحرارة في الأماكن العامة  
الخارجية في دبي

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Dissertation submitted in partial fulfillment of  
MSc Sustainable Design of the Built Environment

Faculty of Engineering & IT

May 2011

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## **ACKNOWLEDGEMENTS**

I would like to express my sincere gratitude and appreciation to Dr. Moshood Olawale Fadeyi for the constant guidance and moral supervision given to me during preparation and completion of this study. As my supervisor, he patiently supported and encouraged me to remain focused and to make the research study more resourceful. The comments and observations made by him were very valuable and helped me to attain the research objectives and goals fruitfully and were able to add more quality to the research outcome. This dissertation would not have been achievable without his enormous appreciable support and I will never forget his encouragement.

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## **ABSTRACT**

High degrees of competition and globalization in fact made it imperative for nations to adopt systematic methods at the various stages of developmental planning in order to create or improve the designs for the benefit of the people, society, region, economy and environment. It is seen that comfortable outdoor spaces play a part in improving the quality of life particularly in urban areas. As thermal comfort form a decisive factor in influencing the utility value of spaces, evaluations on the user preferences and associated aspects would be beneficial in rightly categorizing and designing outdoor spaces. So the current research study was conducted for the purpose of exploring the role of psychological adaptation in estimating thermal comfort levels and for analyzing the various factors that influence thermal comfort in public outdoor spaces in Dubai. Both quantitative and qualitative research methods were used for this research. Various physical parameters like temperature, humidity and air velocity were measured from the selected eight outdoor (six Parks and two Walkways) locations in Dubai in addition to the subjective measurements made for understanding the perceptions, expectations, psychological adaptations and behavioural adaptations of the people. Based on the research study it was found that in addition to psychological adaptation, physical parameters like temperature, humidity and wind speed, vegetation in the area and adaptive behaviors also seem to play a dominant role in deciding the thermal comfort of individuals in public outdoor places in Dubai. It was noticed that there are no specific values of temperature, humidity, wind speed, etc, under which the individuals are comfortable at all times and the comfort preferences vary within a range of values. Major recommendations for bettering the public outdoor spaces include, develop optimum levels of vegetation based on demand and to design spaces so as to provide thermal comfort across seasons. This study provided better insights and knowledge on the real time facts that have relevance at practical and academic realms and would be useful in rightly transforming outdoor spaces as well as for increasing the value of the region.

## ملخص البحث :

الحقيقة ان المنافسة و العولمة الآخذة في التزايد قد دفعت الناس إلى اتخاذ أساليب نظامية في شتى المراحل لوضع أو تطوير خطط باتجاه مصالح العموم و المجتمع و المنطقة و الاقتصاد و البيئة . و مما يبدو أن الأماكن الخارجية(المكشوفة) المريحة تلعب دوراً مهماً في تحسين نوعية المعيشة في المدن على وجه الخصوص . و بما أن الراحة من حيث درجة حرارة البيئة يشكل عنصراً قطعياً في القيمة الفعلية و التطبيقية للأماكن ، سيكون نافعاً تقييماً رغبات العملاء و الخصائص ذات الصلة في التصنيف الصحيح و تصميم الأماكن و الفضاءات الخارجية . و على هذا الأساس جاء هذا البحث بهدف معرفة دور التطابق(التلاؤم) النفسي في تخمين مستويات الراحة و دراسة و تحليل العوامل التي تؤثر في الشعور بالراحة من حيث درجة حرارة بيئة الأماكن العامة في دبي . و قد استخدم في البحث كلا الأسلوبين الكمي و النوعي ، و فضلاً عن الدراسة و التقييم الفكري لمعرفة الإدراكات و المشاهدات و التوقعات و التطابقات النفسية و السلوكية لدى الناس ، تم أيضاً تقييم مؤثرات و متغيرات مادية (فيزيائية) مختلفة مثل درجة الحرارة و الرطوبة و سرعة الرياح من ثمانية أمكنة خارجية (6 حدائق و رصيفين اثنين) مختارة في دبي . و حسب هذا البحث عرفنا أنه فضلاً عن التطابق(التلاؤم) النفسي ، يكون للمتغيرات و المؤثرات الفيزيائية مثل درجة الحرارة و الرطوبة و سرعة الرياح و تواجد النبات في المنطقة و السلوكيات التطابقية أيضاً دور مهم في اتخاذ القرار فيما يتعلق بشعور الناس بالراحة من حيث درجة الحرارة في الأماكن العامة المكشوفة في دبي . و عرفنا من خلال هذا البحث أيضاً أنه لا توجد هناك أية كميات خاصة و محددة من درجة الحرارة و الرطوبة و سرعة الرياح و غيرها تجعل الناس يشعرون بالراحة في ظروفها على الدوام ، كما أن الرغبات المتعلقة بالراحة موزعة على نطاق من الكميات المختلفة . أما النصائح المهمة لتحسين الأماكن العامة المكشوفة هي عبارة عن تنمية و توسيع المستويات المطورة من نمو النبات حسب الطلب و تصميم فضاءات بغية توفير الشعور بالراحة من حيث درجة الحرارة خلال فصول السنة . و قدم هذا البحث رؤى و معرفة جديدة عن حقائق واقع الزمن لها علاقة بالمناطق العلمية و التعليمية و تنفع لرفع قيمة المنطقة .

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# CHAPTER 1. INTRODUCTION

## 1.1 Introduction

Highly attractive and comfortable outdoor public spaces are expected to form vital design related factors that has the capability for increasing the quality of life particularly in urban centers and might as well be helpful in reducing the unconstructive impact of urbanization. In view to achieve this purpose, there is need for attracting both the present and prospective users through providing them with the right blend of features that matches with the ecological conditions, social set up, and other user preferences (Bruse, 2009). As it is quite evident that the microclimatic conditions that are present in the region form one among the most important factor that influences the perceptions and evaluations of the user with regard to the outdoor spaces, it is the responsibility of the town planners and other authorities to develop the region in such a way as to offer the most suitable microclimatic conditions with adequate proportions of sunlight and shade or protection from wind, etc (Bruse, 2009). Since it is the pleasantness of the micro climatic conditions that drives people in to frequenting any particular location evaluations on the user preferences on different regions would be useful in rightly categorizing and designing outdoor spaces. Such evaluations on the comfort levels of individuals would be very much useful for the town planners to skillfully and accurately allocate and design spaces for recreation, residential locations, tourism related activities, business circles, etc.

Based on the need for assessing the perceptions and expectations of individuals that are particularly aimed at understanding the thermal comfort levels of individuals, the current research study was initiated. According to Brandenberg and Arnberger (2001), major factors that are indicative of the thermal comfort of individuals like the air temperature, humidity, wind speed and radiation are found to have an impact on the outdoor activities and behavior of persons and groups. Hence this research study aimed at understanding the importance of psychological adaptation in estimating thermal comfort in public outdoor spaces in Dubai; to evaluate psychological adaptation and their role in thermal comfort in public outdoor spaces and to analyze the various factors that influence

thermal comfort in public outdoor spaces in Dubai would be helpful in adding more knowledge and insights in to the preferences and specific behavior of the people in this regard. As the Dubai government is trying hard to attract more international tourists into the region there is need for making a few ground level alterations in the town planning and design activities for making the allocations right and appropriate. Thus, Dubai was selected as the study area for this study.

## **1.2 Background of the Study**

Environmental conditions influences human behaviour considerably and hence the thermal comfort, which can be considered as the mental state that articulates contentment with the thermal conditions (ASHRAE, 1997), also varies from individual to individual. Thermal comfort levels of people depend on their specific preferences and tolerances with regard to air temperatures, average relative humidity, global radiation, wind speed, globe temperature, etc (Lin, 2009). Developing knowledge on the various factors that are mostly associated with the thermal comfort in outdoor spaces, which are capable of influencing people are in fact essential for identifying, developing and promoting potential and prospective tourism related areas. According to Lin (2009), the thermal comfort and the tolerance levels in outdoors would most likely vary due to the various mental and behavioural aspects when compared to the indoors. Thus, thermal adaptation forms major role in deciding the thermal comfort of individuals and groups.

Thermal comfort is subjective response that includes psychological factors in addition to the thermal sensation which is objective response to an environment. It is difficult to measure as it is subjective to the person. The following psychological factors may affect the thermal comfort. Freedom of choice, regional expectation, seasonal expectation, recent history, activity, and quality/ type of environment is some them, (Taylor and Guthrie, 2008).

The behaviour and expectations of people with regards to outdoor spaces is more complex and different than indoor spaces like home or offices. The behaviour at office or home is more deskbound where as for outdoor spaces it is more intricate with regards to

standing, walking or sitting and people do not need to remain in a specific terminal without the possibility of choosing the place to stay, (Monteiro and Alucci, 2007). Hence, more attention needs to be paid with regards to every aspect of outdoor spaces.

Socio-economic background and Socio-cultural factor also plays an important role in influencing the behavior of people in outdoor activities. In comparison with higher ranking people with regards to job, education and financial situation, lower ranking people spend more time in outdoor spaces. Culture also impacts how people use, adapt and do activities in outdoor places. Dressing also impacts the thermal adaptability in outdoor spaces, for example in western societies people wear short and cotton clothes in summer for outdoor activities and better adapt to thermal conditions whereas people in conservative societies wear clothes which cover them fully and may find it difficult to adapt to thermal conditions in summer. Therefore socio economic and socio cultural factors should also be considered in designing urban outdoor places, (ALJawabra and Nikolopoulou, 2009).

In delivering of thermal adaptations and management of the outdoor spaces, socio economic background has a critical implication because the access to these open spaces should also cater to the needs of all people of different economic background as it neither should be too costly to them or that it becomes too costly to manage (Nicol et al, 2008).

Physical acclimatization of individuals to the altering environmental conditions also plays an important role in deciding the thermal comfort of people in addition to the influences of location and time, particularly in an urban background (Ouameur and Potvin, 2007). The movement of the people and level of clothing are regarded as two effective physical adaptation means. People try to adjust themselves not only psychologically but also physically to overcome any thermal distress they might be feeling in outdoor spaces. Like if they are feeling hot they might want to sit in the shade or near water. They might wear light, short and cotton clothes. If they are feeling cold they might better keep moving and wear warm clothes.

According to study conducted by Nicol et al, (2008) on United Kingdom (UK) subjects, it was concluded that people adapt more easily to moderate outdoor conditions but they do not adapt completely to, too extreme outdoor conditions they feel cold in very cold climate and hot in very hot climate. Thus, people have different comfort responses in seasons like autumn and spring compared to winter and summer. This effect is not only due to thermal but also because of wind and solar intensity. From this study (Nicol et al, 2008) it can be said that there is a limitation to how much people can adapt themselves psychologically to thermal conditions.

In a study conducted on open air terraces provided by restaurants, taverns it was found that utilization and outdoor space dependence on thermal conditions is strongly affected by the design of the open-air places. If the ambience is good people adapt easily as compared to shabby open space. This study also concluded that people prefer more natural outdoor spaces compared to artificial ones and they better adapt and tolerate extreme thermal conditions in natural environment compared to the artificial environment, (Egerhazi et al, 2009).

The present study also would be evaluating whether the above psychological behavior of people with respect to different factors as concluded by other studies also has a similar impact on thermal adaptation and comfort level experience of people in Dubai as well.

Studies aimed at evaluating psychological adaptation as a factor for determining thermal comfort in public outdoor spaces in Dubai, might be useful in providing newer insights and knowledge for developing touristic areas and might be helpful in enhancing their recreational values. Since tourism is considered as an industry that has the capability to influence in the economic activity of the region any attempts for promoting tourism worth the effort especially in regions like Dubai, which is strategically located and well connected. According to Nikolopoulou(2001) better awareness on the diversity and intensity of the microclimatic qualities and features of the outdoor spaces and evaluations on the extent of comfort offered to the users would be useful in planning the housing in

urban areas, augment tourism related advancements, urban design or planning as well as in an array of large scale infrastructural projects. The different features of the micro climatic conditions of a region decide the level of satisfaction of the users and the measurement of the thermal comfort levels in relation to psychological adaptation appear to be most ideal in understanding the thermal sensations of people.

When people are travelling from one extreme climate to another extreme climate they might suffer from thermal stress which can be outdoor work related, sporting and recreational activities. Thermal stress seriously affects a person's health and reduces his tolerance and thermal adaptability. It happens because they are exposed to climatic conditions which are totally different from their home countries for example tourists from Scandinavian countries when traveling to Middle East may face this. They undergo thermal loading and its affects their psychological adaptability to thermal comfort. To avoid this and to take care of the tourist's well being, the outdoor spaces must be in such a way that it considers this factor in designing the thermal adaptability which does not hamper their vacation plans (Frietas and Grigorieva, 2010).

An understanding on the categories of users frequenting the areas could also provide clues for customizing the developmental activities of the locations as well. Understanding of the microclimatic conditions of the outdoors in relation to user preferences is integral to user satisfaction and would be helpful in the successful development of the outdoor spaces. Hence an understanding on the thermal comfort levels of the users based on the assessments of the various influential factors would progressively aid the tourism industry of Dubai and might prove useful for improving the overall structure. There are only very limited studies from the Dubai region and hence the research study would be useful in providing better knowledge and insights on the comfort levels of individuals in relation to the microclimatic regions. Such knowledge might be helpful in developing outdoor spaces that are more comfortable to the users as well as enable them to frequent the location. This data is very much important for designing the tourist locations, which in turn could be developed in to rich and diverse tourist spot capable of drawing large crowds.

Cities like Dubai in gulf region face extreme climatic conditions. It is common in Dubai that the indoor environment is heavily air-conditioned compared to the high outside temperature. The instruments used for intervention in indoor thermal comfort cause more urban warming and more high cooling load for the indoors. This cycle heightens the conspicuous estrangement from the outdoors environment. There is a need to narrow down the climatic difference between the indoor and outdoor environment especially in the gulf region to attract the people to use and enjoy the outdoor places by eliminating their perceptible difference which sure has an influence on the psychological adaptability on thermal comfort, (Yannas, 2007).

Nordstrom (1993) noted the importance of the cooperation of the users as it is difficult to evaluate their preferences and tolerance levels without the support of the users. For a better understanding of the psychological parameters which influence planning it is best to involve people in planning also, because all these outdoor space is built for their well-being. To serve this objective some sort of public representation should be used so that they can also lay their opinion as to what is best for them and what they want.

The maintenance of thermal comfort is also affected by the repercussion of climate change in open areas. There is limited scope for physical intervention like urban and built form design and to build adaptive capacity due to the impact of climate change (Nicol et al, 2008). When designing the outdoor spaces not only the physical or psychological behavior of people with regards to thermal comfort should be analyzed but also how these interventions impact the environment and the climate change. The design impact on climate change poses a constraint in designing the best outdoor environment.

The above background of the study gives how crucial thermal comfort is for enhancing the quality of outdoor spaces and how people adapt to thermal conditions with varying degrees depending upon the psychological factor. This psychological adaptation is in turn depends upon the socio economic background, culture, region and also on the ambience of the open space. Understanding on the thermal comfort is important for a place

like Dubai as it is emerging in to an international tourist hub as well as for the sustainable development of the region. It is essential to evaluate further how designs can be improved for the benefit of the city, people, tourists, economy and environment in the long run.

### **1.3 Motivation of the Study**

In this age of globalization it has become more of a necessity for countries to adopt appropriate strategies to attract more investments in to their region. Developing the tourism industry of the region could considerably increase the number of international travelers and also economic activities in the region. As a result of which there is increased need for developing many outdoor tourist spots and other recreation related locations. So a better understanding on the thermal comfort of outdoor spaces would be appropriate for designing the outdoors spaces systematically as well as based on the needs and demands of the customers. It was opined by Gaitani et al, (2005: 4) that the thermal comfort status of the region were considered as a guide for the microclimatic up gradations or alterations in the experimented area.

Exploring and assessing the thermal comfort levels of individuals are in fact needed for getting clear cut comprehensions with regard to the different activities that might most likely occur in a particular areas or spaces and hence the planning's based on the actual or real facts could enhance and promote the clients' thermal comfort. Carmona et al (2003) claims that the success of these outdoor public spaces depends on the frequency with which people visit the place, and on their revisits. The various factors that intervene with the thermal comfort levels of urban or outdoor spaces have similarities with the indoor spaces, but it appear to be more widespread and changeable (Zambrano et al, 2006). Since there are lots of complications with regard to the various characteristics of the outdoor spaces, there is need for understanding the specific reactions of the individuals in response to these microclimatic characteristics. Zambrano et al (2006) have rightly expressed the need for understanding the various thermal factors that influence the outdoor environment particularly in case of metropolitan projects.

There are lots of parameters which are interrelated, have a significant role to play in designing outdoor places. The parameters are psychological in nature like naturalness, expectations, experience (short and long term), time of exposure, perceived control and environmental stimulations. These parameters influence the design considerations or vice versa. Quantifying these parameters is not possible but due considerations has to be given during designing phase. (Nikolopoulou and Steemers, 2003). The motivation for this study was to understand these parameters and what role they play in giving thermal comfort to people in outdoor spaces.

Gaitani et al (2005) rightly stressed the dependence of urban design on the various microclimatic factors that influence thermal comfort in outdoor spaces. Hence the studies aimed at evaluating the thermal comfort levels of individuals have greater applicability at different realms. Knowledge on topics like this has the capability of adding to the economic development in the region and could make the region more attractive and popular internationally as well. According to (de Freitas, 2001), so far, majority of the climatology related works associated with tourism has been measured subjectively and also based on unconfirmed opinions or perceptions of the tourists, that too very unorganized. Hence there is need for conducting many more researches particularly based on field studies and observations for gathering more real time data in view to clearly understand the real responses, opinions, views, demands, requirements, reactions and anticipation of travelers (de Freitas, 2001). Based on the literature survey it was found that there appear lot of gaps in knowledge in this regard and as this topic requires greater research inputs the topic has been selected for conducting research to reduce this lacuna.

The other important motivating factor of this study is that outdoor environment and access to open space in the concrete jungle of the cities is vital to the well-being of man. In urban areas people have limited open areas in the dense residential buildings where access to open space is restricted. This study will be carried out to suggest to the landscape authorities how important outdoor space has become in today's dense cities and how they can design the landscape by keeping in mind the psychological adaptation of people to



thermal comfort in outdoor environment to best serve the above objective (Nordstrom, 1993).

From preliminary research it is clear that thermal comfort forms a crucial factor that influence the utilization of outdoor spaces and how people adapt to it psychologically. This study is motivated by all the factors discussed above and also based on the significance and relevance of outdoor spaces particularly for leisure and recreational activities in today's thickly populated cities that are mostly filled with skyscrapers and concrete structures.

#### **1.4 Significance of the Study**

Knowledge on the thermal conditions of the outdoor spaces in relation to human interactions are very much essential for the planning and development of the region and would also be helpful for the planners and designers to improve the quality of these spaces. As a result of the intricacies observed in outdoor spaces, with regard to unpredictability, chronology and space, there are possibilities for the existence of different types or categories of user's activities, and an understanding on the thermal comfort conditions of these spaces are very much needed (Zambrano et al, 2006) for the development of the region. Hence such studies are essential form integral part of urban planning and development of regions.

Individual's perceptions or sensitivity towards specific thermal comfort zones in the outdoor spaces in fact highly influences the various activities associated with these public outdoor areas. The amount and extend of activity depend a lot on the extent of contentment or discontentment experienced by the individuals under the existing climatic conditions of the outdoor spaces. Hence there is need for studies like this and even more in depth analyses for developing clear cut knowledge on the human behavior and interactions under different situations. Such evaluations need to be conducted at regular intervals so that these studies would aid the town planners in specifically designing the best utility designs for the region (Nikolopoulou, 2001). Such town planning and implementations would be useful in attracting more tourists in to the region and various locations with

highly favorable microclimatic conditions would most likely become highly preferred locations if they also have been capability to provide satisfaction to the majorities needs.

The significance of this study is that by microclimatic design the thermal comfort can be enhanced without overdue increase and actual reduction in energy consumption of cities by encouraging people to walk, cycling and using public transport. This can be done only when people are comfortable in using outdoor environments (Taylor and Guthrie, 2008).

This study is also significant because more research has been done for thermal comfort in indoor environment as compared to outdoor environments because earlier people used to spend more time indoors. As there is difficulty in modeling outdoor environment's thermal conditions because it is complex to make outdoor environments as comfortable as indoor environments. This study will help in understanding more about outdoor environment thermal comfort because due to limited and compact housing system people are spending more and more time for outdoor activities (Lin Tzu-Ping et al, 2008). An understanding on the thermal comfort levels of individuals in relation to psychological adaptation is useful in rightly transforming outdoor spaces as well as for increasing the recreational value of the region. Such studies would have greater applicability in developing various highly prospective spots for attracting more national and international tourists in to the area and thereby facilitate in the economic development of the region. Since not much study has been conducted in this regard the outcome of the research study would be of greater importance and applicability in the current context.

## **1.5 Outline**

The research study is presented in six chapters. The first chapter is the introduction where the researcher provides information on the need for doing research on thermal comfort. The chapter clearly explains the background of the study based on previous literatures, motivation for the study and the relevance of conducting such a research study on this topic. The next chapter provides a detailed evaluation on the previous literatures that are relevant to the subject. An extensive and evaluative account of the literatures on

the topics like concept of thermal comfort, thermal comfort and its relevance, factors influencing thermal perception of individuals, indoor and outdoor thermal comfort, adaptive behaviors and features, thermal comfort and design of outdoor spaces and other relevant information are given. This section discusses on the knowledge gaps that exist in the literature, which in turn helped in developing the research framework. Research methodology is described in the next chapter. In this chapter the different research techniques, methods, tools used for conducting the current research study is discussed. This chapter provides justifications for using the current methodology and the rationale for not using certain techniques are also clearly mentioned. The fourth chapter is the data analysis and results chapter in which the data collected has been analyzed and is presented in the form of charts. Descriptions of the figures and the possible reasons for the patterns and trends identified as a part of this research study is also given. After the data analysis chapter is the discussion chapter in which the findings are being evaluated, compared and contrasted in the light of previous research works and relevant information. The last part is the conclusion and the recommendations chapter in which the valid conclusions of the current research study has been presented. Towards the end of this chapter valid recommendation for bettering the situation in Dubai has been provided.

## CHAPTER 2. LITERATURE REVIEW

### 2.1 Thermal Comfort and its Relevance

Thermal comfort can be defined as the state of mind that articulates contentment with the thermal conditions (Khodakarami, 2006). In other words, thermal comfort levels also provide information on the temperature tolerance of the individuals. People appear to be comfortable within particular thermal conditions and this state of comfort is very much dependent on the physiological, psychological and other behavioral factors that are closely associated with the individual. As the thermal comfort levels do vary with the individual's psychological, physiological state it is better to consider a range of values in which the individual would be comfortable. In agreement with these views, Moreno et al (2008) have claimed that establishing a particular comfort value with regard to outdoor spaces is not necessary since the perception of comfort in outdoor spaces appear to be a dynamic happening and the comfort preferences of individuals are most likely to vary within a range of values, which might frequently adjust based on the ambient conditions.

Thermal comfort levels are good indicators of the quality of the environment and this seems to influence not only the satisfaction of the people but also their efficiency as well. Hence thermal comfort studies have greater relevance particularly with regard to urban planning and design. Marshall (2009) claims that the developments in the urban areas form key to developing competitive advantages. As a result of which the need for systematically and scientifically developing highly effective urban centers have intensified. Hence, in the most recent times the demand for knowledge in this area, particularly with regard to thermal comfort, is high as town planners, construction engineers and architects consider it as inevitable to plan the outdoors and indoors based on sound understanding on matters like thermal comfort.

Thermal comfort levels is dependent not only on the temperature factor alone but also on different related aspects like wind, humidity, cloud cover, metabolic rate, clothing, etc and hence these associated aspects also need to be considered when calculating the values for thermal comfort levels. According to Chenvidyakarn (2007) the influence of the

various factors on the thermal equilibrium of the human body and its adaptive capabilities need to be considered for rightly understanding the thermal comfort levels. But in reality most studies do ignore the adaptation factor completely when developing models for investigating thermal comfort and such approaches cannot be justified as they might not give the right and needed information. But studies by Aljawabra and Nikolopoulou (2009) even investigated the influence of socioeconomic background and cultural disparity on thermal perception of individuals and hence the study has more practical applicability and relevance in urban planning and design of outdoor spaces. Studies like this provide greater opportunity to evaluate whether thermal comfort levels have the scope to extend beyond the existing models.

Thermal comfort studies appear to be complicated and partially subjective. Researchers (Huang et al, 2009; Lin et al. 2009; Ali-Toudert and Mayer, 2006; Johansson 2006 ) in this field have unanimously agreed to the fact that the tolerance to the thermal conditions particularly that of the outdoors do vary for individuals coming from different climatic conditions and they would have different tolerance levels. Hence region specific investigations appear to be essential for designing outdoor spaces. But in designing tourist locations or other spots where different classes and categories of people are expected to frequent there is need to include lot of shading options like multiple shading types and levels, etc which in fact would provide greater options for the visitors to choose places based on one's preferences and priorities with regard to their thermal comfort. Panagopoulos (2008) rightly pointed out that appropriate designs of outdoor spaces are essential for developing quality urban surroundings. Proper knowledge on the various factors and its impact on the thermal comfort in these spaces might contribute significantly towards designing places that would have the capability to persuade the general public to utilize these spots at all times of the year.

Individuals usually seems to select locations particularly for different recreational or other outdoor activities based on their preferences and priorities and hence systematic studies in this regard are essential for the planners to design outdoor spaces to be more appealing to different categories of people. Mayer et al (2009) have stressed the

importance of human thermal comfort studies for urban planning since such an understanding might as well help the planners to design spaces to be more suitable or acceptable to their citizens as well as for other national and international travelers.

### 2.1.1 Factors Influencing Thermal Perception and Comfort

Physiological, psychological, behavioral and environmental factors do influence the thermal perception and comfort of individuals. Hence, the comfort values are subjected to alterations based on these factors. Air temperature, wind speed, solar radiation, cloud cover, humidity, metabolic rates, clothing, building design and nature, building materials, vegetation, adaptability of individuals, etc do influence the thermal comfort levels of people to a considerable extent (Moreno et al, 2008). The environmental and personal factors that influence thermal comfort of individuals are given in Figure 2.1. Intensity, types and levels of shading of outdoor spaces do affect the thermal perception and comfort levels of individuals. The impact of shading also seems to be different under different seasonal conditions. For example, studies by Huang et al (2009) reveal that scarcely shaded areas were uncomfortable during summer while they were found to be comfortable in winter. Based on the researches it can be assumed that space with little and excessive shading seems to have shorter thermal comfort periods.

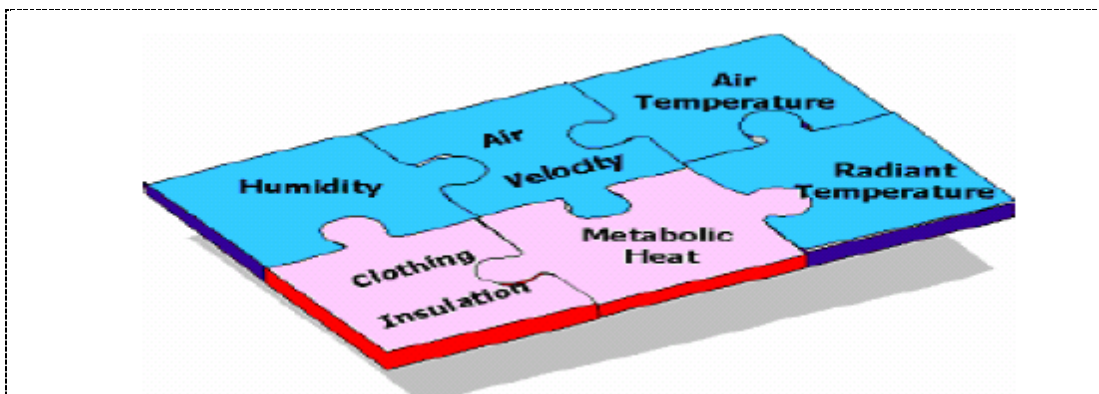


Figure 2.1: Various personal and environmental factors that influence thermal comfort (Source: Shakir, 2009: 16)

According to Aljawabra and Nikolopoulou (2009), in addition to the impact of microclimatic conditions, socio economic background and cultural differences do play a

major role in deciding thermal comfort of individuals. In order to make these outdoor spaces to be more appealing there is need for identifying and evaluating all the factors that influence the thermal comfort levels of the people. Hence the studies that do not take in to consideration the psychological adaptation part and other personal factors might prove to be least applicable in the practical realm. Shakir (2009) has rightly opined that the assessments on thermal comfort levels based on climatic conditions alone appear to be incomplete and invalid as the thermal comfort levels do vary based on the different psychological conditions they encounter. Factors like adaptability and acclimatization also have the capability to bring about changes in the thermal comfort levels of individuals. People who live in extremely cold conditions have thermal comfort zones quite different from the individual who live in hot conditions. The inter-relation between different environmental factors like temperature and relative humidity on the tolerance levels of people is given in Figure 2.2, which in fact indicates the thermal comfort levels of people under these conditions.

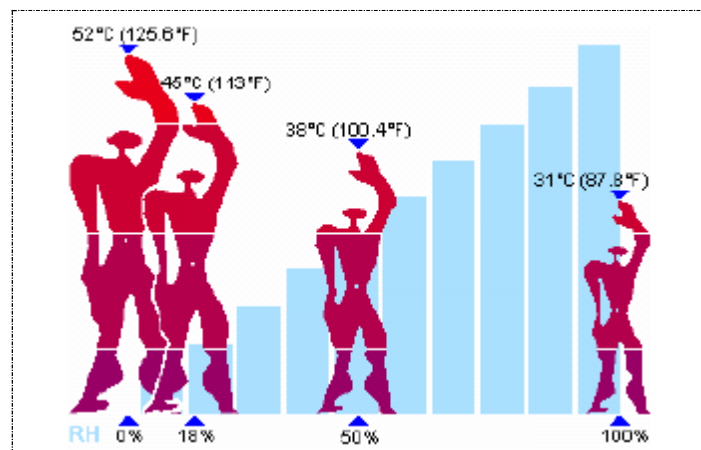


Figure 2.2: Changes in the temperature tolerances in relation to changes in relative humidity factor (Shakir, 2009: 18)

Based on the outcome of many researches (Nicol and Humphreys, 2007; McCartney and Nicol 2002), it is seen that in addition to the thermal environment, physiological and psychological condition of the individual do play an important role in deciding the thermal comfort levels of people. Hence adaptive approach is found to be

more appropriate for calculating the thermal comfort index in both outdoor and indoor spaces. Such an approach is very much needed when calculating thermal comfort levels, in particular, for the outdoors as there appear lot of variations in the climatic conditions as well. The adaptive method, which is a type of behavioural approach, is found to be more appropriate based on the fact that the activities of the people in everyday life are subject to alterations in relation to their environment, physical and mental state and human beings have an inborn capability to adapt at all times within a certain limit. That is, they become predisposed to make themselves comfortable in a particular condition, by doing some alterations or adjustments (adaptations) to their outfits, movement or actions and posture, as well as to their thermal environment itself (Nicol and Pagliano, 2008). But Nicols and Humphreys (2005) opined that in the adaptive approach there appear some difficulty in calculating the insulation provided by the clothing and the metabolic rates of the users. So there is some amount of subjectivity associated with the adaptive approaches as well. Hence all these factors need to be considered when analyzing the thermal comfort levels of individuals in view to increase the applicability of the research and its outcome. But is it possible to design areas with favorable thermal comfort levels where people from diverse places, nationalities, status, attitudes, etc are expected to come?

### **2.1.2 Indoor and Outdoor Thermal Comfort**

Lin (2009) pointed to the fact that the thermal comfort levels of individuals vary considerably between indoor and outdoor spaces and even the impact of the factors that influence the comfort levels of individuals differ to certain extend. The condition of the thermal environment as experienced by the individuals are sure to influence the activities of the people in both outdoor and indoor spaces but the degree of influence of the thermal environment is found to be relatively more pronounced in the outdoor spaces (Gaitani et al, 2005). This is particularly because of great amount of variations in the climatic conditions experienced in the outdoor spaces and the influence of these factors on the physiological, psychological and behavioral condition of the people and their impacts on the thermal comfort levels as well.



It is seen that the time spend indoors is very much higher compared to the time spend outdoors and the time duration is subjected to seasonal variations as well. That is, relatively more time is spent in the outdoor spaces during summer than during winter times. Though psychological, physiological and other behavioral factors do influence the thermal comfort levels of people in both outdoors and indoors, the impact of these are more evident in the outdoor spaces. In case of indoors there appear more flexibility in adjusting or adapting to the thermal conditions based on the specific likes and dislikes of the users, to certain extend. This is not possible in case of outdoor spaces as the variations in the different factors also appear to be more and are highly unpredictable. In conjunction with these ideas, Treech (2009) pointed out that though the different factors and climatic conditions that influence thermal comfort levels of individuals are almost similar in outdoor and indoor spaces, there appear some differences with regard to variability, alterations with respect to time and space and the categories of activities they would get engaged.

Providing quality indoor environment is inevitable as these conditions would influence productivity, thermal comfort and health of the users as well. Hence certain specifications and standards for the indoor environment exists in this regard and the quality depends on different features or aspects of the building, the kind of usage, the indoor air characteristics and other related variables (Melhado et al, 2005). It is seen that expectations and memory of the individuals also play an important role in deciding on the thermal comfort levels. The expectations of the people in a centrally air conditioned indoors would be quite different from the expectations of individuals in a non air conditioned environment. The reason for this difference, according to Nicols and Humphreys (2005) would probably be due to a buildup of the minute effects caused by a broad array of adaptive deeds that collectively total up to a huge dissimilarity in conditions for comfort.

The influence of building materials, type of housing and their design, pavement surfaces, incidence of vegetation, etc do influence the thermal comfort levels at outdoor spaces (Moreno et al, 2003). These factors seem to influence the thermal comfort of indoors as well, but the intensity of the impact does vary substantially. Does the materials

used for construction, building design and other related aspects play a major role in bringing about thermal comfort in both indoor and outdoor spaces? Shakir (2009) is of the opinion that as the conditions in the outdoors are quite different from the indoor conditions, the various models used for assessing or estimating thermal comfort levels in indoor spaces would not be applicable in the case of outdoors. It is seen that there are lot of previous studies related to the design of indoor spaces in relation to the thermal comfort. But there are only very few research studies on the thermal comfort levels in outdoor spaces. Hence there is need to intensify researches on analyzing the thermal comfort levels in outdoor spaces.

## **2.2 Climate Tourism and Thermal Comfort**

In order to design and develop tourist locations and places as well as for analyzing the future touristic prospect of the region, information regarding the climatic conditions in relation to the thermal comfort indices are essential. Hence evaluations on the different categories and strata of individuals who are expected to frequent the location also seem to be inevitable. In addition to that there is need for identifying the set of environmental conditions that are mostly favored by the majority of the people. As the tourist destinations would be frequented by people with diverse traits, different comfort levels, needs, requirements, expectations, etc it would be appropriate to design these spaces with ample choices and features to cater to different categories of people. Matzarakis (2007) has rightly pointed out the importance of estimating “thermal effective complex” particularly with regard to tourism climatology. Guides on the weather conditions are also very much needed for climate tourism in view to understand the interactions of various parameters at different levels (Abegg, 1996).

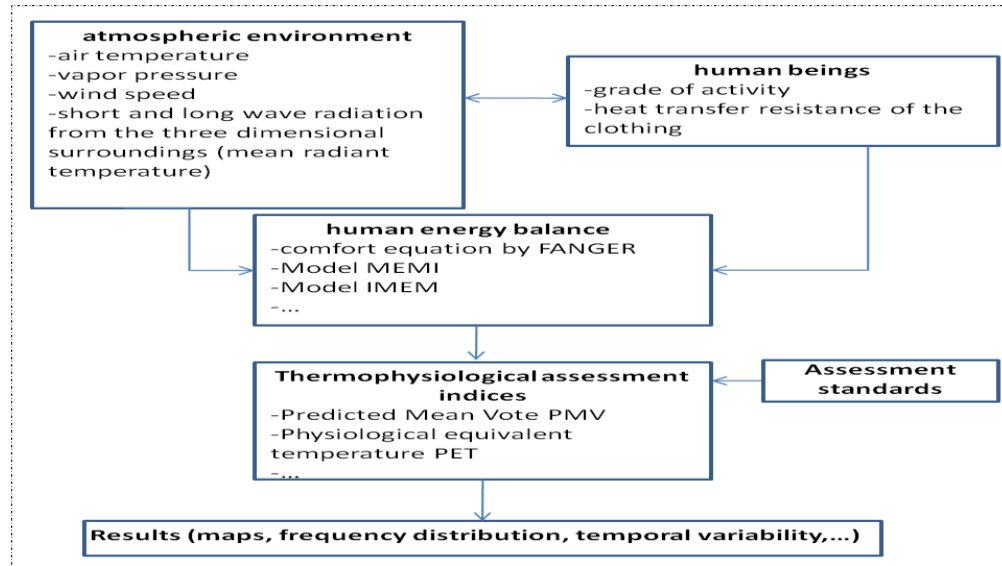


Figure 2.3: Different steps involved in the biometeorological assessments (Source: Matzarakis, 2007: 144)

The biometeorological assessments (Figure 2.3) offer highly compatible values based on the thermal conditions, which would be based on the individual's energy equilibrium. Biometeorological studies in fact provide information on the impact of all the relevant thermal components involved in climate assessments. According to Matzarakis and Alcoforado (2007) these evaluations are essential for understanding the influence of the thermal conditions on human beings, which in turn would also be used for the planning, design and development of touristic areas and other related amenities. A series of related information on the climatic conditions and the related assessments are required for climate tourism related purposes (Matzarakis, 2007). In addition to the thermal comfort estimations in relation to the climatic conditions of the region, it is in fact imperative for understanding the different factors like socio economic status, behaviour in relation to recreational or leisurely activities, etc. Does tourist spots which were not designed nor developed based on scientific assessments fail to attract tourists in to the location?

Several studies (Murphy et al., 2000; de Freitas, 2003, etc) reveals that the weather conditions influence the behavior of the visitors and this forms one among the major factors that influences the choice of the tourist spots as well as the activities they intent to

do. Though lot of research studies emphasize the importance of these assessments in designing tourist locations, it is difficult to perform these assessments in a systematic manner. That is, as there appear lots of subjectivity associated with these assessments and hence the possibility to rightly extract the needed knowledge do depend a lot on the capability of researcher in interpreting the data correctly. It is opined by Scott et al (2004) that climate form an important factor that influences the tourism capabilities of the region and tourists mostly respond to the combined effects of the climate. Hence, the Tourism Climate Index (TCI) calculations that takes in to considerations different parameters like temperature, relative humidity, wind, rain, sunshine, etc might appear more effective in this regard (Table 2.1). In fact there are different indices developed for the purpose of helping the planners, both in the tourism industry as well as for the travelers.

Table 2.1: Different components used in calculating TCI (Source: Scott et al, 2004: 107)

Abbrev.	Sub-index	Monthly climate variables	Influence on TCI	Weight (%)
CID	Daytime comfort	Max. daily temperature and min. daily relative humidity	Thermal comfort during max. tourist activity	40
CIA	Daily comfort	Mean daily temperature and mean daily relative humidity	Thermal comfort over 24 h	10
P	Precipitation	Total precipitation	Negative impact of precipitation	20
S	Sunshine	Total hours of sunshine	Influence of the amount of sunshine	20
W	Wind	Average wind speed	Influence of average wind speed	10

$$TCI = 2 [(4 \times CID) + CIA + (2 \times P) + (2 \times S) + W]$$

Studies associated with climate tourism are mostly used by the planners in developing the regions as well as for designing the recreational activities as these assessments have the capability to make useful forecasts on the tourist seasons, length of the seasons, etc (de Frietas, 2001). If these studies are rightly correlated with the thermal comfort studies then it might be more applicable in even predicting the tourist behaviour. Researchers like Eliasson et al (2007); Shakir, 2009, etc also express similar ideas as de Frietes (2001) and the authors extend their support for using climate sensitive plan with regard to designing and planning of projects for the metropolises in the future. This is specifically because the physical constituent of a location can be planned in such a way as to have an impact on the “site-specific microclimate” and therefore on the turn out, views,

opinions and emotions of people particularly with regard to the location. The authors (Eliasson et al, 2007; Mills, 2006) have also rightly identified the need for integrated studies in view to delineate the importance and influence of different factors like climatic conditions, psychological and physiological parameters when come together. Such studies would be more relevant since in the natural world since no one factor seems to influence the thermal behaviour of people in isolation.

### **2.2.1 Impact of Microclimate on the Usage of Outdoor Spaces**

The distinctive microclimate of the urban areas can be considered as the outcome of their complicated built backgrounds, absence or reduction in the number of cooling vegetative surfaces, and the enhanced anthropogenic activity (Smith and Levermore, 2008). Developing awareness on the diversity of the microclimatic conditions that are prevalent in the outdoor areas in relation to thermal comfort levels of individuals would be useful in designing and developing touristic locations, planning recreational activities, etc (Nikolopoulou, 2004). Such an understanding is expected to enhance the touristic capability of the location which in turn would be helpful in attracting more people in to these locations. It has also been noticed by Nikolopoulou et al (2001) that the microclimatic conditions have the capability to evoke positive or negative responses in individuals, which in turn would most likely influence the use of outdoor spaces. Hence designing the outdoor spaces based on the assessments of the microclimatic conditions and the thermal comfort levels might make these locations more attractive to a wide variety of people. People focused developmental activities are expected to bring about highly effective outcomes by enhancing the usable ranges for attracting more people in to these areas.

According to Thapar and Yannas (2008), the microclimatic conditions of urban areas can be altered to a certain extend through modification processes as shown in Figure 2.4. The authors (Thapar and Yannas, 2008) claim that the alterations in the environmental conditions can be brought about particularly through modifying the geometry and material characteristics and type of the constructions, flora and water, as well as by altering the tactics that would be applied for restraining the production and effect of anthropogenic heat. All these alterations and modifications are aimed at making the thermal conditions

more propitious to majority of people. So if cities are planned and developed in such a way as to develop more areas with favorable environmental conditions that come within the thermal comfort ranges, such areas could attract more people or influence people to adopt favorable behavioral modifications as well. Based on the studies, it can be observed that the microclimatic conditions do influence the individuals in selecting the outdoor places for different activities. If more options are available more people might resort to spend more time outdoors basically for recreational activities.

Improving or enhancing the microclimatic conditions in line with the needs and demands of the prospective customers would in turn bring about major changes in quality, particularly with regard to the development of cities (Lin, 2009). This can be basically done by appropriately identifying the forces that cause discomfort and also by reducing these sources in view to control the sources of discomfort. Since the highly effective outdoor spaces have the capability to attract greater number of people, there is need to make the needed modifications to the outdoor spaces in order to make it more focused on the people’s needs and expectations. These could make region more attractive as well as profitable in purely economic terms (Duarte et al, 2007). In short, effectively designed outdoor spaces would likely attract more crowds in to region as well as would be helpful in improving the image of the city.

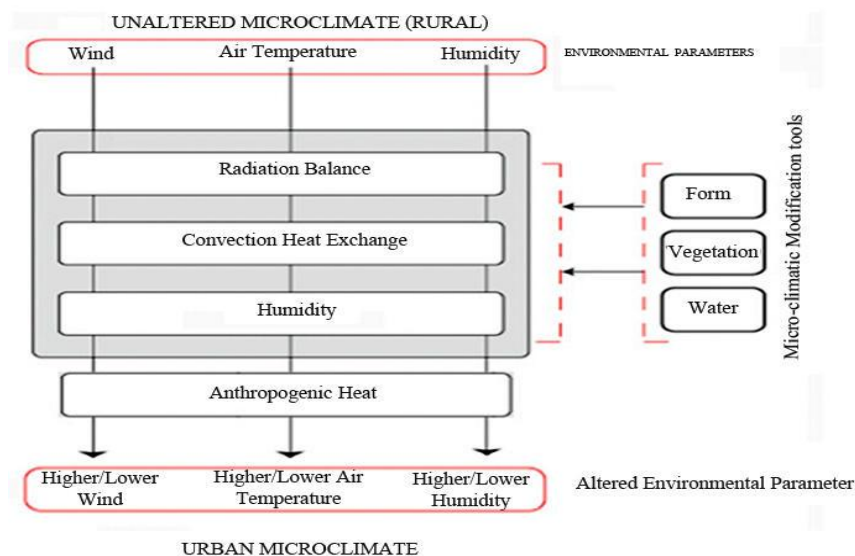


Figure 2.4: Climate modification process (Source: Thapar and Yannas, 2008: 2)

Aljawabra and Nikolopoulou (2009) opined that design form a significant factor that can chiefly perk up microclimatic conditions and it is vital in the precise climatic context. Nikolopoulou et al (2001) also have expressed the fact that the usage of outdoor places do depend on the prevailing microclimatic conditions of the region. But there is possibility for altering the microclimatic conditions to a certain extent through slight modifications with regard to the shading, construction materials, etc. So there is need for the planners and urban designers to develop awareness on the different constituents of the microclimate and how it can be affected from the components of the landscape. Greater correlations between microclimatic conditions and the comfort levels in fact reveal that only prudent designs can permit the use of outdoor spaces, particularly by harmonizing exposure, and shield with regard to different climatic elements (Nikolopoulou et al, 2001).

Most effective ways for changing the urban microclimate is by adapting its heat absorption and emission to desirable levels. For example, “urban greening” can be made effective through the use of high-reflectivity equipments and by enhancing the ventilating capabilities to allow more cooling winds. Nikolopoulou et al (2001) opined that modern researches indicate that the microclimatic conditions of the outdoor spaces were considered as vital to understand how these outdoor spaces could be used as well as for gaining insights on the type of activities that could be performed. This is mainly due to the fact that the thermal conditions influence human behaviour and usage of outdoor spaces. Reactions to the microclimate may appear oblivious, but at the same time might result in a diverse utilization of outdoor spaces under varied climatic conditions.

### **2.2.2 Behavioral Adaptation**

Behavioural adaptation includes all the alterations and modifications that a person would make both consciously and subconsciously in view to adjust to the altered environmental conditions. These adaptations can further be divided in to personal, cultural, technological, etc based on the activity performed (de Dear and Brager, 1998). Personal adjustments include making slight modifications to their clothing to suit the altered environmental state. Technological adaptation include using some form of sophisticated technological tools to make one cool or warm, whichever is applicable. Cultural responses

include resting or taking a nap during extreme heat. Humphreys (1994) is of the opinion that behavioral adaptation or the adjustment made to the “body’s heat-balance” in fact presents the best prospect for people to play a dynamic role in maintaining their own comfort. People tend to make adjustments in such a way as to make the prevailing environmental conditions to be more comfortable.

The different behavioural adaptations made in response to the altered environmental conditions are done in view to adjust the thermal equilibrium of the body and there by develop the thermal comfort values well with the desirable ranges (Nikopoloulou, 2008). The insulation provided by the clothing form an important component that might have an impact on the thermal comfort levels of individuals. Humphreys (1994); Nicol and Raja (1996) and a few other researchers rightly pointed that behavioural adjustments like clothing change appear to have a strong positive correlation with the outdoor thermal conditions. As a result of which, any adjustments made to the clothing in response to the altered environmental conditions, for example, wearing a jacket to avoid excessive cold conditions, etc and its impact it produces also need to be calculated for understanding the thermal comfort values of individuals under specific conditions (Shakir, 2009). Since these adjustments made are quite difficult to quantify there is need to standardize the impact of various behavioural responses in order to make the assessments more accurate and clear as well as for making comparisons in future as well.

If the environmental conditions were so unfavorable as there exist no or very limited scope for making behavioral modifications in order to remain well within the thermal comfort levels of the individuals, then people would be forced to avoid using the outdoor spaces or reduce the time spend there in the midst. Any other behavioral adaptations made in response to the conditions prevailing in the outdoor places also need to be quantified accordingly (de Dear and Brager, 1998). All the responses of the individuals can be quantified if the questionnaires used for understanding the behavioral adaptations are structured accordingly as well as need to follow a uniform pattern for gathering information. There is also need to fix values to all non quantifiable activities that would also be measured for evaluating behavioral adaptations.



### 2.2.3 Physiological Adaptation

Physiological adaptation includes the variations in the physiological reactions that occur as a result of the repetitive exposure to a stimulus, which would ultimately minimize the strain from similar exposures. With regard to the thermal environment, such physiological adaptations are called physiological acclimatization. Acclimatization can also be considered as a mechanism through which the body unconsciously adjusts to the conditions, though it takes quite some time (de Dear and Brager, 1998). The author considers this as an important mechanism that has greater applicability in extreme environmental conditions, but at the same time the authors fails to identify the importance of this feature in the case of outdoor spaces. In disagreement with the observations made by de Dear and Brager (1998), Aljawabra and Nikolopoulou (2009) have opined that people from hot climate have more tolerance for high temperatures and vice versa. This indicates that people from hot climates get acclimatized faster to hotter conditions and have more tolerance for higher temperatures in comparison to people from colder regions.

According to Yao et al (2007) thermal comfort is found to be dependable on the instigation of “behavioral thermoregulation”. Hence it is considered as highly significant in humans to maintain the “homeostasis” with regard to the body temperature particularly when faced with challenges with regard to environmental or thermal conditions, which in turn play a major role in deciding the thermal comfort levels in individuals. This indicated that the chances for individual level variations are many and diverse. As a result of which researchers need to extract more data to make their recommendations more applicable. But at the same, time act a major factor in deciding the response of the individual to any particular thermal conditions. For example, if the change is instantaneous, the level of discomfort would be more and if there was more time gap between the changes in the conditions the levels of discomfort might most likely be reduced (Tan and Kosonen, 2003).

The genetic set up of the individual also has some influence on the physiological adaptability. Hence it is not easy to predict the adaptive response of individuals and there is need for in depth understanding of the individuals (Tan and Kosonan, 2003). Assessments of physiological adaptation is also found to have relevance in the thermal

comfort studies in outdoor spaces as there exists lot of opportunity for the individuals to unconsciously alter their thermal preferences based on the prevailing conditions. According to Nicolopoulou et al (1999), different people recognize or identify the surroundings in multifarious ways, and the reactions of the humans towards a physical stimulus is found to have no straight forward association with the magnitude of the stimuli, but rather based on the different types of ‘information’ which the people have with regard to a specific situation.

#### **2.2.4 Psychological adaptation**

The psychological adaptation with regard to thermal conditions refers to the changed opinion or perception particularly in the case of the sensory information, which might be due to former experience and expectations. According to Nikolopoulou and Steemers (2003) different elements that influence psychological adaptation and the thermal comfort levels of individuals include, “naturalness” of the place; expectations, experience, time of exposure, perceived control, environmental stimulation, etc. That is, if the environment is found to possess more natural things and lacks pretensions then the people are found to be more tolerant to the changes in the environmental conditions (Nicolopoulou, 2008). Experience, expectations, exposure and expertise also are found to influence psychological adaptation of individuals to certain extent and there by thermal comfort levels are also associated with these factors. So studies aimed at understanding psychological adaptation of individuals under a given thermal conditions would be difficult as there are a lot of subjective observations and calculations that need to be done for providing a clear cut answer in this regard.

Many studies (Baker, 1993; Baker and Standeven, 1996, etc) revealed that the thermal satisfaction of the people are attainable particularly by providing greater scope for adaptive opportunity. Hence a study based purely on psychological adaptation capabilities of people would not be appropriate in attracting more crowds in to the region. This is particularly true as humans make use of different levels of adaptations to adjust or get acclimatize to the prevailing thermal conditions in order to remain comfortable within certain range of thermal conditions. But this are also subjected to variations based on

individual preferences and peculiarities (Yao, 2007). A thorough understanding on the different psychological stages and its impact on the thermal comfort levels and adaptive capability of the individuals need to be made.

Studies by Knez and Thorsson (2006) identifies that there exists some type of associations between thermal comfort and psychological aspects of the individual's information and expectations with regard to the environmental conditions. It is also seen that the mental state of an individual alongside with the emotions, perceptions, attitudes, etc of the individual do play a major role in deciding the thermal comfort indices of humans. Hence lot of unpredicted alterations can be expected in this regard. But as thermal comfort is based on different factors like thermal conditions, behavioral adaptations, physiological adaptations and psychological adaptations of individuals, chances for high degrees of variations are less despite the possibility for variations with regard to single parameters appears more.

According to Paciuck (1990), expectations and experience has greater capability to influence the responses of individuals in a particular situation. If people feel they have more control over the situation or the environmental factors in particular then they appear to be more comfortable over a wider range of thermal conditions than otherwise. But as there appear relatively very little opportunity for developing control over the environment with regard to outdoor spaces in comparison with the indoor spaces, the elements associated with perceived control has little relevance in the context of outdoor spaces. The results of the adaptive approaches have little scope for making generalizations as there appear lot of region specific peculiarities and diversities and the adaptive capabilities vary from individual to individual.

### **2.3 Thermal Comfort and Design of Outdoor Spaces**

In order to make the outdoor spaces more lively and filled with greater levels of vitality there is need to design these spaces based on an understanding on the thermal comfort levels as well as on the different factors that influence thermal comfort (Angeloti et al, 2007). Evaluations on the thermal comfort levels based on an adaptive approach was

found to be highly useful in designing outdoor spaces that would be appealing to greater number and wider categories of people. Hence planning and designing outdoor spaces in a scientific background is in fact inevitable for developing these spaces in to highly acknowledged tourist spots and locations with greater reach (Ali-Toudert and Mayer, 2006). Angelotti et al (2007) claims that a more nontraditional method might be better suited for developing attractive open space designs. There is need for evaluations on the energy related performance in case of renovating open spaces and with regard to developing new outdoor spaces designing based on systematic forecasting would be more appropriate.

Designing of outdoor spaces based on the systematic thermal comfort studies are more relevant and applicable in areas where the climatic conditions are more intense and severe. For example, regions of UAE face extreme heat conditions during summer, which last for longer periods. Hence these studies and evaluations would be more applicable especially in those regions. According to Mayer et al (2009) it can be clearly noticed that the requirement for human “biometeorologically” based models and ideas are constantly rising basically with regard to urban planning. As a result there is need for undertaking more comprehensive studies on the thermal comfort in view to support the urban planners in planning and designing outdoor spaces more effectively. In agreement with these views, Angelotti et al (2007) opines that one among the major component that needs to be considered with regard to the design of urban spaces are the adaptations that can be made to the microclimate in view to perk up the thermal comfort conditions of individuals residing in these urban areas. Are these thermal comfort studies useful only in scientifically planning, designing and developing new urban centers? What is the applicability of these studies particularly when considering the already developed urban centers?

Duarte et al (2007) have acknowledged the significance of considering the urban design and the restricted handling of outdoor places in view to establish outdoor spaces that are thermally appropriate, and for setting conditions that are capable of making effective use of the urban spaces. The authors observed that “high density constructions” in

fact permitted longer periods in comfort conditions, because of the reduction in the “sky view factor” and therefore the momentous shading impacts upon the area (Duarte et al, 2007). It was also noticed that areas that had plenty of vegetation or greenery provided even better results, taking in to consideration the shade and the “evapotranspiration” that impacts thermal comfort values. The thermal comfort values of the people are subjected to seasonal variations and hence the design of outdoor spaces need to be done based on the assessments of thermal comfort indices obtained over different periods of time or different seasons (Huang et al, 2009). Hence identifying the range of values that are considered as comfortable is very much essential for successfully developing outdoor spaces.

Quantity of natural components like urban foliage and the panorama that seep into urban tissues is found to directly impact the thermal state of huge metropolitan gathering and is found to indirectly influence the quality of life in cities. The significance of the natural constituents with regard to the comfort state of edifices and urban regions rely mostly on the varieties or categories of plants species present, the vegetation, “treetops area” and concentration of tree distribution (Moreno et al, 2008). According to Nikolopoulou and Lykoudis (2006) the microclimatic setting were found to be integral to an open space. There is need to develop systematic knowledge on the different aspects of outdoor spaces and such knowledge would be very much useful for the sustainable development of cities in future.

The structure and the selection of objects ascertain the “radiative and convective exchanges”, and these form the basic characteristic to institute the comfort state of individuals particularly with regard to outdoor spaces (Panagapoulos, 2008). According to Bruce (2009) in order to develop a highly applicable design for open spaces there is need for urban planners and architects to make right assessment on the interactions involving the local design, the ensuing microclimate and the reaction of the probable users. These studies in fact reveal the need for more extensive studies on outdoor spaces in relation to their interactions with the human elements and their needs, demands and expectations and such an understanding seems to influence the design of outdoor spaces.

## 2.4 Knowledge Gap

Based on the literature survey various gaps in knowledge has been identified and this include,

- Only very limited information is available with regard to thermal comfort estimations from UAE or Dubai in particular. Knowledge of the thermal comfort levels would be useful in the designing and planning of urban areas and other centers that need to be developed for attracting tourists.
- Lack of comprehensive studies with regard to thermal comfort and related aspects. It is seen that thermal comfort studies are essential for the systematic and sustainable development of the regions hence there is need for undertaking research studies in this regard.
- Lack of proper understanding on the various factors that influence thermal comfort and the extend of influence each factors like temperature, wind, humidity, cloud cover, metabolic rate, clothing, etc have on the comfort levels of individuals particularly with regard to Dubai.
- There is very little knowledge regarding the adaptive approaches in relation to thermal comfort particularly in outdoor spaces and not much information is available with regard to the extent of influence the adaptation factor has on the thermal comfort levels.
- Absence of in depth studies for assessing the role of psychological assumption in thermal comfort.
- Lack of periodic assessments on the thermal comfort levels. These evaluations on the thermal comfort levels of individuals are a must for rightly designing the outdoor spaces to cater to the ever increasing and altering thermal comfort levels of individuals.

- There is no proper balance between the knowledge gained and its need. In the most recent times the demand for knowledge in this area, particularly with regard to thermal comfort is high, as town planners, construction engineers and architects consider it as inevitable to plan the outdoors and indoors based on sound understanding on matters like thermal comfort.

Based on greater demand for knowledge particularly with regard to the thermal comfort levels of individuals in both indoor and outdoor spaces, the current research study was initiated. This study is expected to provide understanding on the thermal comfort levels of individuals in outdoor spaces in Dubai in relation to the psychological adaptation, which would be useful in developing better insights for creating design and development plans for the region. As only a very few studies have been reported from the study region, the research results would be of greater relevance if conducted systematically.

## **2.5 Research Question**

Does psychological adaptation have a major role in determining thermal comfort in public outdoor spaces in Dubai?

## **2.6 Research Aims and Objectives**

- To understand the importance of psychological adaptation in estimating thermal comfort in public outdoor spaces in Dubai (Primary and secondary research).
- To evaluate psychological adaptation and their role in thermal comfort in public outdoor spaces with special reference to Dubai (Primary research).
- To analyze the various factors that influence thermal comfort in public outdoor spaces in Dubai (Primary and secondary research.)

## CHAPTER 3. RESEARCH METHODOLOGY

### 3.1 Study Area and Justification

For the research study aimed at critically analyzing the thermal comfort in public outdoor spaces in Dubai, the primary data were collected from six parks and two walkways in Dubai. The parks that were selected for the study include two beach parks, the Al Mumzar Beach Park and the Jumeira beach park; one park on the bay side, the Creek Park; two other regular parks (parks that are neither close to any water body nor close to the desert) the Zabeel Park, and Safa Park and a park far from sea that is almost in the desert, the Mushrif Park and the details of which are given in the Table (3.1). The two walkways selected for the study are the walk at Jumeira Beach Residence (JBR), and Marina walk and the details of these two are given in the Table (3.2). These outdoor spaces were selected for the research study as these parks and walkways form the major places where people, both local and international tourists frequent and these places seem to be the most popular recreational spots in and around Dubai. In the present state itself all the selected parks and walkways attract a reasonable number of tourists and have greater prospect and potential to develop into highly preferred tourist locations. More details on the location of the selected outdoor spaces in Dubai are given in the Appendix (3) and Appendix (4).

Though there are few more parks present in Dubai, and as most of them look almost deserted and some, for example, Al Khazzan Park, Towar Park, Al Wasl Park, etc appear to be more like private parks or family parks for neighbors only and so these locations were excluded from the survey. This is because conducting surveys in those places would not provide the needed data that have the ability to fulfill the research objectives and the results cannot be generalized as well. Some of the parks especially the water theme parks were avoided as the entry to these parks were quite expensive. Entry fees to all the six parks where the surveys were conducted are found to be less and this also could form a factor in the selection of the study area. Since the study is aimed at understanding the thermal comfort in public places with psychological adaptation as a factor, parks and walkways were selected based on its popularity among the visitors, crowd intensity, scope, location, etc. All the six selected parks and walkways are frequented by



different categories of people belonging to different nationalities, gender, age, etc, and as a result of which the survey is expected to provide more diverse data and information. Data collected from these places are expected to provide information and knowledge on the priorities and preferences of diverse groups of people and hence could be utilized for practical purposes like urban planning as well as for developing or transforming outdoor tourist locations.

Table 3.1: Details of the Parks selected for the study

Name	Location	Time	Features
<b>1. Al Mamzar Beach Park</b>	Deira, next to the beach, north of Al Hamriya Port.	Friday 22 October 8 am -10 pm Sunday 23 October 7 pm -10 pm	Beach facilities, barbecue and grassed picnic areas, private chalets, swimming pool, food kiosks, children playgrounds, bicycle, in-park transport system, amphitheatre
<b>2. Jumeirah Beach Park</b>	Jumeirah Beach Road	Saturday 23 October 8 am -10 pm, Tuesday 25 October 7 pm -10 pm	Beach facilities, children's playground, barbecue and grassed picnic areas with tables, volleyball play area restaurants
<b>3. Creek Park</b>	Bur Dubai, next to the creek	Friday 29 October 8 am -10 pm, Sunday 31 October 7 pm -10 pm	Dolphinarium, park train, children games, cable cabin, bicycle, Mini golf course, amphitheatre, green area, pleasant grassed area barbecue areas, restaurants
<b>4. Zabeel Park</b>	Bur Dubai, middle distance from the sea	Saturday 30 October 8 am -10 pm, Monday 1 November 7 pm -10 pm	Shaded barbecue and grassed picnic areas, restaurants, lake with fountain and boating facilities, amphitheatre, jogging track, mini cricket pitch, kids playground, maze, park train, amphitheatre, adventure game, pedal carts
<b>5. Safa Park</b>	Al Wasl Road, middle distance from the sea	Friday 5 November 8 am -10 pm, Sunday 7 November 7 pm -10 pm	Children's playground, barbecue and grassed picnic areas, restaurants, sport & games area, a lake with fountain and boating facilities, park train, bicycle rental

<b>6. Mushrif Park</b>	Deira, far from the sea, in dessert	Saturday 6 November 8 am -10 pm, Monday 8 November 7 pm -10 pm	Desert-like park, swimming pools, fountain and lakes, children's playground, park train, camel and pony rides, barbecue and grassed picnic areas, restaurants, sport & games area, natural green area, international garden Area
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Table 3.2: Details of the Walks selected for the study

<b>Name</b>	<b>Location</b>	<b>Time</b>	<b>Features</b>
<b>1. The Walk at JBR</b>	Jumeira Beach Residence, beachfront location	Friday 12 November 8 am -10 pm Sunday 14 November 7 pm -10 pm	Access to the beach, food kiosks, restaurants, boutiques, shops, seasonal events such as heritage village, funfair, horse riding and market events throughout cooler season, large-scale events held on-site
<b>2. Marina Walk</b>	Landward side of the manmade marina, near the sea, close to Dubai Internet City,	Saturday 13 November 8 am -10 pm, Monday 15 November 7 pm -10 pm	Waterside promenade, cafés, and restaurants, boutiques, shops, regular market events on weekends throughout cooler season, rental bike

### 3.2 Objective Measurement

Objective measurements yields quantifiable data and hence such measurements are mostly used in researches that are quantitative in nature (Fan et al, 2002). For taking objective measurements there is need for clearly identifying the different parameters, standardizing the instruments as well as for structuring the questions in alignment with the research objectives. The results of these measurements can be easily interpreted and could make highly relevant comparisons. The objective measurements in this research study are mainly used for calculating the different physical parameters in the survey region as well as for calculating the thermal comfort levels of individuals under these conditions. The

instruments used for collecting the readings of the different selected physical parameters or thermal conditions are Hygro – Thermo – Anemometer - Light Meter or some relevant meteorological details can be taken from the website of National Centre for Meteorology and Seismology (NCMS).

### **3.2.1 Instrumentation**

A Pocket sized rugged 4-in-1 meter called the Hygro – Thermo – Anemometer - Light Meter was used for measuring the different parameters like humidity, temperature and air velocity (Figure 3.1). The instrument appeared very handy and was very easy to use. Though instrument is used for measuring different physical parameters it is easy to maneuver for getting different functions and measurements. It does not take much time in giving the different measurements. This instrument records both the minimum and maximum values and it has a four digit dual display LCD that indicates temperature, humidity and air velocity values and hence the reading errors associated could be minimized to a considerable extend. It has relatively high resolution and hence the instrument provides highly precise results. In view to increase the validity of the outcome the instrument was validated prior to taking the measurements from the selected locations and time. Validations were done by comparing the measurements of the parameters like temperature, humidity, etc taken using the instrument with that of the weather information available on the website.

More details regarding the meteorological parameters can be obtained from the website developed by the National Centre for Meteorology and Seismology (NCMS) which is the specialized centre providing meteorological data and this website is developed and managed by the Ministry of Presidential Affairs. This site provides the latest details of the microclimatic conditions in the region. Highly structured questionnaire with close ended questions and a few open ended questions were used for collecting primary data. The close ended questions of the questionnaire were designed appropriately to get the quantifiable data that can be used for understanding the thermal comfort levels. Quantifiable data for understanding the thermal comfort condition of the surveyed

users as well as for understanding their perceptions with regard to thermal comfort can be obtained as the survey questions are mostly structured.



Figure 3.1: Hygro – Thermo – Anemometer - Light Meter (Source: Extech, 2009: 1)

### 3.2.2 Physical Parameters

Various physical parameters that were measured for the thermal comfort study were temperature, humidity and air velocity particularly based on its relevance in the context. Based on the earlier studies (Moreno et al, 2008; Huang et al, 2009; Aljawabra and Nikolopoulou, 2009, etc) it was observed that these three environmental parameters were found to have a major influence on the thermal comfort of individuals and hence measured during the current research study. For thermal comfort studies there is need for understanding the environmental conditions under which the individual is comfortable, that is when the person is not experiencing too much cold or heat. It was observed that measuring the various factors like temperature, humidity and air velocity form integral to the thermal comfort estimations. The different parameters measured for calculating thermal comfort using different methods are given in the Table 3.3. Use of any two or all the three of these parameters in the thermal comfort calculations using four different methods are an indication of the relevance of these factors for these studies.

Table 3.3: Environmental parameters used for calculating thermal comfort index (Source: Orosa, 2009: 223)

Method 1	Air Velocity (Va)	Air Temperature (Ta)	Mean Radiant Temperature (Tr)	Humidity (W)
	Measure	Measure	Calculate	Measure
Method 2	Air Velocity (Va)	Operative Temperature (To)		Humidity (W)
	Measure	Measure		Measure
Method 3	Equivalent Temperature (Tev)			Humidity (W)
	Measure			Measure
Method 4	Air Velocity (Va)	Effective Temperature (ET*)		
	Measure	Calculate		

Though it is quite impossible to design and develop outdoor spaces that can provide satisfactory thermal environment to everyone at all times, studies on thermal comfort is aimed at identifying optimum conditions which can satisfy the thermal requirements of at least the majority. The three environmental parameters selected for the study are considered as the best indicators of the condition or state of the thermal environment and hence would be helpful for understanding the thermal comfort levels with more accuracy (Markov, 2002). It was observed that acceptance and the utilization of outdoor places are dependent on the prevailing thermal conditions in addition to psychological and physiological conditions of the individuals. Hence, calculations of the temperature, humidity and air velocity from the surveyed areas can provide a better understanding on the thermal conditions and so these parameters were selected for the study. From the literature it can be assumed that the three physical parameters like temperature, humidity and air velocity of the region would most possibly influence the attitude and behaviour of the individuals in both indoor and outdoor spaces (Orosa, 2009; de Freitas, 2001). These parameters have the capability to instil cold and heat sensations in individuals either singly or in combinations.

### 3.2.3 Limitation of Measurement

The major limitations of the measurement include,

- Recording errors associated with using the instrument like Hygro – Thermo – Anemometer - Light Meter due to lack of expertise and experience in using the instrument. But as the user manual that was supplied along with the instrument was easy to understand and all the major instructions were given in that.
- Since measurements of the three different parameters like temperature, humidity and wind speed had to be taken at selected time intervals alongside with the questionnaire survey, it was rather difficult to manage all these individually.
- Success of the surveys depends a lot on the cooperation of the respondents as well as on quality of the responses. Since only those users who had time to help were only interviewed.
- Couple of occasions the recording and survey schedules was postponed due to hostile weather conditions and other technical reasons. But managed to get the details through effective reschedules.
- The spatial separation between the selected locations also formed a barrier in rescheduling the surveys in between.

### **3.3 Subjective Measurement**

Subjective measurements are taken for getting more details and better insights on the real time scenario. These measurements would help us to understand the subject matter from the perception of the respondent as well. Such measurements would be helpful in making the interpretations more realistic and improves the applicability of the research outcome. Subjective measurements provide the user to rightly express their point of view more elaborately. So the instruments used for taking subjective measurements can be either semi structured or unstructured and open ended.

#### **3.3.1 Design of Questionnaire**

Questionnaire with both close ended questions and open ended questions were used for collecting primary data from the selected visitors at the locations chosen for the study (six parks and two walkways) (Appendix 1). The open ended or descriptive questions were semi structured and were aimed at collecting more in depth data that has the ability to develop a greater understanding on the real time situation. As a result of which the analysis and interpretations appeared more realistic and was helpful in generating high quality outcome that was close to the real time situation. So the researcher was able to come up with recommendations that had greater relevance and applicability both practically and academically. Secondary data would be collected using the in-depth literature survey and relied mostly on journal articles, online sources, books, etc.

There were questions aimed at understanding their present experiences as well as on their expectations with regard to outdoor spaces. First part of the close ended questions were designed in such a way as to gather information or get their perception with regard to the present comfort levels, satisfaction towards the present physical parameters like temperature, wind, sun, vegetation. Close ended questions aimed at understanding their personal traits like clothing, activity, whether they were consuming any drink or food, etc were also included. Questions for understanding their nationality, culture and social condition or status, for example questions like “what is the purpose of the visit?” etc were included in another section.

Descriptive questions were included in the next section in order to get a clear cut idea on the purpose of their visit as well as on their likings towards the place. Qualitative questions aimed at understanding their perception of a good outdoor location was included to get a better picture on their expectations with regard to outdoor tourist spots or recreational sites. In addition to gathering information from the respondent there were some specific questions filled by the surveyor itself based on his or her observation of the respondents (Appendix 2). The surveyor needs to assess quantitatively or make a rough estimate of the approximate number of visitors that were present in the locations during the survey period. The questions in the observation part were useful in developing a clear picture about the nature, type and condition of the respondent. These questions were also structured and close ended in order to make it easier to categorize and quantify data as well as for making the interpretations more effective. Questions aimed at understanding the gender, age, colour and texture of the clothing, appearance, nationality, clothing, condition and weight were also included in this section. This section was useful in defining and describing the respondent more clearly. Observations on the different aspects related to the clothing of the respondent, for example “the colour and texture of the clothing” would be useful in understanding the type of protection or preparation taken by the individual to attain thermal comfort. As lot of classifying questions have been included in this section there will be bases for comparing the responses after categorizing the respondents effectively.

### **3.3.2 Sample Size**

Questionnaires were distributed to over 100 people belonging to different gender, age, nationality, etc for the six (6) parks and two (2) walkways (Al Mumzar Beach Park, Jumeirah beach park, the Creek Park, the Zabeel Park, Safa Park and the Mushrif Park, Walk at JBR and Marina Walk) selected for the research study. The total sample size used for the research came to around 1400 but about one third of the people returned the questionnaires without completing or cooperating with the survey. So the response rate came to around 67 percent, which can be considered as good when surveying people in public outdoor places. Both males and females belonging to different nationalities (G.C.C. Arabs, Filipinos, Indians, Pakistanis, Emiratis, Westerners, Middle Easterners,



international tourists, etc) and age groups (20 – 30; 30 – 40; 40 – 50 and Above 50) were surveyed during the period. From Zabeel Park about 65 Females and 51 Males; Safa Park about 73 Females and 67 Males; Mushrif Park about 66 Females and 50 Males; Creek Park about 60 Females and 60 Males; Al Mumzar Beach Park around 60 Females and 55 Males; Jumeirah Beach Park about 62 Females and 58 Males; Marina Walk around 65 Females and 55 Males and at JBR Walk about 42 Females and 48 Males were surveyed during these time periods. Surveys were done during both weekdays and weekends at each location. During weekdays the surveys were done from evening to night hours and during weekends the surveys conducted from morning hours until night time.

### **3.3.3 Method of Conducting the Survey**

Questionnaire surveys were conducted for gathering primary information. Convenience sampling techniques were used for selecting the sample as it is easier and selection is based on accessibility and immediacy to the researcher. Data collection using questionnaire surveys were done for two times at each of the selected locations. That is, one day during weekdays and one day in weekend the surveys were conducted. So a total of two days were taken for collecting the survey data from a single location. During each day at least 50 visitors were surveyed, which means more than 100 people would be surveyed from a single location.

Prior to questionnaire survey the researcher had taken written consent from the respondent and surveys were conducted for people who were willing to cooperate with the process. Since there is the possibility that the respondent might lose their interest in answering questions if it is lengthy and ambiguous; the questions of the questionnaires were structured in such a way as to complete the survey in five minutes or less. Questionnaires were directly handed over to the people in view to better the response rates by providing them opportunity to clarify any doubts related to the questions and would be helpful in gathering the needed information from the respondents. During the times when the respondents were selected from a large group then the questionnaire was distributed to two or more people in the group depending on the total number in the group and survey questionnaires were distributed simultaneously to all the selected members at the same

time. When the respondent was found to be alone or was in a very small group, only one person was surveyed from that group. There were questions that need to be answered by the researcher based on his or her observation of the respondent. But at the same time, a few questions that come under this section need to be gathered from the respondent itself. For example, “what is his / her nationality?” In between surveys, the researcher recorded observations on the crowd strength from the surveyed locations.

### **3.3.4 Limitation of Measurement**

The limitations of the measurement include,

- Rate of responses and the quality of responses as these form a major criteria for making interpretations.
- Since the selected parks and walkways were mostly deserted during day time at weekdays it was not possible to record the thermal comfort related information at those times. So comparisons between the weekend and weekday data during day hours were not possible.
- As the respondents were selected from the visitors who have come to these outdoor places for entertainment, fitness and health related activities, it was difficult to get consent from the visitors for doing the survey. Most of them preferred to relax and get engaged in their own or their group activities. Somehow adequate numbers of respondents were obtained during these time periods particularly because of the academic nature of the survey and the questions were structured properly.
- About one third of the people who had given consent for doing the survey also reverted back and returned the questionnaire without answering the questions rightly. The questionnaires which were not completed were not included for analysis.
- Transportation expenses were relatively higher than expected due to increased distance between different locations.

### 3.4 Expert-walkthrough

Structured questionnaire and close ended and open ended questions were used for collecting quantitative and qualitative data. In addition to recording the answers of the structured questions, the researcher had taken note of the peculiarities, uniqueness and similarities that were observed at selected locations. These observations were useful in making good interpretations with relevance in the context. Observations on the crowd behavior, intensity, activities, etc were also noted in view to get a better understanding on the crowd quality and quantity. Based on our observations it was seen that the busiest times in the walks were Thursday night, Friday night and Saturday nights during the weekend. Though the walks were found to be more crowded at night it was seen that Friday morning's and Saturday morning's were also found to be busy and the visitors were mostly families and tourists. Additionally, parks were also found to be busy during the weekends from early morning to late evening and the visitors are mostly big groups of adult which enjoy the barbeques, however, during the weekdays' evening visitors were mostly families with kids.

**Beach Walk:** The walk at JBR is quite breezy and the skyscrapers and tall buildings that are close to the location create good shadow until 12 pm in the walk way. The outside tables and sits of the cafes and restaurants are always full during weekends. Joggers are common during 6 am to 12pm, and they are mostly tourists from neighbourhood hotels or residence of the nearby buildings. The kiosk market in the middle of the walk bring tourist to the area. There are attractions for the kids too and this includes face painting, colour drawing, etc. During day time, the visitors mostly prefer to sit in the outside areas of the cafe or promenade's benches and enjoy the sea breeze. The shadows provided by high-rises are a blessing for the restaurateurs as well as the visitors. The visitors are mostly European and Middle Easterners. (Appendix 5).

**Walk:** Marina walk is mostly occupied by families, since kids have lots of entertainment by the water feature. The parents are mostly smoking shisha or drinking cold/hot beverage in nearby restaurant and they can watch their child from there. The man-made marina,

seasonal friday market and restaurants are a major attraction for the tourists. Joggers are active from 6 am to 12pm (Appendix 5).

**Beach Parks:** Al Mumzar beach park and Jumeirah beach park are relatively busy during both weekends and week days from morning until evening as there is cool sea breeze even during the times of high temperature. Mostly tourists visit these parks during the weekdays. But the park except the restaurant space appears deserted during weekdays as the guests prefer to stay on the beach side. During weekends families and friends mostly occupy the picnic tables and barbeque area and the kid's playgrounds appear almost empty since there is not enough shade. There are not enough trees, greenery or even shades for visitors in grassed area and the shoreline is busy and crowded. There is need for more grass, greenery, shades and trees there in the park side. It is seen that the temperature near the shoreline is a little less than temperature far from the beach, and the humidity is a little more during days in beach side, but the wind speed in coast is six times more (appendix 5).

**Parks:** Since there is an entrance fee for the parks, mostly the parks are almost empty during weekdays, and only the path walk which is designed with jogging tracks around some parks are crowded during early mornings and evenings. In weekend the parks occupied by Asians from early morning to night. The Middle Easterners come after noon. The temperature near water bodies is a little less than temperature far from the water in both artificial lakes of natural creek, but in day time the humidity near water is more by around 20%. Europeans do not visit of regular parks much, as they prefer beach parks (Appendix 5).

### 3.5 Limitation of the Study

The major limitation of the study include,

- As the parks and walks were found to be deserted during the weekdays and were mostly actively during evening to night time it was difficult to plan the surveys in eight different locations within the time frame. Proper planning was done in view to minimize the constraints to certain extend.

- Hostile weather conditions also might affect the survey as people tend to stay indoors if the climate is quite hostile.
- As the survey locations are spatially separated it was difficult to change the survey sites in case of any unexpected happenings in the planned areas.
- The responses of the respondents and the response rates also might act as a major constraint as the research outcome is highly dependent on these responses. So only the people who were willing to cooperate with the research study were surveyed.
- Any error associated with the instrument used for measuring the physical parameters like temperature, humidity, etc. The instrument was validated prior to taking measurements in view to minimize the errors.
- Lot of international tourists was present in these walks and it was difficult to convince these foreigners about the academic nature of the survey. Since some important documents claiming the authenticity of the survey were carried as a proof of its academic relevance we were able to conduct the survey. It was only after written assurance to stick to ethical practices in research they obliged to take part in the survey.
- Since the people had come to the walkways for relaxation or entertainment or fitness related activities they were quite reluctant to spare their time for doing the survey. The respondents yielded based on its academic relevance.

## **CHAPTER 4. RESULTS**

### **4.1 Introduction**

The research study that investigates the role of psychological adaptation in determining thermal comfort in public outdoor spaces in Dubai basically utilizes the primary data collected from six parks (Al Mumzar Beach Park, Jumeirah beach park, Creek Park, Zabeel Park, Safa Park and Mushrif Park) and two walkways (JBR walk and Marina walk) in Dubai. The data analysis is based on the primary data collected from 800 people from the selected eight locations using the survey questionnaire. A total of 100 people were surveyed from a single location and the surveyed individuals were the people who visited these select outdoor locations. Surveys were done both during weekdays and weekends from a single location, but as the researcher observed that the parks were almost deserted during the time period between 8.00 and 16.00 hrs and as a result of which the surveys during weekdays were taken from 16.00 hrs to about 22.00 hrs. While the weekend surveys were made from 8.00 to about 22.00 hrs. The surveys were conducted during the months of October and November in the year 2010. The survey contained both close and open ended questions which were aimed at understanding their social status, perceptions on thermal comfort levels, etc. Valid observations about their gender, activity, clothing, etc were made by the researcher for developing correlations between thermal comfort and adaptive activities. Observations on the crowd behaviour, intensity, activities, etc were also noted in view to get a better understanding on the crowd quality and quantity. Measurements of the physical parameters like temperature, humidity, wind, etc were recorded for understanding and assessing the thermal comfort levels of individuals. The findings based on the data analysis are presented below.

### **4.2 Findings**

The primary data collected from each of the 8 locations are analyzed separately and is presented separately using charts and graphs. Such a presentation would be helpful in identifying the patterns and trends in different locations and thereby enable us to evaluate the thermal comfort situation in different outdoor locations in Dubai. Data collected during

weekends and weekdays are presented separately in view to make comparisons easier. The various assessments done from each location include, variations in the crowd intensity in relation to temperature and humidity; crowd diversity; Perceptions with regard to the prevailing physical conditions; changes in the crowd composition; comfort votes in relation to temperature and humidity. Throughout this analysis the value of the number of visitors have been interpolated the original numbers to values out of hundred in order to provide more clarity to the graphical representations used for comparing the crowd intensity with that of temperature and humidity.

#### **4.2.1 Zabeel Park**

The relationship between crowd intensity, temperature and humidity at Zabeel Park during weekday and weekend at various time intervals are given in Figure 4.1 and 4.2 respectively. X axis represents the time periods and the Y axis represents the values for temperature ( $^{\circ}\text{C}$ ), humidity (%) and the number of visitors. In the case of measurements taken during weekdays, it was observed that there were not much variations in both temperature and humidity values at these time periods. Figure 4.1 shows that the crowd intensity was more during 17.00 hrs. That is the time when the temperature was relatively high ( $29.5^{\circ}\text{C}$ ) and humidity was low (51 %). The number of visitors in the park reduced mostly after sunset. Ladies, maids and kids dominated the park during 17.00 hrs and 18.00 hrs and kids were playing and the ladies were mostly sitting or watching them play or were involved in social interactions. Perhaps the reduction in the number of visitors to the park or the crowd behaviour may not have much relation to temperature or humidity, but time might be a major factor that influences the crowd behaviour. From dusk onwards the proportion of male visitors increased while the number of ladies and kids who visited or remained at the site reduced considerably as time elapsed. The visitors were mostly involved in playing, jogging, eating, etc. Perhaps this change in the crowd composition have some relation to the school and office timings, which make it more appropriate for ladies and kids to be around during 17.00 to 18.00 hrs and the working class male visitors to be around the park for relaxing after their hectic day at office after dusk.

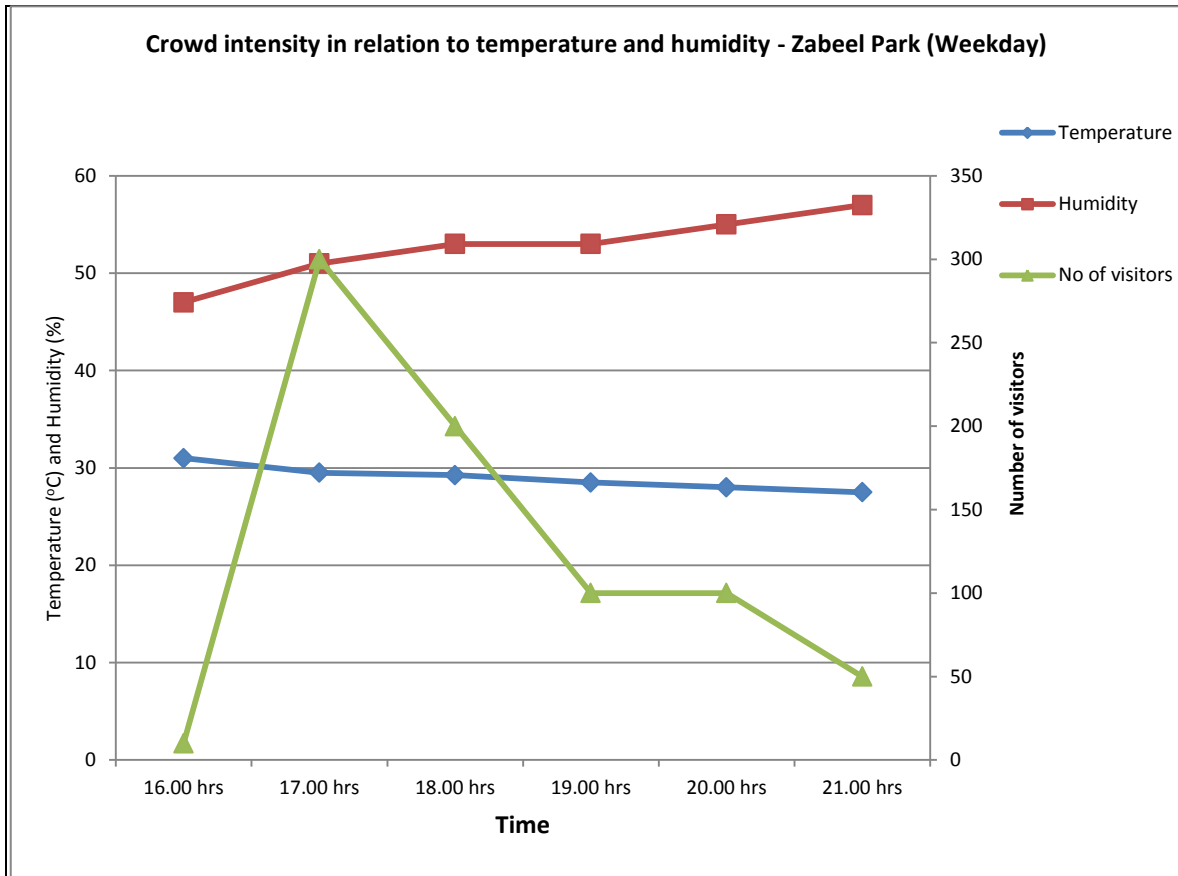


Figure 4.1: Relation between crowd behaviour, temperature and humidity (Zabeel Park – Weekday)

During weekends, it was noticed that the park was more crowded from 13.00 hrs to 18.00 hrs when temperature was relatively on the higher side (average of  $31.4^{\circ}\text{C}$ ) and humidity was relatively lower (average of 47.5 %) (See Figure 4.2). Quite similar to the crowd behaviour observed during the weekday it was observed that the prevailing physical parameters like temperature, humidity, etc do not seem to form a major decisive factor in drawing people in to the park. Most people preferred to remain in the shaded spots of the park and were mostly involved in playing games, preparing barbeques, eating and jogging. It can be assumed that people prefer to choose the outdoor location suiting their activities and priorities and the majority preferred to remain outdoors mostly before sunset or in the afternoon until sunset. It was also noted that the people dressed according to the prevailing weather conditions, which can be considered as an adaptive measure for making them feel more comfortable. Visitors were not thermally comfortable with the weather condition



during the time from 13:00 to 16:00 hrs and they mostly felt either warm or hot. They tried to lower their activity levels by sitting, relaxing, drinking cold beverage and chatting under the shades. Since a few months back they have experienced hot conditions with values as high as 50<sup>0</sup>C, the temperature values up to 35<sup>0</sup>C were not so harsh for them.

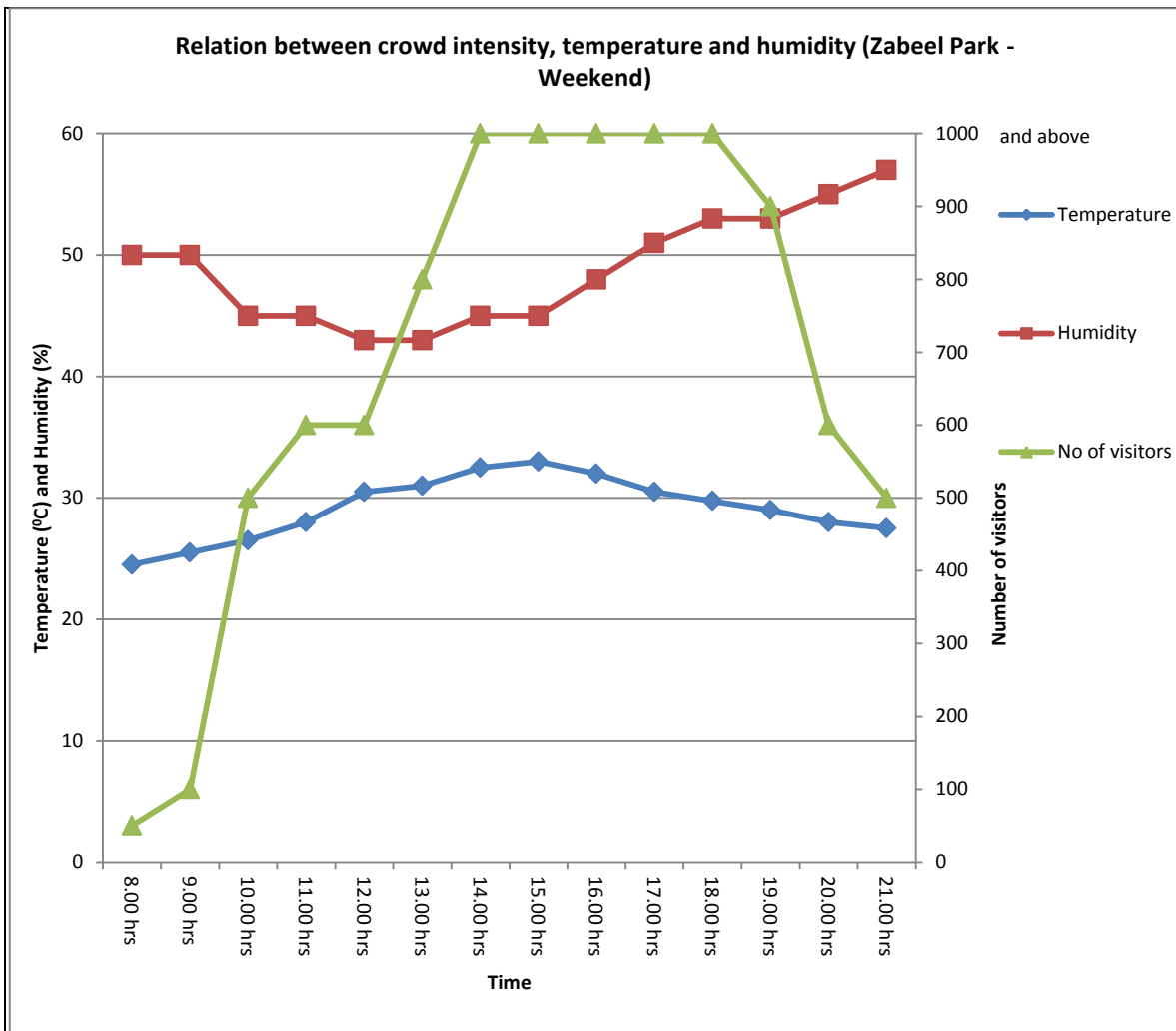


Figure 4.2: Relation between crowd intensity, temperature and humidity (Zabeel Park – Weekend)

It was observed from the analysis that during weekdays, Emiratis, Middle Easterners, Indians, Westerners, etc were more prevalent in the park during these times. The diversity of the visitors with regard to their nationality is given in the Figure 4.3. It is

clear from Figure 4.4 that Filipinos and Emiratis constituted the major visitors at the park during weekends.

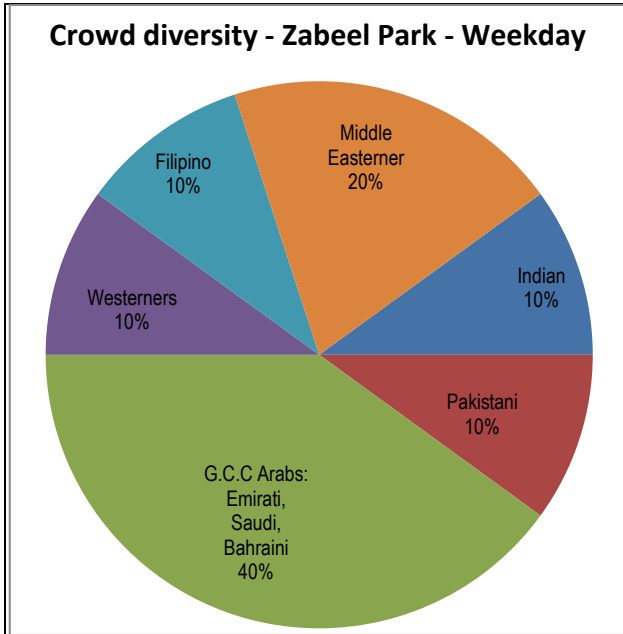


Figure 4.3: Crowd diversity for Zabeel Park during weekday

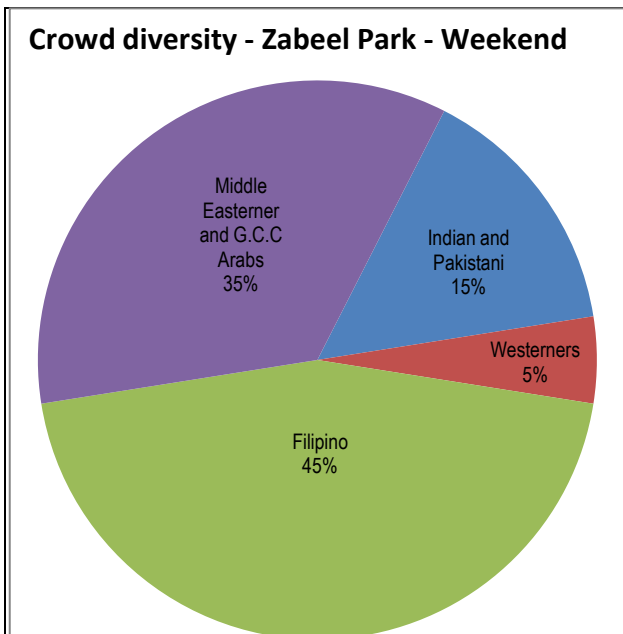


Figure 4.4: Crowd diversity for Zabeel Park during weekend

Comparison between the perceptions of the individuals at Zabeel Park in relation to the four physical parameters at around 16.00 – 18.00 hours, 18.00 – 20.00 hrs and 20.00 – 22.00 hrs are depicted in the Figure 4.5. X axis represent the physical parameters and Y axis gives the percentages based on the responses. When analyzing the changes in the perceptions of the visitors with regards to the prevailing thermal comfort conditions before sunset to 22.00 hrs, it was observed that almost all of the surveyed individuals were found to be satisfied with regard to the present vegetation in the region. At the same time majority preferred more wind movement and about 100 percent preferred reduced temperatures at these times. It was seen that about 50 percent of the visitors were sitting or standing near the playground where the kids where playing and the other fifty percent resorted to walking during 16.00 – 18.00 hrs and the differences in the crowd composition as time progresses are given in the Figure 4.6. While after sunset, visits to the parks were mostly fitness and entertainment related. During these times it was noticed that majority of the visitors had either cold snacks or cold beverages so as to make them more comfortable in the present conditions. Majority of the visitors felt only slightly warm and were found to be thermally comfortable in the present conditions, perhaps this is due to the fact that most of them had experienced extremely harsh hot summer with around 50<sup>0</sup>C about a few months back. Location, greenery, vegetation, availability of entertainment options, etc seem to be the driving force for attracting people in to the park.

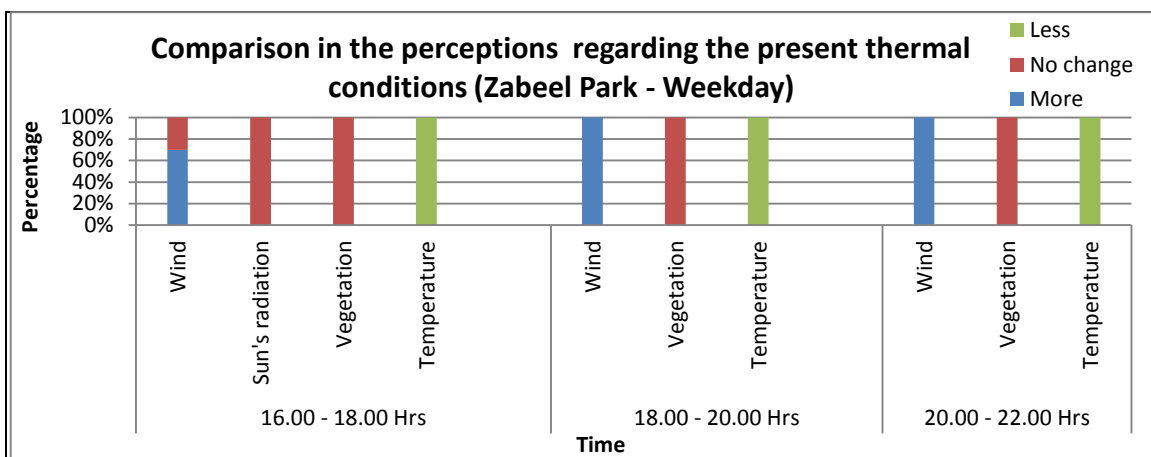


Figure 4.5: Comparing perceptions with regard to the prevailing thermal conditions (Zabeel Park – Weekday)

Assessments on the perceptions with regard to the prevailing conditions at Zabeel Park during the weekend indicate that at 8.00 to 11.00 hrs all the prevailing physical parameters (average temperature around 26<sup>0</sup>c; humidity 47.5 %; wind around 2 m/s) were satisfactory for the visitors (See Figure 4.6). Despite having relatively high crowd intensity during the periods from 13.00 hrs to 18.00 hrs it was seen that they preferred to have lower temperatures, lesser sun’s radiation, more wind and more vegetation in the region. The comfort measurements taken during the various time intervals (13.00 – 18.00 hrs) indicated that they felt warm in the shaded places of the park while felt hot in other areas. In general the thermal condition was either warm or hot, so there was not much activity inside the park and visitors are mostly resting, relaxing and chatting under the shades, or making the barbeque.

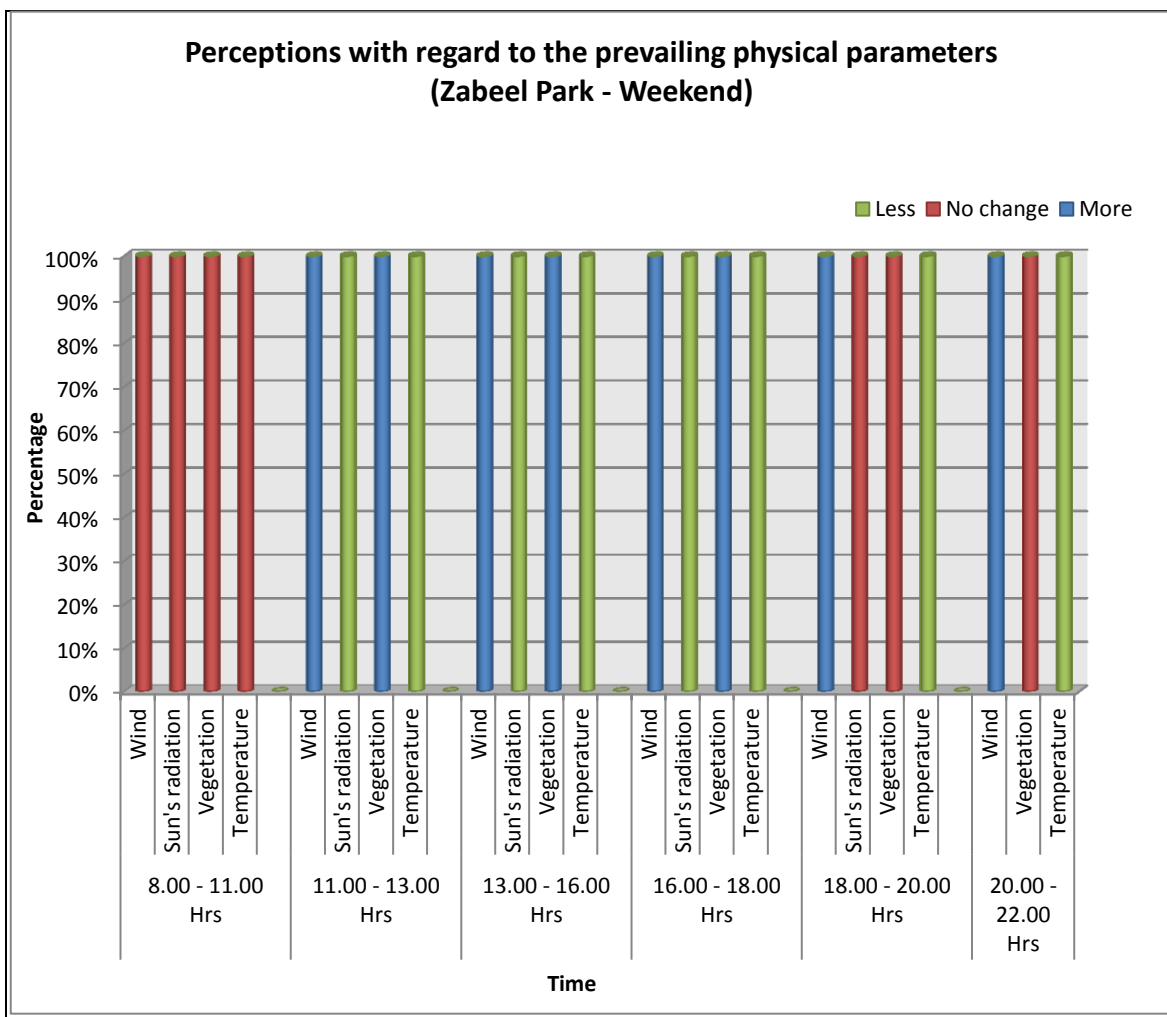


Figure 4.6: Perceptions in relation to the physical conditions (Zabeel Park – Weekend)

Figure 4.7 indicates that the crowd composition varies with time as different categories of people prefer different timings for outdoor activities. It was seen that there were no international tourists who visited the park both during weekdays and weekends. During weekdays the park was mostly active by the presence of mothers, maids and kids during 17.00 hrs and 18.00 hrs. But after 19.00 hrs, joggers and adult groups formed the main visitors in the park. As evident in Figure 4.8 mostly adult groups dominated the park from 8.00 – 10.00 hrs during weekends. The crowds in the park from 11.00 hrs until 18.00 hrs were mostly families. From 18.00 hrs onwards till 20.00 hrs the joggers and adult groups were more prevalent.

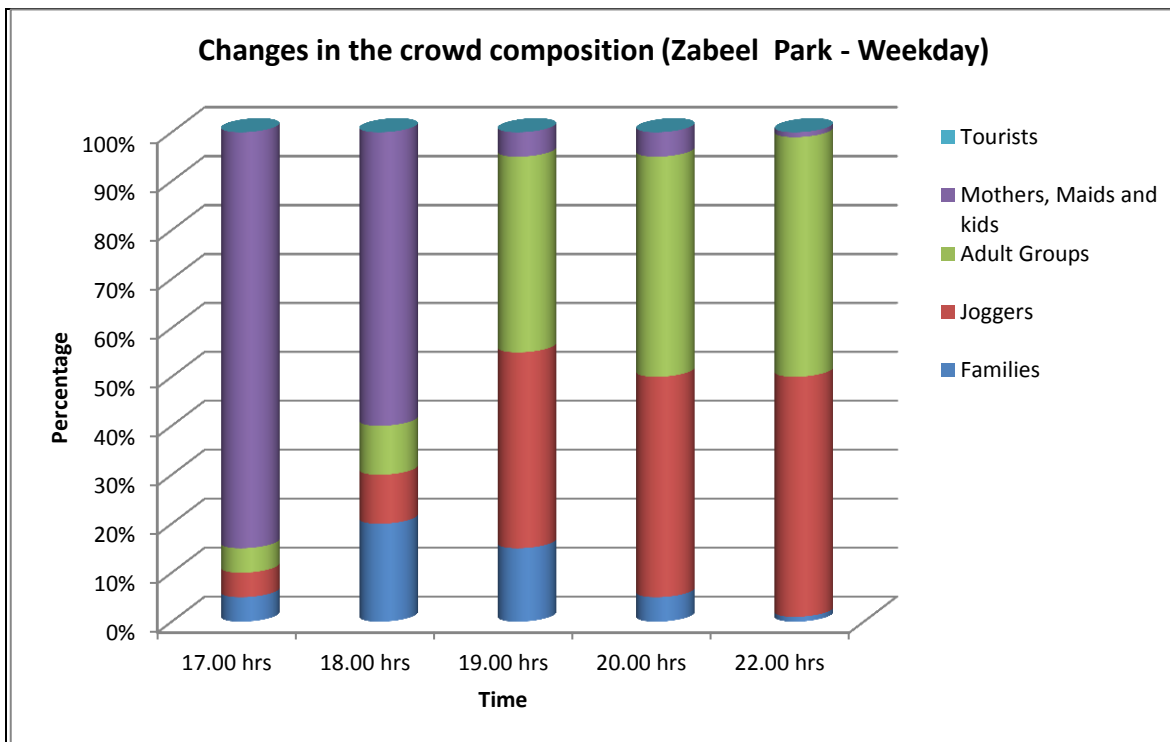


Figure 4.7: Crowd composition over time (Zabeel Park – Weekday)

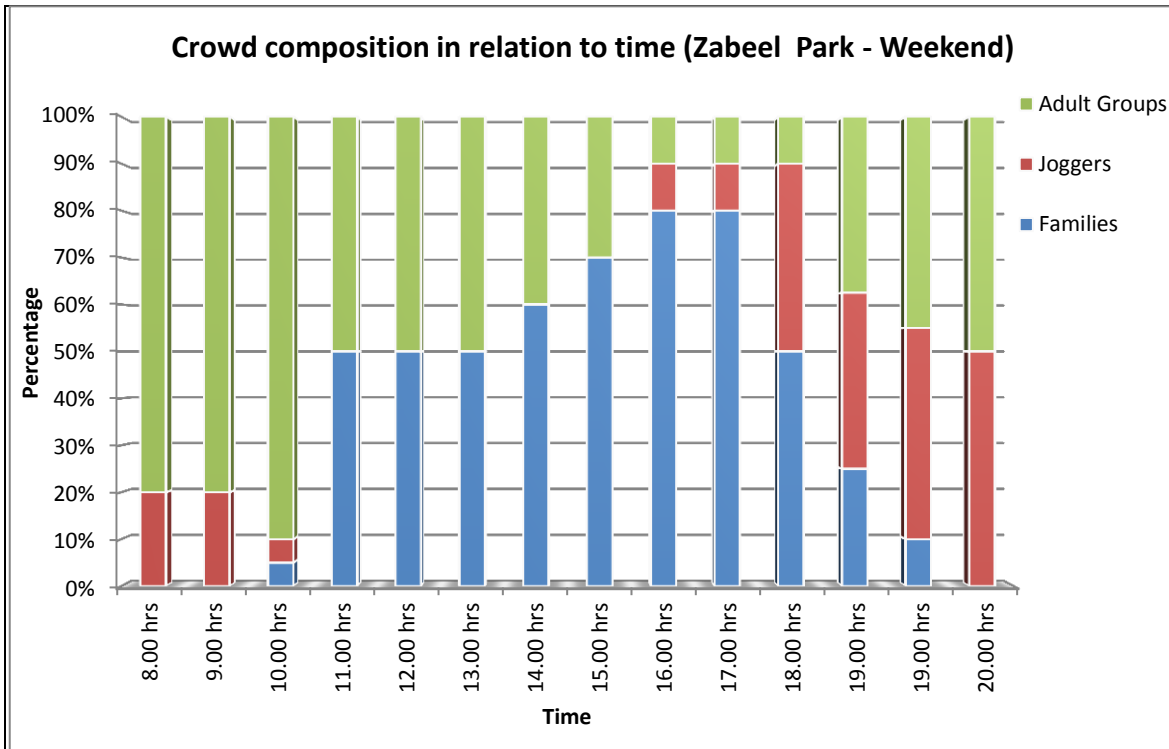


Figure 4.8: Crowd composition in relation to time (Zabeel Park – Weekend)

Comfort votes were assessed in relation to temperature and humidity and the analysis from Zabeel Park during weekday and weekend are presented in Figure 4.9 and 4.10 respectively. Temperature and humidity values are given along the X axis and the responses of the respondents are given in the Y axis. During weekdays, it is seen that the surveyed individuals were a sort of comfortable in the current thermal conditions as the responses were mostly neutral to slightly warm. Slightly warm responses were obtained mostly when the temperature was low (25.5°C to 29.5°C) and humidity was high (43 to 47 %). During weekends it was seen that though the respondents seemed to be comfortable during most of the times as their responses varied from slightly cold, neutral and slightly warm but when the temperatures were between 31°C and 33°C people were found to be quite uncomfortable. Fair amount of visitors (10 – 40 %) claimed that the conditions were hot during those periods. Adaptive responses in relation to the physical parameter were also quite evident and this includes variations in the activity levels, choices, dressing, etc. Majority of the visitors wore sleeveless tops or T-shirts and shorts or sportswear that was made of material like cotton and most of the people opted for cool colours.

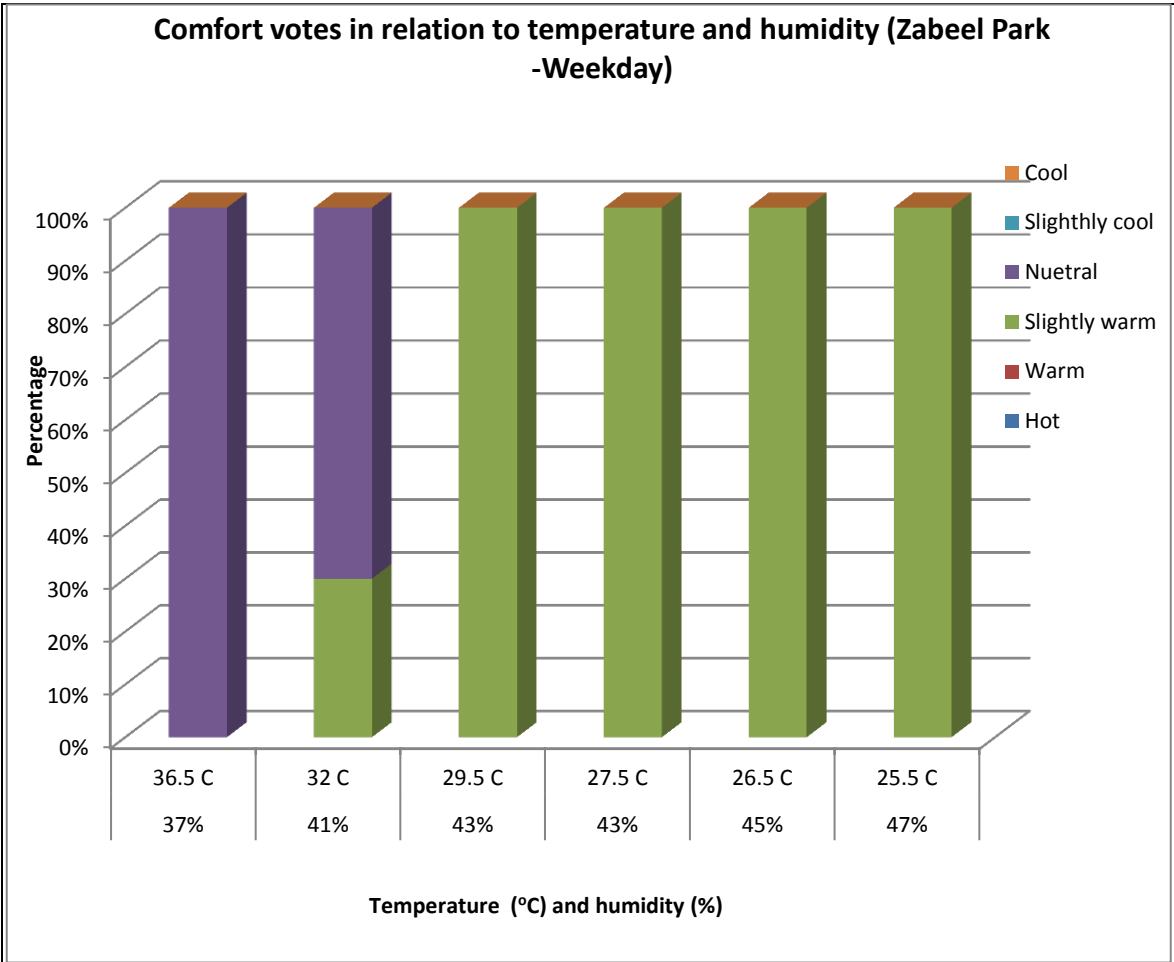


Figure 4.9: Relation between comfort levels, temperature and humidity (Zabeel Park – Weekday – from 16.00 to 21.00 hrs)

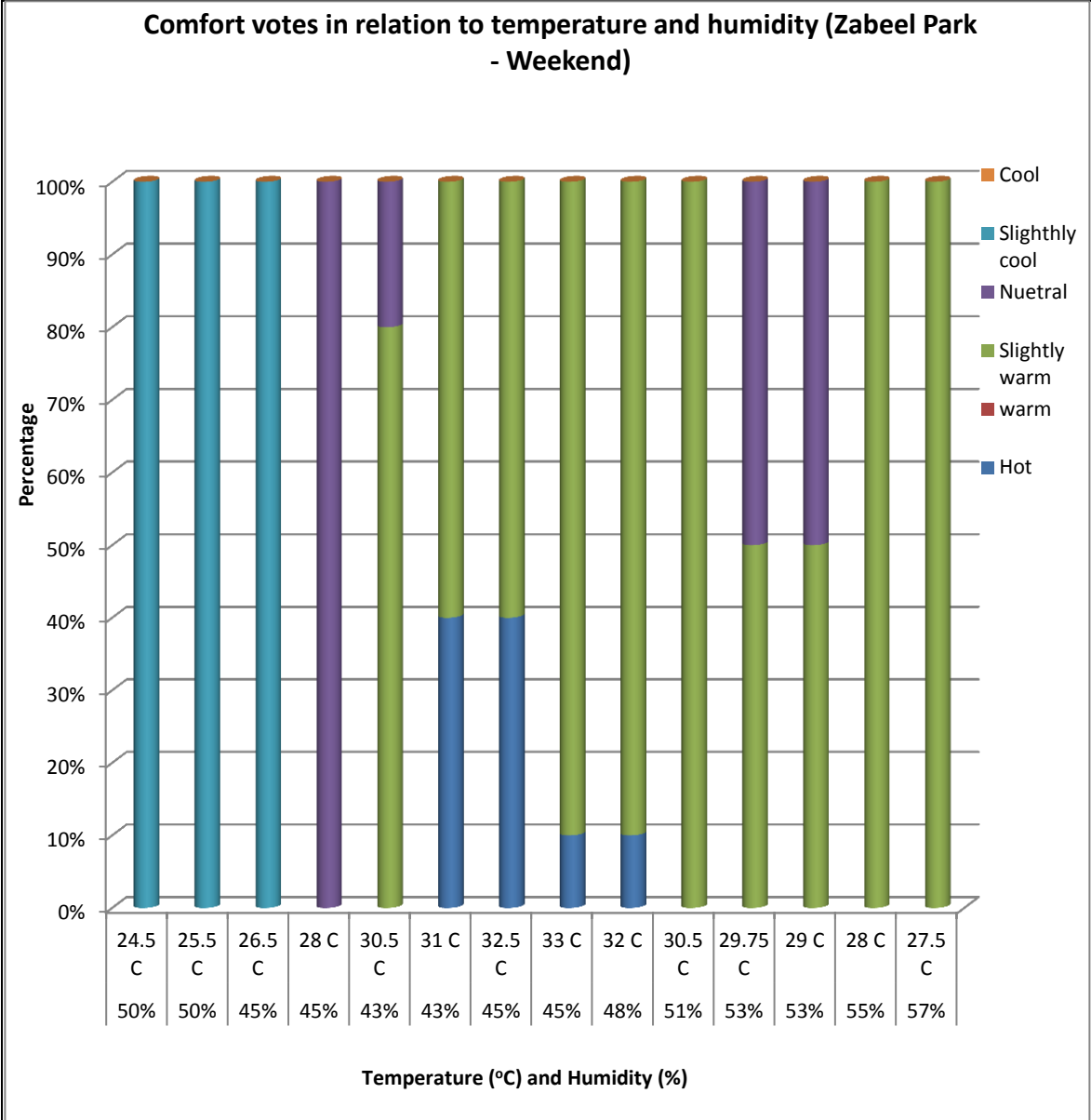


Figure 4.10: Relationship between comfort votes, temperature and humidity (Zabeel Park – Weekend – from 8.00 hrs to 21.00 hrs)



### 4.2.2 Creek Park

Assessments on the crowd volume and its relation to temperature and humidity at different time intervals from Creek Park during weekday and weekends are given in Figure 4.11 and 4.12 respectively. Only slight variations in temperature and humidity only occurred during these periods and it was seen that the crowd intensity was maximum between 17.00 hrs and 20.00 hrs. During these periods the temperature varied from 28 to 30.5°C and the humidity values varied from 56 to 58 %. Analysis on the weekend data reveals that the crowd intensity was maximum during 14.00 hrs and 18.00 hrs when the temperature values were between 29.75 and 33°C and the humidity were between 53 to 57 %.

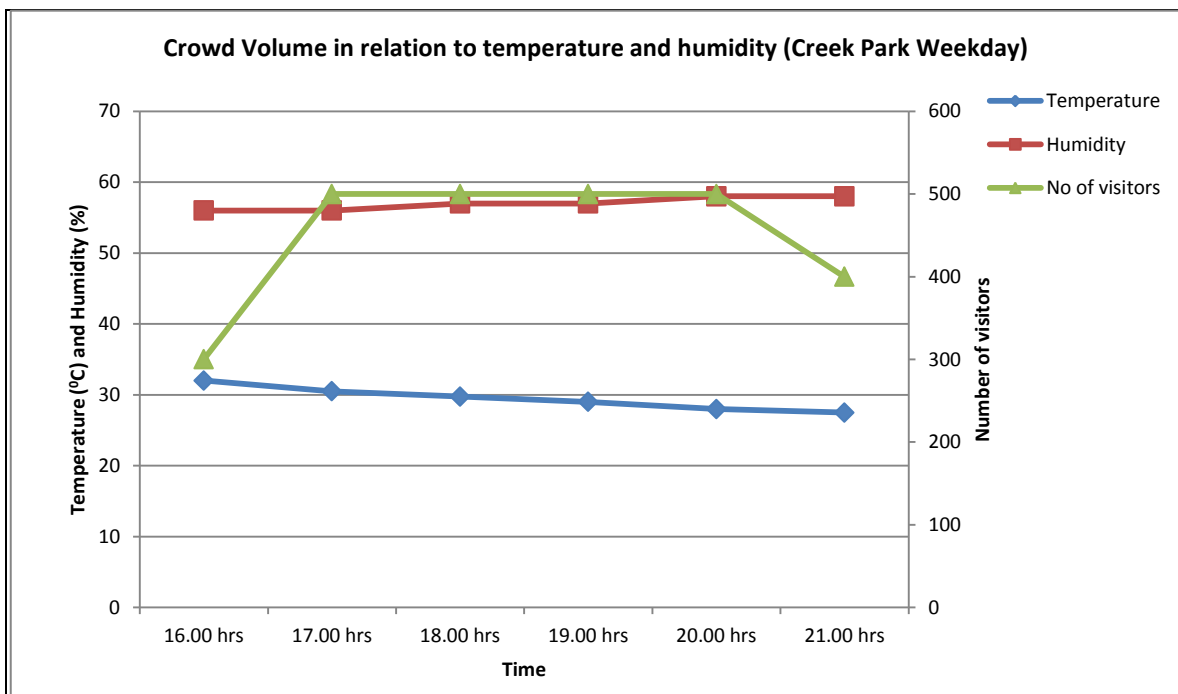


Figure 4.11: Crowd volume in relation with temperature, humidity and time (Creek Park – Weekday)

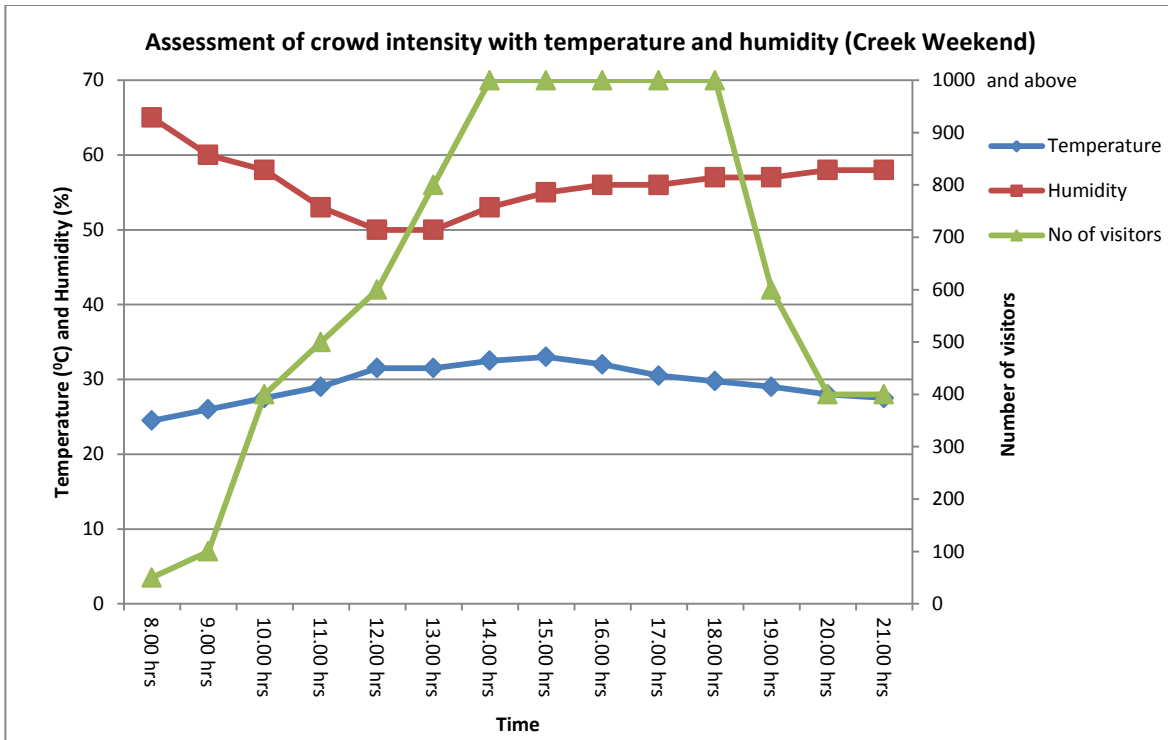


Figure 4.12: Crowd volume in relation to temperature and humidity (Creek Park – Weekend)

The analysis on the crowd diversity at Creek Park during weekdays (Figure 4.13) and weekends (Figure 4.14) reveal that there appear some major changes in the crowd composition. It is seen that westerners and Middle Easterners constitute the major visitors during weekdays, while Filipinos and Westerners form the main visitors to the Creek Park during Weekends. The alteration in the crowd composition with regard to nationality also might most likely influence the comfort levels.

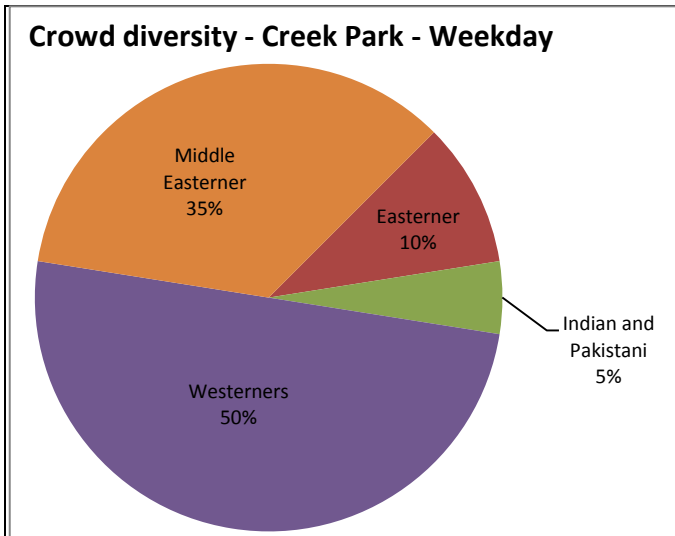


Figure 4.13: Crowd diversity at Creek Park during weekday

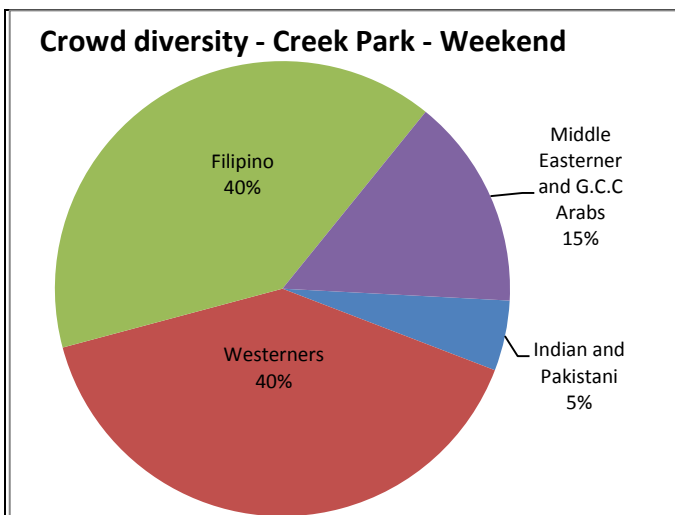


Figure 4.14: Crowd diversity at Creek Park during weekend

Assessments were made for understanding the perceptions of the individuals in relation to the different physical parameters at Creek Park during weekday (Figure 4.15) and weekend (Figure 4.16) at various time intervals. During weekday it is seen that people preferred low temperatures, more wind movements from 16.00 hrs to 22.00 hrs. With regard to vegetation, it is seen that majority wanted more vegetation and less sun's radiation when surveyed during 16.00 – 18.00 hrs. While on the other hand after 18.00 hrs until 22.00 hrs majorities preferred no change in vegetation. Most of the visitors were either sitting or walking and enjoying the entertainment activities in the park. More than 90% liked this park because of the cable cabin which gives them a panoramic view of the whole creek, or the mini golf area that could be used by the visitors.

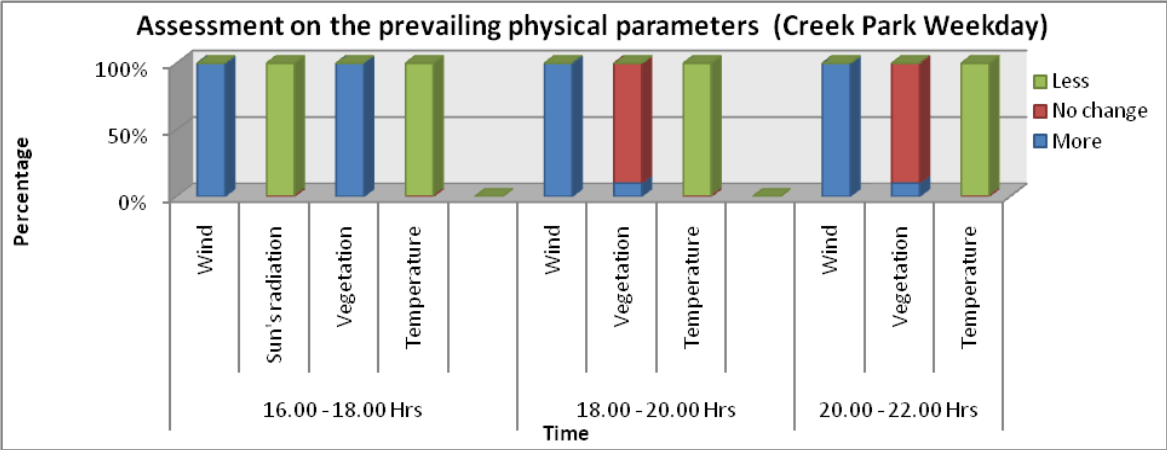


Figure 4.15: Assessing the prevailing physical parameters (Creek Park – Weekday)

From the analysis it was seen that at weekends, during the different time periods from 8.00 hrs to 18.00 hrs it was seen that people preferred more wind movements, lesser temperatures, more vegetation and lesser sun’s radiation during these times. During the morning hours the visitors were mostly engaged in walking around the creek, playing games, jogging, preparing barbeques, and eating. But from 18.00 to about 22.00 hrs, it was noticed that they did not bother about the vegetation and shading options available in the Park. 80 percent of the people were having some form of cold drink or cold snack. People were making appropriate adaptive responses in view to adjust in proportion with the current physical conditions.

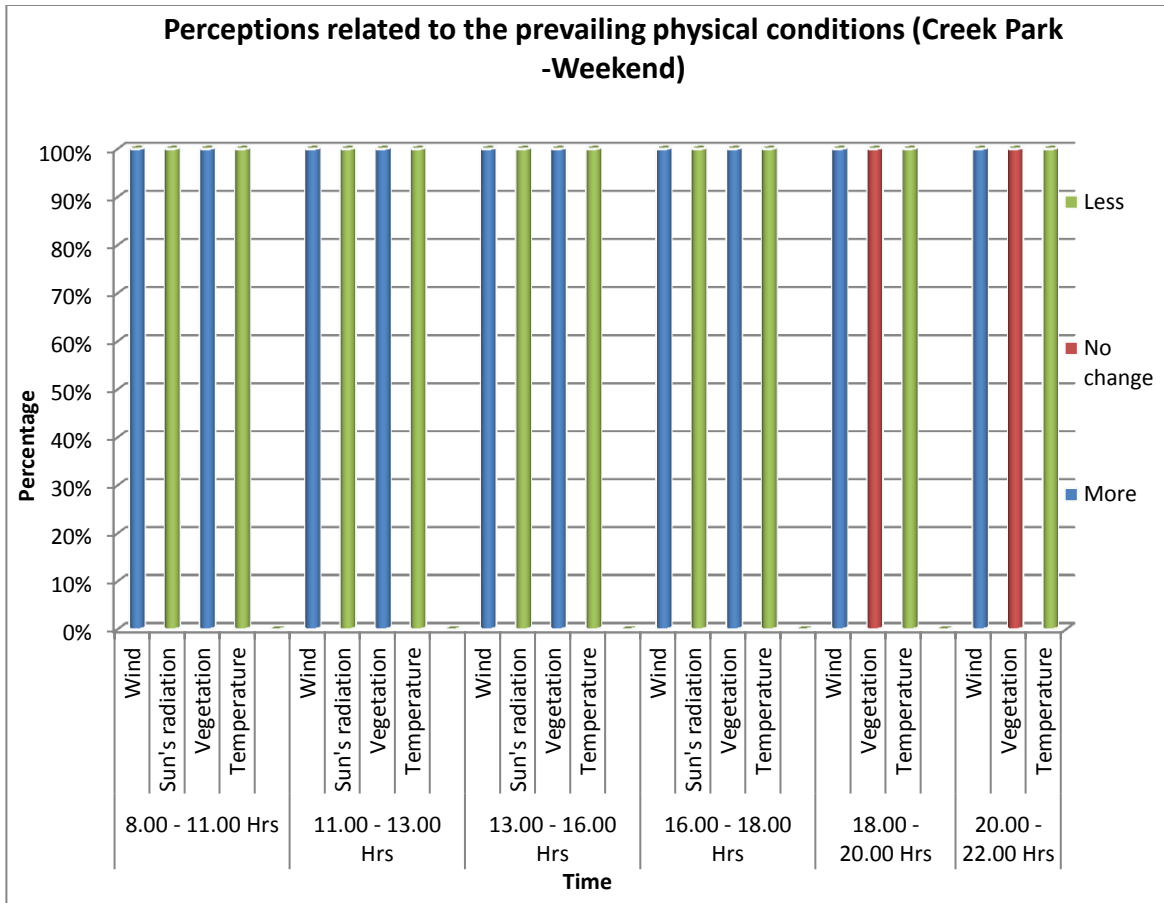


Figure 4.16: Perceptions with regard to the physical conditions (Creek Park – Weekend)

When assessing the nature of the crowd in relation to time it was seen that international tourists and adult groups formed the main visitors at Creek Park during weekdays during the time from 17.00 hrs to 23.00 hrs (See Figure 4.17). Based on the analysis made of the weekend data it was seen that though international tourists and adult groups dominated the crowd composition at most of the times, families (UAE residents) also formed a major component during the time from 12.00 hrs to 17.00 hrs (see Figure 4.18). The presence of large numbers of family crowds at these times despite higher temperatures indicates their preference for outdoor activities during these times at weekends. Unlike Zabeel Park where there were no tourists during the surveyed timings both during weekdays and weekends; Creek Park seems to attract more tourists in to the park. Perhaps the cable cabin, mini golf area and the site seeing opportunities, climatic conditions and entertainment options of this place might form a major factor in attracting more international travelers in to the park.

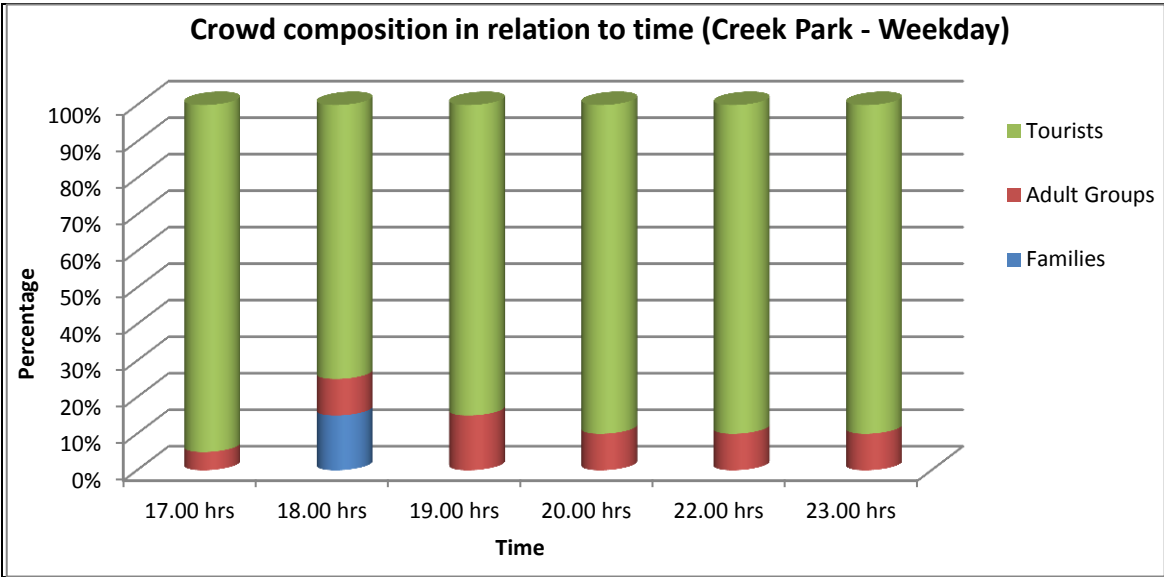


Figure 4.17: Crowd composition in relation to time (Creek Park – Weekday)

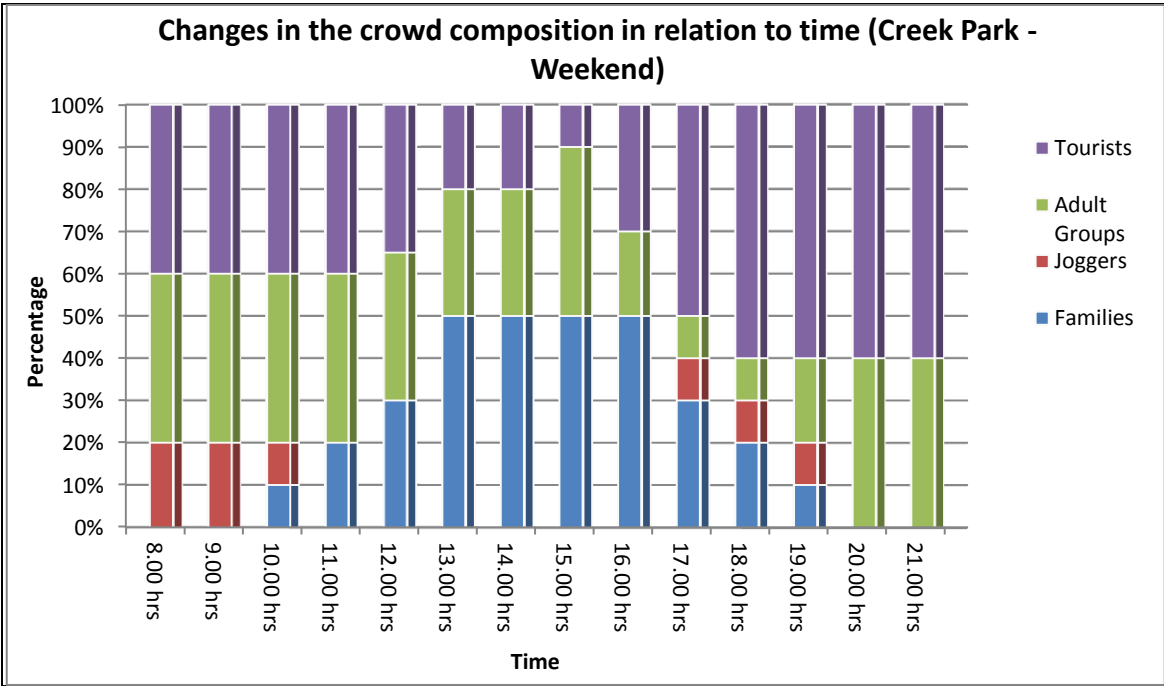


Figure 4.18: Changes in the crowd composition (Creek Park – Weekend)

The comfort level assessments made during weekdays from Creek Park (Figure 4.19) indicates that the visitors were mostly not comfortable as majority of the people considered the condition to be hot at temperatures around 27.5 to 30°C and with humidity

about 57 – 58 %. But it was noted that at higher temperatures between 30.5 to 32°C, the responses were neutral (50 %), slightly warm (30 %) and warm (20 %). This perhaps indicates that the expectations of the people with regard to the climatic conditions also play a role in deciding the comfort levels of individuals. Analysis of the weekend data (See Figure 4.20) shows that the respondents were found to be moderately comfortable during daytime (8.00 to 18.00 hrs) even at temperatures which varied from 24.5 to 33 °C and humidity values varied from 50 to 65 %. But after sunset majority (about 60 %) of the visitors were found to be uncomfortable even at lower temperatures around 27.5 to 30°C and humidity between 57 and 58 %. This might be because most of the visitors were less tolerance to highly humid conditions even at relatively low temperatures (27.5°C). Another reason might be that the expectations of the visitors with regard to the climatic factors during evening and night times would be different and perhaps they prefer cooler and less humid conditions during these times.

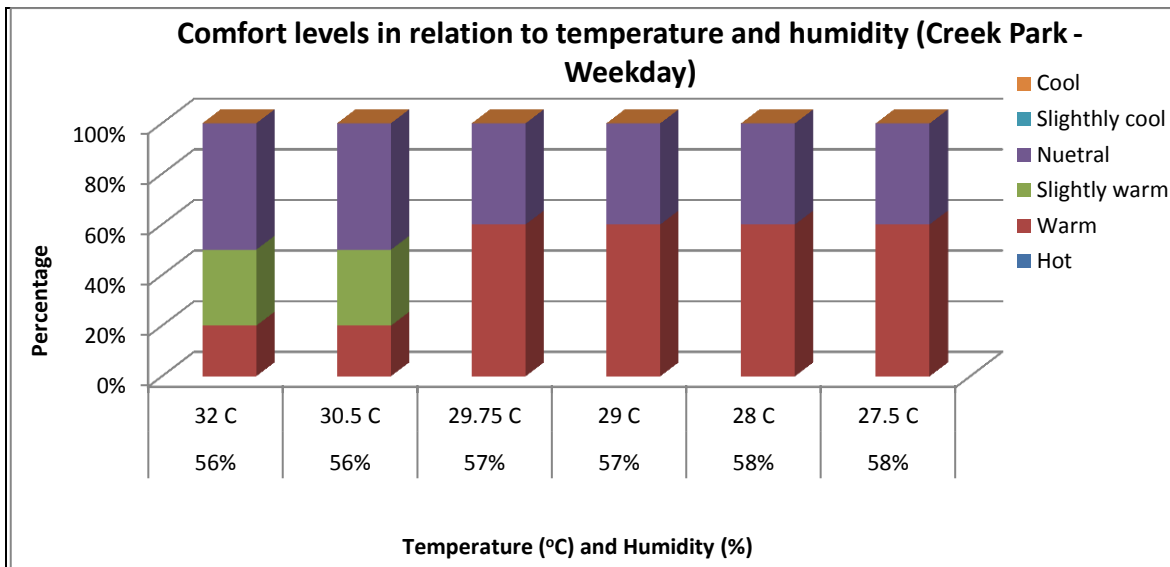


Figure 4.19: Comfort levels with respect to temperature and humidity (Creek Park – Weekday)

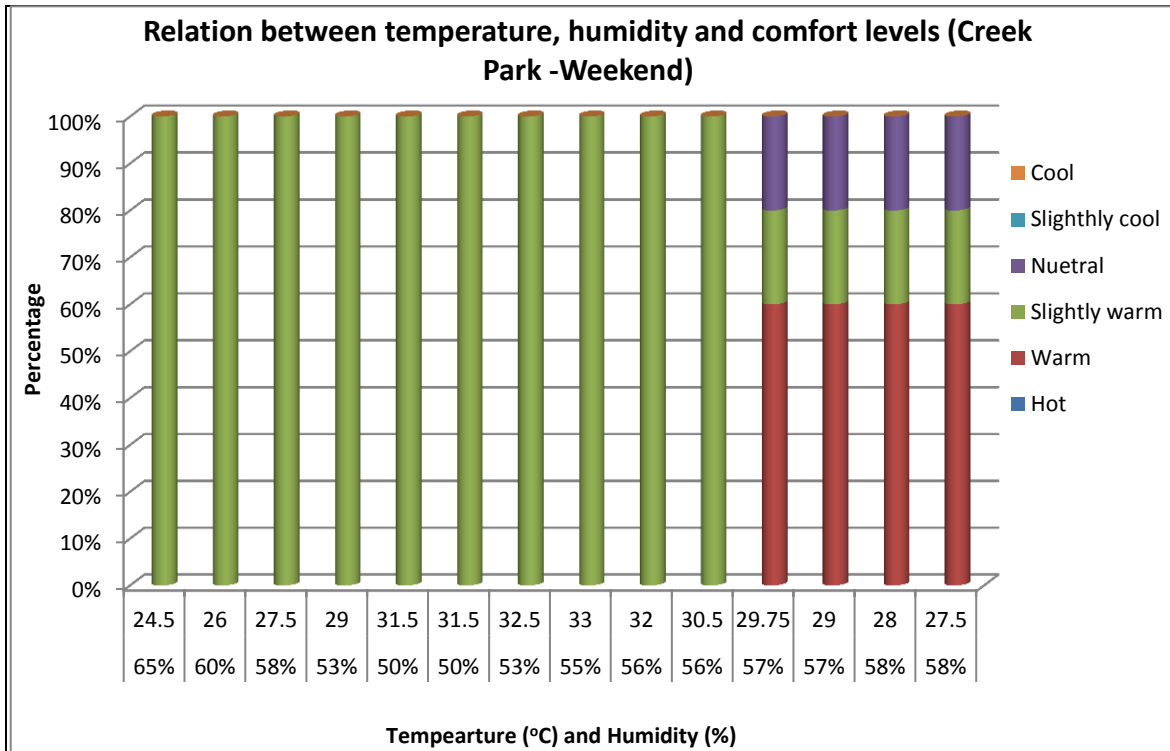


Figure 4.20: Temperature, humidity and comfort levels (Creek Park – Weekend)

### 4.2.3 Safa Park

Assessments on the crowd volume in relation to temperature and humidity at Safa Park during weekdays (Figure 4.21) and weekends (Figure 4.22) reveals that there were marked changes in the number of visitors during different times. It was seen that the place was mostly crowded during 18.00 to 20.00 hrs with maximum at around 19.00 hrs. The temperature varied from 26.5 to 30°C and humidity varied between 49 and 60 % during this period. Activity in the evenings before sunset was mostly of kids playing and the accompanied mothers and maids watching or chatting. While after sunset the activity was mostly playing games, jogging and eating. While during weekends the park was mostly crowded in the afternoon from around 14.00 to 18.00 hrs until sunset when the temperatures were higher (28.5 to 31.5 °C) and humidity ranged between 45 and 53 %. This is indicative of the people’s preference for spending time outdoors in the afternoons and evenings and they were mostly from the neighborhood places and were engaged in playing games, preparing barbeques, etc.



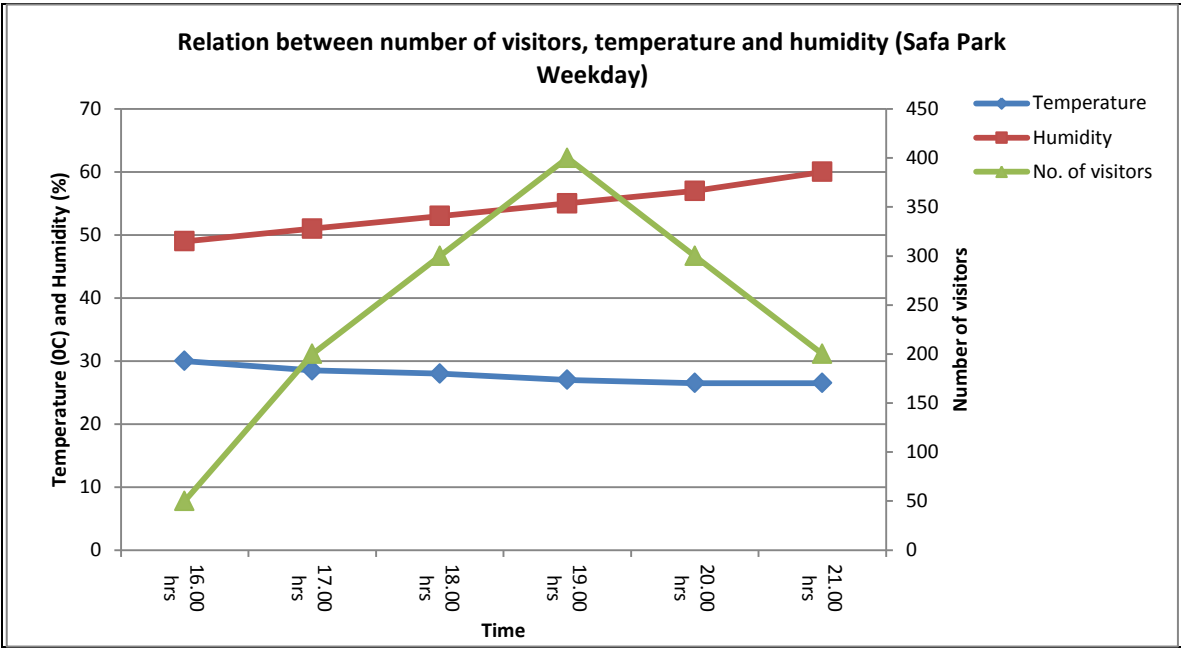


Figure 4.21: Crowd volume in relation with temperature and humidity (Safa Park – Weekday)

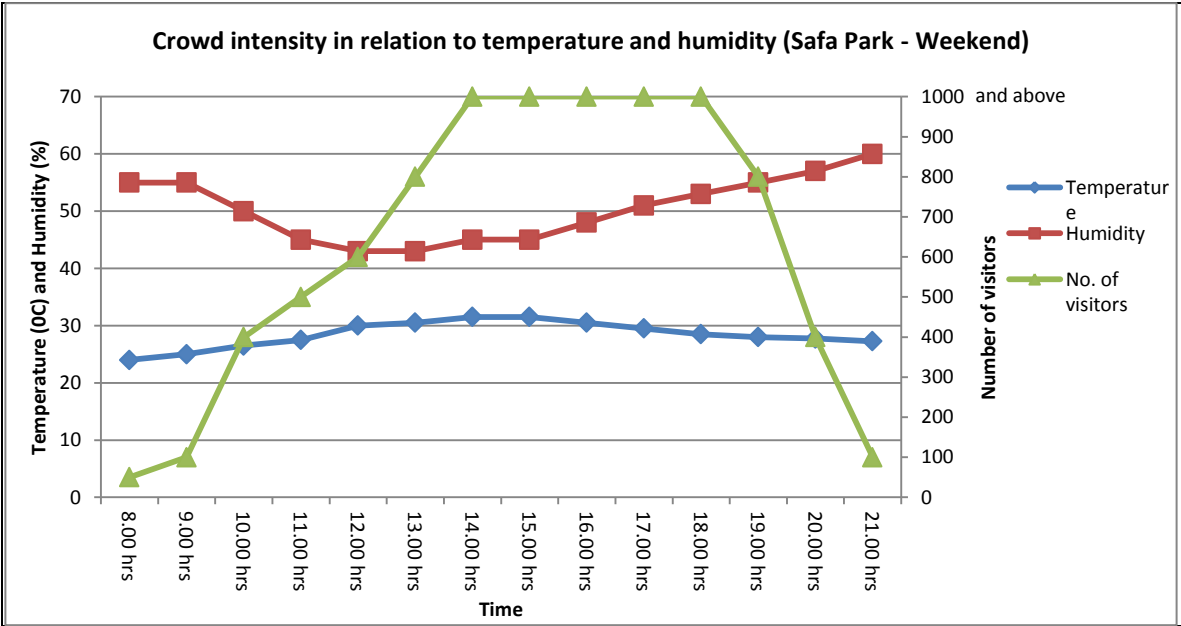


Figure 4.22: Assessment of crowd volume in relation to temperature and humidity (Safa Park – Weekend)

Categorization of the visitors at Safa Park based on their nationality revealed that G.C.C. Arabs (mostly UAE, Saudi and Bahraini), Middle Easterners (mostly Lebanese, Egyptian, Iranian and Turkish) and Westerners form the main visitors to the park during weekdays (Figure 4.23). Assessments on the crowd diversity during weekends (from 16.00 to 21.00 hrs) Figure 2.24) showed that Indians and Pakistanis together constituted about 40 percent; Filipinos (35 %) and Middle Easterners and G.C.C. Arabs together formed about 20 percent of the visitors at Safa Park. Though the people in the park were found to be multi cultural both during weekdays and weekends the proportion of the people does vary considerably, which might point out to the fact that there appear multicultural differences in the choice of outdoor locations as well as with regard to their comforts levels.

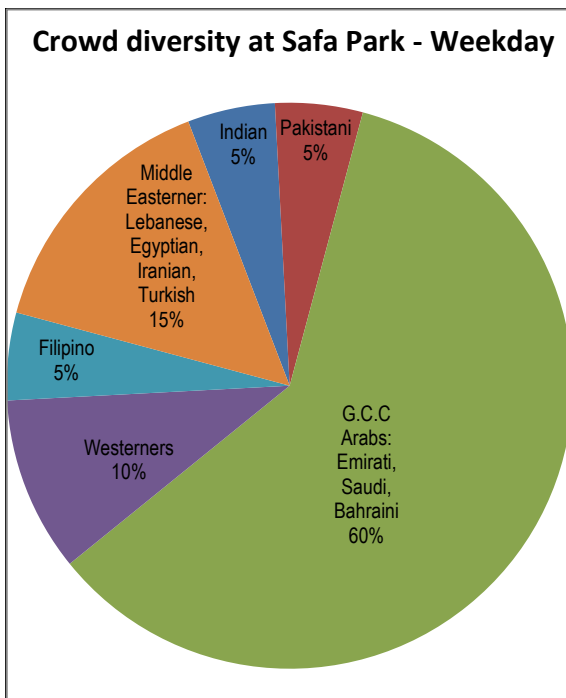


Figure 4.23: Crowd diversity at Safa Park during weekday

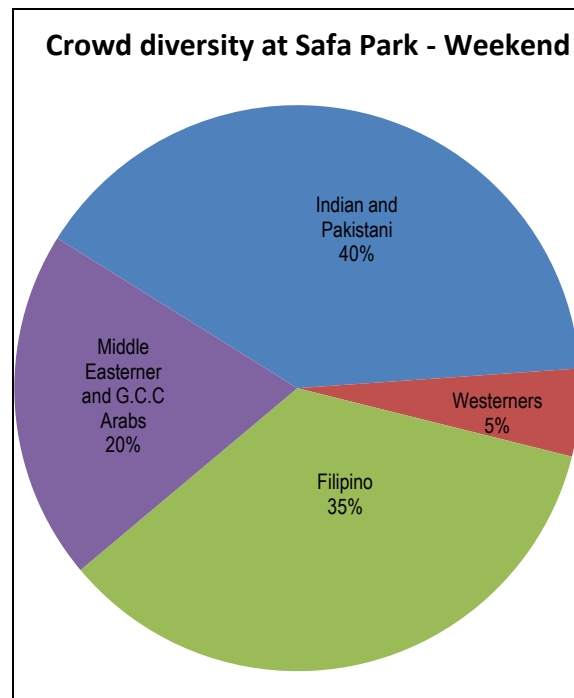


Figure 4.24: Crowd diversity at Safa Park during weekend

Assessments were made for understanding the perceptions of individuals in relation to the existing physical parameters both during weekdays and weekends, which are presented in the Figures 24 and 25 respectively. The analysis made of the weekday data reveals that the people were quite happy with the vegetation that is present in the park.

Though majority of the people preferred more wind movement and lower temperatures they seem to be quite tolerant to the prevailing physical conditions in the region. During weekends it was seen that the people were quite satisfied with the existing parameters (temperature 25.5°C; humidity 48 % and wind speed around 2 m/ s) during the time interval between 8.00 and 11.00 hrs. Based on the responses it is noticed that the people preferred lower temperatures and more wind during the period from 11.00 to 22.00 hrs during which the temperature varied between 27 and 31.5°C; humidity ranged between 45 and 60 %. At the same time it was seen that the people were willing to remain in the region for one or more hours despite slight dissatisfactions on the existing climatic conditions. It was observed that all the respondents irrespective of time both during weekdays and weekends expressed that they were satisfied by the vegetation in the region.

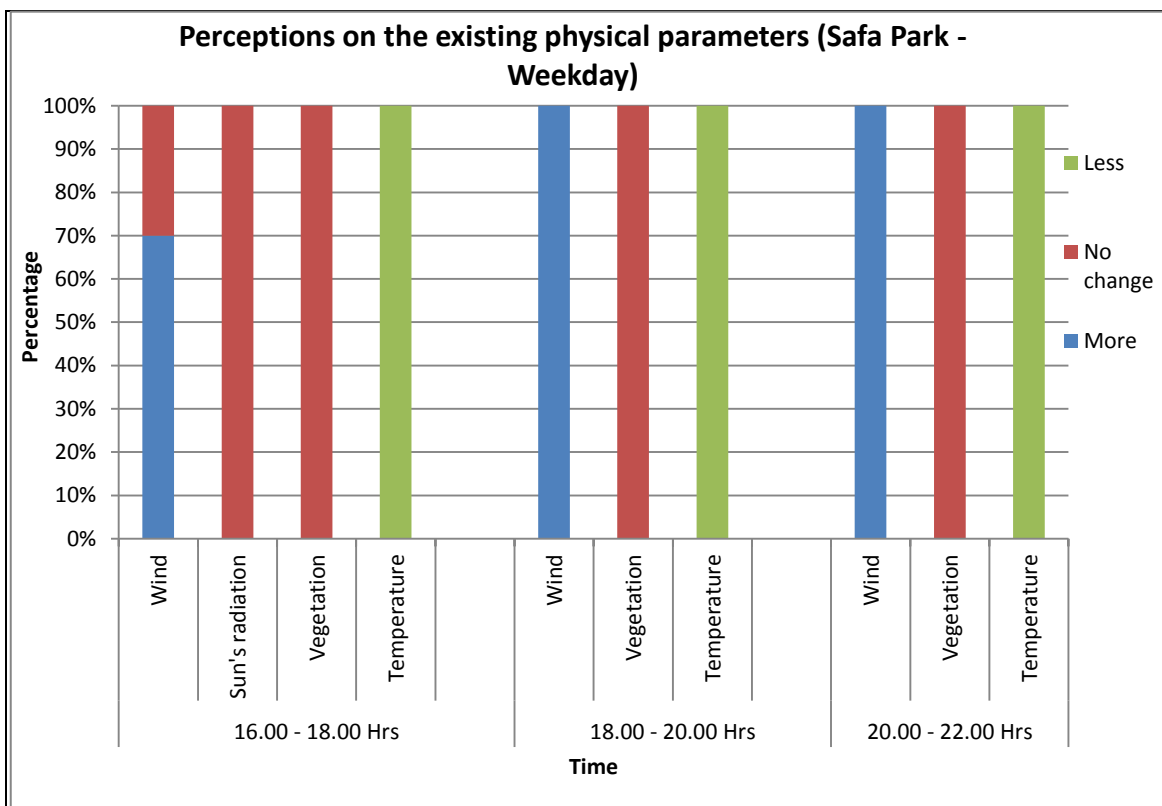


Figure 4. 25: Assessments on the existing physical conditions (Safa Park – Weekday)

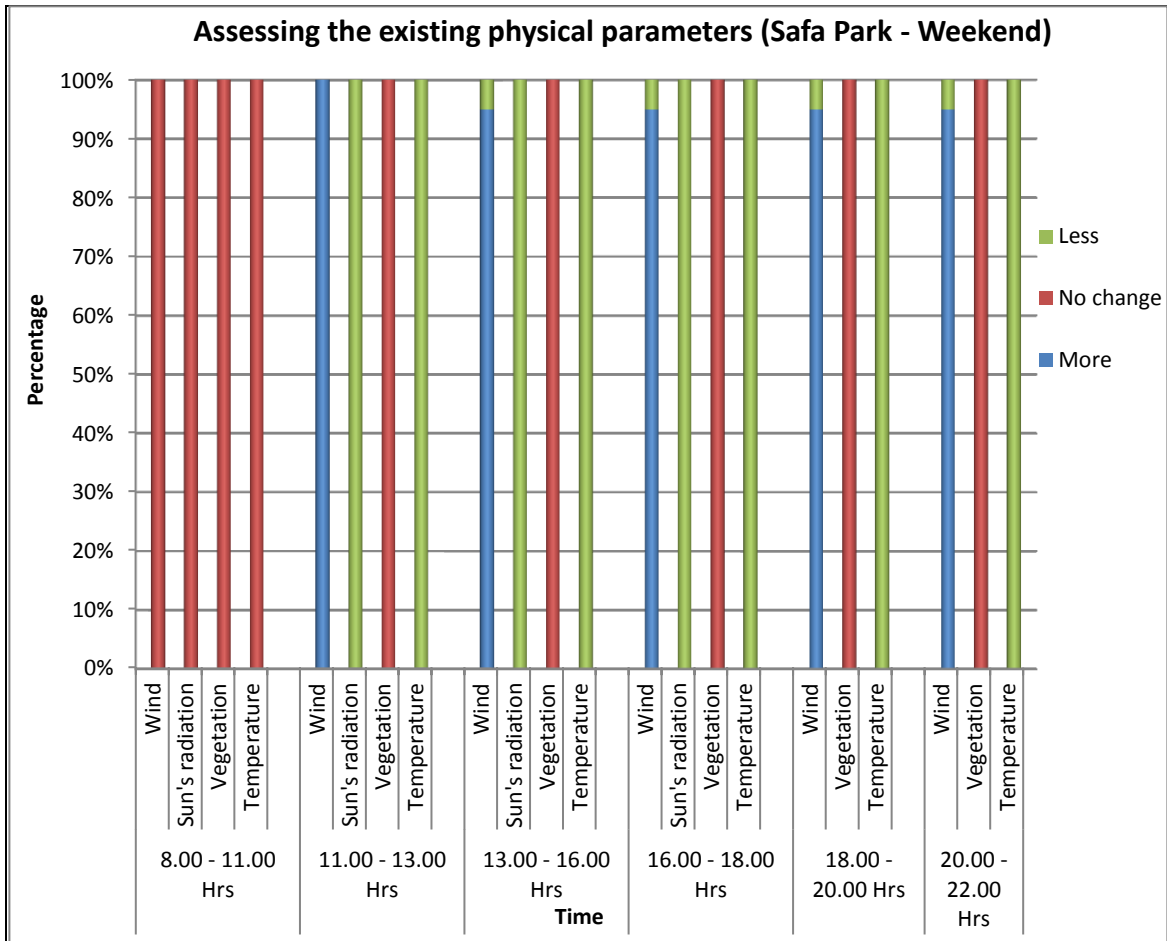


Figure 4.26: Perceptions regarding the present physical parameters (Safa Park – Weekend)

Analysis on the crowd composition in relation to time was done during weekdays and weekends are presented in the Figures 4.27 and 4.28 respectively. The X axis represents the time and the Y axis show the percentages based on the number of visitors. The study reveals that families, mothers, maids and kids formed the main visitors during the period from 17.00 to 19.00 hrs. Throughout the analysis, family includes husband, wife, kids and other relatives. But from 20.00 hrs to 22.00 hrs it was noticed that joggers and adult groups mainly contributed to the crowd in the park. Analysis on the weekend data indicates that joggers and adult groups formed the main components of the crowd particularly during 8.00 to 10.00 hrs and from 20.00 to 21.00 hrs. But at the same time family crowds were more dominant during the periods from 14.00 to 18.00 hrs. It was also noted that international tourists were not observed either during weekday or weekends. So it can be assumed that Safa Park remains a local entertainment area, which has visitors

mostly from the neighborhood locations. Perhaps the changes in the crowd composition at least during weekday have some relation to the kid’s school timings and the office timings of the working population.

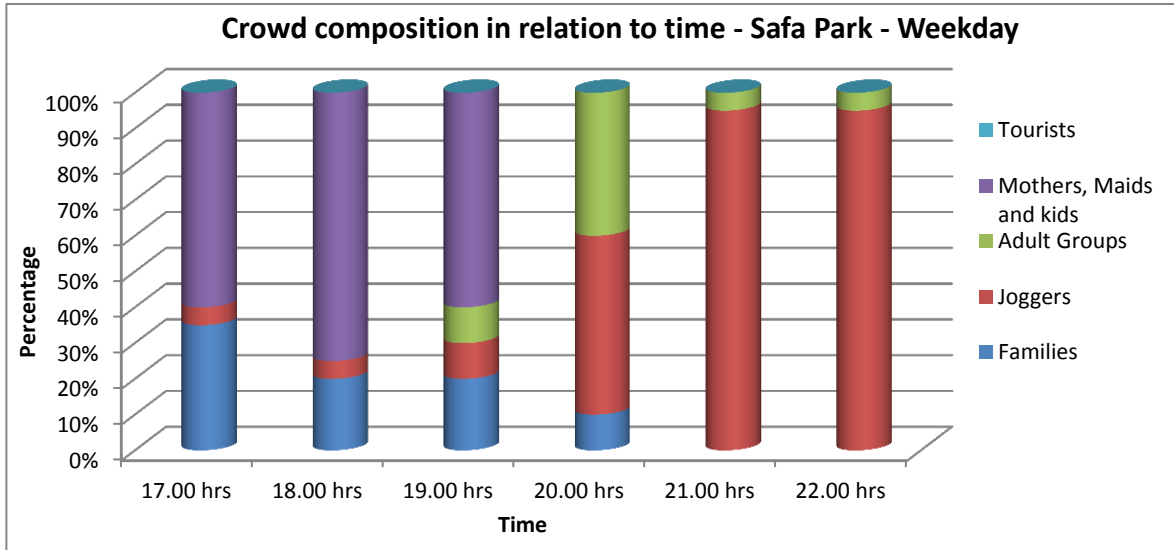


Figure 4.27: Changes in the crowd composition with time (Safa Park – Weekday)

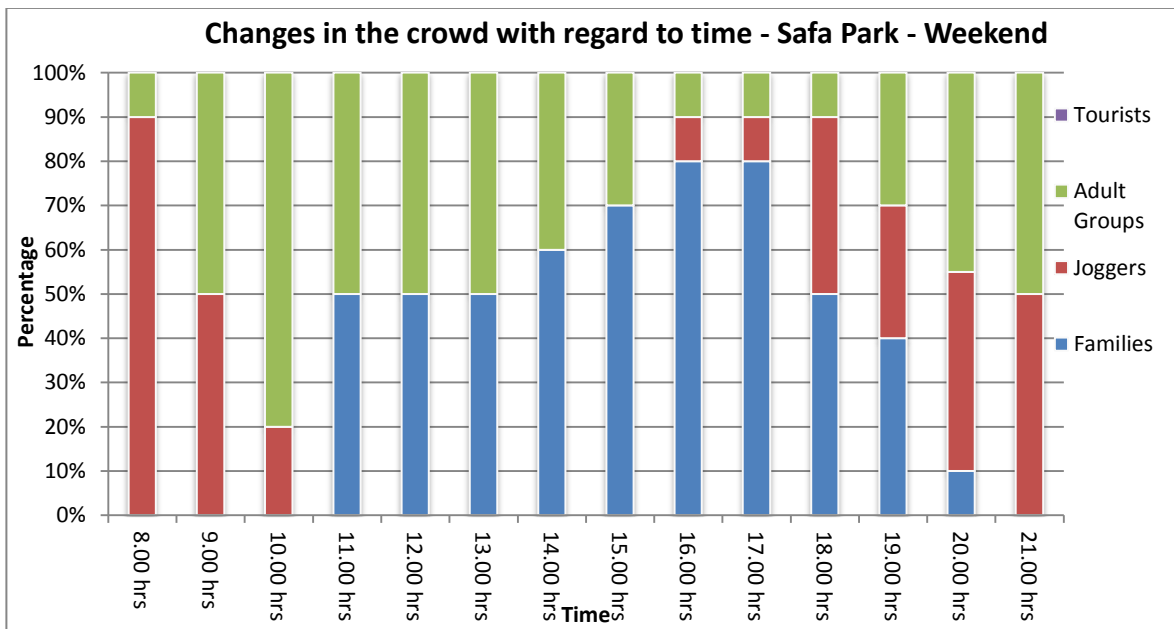


Figure 4.28: Crowd composition in relation to time (Safa Park – Weekend)

Assessments of the comfort levels of individuals in relation to the prevailing weather conditions which were made during weekdays and weekends are given in Figure 4.29 and 4.30 respectively. The X axis indicates the temperature and humidity while the Y axis gives the percentages based on the responses. During weekday it was observed that the respondents were found to be mostly comfortable as the responses were mostly neutral and slightly warm. Neutral responses were obtained when the temperatures ranged between 28.5 and 30°C and the humidity varied between 49 and 51 %. Slightly warm responses were obtained when the temperatures were relatively lower (26.5 to 28°C) and humidity was on the higher side (53 to 60 %). Analysis on the weekend shows that the people were almost comfortable during the surveyed period as the responses were slightly cold and slightly warm. “Slightly cold” responses were obtained when the temperatures varied from 24 to 26.5°C and the humidity values were between 50 and 55 %. The response “slightly warm” was obtained at temperatures as low as 27.25°C and as high as 31.5°C and the humidity varied between 43 and 60 %.

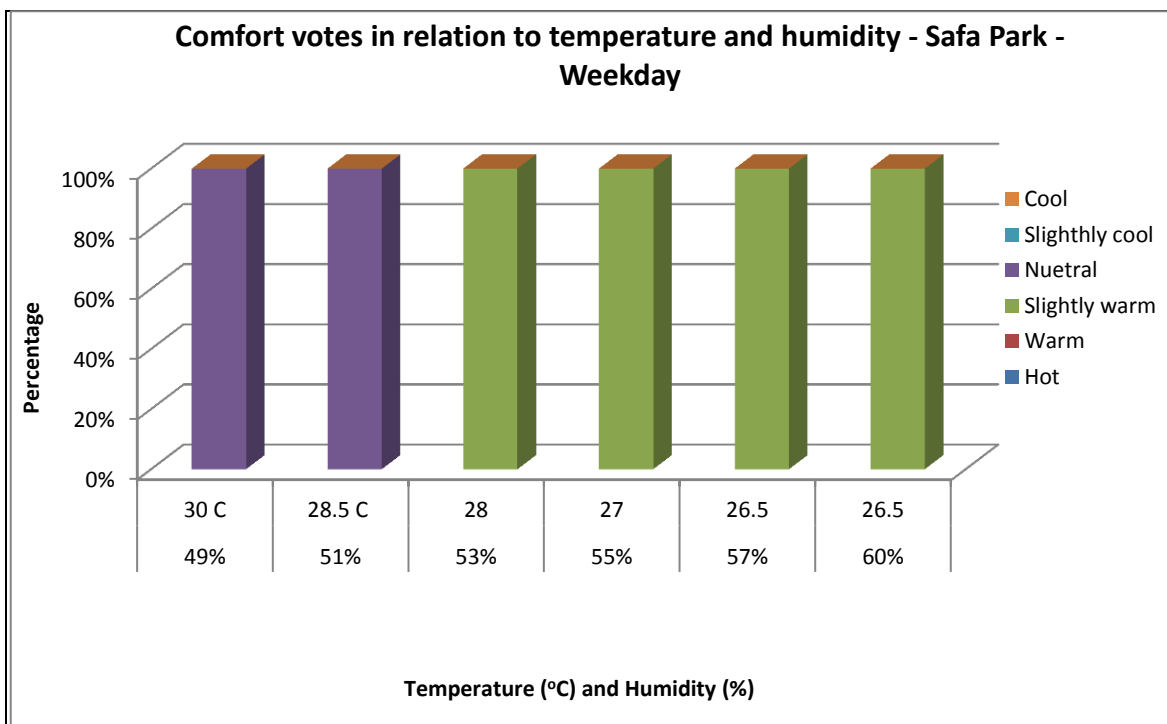


Figure 4.29: Comfort level assessments in relation to temperature and humidity (Safa Park – Weekday)

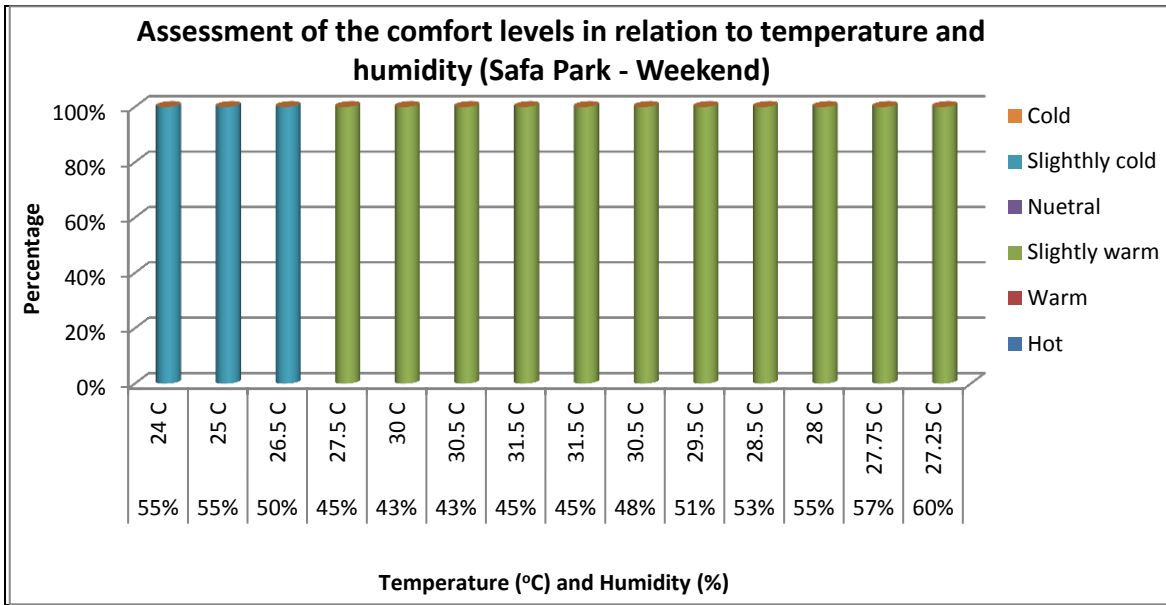


Figure 4.30: Comfort votes, temperature and humidity (Safa Park – Weekend)

#### 4.2.4 Mushrif Park

Relation between temperature, humidity and the number of visitors at Mushrif Park during weekdays and weekends were analyzed and is presented in Figure 4.31 and 4.32 respectively. X axis represents the time and Y axis gives the values of temperature, humidity and number of visitors. It was seen that the crowd volume was relatively low during weekdays and it was seen that the park was more crowded during 17.00 hrs (temperature 32°C and humidity 41 %) 18.00 hrs (temperature 29.5°C and humidity 43 %). While during weekend it was seen that it was more crowded when compared to weekdays. Crowd intensity was more when the temperatures ranged between 30.5 and 31.5°C and the humidity was around 53% (18.00 to 19.00 hrs). Unlike other parks surveyed it was seen that Mushrif Park was less crowded during the afternoon period. This might be due to very high temperatures (around 39°C) with moderate humidity. The surveys were done in the month of November and perhaps people expect much lesser temperatures during these periods as it comes soon after the hot summer periods.

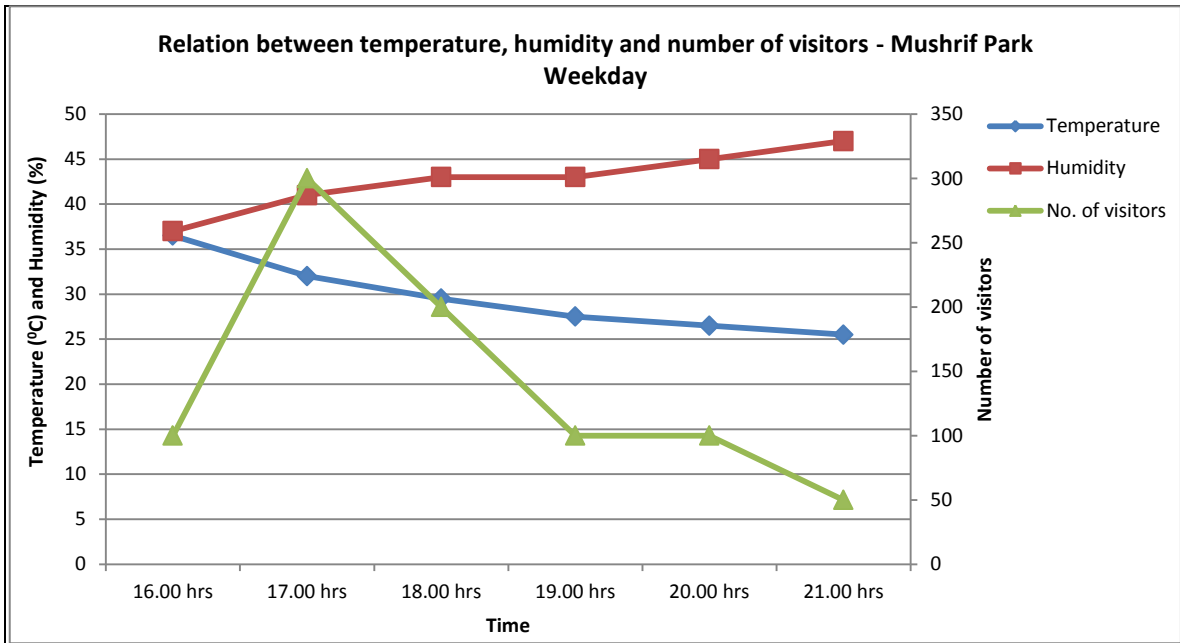


Figure 4.31: Temperature, humidity and number of visitors (Mushrif Park – Weekday)

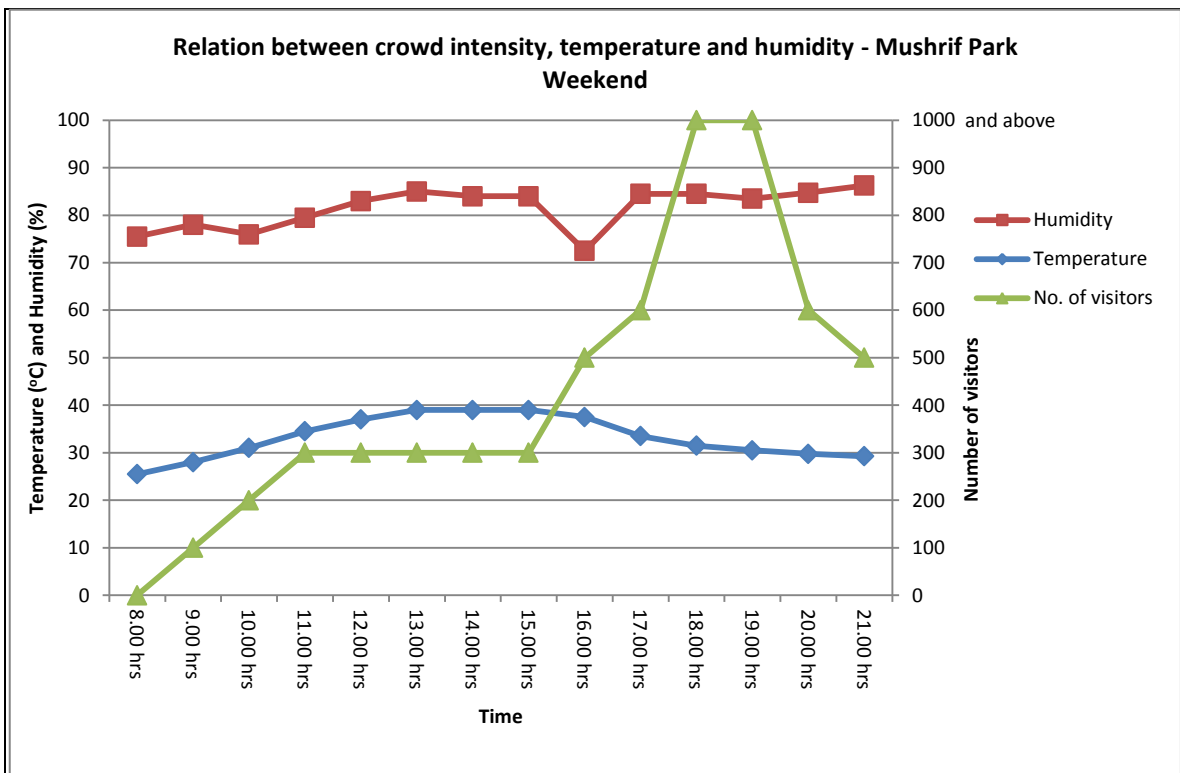


Figure 4.32: Crowd intensity and its relation to temperature and humidity (Mushrif Park – Weekend)



Analysis on the diversity of the visitors based on nationality revealed that there are variations in the type of visitors that are present in the park during weekdays and weekends. It was seen that during weekdays (Figure 4.33) G.C.C (there are dot between G.C.C) Arabs (includes UAE, Saudi and Bahraini) that formed about 30 percent, middle Easterners (Lebanese, Egyptian, Iranian, Turkish) that formed 20 percent and Indians (about 20 %) and Pakistanis (20 %) contributed to the crowd volume. While during weekends (Figure 4.34) Indian and Pakistanis together constituted about 60 % and Middle Easterners and G.C.C Arabs contributed about 35 % of the crowd during those periods.

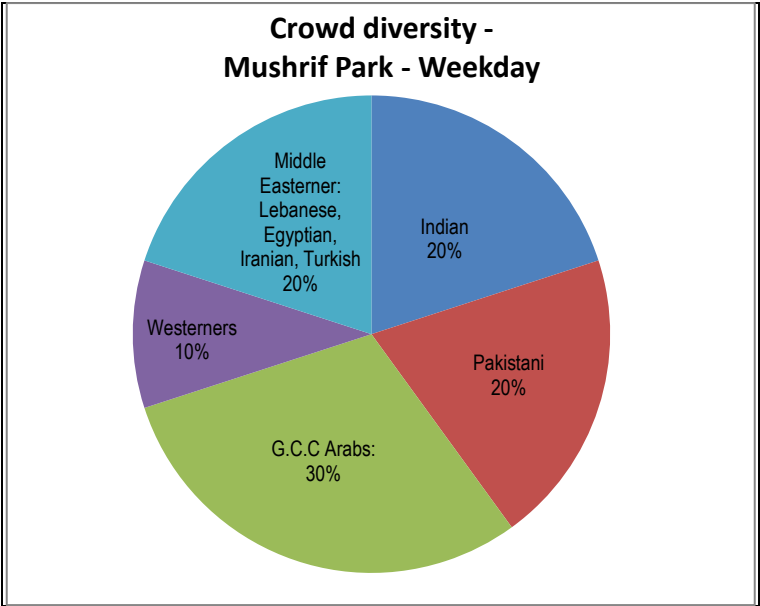


Figure 4.34: Crowd diversity at Mushrif Park during weekend

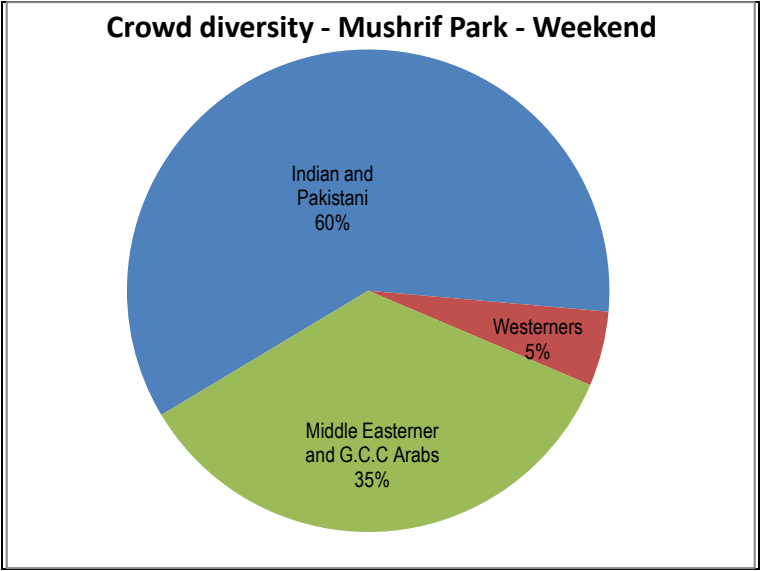


Figure 4.33: Crowd diversity at Mushrif Park during weekday

The perceptions of the visitors in relation to the various physical parameters were analyzed and are presented below. The weekday analysis (Figure 4.35) revealed that majority of the visitors preferred more wind, lower temperatures and no change in vegetation during the time from 16.00 to 22.00hrs. It was also noted that people who wore Abaya (about 40 %) expressed that they do not want any change in the wind during the time period from 16.00 to 18.00 hrs, which can be considered as the role of dressing in altering the perceptions with regard to thermal comfort and other related aspects or perhaps they were concerned about the effect of wind on their clothing. Assessments made during weekends indicates that during morning time (8.00 to 11.00 hrs) all the visitors expressed their satisfaction regarding the weather conditions and they preferred not to have any change in temperature, wind, vegetation and sun’s radiation. During this period the temperature values varied from 25.5 to 34.5°C and humidity ranged between 45 and 50 %. But after 11.00 hrs until 22.00 hrs the visitors expressed their likeness for more wind and lower temperatures. People preferred lesser sun’s radiation and showed likeness for more vegetation until sunset and after sunset the crowd did not express the need for any change in vegetation.

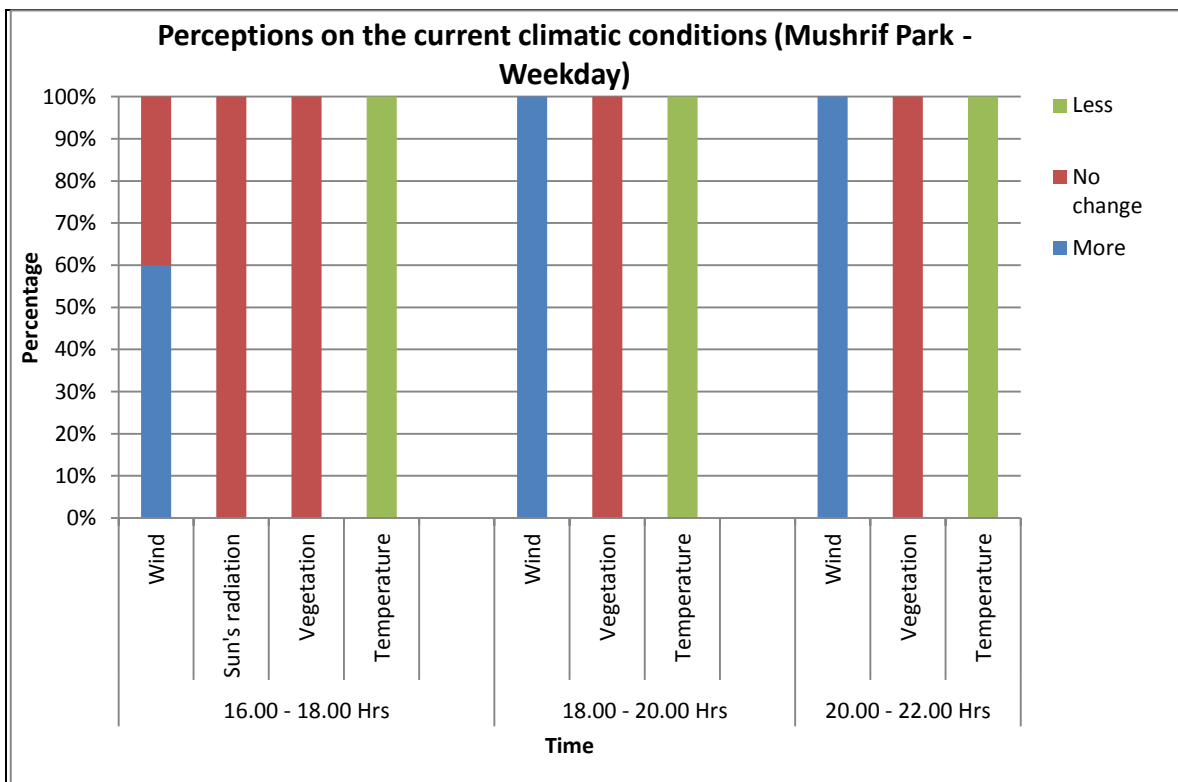


Figure 4.35: Assessments on the prevailing physical conditions (Mushrif Park – Weekday)

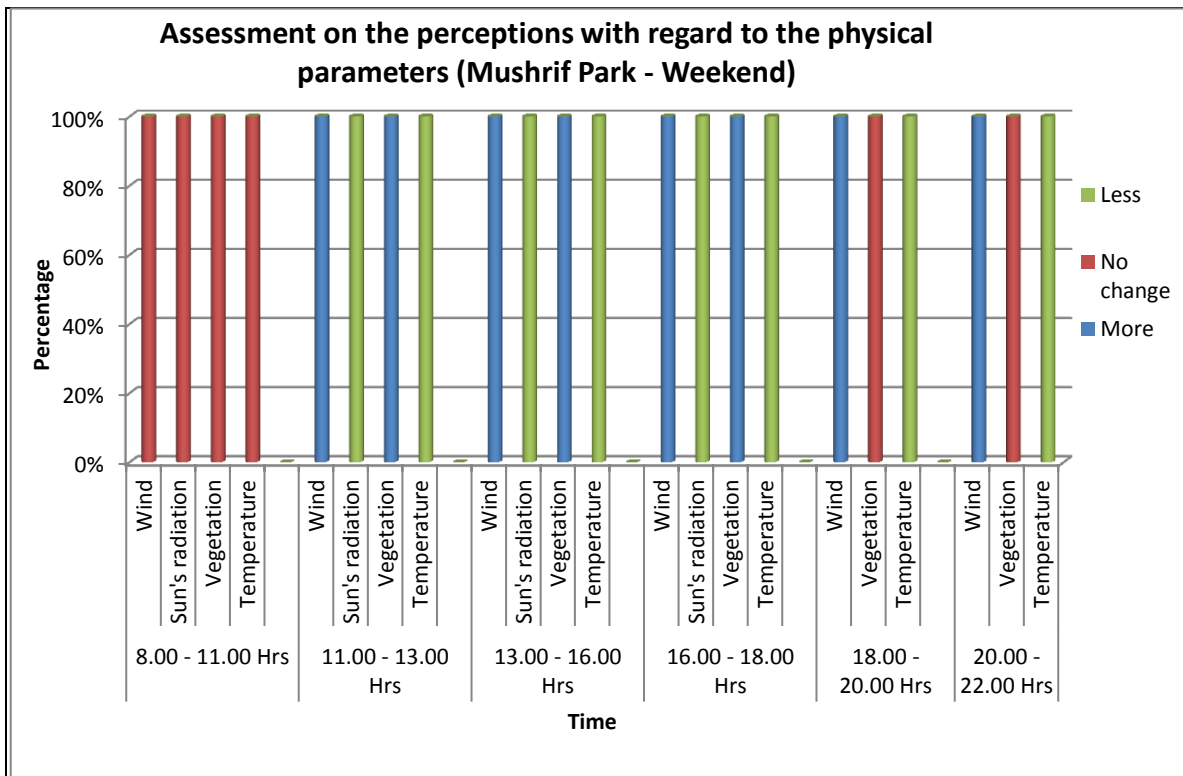


Figure 4.36: Perceptions with regard to the physical parameters (Mushrif Park – Weekend)

The changes in the crowd composition at Mushrif Park was analyzed based on the data collected during weekends and weekdays and is presented below. During weekdays it was noted that there occur some changes in the categories of people who visit the park and these changes were found to have some relation to time (Figure 4.37). It was observed that the families and adult groups formed the major constituent of the visitors in the Park particularly during the time periods from 17.00 – 19.00 hrs. From 20.00 hrs onwards until 22.00 hrs, it was seen that adult groups were more dominant. Perhaps the choice for outdoor location has some relation with time, convenience and purpose. Weekend analysis (Figure 4.38) shows that families and adult groups formed the main component of the crowd at all times. It was seen that families dominated the weekend crowd during majority of time periods (10.00 to 21.00 hrs) except around 9.00 hrs. Perhaps the shaded barbeque zones, grassed picnic areas, huge grassed open spaces for games, lots of greenery, International Village, horse ridding and other entertainment and fitness related options available in the region might attract more people in to the region.

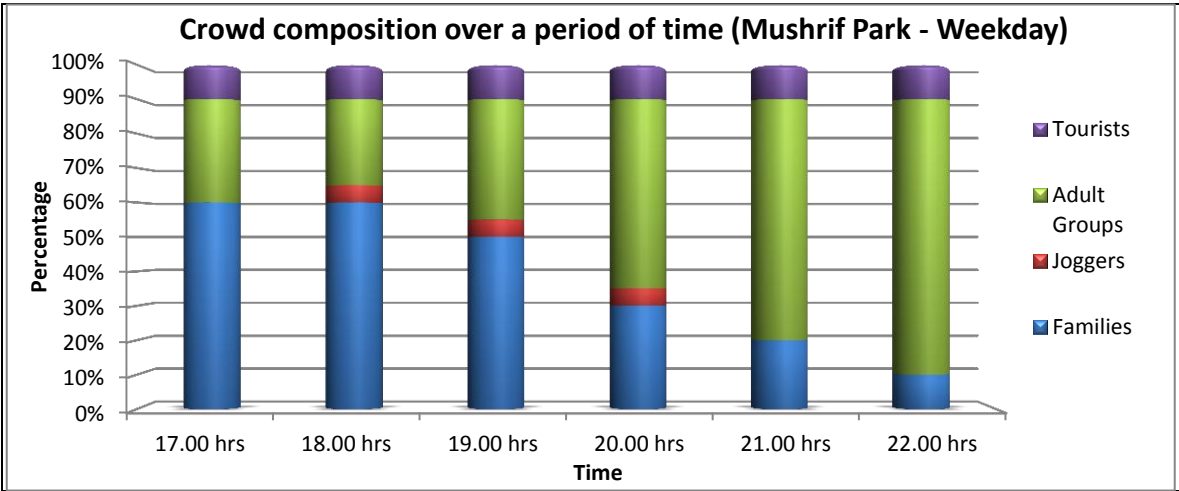


Figure 4.37: Variations in the crowd composition based on time (Mushrif Park – Weekday)

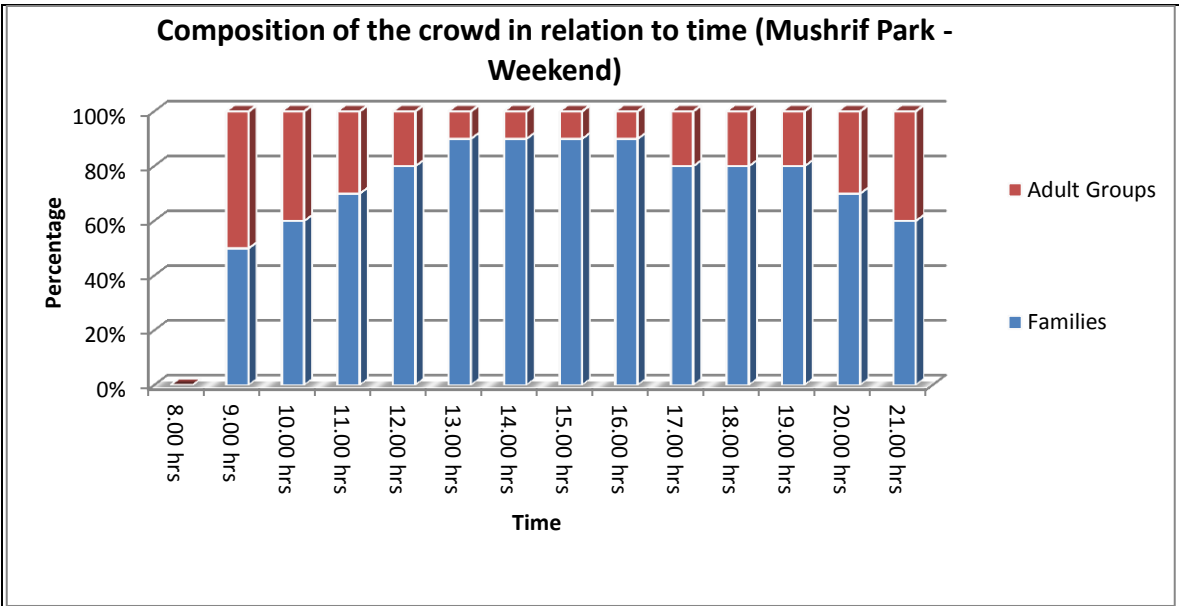


Figure 4.38: Changes in the crowd structure in relation to time (Mushrif Park – Weekend)

The votes related to the comfort levels of individuals were assessed in relation to temperature and humidity and is presented in the Figures 4.39 and 4.40. The analysis during weekdays (Figure 4.39) reveal that majority of the visitors were found to be quite satisfied with the conditions as the responses varied from slightly cold to warm. It is seen that slightly warm responses were present during the times when the temperature varied between 25.5 and 29.5°C and the humidity values varied from 43 to 47 %. At temperatures

around 32 and 36.5°C and with humidity about 37 to 41 % majority of the crowd at the park felt that it was either neutral or slightly cold. Assessments on the weekend (Figure 4.40) data shows that responses like slightly cold were obtained at temperatures around 28 – 31°C and humidity around 45 to 50 %. People were found to be quite uncomfortable with the weather conditions when the temperatures were between 33.5 and 39°C and humidity values were between 43 and 45 %. “Slightly warm” responses were obtained when the temperatures were between 29.25 and 33.5°C and the humidity values appeared between 51 and 57 %. The comfort values at 8.00 hrs when the temperature was around 25.5°C and humidity around 50 % is not available as there were no visitors during that time. Perhaps the people preferred to remain indoors because of lower temperatures and average humidity or it may be due to other reasons for example, timing of the park, culture of people living around the park for example they may not be used to jogging in the morning / or using park very early in the morning.

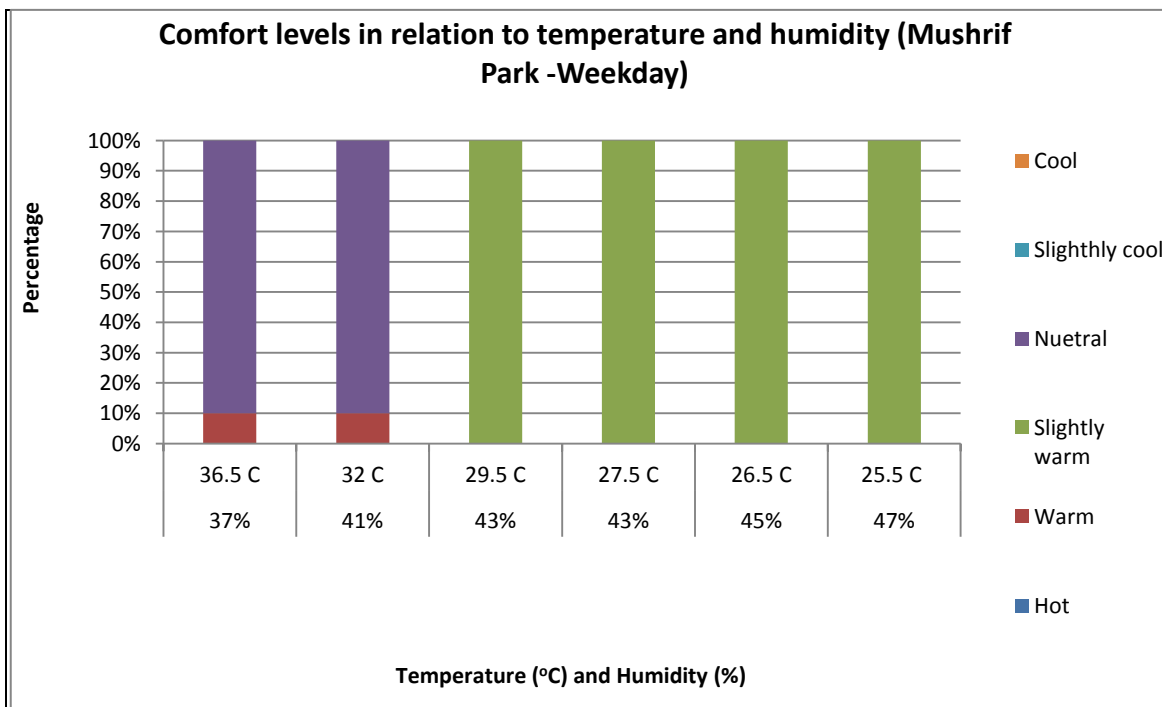


Figure 4.39: Comfort votes in relation to temperature and humidity (Mushrif Park – Weekday from 16.00 to 21.00 hrs)

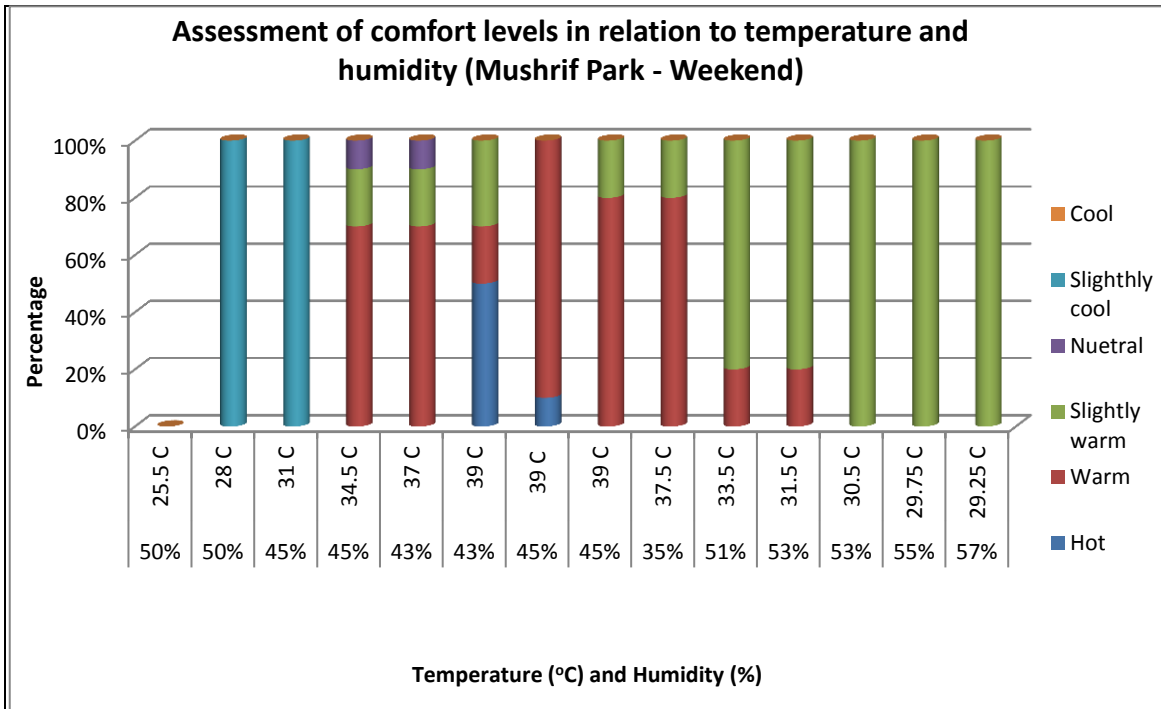


Figure 4.40: Analysis of the comfort levels of individuals in relation to temperature and humidity (Mushrif Park – Weekend from 8.00 to 21.00 hrs )

### 4.2.5 Jumeirah Beach Park

Figures 4.41 and 4.42 give the relation between crowd intensity, temperature and humidity at Jumeirah Beach Park during week day and weekend respectively at various time intervals. The Y axis on the graph shows the values of temperature in (°C), humidity in (%) and number of visitors. The X axis shows the time frame during which the measurement was done. The graph shows that the temperature was relatively stable it was 32°C at 17.00 hrs and decreased after the sunset to 29°C. But the humidity level increased from 55% to 75% from 17.00 hrs to 21.00 hrs. During this time the crowd also decreased and at 21.00 hrs nobody was left in the park. The humidity is high as the park is near to the sea. The crowd who were mostly tourists were more when humidity was at 55% even though the temperature was quite high at 32°C, they were at least 10 people at the beach park but as the humidity increased to 75% even though temperature was stable at 29°C, all the tourists left the park and it was empty. The visitors were either walking or resting on the benches and watching their kids play in the park and a very few were on the shore line.

Their main intention for visiting this park is for enjoying the beach and relaxing. It can be concluded that temperature does not play deterrence to tourists but humidity does affect their behaviour. From the analysis it can be noted that time also is one factor that influences the crowd intensity, which is true in the case of international travelers as well.

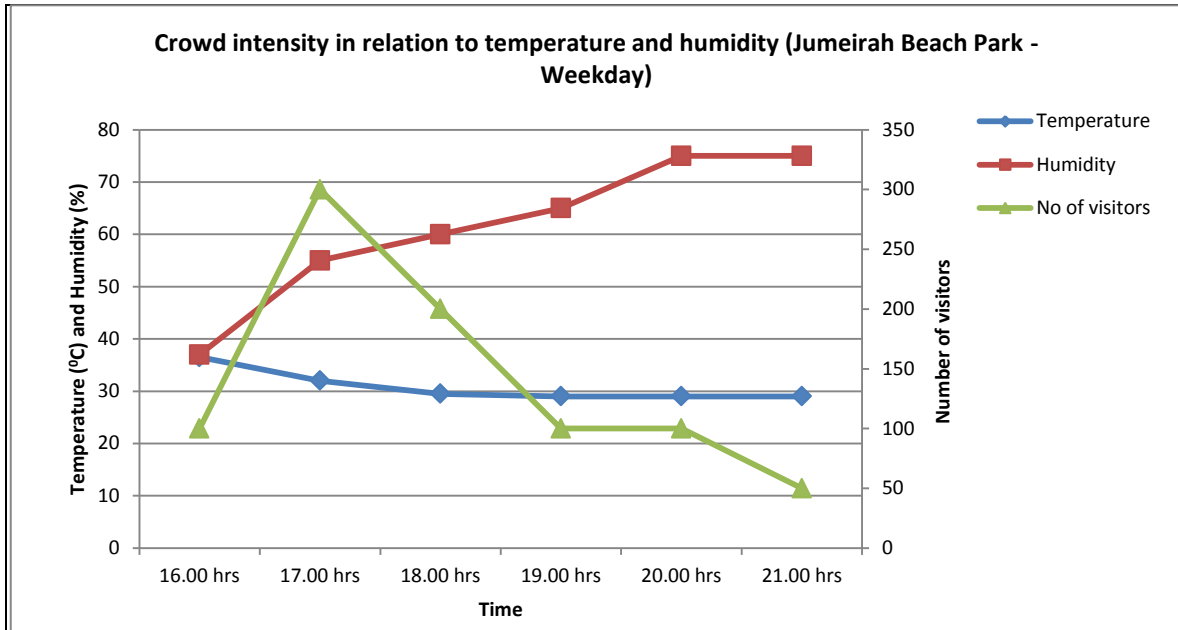


Figure 4.41: Relation between crowd behaviour, temperature and humidity (Jumeirah Beach Park – Weekday)

During weekends the visitors were very high in number during the day time and after the sunset the crowd diminished and at 21.00 hrs nobody was there in the park or at the beach. Visitors were mostly walking around the park, playing games making barbeques, eating, and resting. The maximum average temperature was 37.5°C during that time most of the visitors took shade whereas Filipinos did sweat a lot but they did not mind and continued their activity under sun and all of the visitors had cool drinks. And when the average humidity was lowest at 53%, the number of visitors was also high even during noon time. Humidity fluctuated more from 78% to 53% than temperature and when humidity was high the visitors were less and again when humidity increased to 75%, after the sunset the visitors also left the park and the beach and by 21.00 hrs no one was left. Another point to be noted that Westerners, Filipinos and tourists wore short and light

clothes to make themselves comfortable to high temperature and humidity whereas Pakistanis and middle easterners wore traditional clothes and adapted themselves psychologically rather than physically.

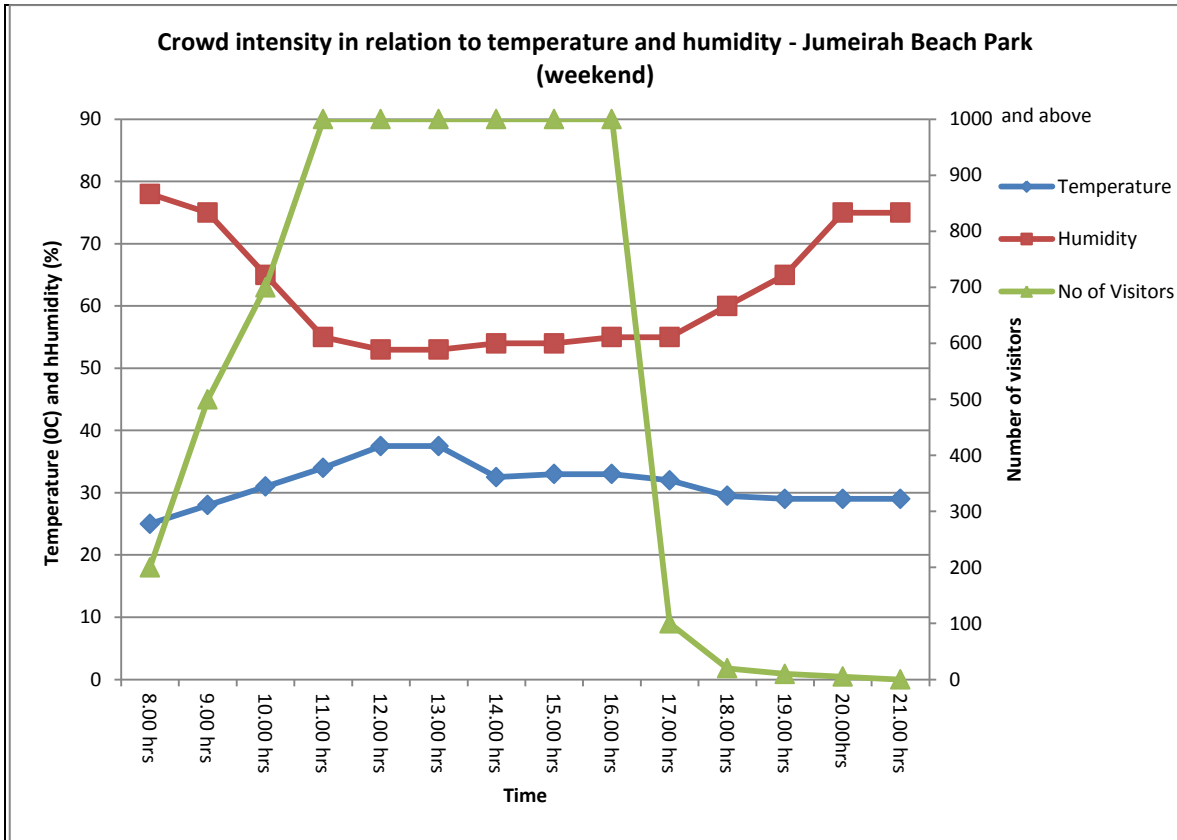


Figure 4.42: Relation between crowd intensity, temperature and humidity (Jumeirah Beach Park – Weekend)

In the graphs the crowd diversity is depicted during the weekday and weekend at the Jumeirah beach park in Figure 43 and 44. During the weekday the park is visited mostly by tourists 90% and only 10% were UAE residents and they were 50% middle easterners comprising of Iranian, Lebanese and Turkish nationality and 50% were westerners comprising of British, Polish, Russian, and American. And there was no Emirati in the park.



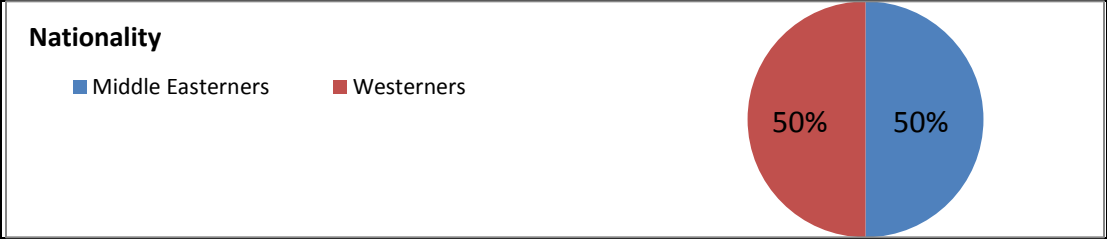


Figure 4.43: Crowd diversity at Jumeirah Beach Park during weekday

The crowd diversity is given for the park and the beach. As shown in Figure 4.44, the crowd at the park is more diverse than compared to weekdays and the park was very busy during the day time. The crowd consists of 60% Filipinos, 20% Westerners comprising of British, Polish, New Zealander, American and Russian, 10% Middle easterners comprising of Lebanese, Syrian, Turkish, Iranian and G.C.C and remaining 10% were Indians and Pakistanis but there was no Emirati in the park or at the beach. It can be noted that Filipinos constituted the majority during the weekend at Jumeirah beach Park. However, at the beach the crowd was not so diverse, which include mostly westerners (50%) and middle easterners (50%) (See Figure 4.45). The westerners were flocking in the beach for enjoying sun and the beach which they were not able to enjoy in their home country due to cold thermal conditions.

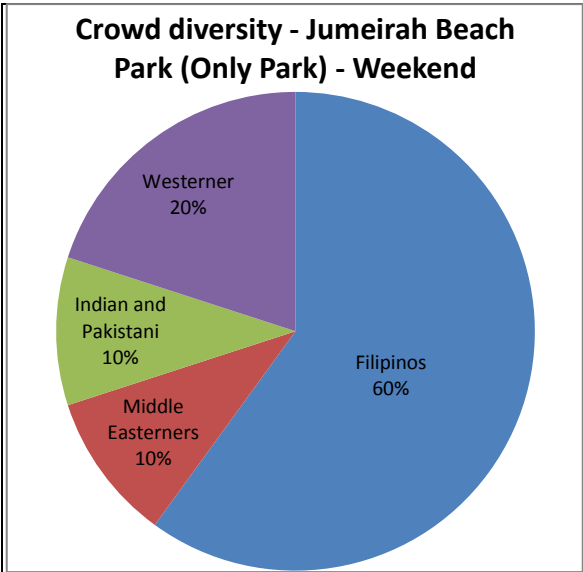


Figure 4.44: Crowd diversity at Jumeirah Beach Park (Only Park) during weekend

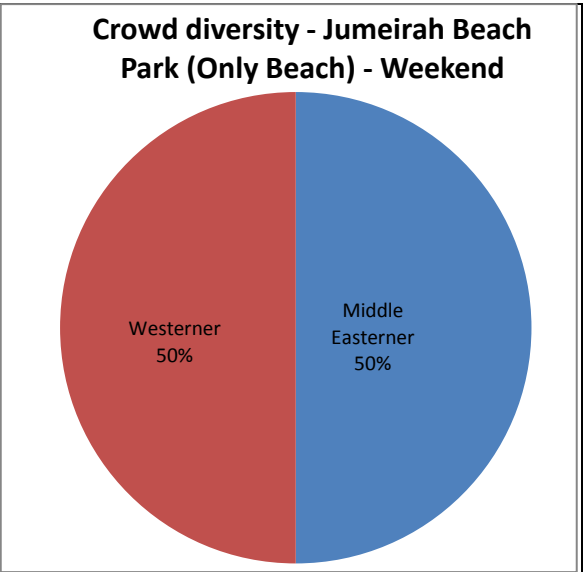


Figure 4.45: Crowd diversity at Jumeirah Beach Park (Only Beach) during weekend

Figure 4.46 shows the comparison between the perceptions of the individuals at Jumeirah Beach Park in relation to the four physical parameters or thermal conditions at around 17.00 – 18.00 hours and 18.00 – 22.00 hrs. X axis represent the physical parameters Temperature, Wind, Sun Radiation and Vegetation and Y axis gives the percentages based on the responses. From the figure it can be analyzed that during 17.00 hrs to 18.00 hrs, 100% of the visitors wanted temperature to be less and 100% wanted more air movement and 100% wanted more sun radiation and 80% more vegetation and only 20% were satisfied with it. During 18.00 hrs to 22.00 hrs after the sunset even though the temperature reduced to 29°C still 100% of the people wanted more reduced temperature, more air movement as the wind movement still reduced to 2.0m/s and 80% wanted more vegetation whereas 20% of them were satisfied with the greenery around them. Due to the relatively hot thermal conditions during 17.00 hrs to 20.00 hrs most of the visitors were resting on the benches, in the shades or seen walking around the park after taking a swim at the beach.

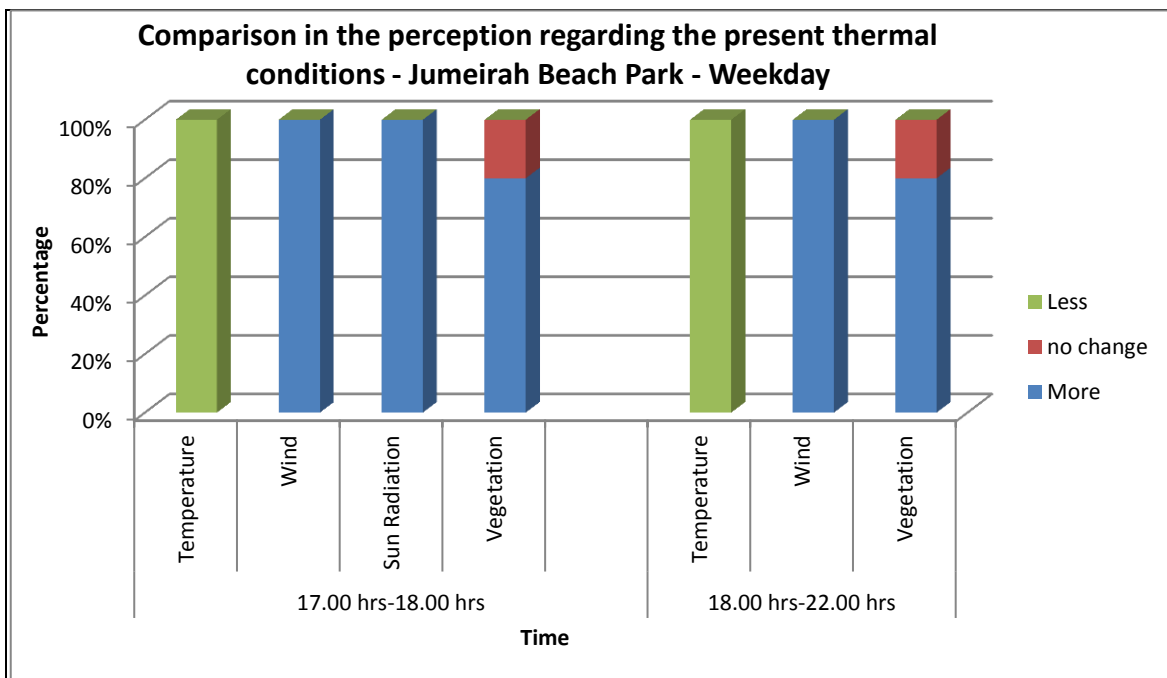


Figure 4.46: Comparing perceptions with regard to the prevailing thermal conditions – (Jumeirah Beach Park – Weekday)

In the Figure 4.47 below, the perceptions regarding the prevailing physical parameters during the weekend are analyzed from 8.00 hrs in the morning to 22.00 hrs in the night. From 8.00 hrs to 18.00 hrs all the people wanted less temperature and less radiation with more wind movement and more vegetation. Even after the sunset 18.00 hrs to 22.00 hrs they wanted less temperature and more wind movement and 50% wanted more vegetation and only 50% were satisfied with the present greenery. It was observed that about 80% were sitting under the trees or under the artificial shades for most of the time and only 20% were walking or playing under the sun. After the sunset, visitors were sitting or walking around the park and drinking something.

The visitors were found to be adapting themselves physiologically, psychologically and physically. Physically by dressing according to the thermal conditions, sitting in the shades and drinking cool drinks. Physiologically, they are acclimatizing themselves with the hot thermal conditions like cooling themselves by swimming before coming to the park. Psychologically, people expectations of the beach with good facilities and blessing breeze, and the restaurant with refreshing food is satisfied as there is lots of greenery and vegetation, secured environment, entertainment for kids and even adults are satisfied with enough shades, benches, refreshing kiosk and even restaurants and cafes. Their expectations matched the experience they had at the park and at the beach. And the beach and the park have naturalness which leads to better psychological adaptations to hot thermal conditions. Greenery also results in better psychological adaptations hence people wanted more greenery 80% during weekdays and 100% during the weekends.

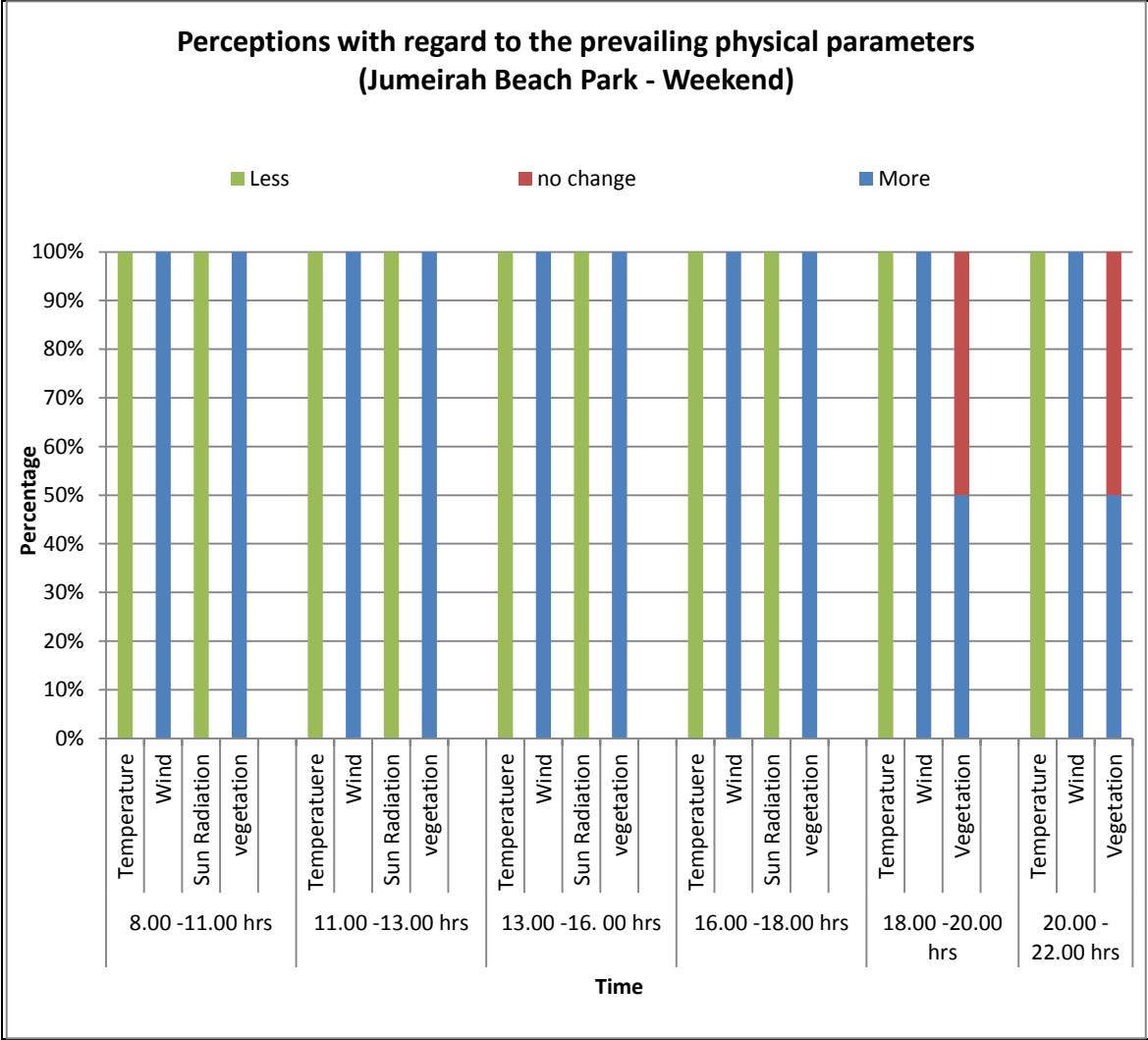


Figure 4.47: Perceptions in relation to the physical conditions (Jumeirah Beach Park – Weekend)

Figure 4.48 shows the changes in the crowd composition at Jumeirah Beach Park during 17.00 hrs to 20.00 hrs as by the time 21.00 hrs the crowd was empty. At 17.00 hrs the crowd composed of mainly international tourists and when the sun set at 18.00 hrs families came to the park and remained for 2 hours till 19.00 hrs and then the park was mostly consisting of adults who were walking around the park. As it was a weekday, families were busy with schools and other works hence their presence is not there at the beach. The beach was almost deserted. As it was noted earlier due to the weekday the visitors are mostly tourists and only one family was in the beach park as at the time of the investigation.

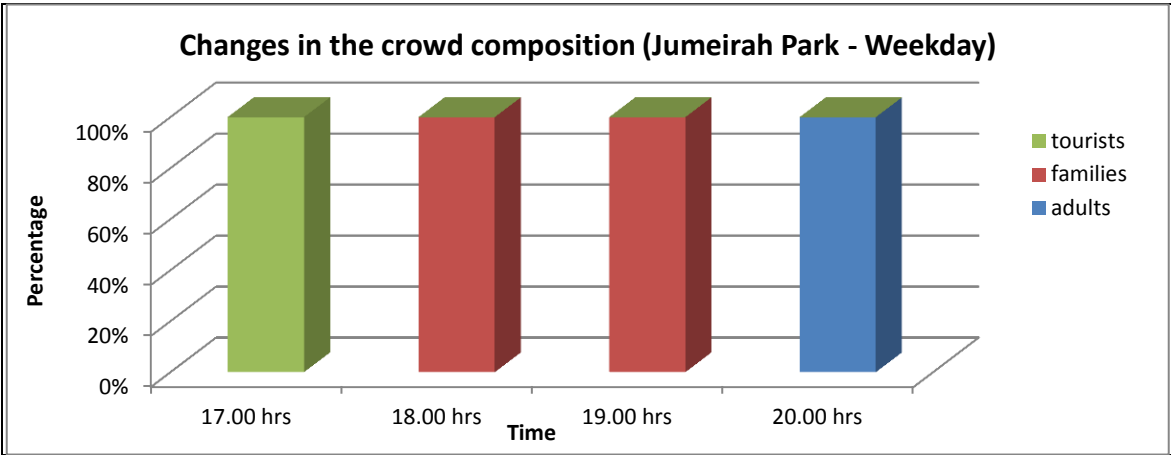


Figure 4.48: Crowd composition in relation to time (Jumeirah Beach Park – Weekday)

Figure 4.49 shows the crowd composition in relation to time from 8.00 hrs to 20.00 hrs during the weekend at Jumeirah Beach Park. In the morning hours 8.00 and 9.00 hrs the crowd was composed of adults with 50% male and 50% female and majority were tourists. From 10.00 hrs till sunset at 18.00 hrs families started coming in and the crowd composed of 50% families and 50% adults as it is a weekend families came for entertainment for kids at the beach and the park. After the sunset again the crowd composed of only adults who were walking, eating and drinking at the park.

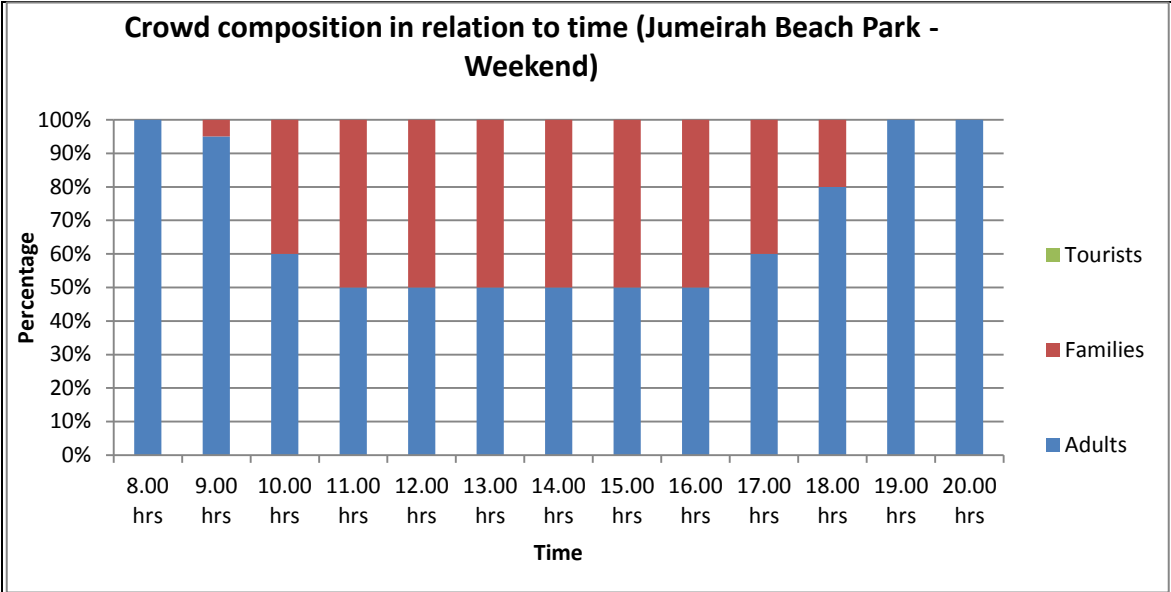


Figure 4.49: Crowd composition in relation to time (Jumeirah Beach Park – Weekend)

Figure 4.50 shows the relation between the physical parameters temperature and humidity with respect to the perception of comfort level during 17.00 hrs to 21.00 hrs in Jumeirah Beach Park in weekdays. It can be noted that temperature was stable and from average maximum of 32.5°C it decreased a little to 29°C but humidity fluctuated from 55% to 75% and it was more after the sunset. Despite of all this all of the visitors responded that their comfort level is neutral and adapting themselves physically with comfortable clothes to the hot thermal conditions. The below Figure 4.51 shows the relation between the physical parameter temperature and humidity with respect to the perception of comfort level during 8.00 hrs to 21.00 hrs in Jumeirah Beach Park in weekend. During the daytime from 8.00 hrs to 18.00 hrs the humidity decreased from 78% to 53% and temperature increased from 25°C to 37.5°C maximum, during this time 50% of the responded that they felt slightly warm and 50% felt warm, hence they took physical adaptations like sitting in the shade and as their comfort level was low they wanted more vegetation to psychologically adapt themselves to the hot thermal conditions. After the sunset from 18.00 hrs to 21.00 hrs the temperature dipped to 29°C and humidity increased to 75% all of the respondents were neutral to the comfort level and by 21.00 all of the visitors left the park. It can be analyzed that visitors comfort level was not much affected by the change in temperature or humidity as they adapting themselves physically, physiologically and psychologically but they wanted cooler temperature, more wind movement and less sun radiation to attain high level of comforts.

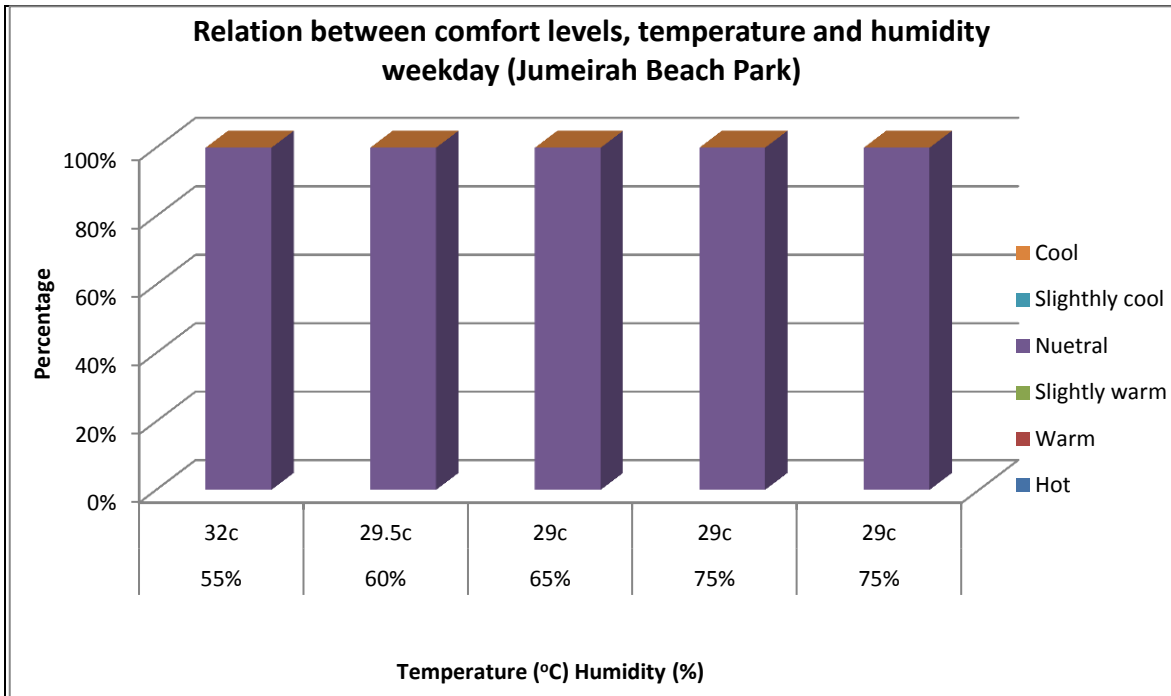


Figure 4.50: Relation between comfort levels, temperature and humidity (Jumeirah Beach Park – Weekday)

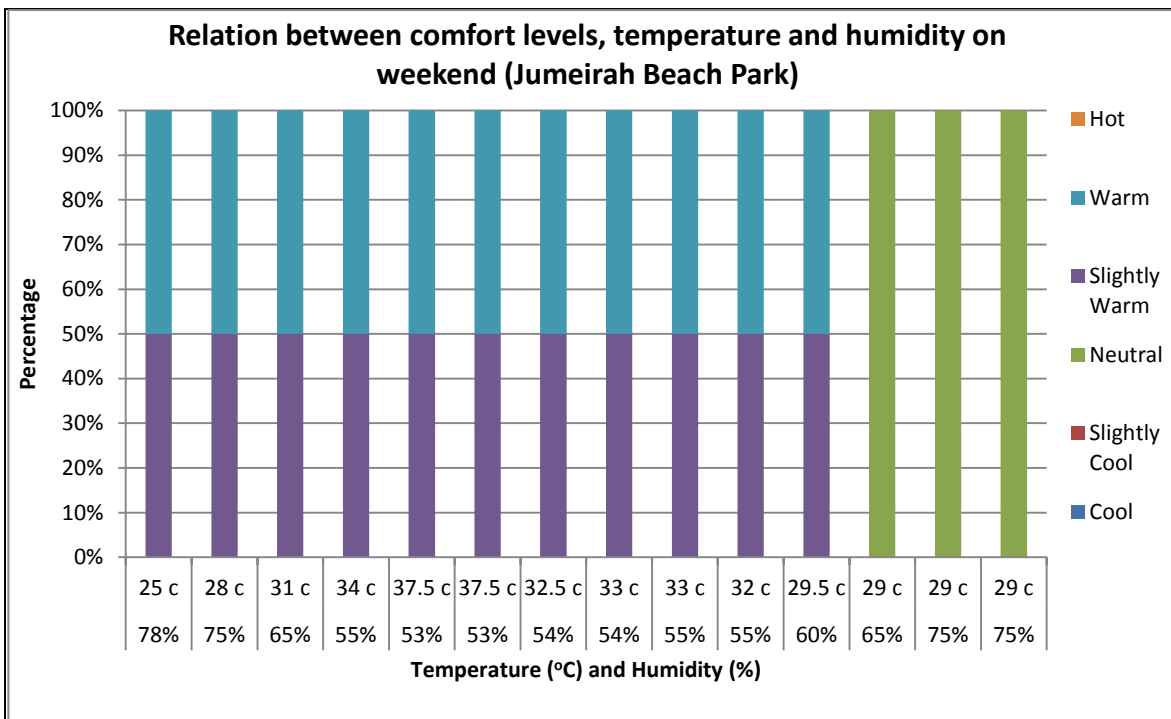


Figure 4.51: Relation between Comfort levels, temperature and humidity (Jumeirah Beach Park – Weekend)

### 4.2.6 Al Mumzar Beach Park

The Figures 4.52 and 4.53, shows the relationship between temperature, humidity and crowd intensity, during the weekday and weekend, in Al Mumzar Beach Park from 16.00 hrs to 21.00 hrs. The temperature decreased from 37.5°c and remained stable at 29°c but humidity increased from 50% to 75% during that time. The crowd intensity showed an inverse relationship with humidity, first the crowd increased from 100 to 300 at 19.00 hrs but by 21.00 hrs it decreased to just 5 people as the humidity was 75%. As it was a weekday time also played an important role in effecting crowd intensity. They were seen walking or resting on the benches, mostly had sun bath or did swim before coming to the greenery zone, there were enjoying on the shore line and some doing sport activities. As they were feeling hot, 50% of them had cool drinks. Visitor's appearance was according to their culture.

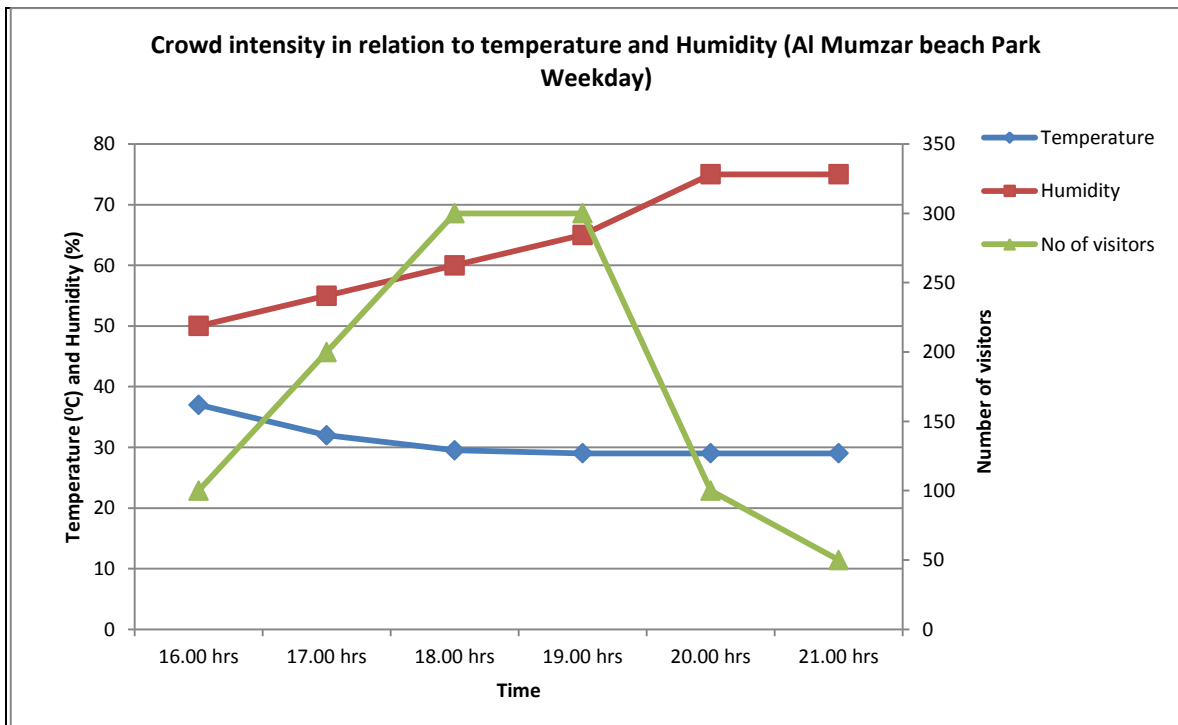


Figure 4.52: Relation between crowd behaviour, temperature and humidity (Al Mumzar Beach Park – Weekday)

During weekends, the park is very busy with about more than 1000 visitors. The temperature fluctuated from reached 37.5°c and then remained stable at 29°c and the



humidity decreased from 78% to 53% during the noon time and was stable, after sunset it roused again to 75%. During the noon time when humidity decreased it can be observed that the number of visitors were at the highest but as the temperature was high they were feeling hot and were resting with very less activities under the shade of trees or artificial shades, but some did not mind barbequing even when sweating and only 20% of them were walking or playing under the sun, 100% of them had cool drink. After the sunset, the visitors decreased and at 22.00 hrs the park and the beach were empty.

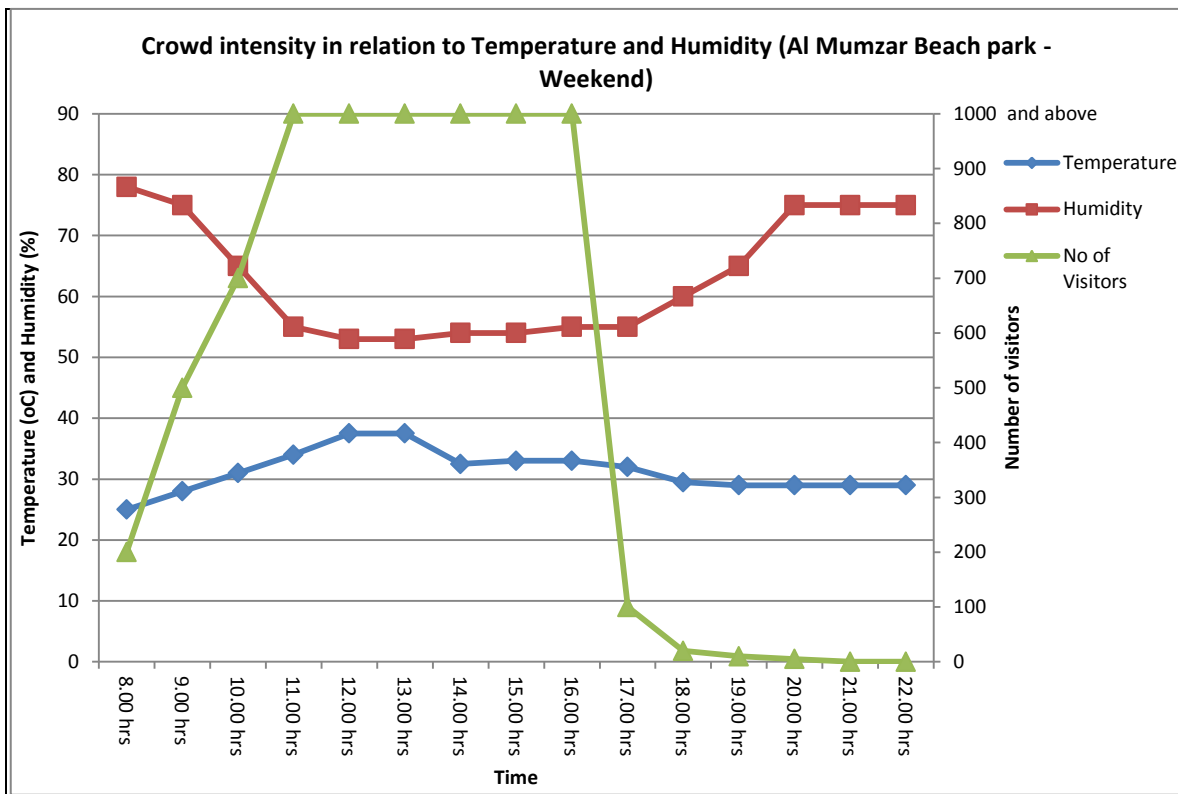


Figure 4.53: Relation between crowd intensity, temperature and humidity (Al Mumzar Beach Park – Weekend)

In the Figures 4.54, 4.56 and 4.57 show the crowd diversity in Al Mumzar Beach park on weekday and weekend separately. During the weekdays, the crowd consisted of 40% of Indians, 20% Pakistanis and 20% G.C.C. Arab nationals which includes Emirati, Saudi and Bahraini's, 10% Middle Easterner which consists of Lebanese, Egyptian, Iranians and Turkish, 5% were Filipinos and 5% were Westerners namely British, Russians, Polish and Americans. Figure 4.55 shows the changes in crowd diversity over

time. Indians remain majority all the time, however G.C.C. nationals were more before sunset and Middle Easterners and Pakistanis were more about 25% and 20% after sunset and Filipinos were there only in the morning hours and westerners were constant over the time and majority were tourists.

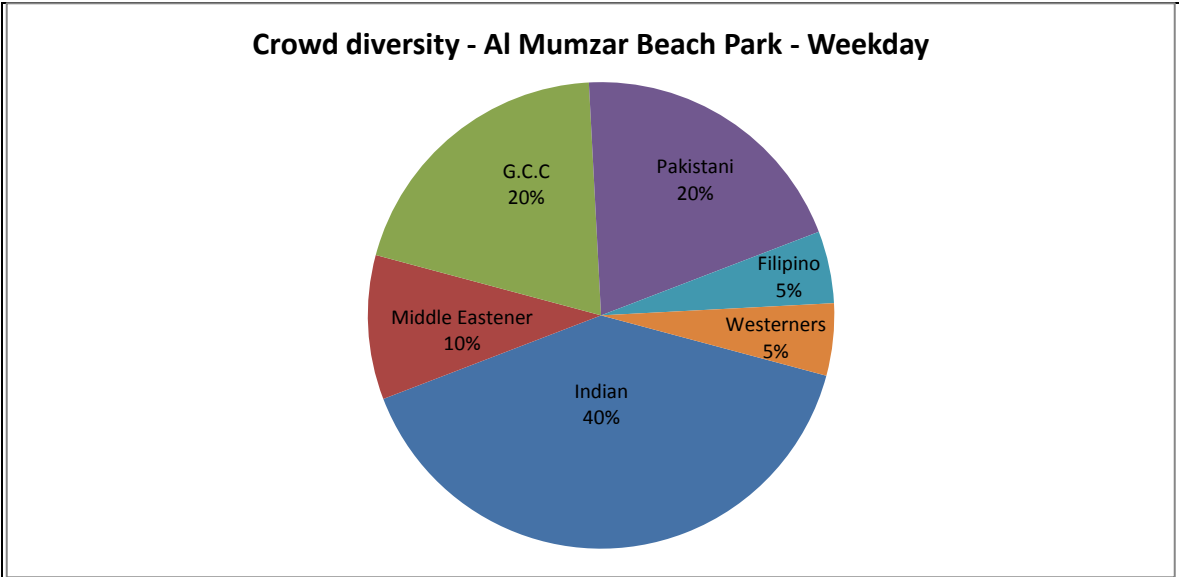


Figure 4.54: Crowd diversity (Al Mumzar Beach Park – Weekday)

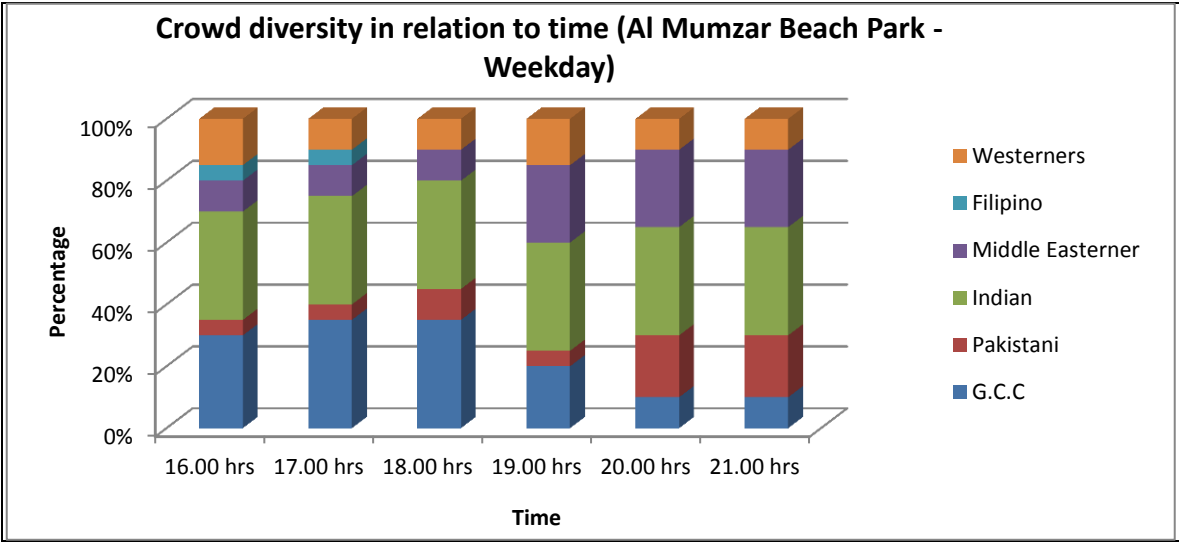


Figure 4.55: Changes in the crowd diversity over time during weekday in (Al Mumzar Beach Park – Weekday)

The crowd diversity at the park, during the weekends had 50% of Indian and Pakistanis, 20% Middle Easterners composing of Lebanese, Syrian, Turkish, Iranian , Emirati, Saudi Bahraini's and other G.C.C. nationals, 20% of Westerners composing of British, Polish, New Zealander, American, Russian and French as depicted in Figure 4.56. Figure 4.57 shows the crowd diversity at the beach during weekends and it had 50% westerners and 50% middle easterners. The crowd during weekends was mostly neighbors and residents of UAE, the tourists were only 10% of the crowd.

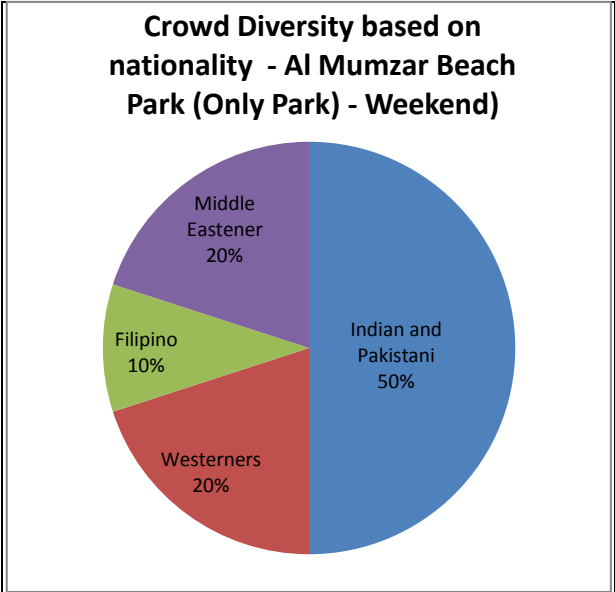


Figure 4.56: Crowd diversity – Al Mumzar Beach Park (Only Park) during Weekend

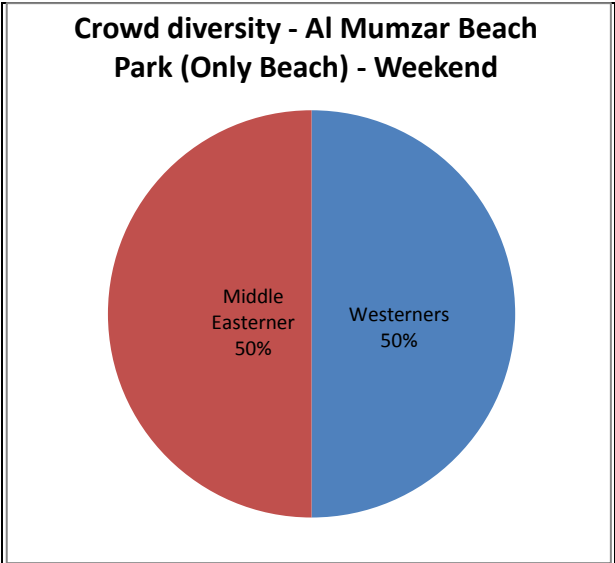


Figure 4.57: Crowd diversity – Al Mumzar Beach Park (Only Beach) during Weekend.

Figure 4.58 shows perceptions of visitors in terms of temperature, humidity, sun radiation and vegetation during weekday. It is clear that all visitors want more sun radiation and more wind movement but cooler temperature. 90% of them are satisfied with the greenery as Al Mumzar Beach Park has good vegetation and only 10% want more vegetation.

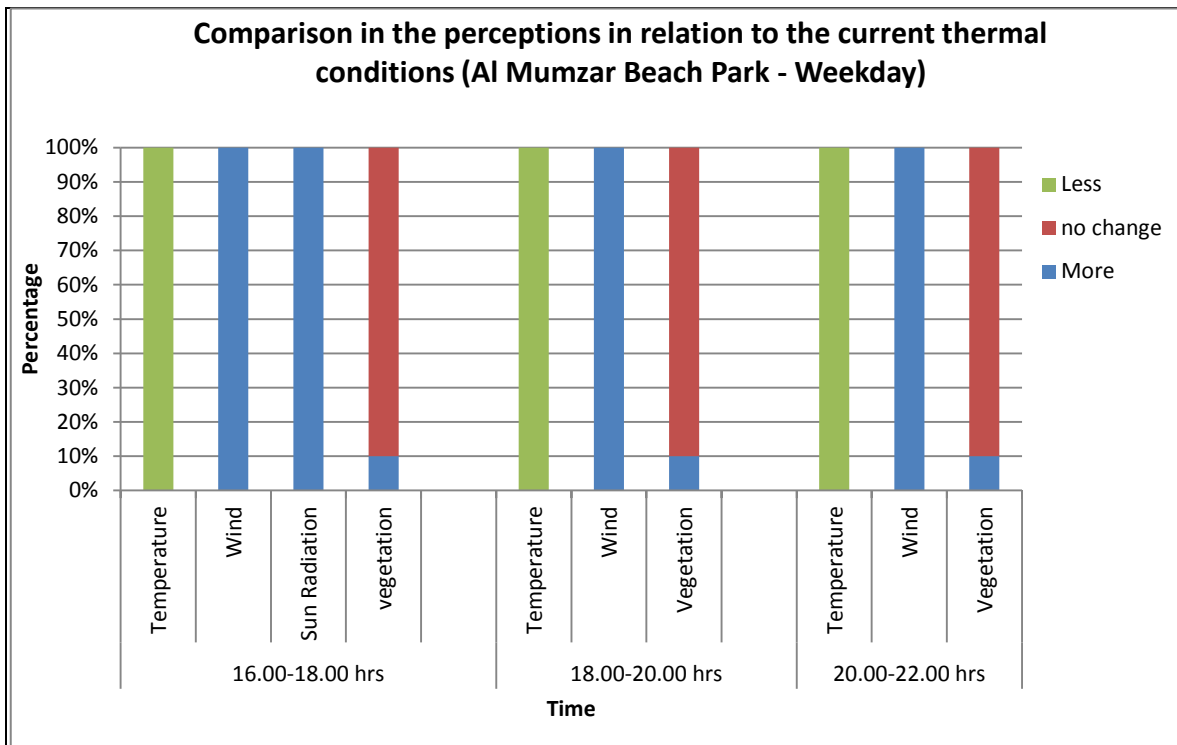


Figure 4.58: Comparing perceptions with regard to the prevailing thermal conditions (Al Mumzar Beach Park – Weekday)

Figure 4.59 shows the perceptions with regard to the prevailing thermal conditions during weekends at various time intervals. It is clear from the graph that all of them want less temperature and less sun radiation but more wind movement and more vegetation and their perception did not change during the day. One major point to be noted is that all of them wanted more vegetation but when compared to weekday only 10% wanted more vegetation. This might be because their thermal comfort is low as compared to the visitors during weekday.

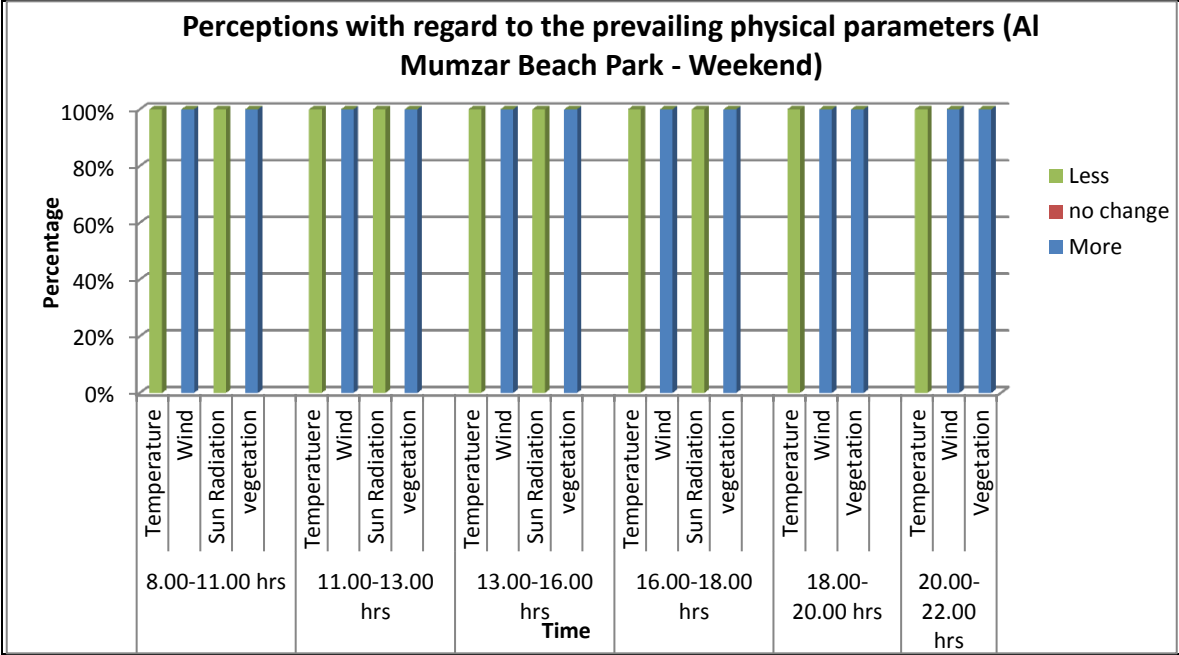


Figure 4.59: Perceptions in relation to the physical conditions (Al Mumzar Beach Park – Weekend)

Figure 4.60 shows the crowd composition in relation to time during 16.00 hrs to 21.00 hrs on weekday. Before sunset till 18.00 hrs it consisted of mostly mothers, maid and kids about 50% and adults and athletes were 20% and only 10% of families with kids but as the time passed mother and kids and families percentage increased while that of adults and athletes decreased. However, after sunset adults and athletes percentage was 40-50% and families and mother and kids decreased and at 21.00 hrs no families can be seen in the park. As this park has good sporting facilities, good vegetation, large number of trees, kid's playground and the restaurant with refreshing food there were, quite a lot of adult and athletic visitors and their main intention of visiting this park is entertainment, fitness and games related.

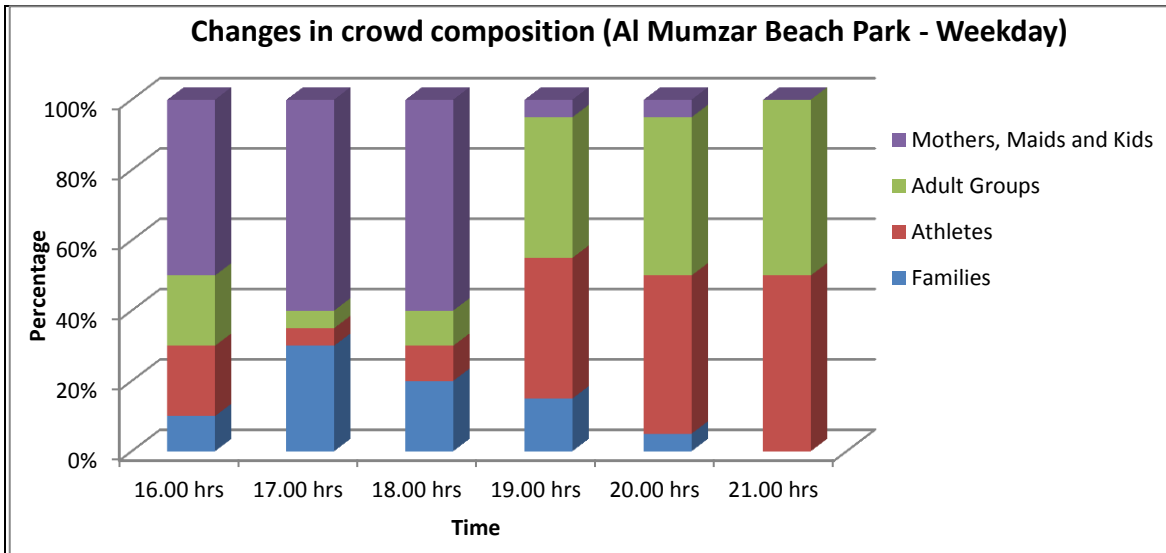


Figure 4.60: Crowd composition in relation to time (Al Mumzar Beach Park – Weekday)

Figure 4.61 shows the crowd composition during weekends. The number of visitors were more during weekends. In the morning hours athletes were about 80% with majority of them being tourists. They were just resting under the shade and preparing for barbequing. However at the noon time the crowd composition changed to 60% families with kids during the noon time and 40% were adults. They were either walking, going to the beach, playing games, barbequing, eating and resting. At 16.00 hrs the crowd included athletes also and 40% of tourists among them and they were resting or playing under the sun and at the beach. After sunset again the crowd composition changed and it included athletes and adult groups with families decreasing and at 21.00 hrs there were no families present in the park. The adult groups were playing games, eating, jogging, chatting, relaxing, and entertaining themselves inside the park.

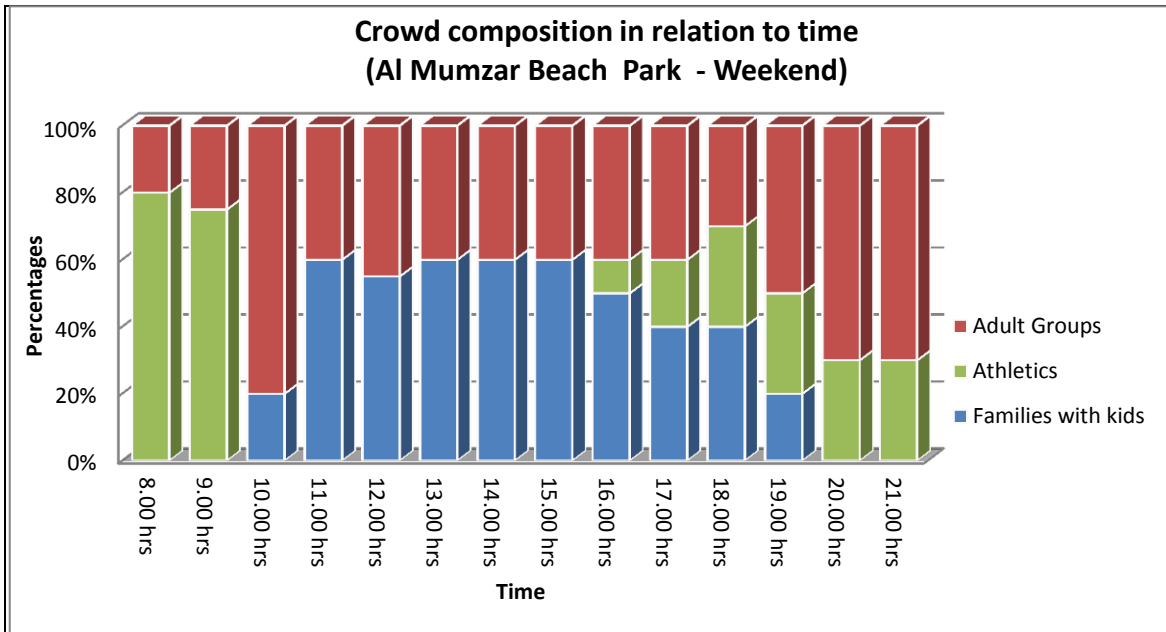


Figure 4.61: Crowd composition in relation to time (Al Mumzar Beach Park – Weekend)

Figure 4.62 shows the relationship between thermal comfort levels, temperature and humidity during weekday at Al Mumzar Beach Park. From the figure it can be said that thermal comfort level of visitors remained neutral even with decreasing temperature and increasing humidity. The reason for the comfort level being neutral because visitors were adjusting themselves physically, physiologically and psychologically and as the number of visitors were less they were able to do so.

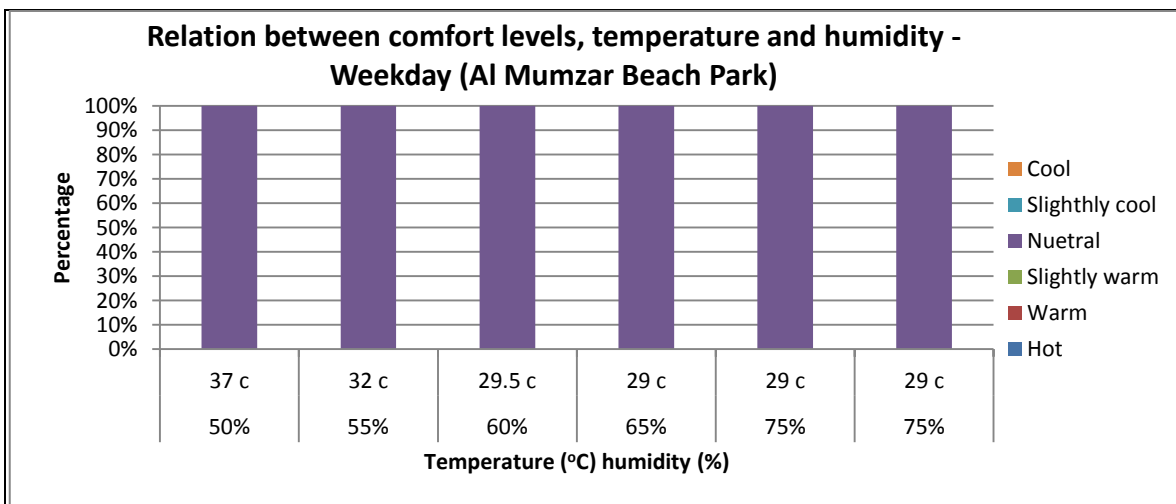


Figure 4.62: Relation between comfort levels, temperature and humidity (Al Mumzar Beach Park – Weekday)

In the Figure 4.63, the relationship between thermal comfort level, temperature and humidity during weekends which is direct with temperature and much affected by humidity during daytime but directly related after sunset when temperature was low and stable. As the temperature was low at 25°C and high humidity of 78%, 50% of visitors were feeling slightly warm and neutral. But when temperature increased to 37.5°C, 50% visitors were feeling hot or warm. As the temperature and humidity decreased, about 50% felt hot, 25% felt either warm or slightly warm. But after sunset the temperature decreased further and humidity was relatively low at that time most of them (about 70%) felt neutral and 30% felt slightly warm. But as the humidity increased, all the visitors felt slightly warm.

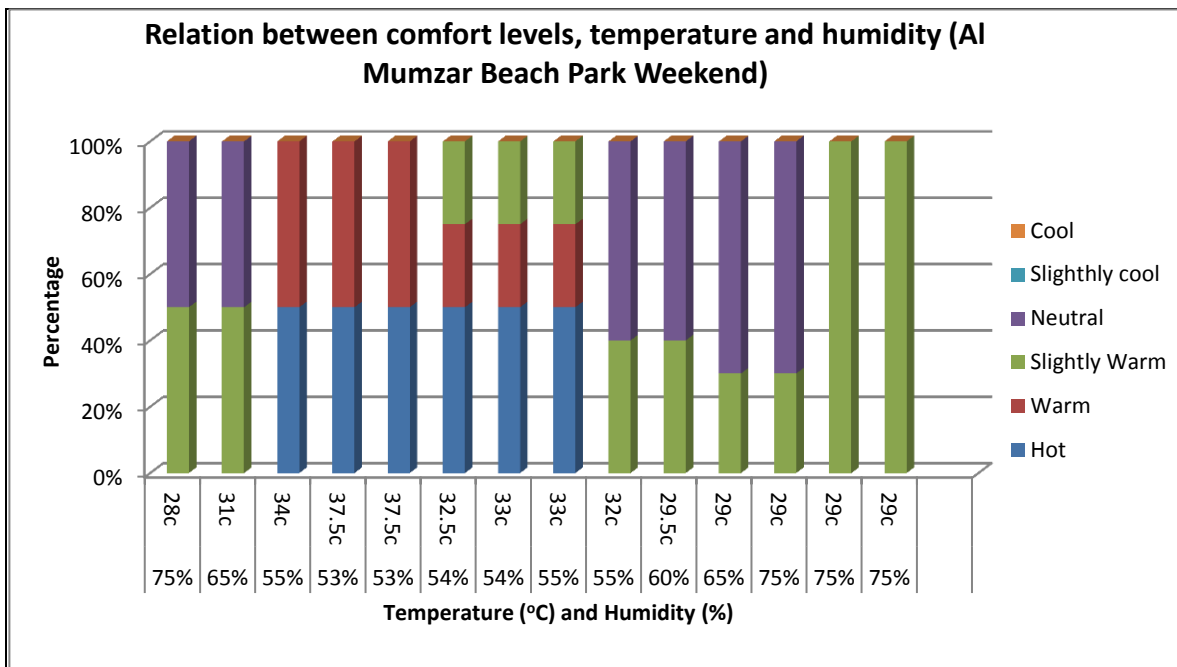


Figure 4.63: Relation between Comfort levels, temperature and humidity on Weekend (AI Mumzar Beach Park – Weekend)

#### 4.2.6 JBR Walk

Crowd intensity at JBR Walk was analyzed in relation to temperature and humidity both during weekdays and weekends at different time intervals and is presented in the Figures 4.64 and 4.65 respectively. In the figures, the X axis gives the time during which the measurements were taken and Y axis indicate the values of temperature (°C), humidity



(%) and the number of visitors. The analysis shows that the JBR walkway was crowded from 16.00 hrs to 21.00 hrs during weekdays and from morning (10.00 hrs) until night (21.00 hrs) during weekends. Such a phenomenon was not observed in any of the six parks that were analyzed during the study. The reason for high crowd intensity for such long hours might be because the walkway has lot of shaded areas as there are many skyscrapers around JBR. In addition to that there are many hotels near this location, which are preferred by tourists. During weekdays though there was no variation in the crowd intensity during the time from 16.00 to 21.00 hrs, temperature varied between 24.5 and 26°C and variations in humidity were from 40 to 57 %. While during weekends the crowd intensity was relatively less during 8.00 to around 10.00 hrs, but from 10.00 hrs onwards the walkways was very crowded and the crowd intensity remained high throughout the day until 21.00 hrs. Though the temperature varied between 20.5 and 27°C and the humidity ranged from 23 to 57% during 10.00 to 21.00 hrs, it was found to have no impact on the crowd intensity.

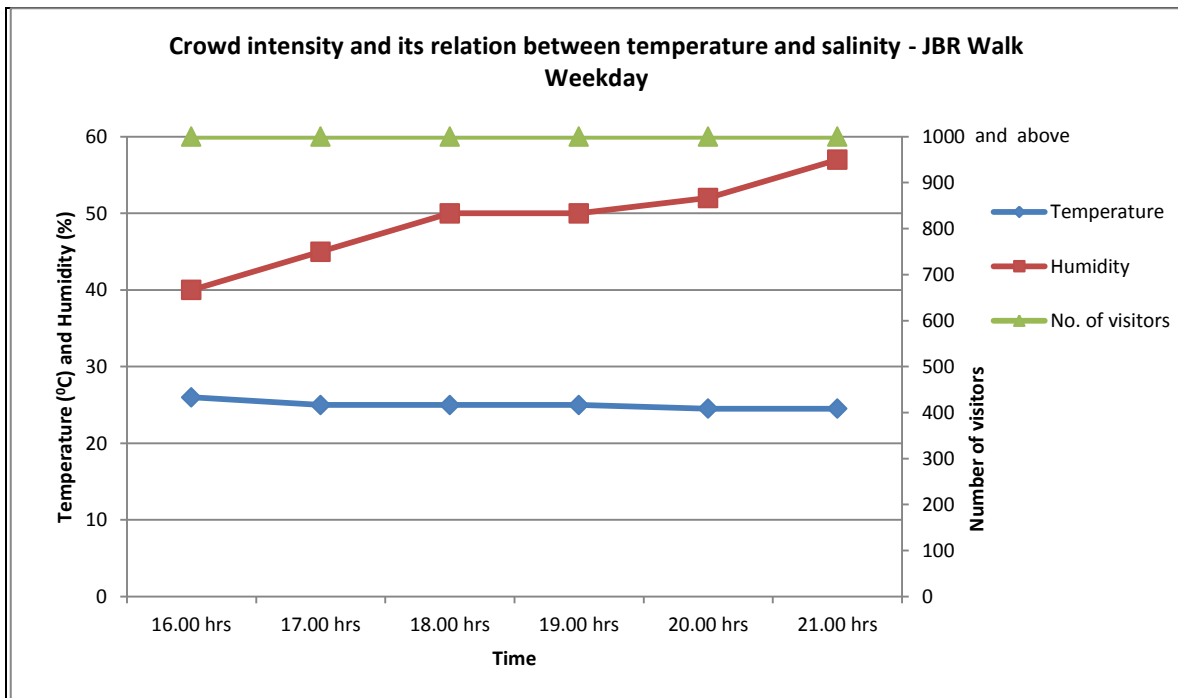


Figure 4.64: Crowd intensity in relation to temperature and humidity (JBR Walk – Weekday)

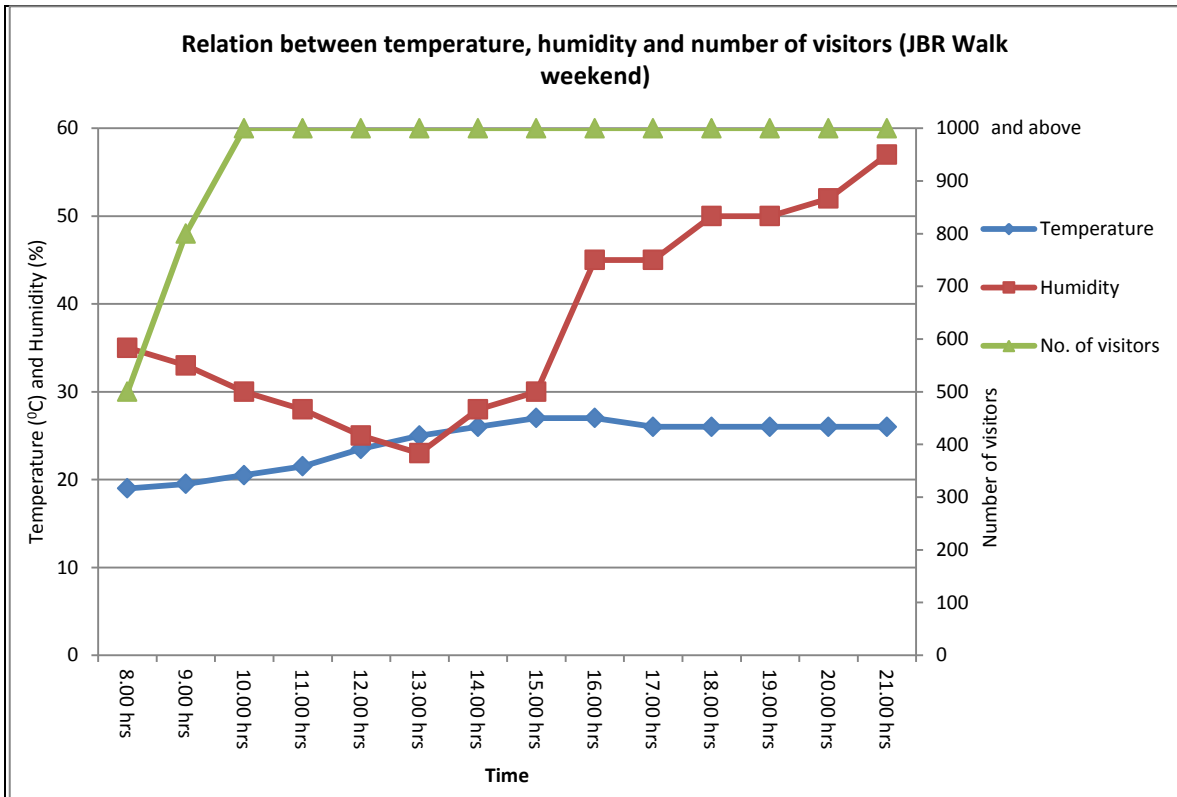


Figure 4.65: Relation between crowd intensity, temperature and humidity (JBR Walk – Weekend)

Assessments on the diversity of the crowd based on nationality done reveal that the crowd diversity was found to be same during both weekdays (Figure 4.66) and weekends (Figure 4.67) quite unlike the parks surveyed and analyzed as part of this research study. It was observed that Middle Easterners (50%) and Westerners (40 %) formed the major components of the crowd at different time intervals. While at the same time, Easterners, Indians and Pakistanis also contributed to the crowd diversity to a certain extent.

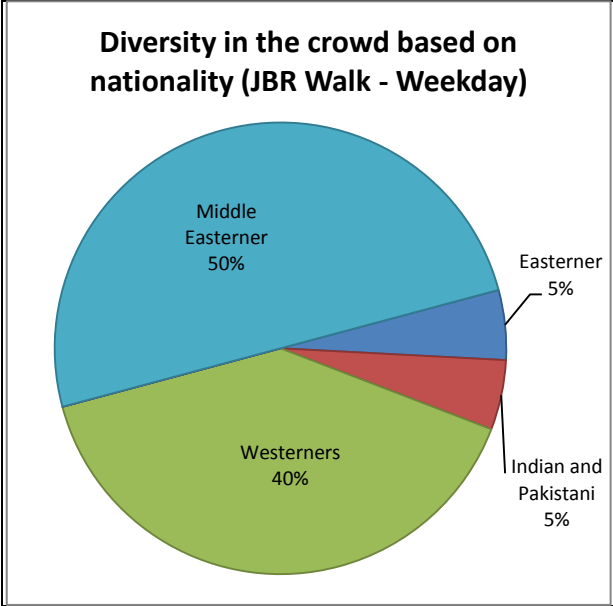


Figure 4.66: Crowd diversity based on nationality (JBR Walk – Weekday)

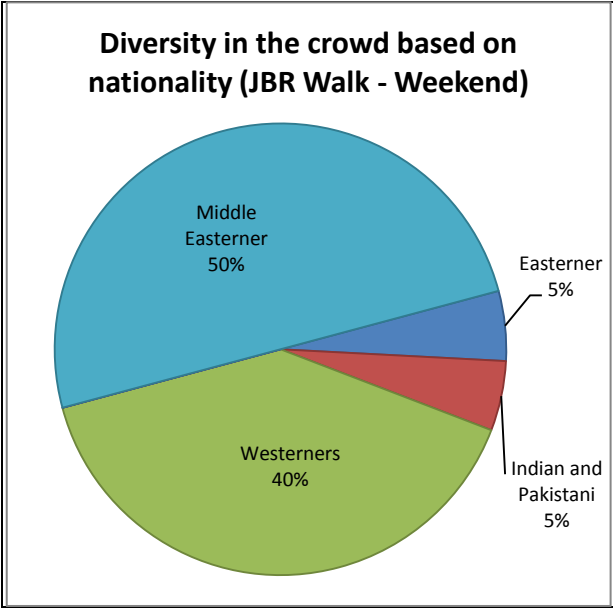


Figure 4.67: Crowd diversity based on nationality (JBR Walk – Weekend)

The perceptions of the visitors with regard to the prevailing physical conditions were assessed at JBR Walk during weekdays and weekends and are given in the Figures 4.68 and 4.69 respectively. Analysis during weekdays shows that majority (about 55 – 60 %) were satisfied with the prevailing physical parameters like wind, temperature and solar radiation during the survey period (16.00 to 22.00 hrs). Regarding vegetation, it was seen that mostly all the visitors surveyed during 16.00 to 18.00 hrs wanted more vegetation and while during other time periods (18.00 to 22.00 hrs) majority (about 55 to 60 %) of the

visitors claimed that they were satisfied with the vegetation in the region. During weekends it was noticed that at 8.00 to 11.00 hrs the temperature (19 to 21°C) and wind (about 3.5 m/s) was found to be satisfactory for majority of the people. At the same time they preferred to have less solar radiation and more vegetation during those periods. It was seen that from 11.00 hrs until 18.00 hrs, people preferred lesser solar radiation, low temperatures and more vegetation. At 11.00 to 13.00 hrs (3.5 – 4 m/s) and 16.00 to 18.00 hrs (3 – 5 m/s) it was seen that the people were satisfied with the wind conditions and at other times they preferred more wind. From 18.00 to 22.00 hrs people preferred more wind, lower temperatures and more vegetation in the region. Despite having lower temperatures (around 26°C) higher humidity values (50 – 57 %) that prevailed during the period might have made the people uncomfortable and might have affected their perceptions in this regard.

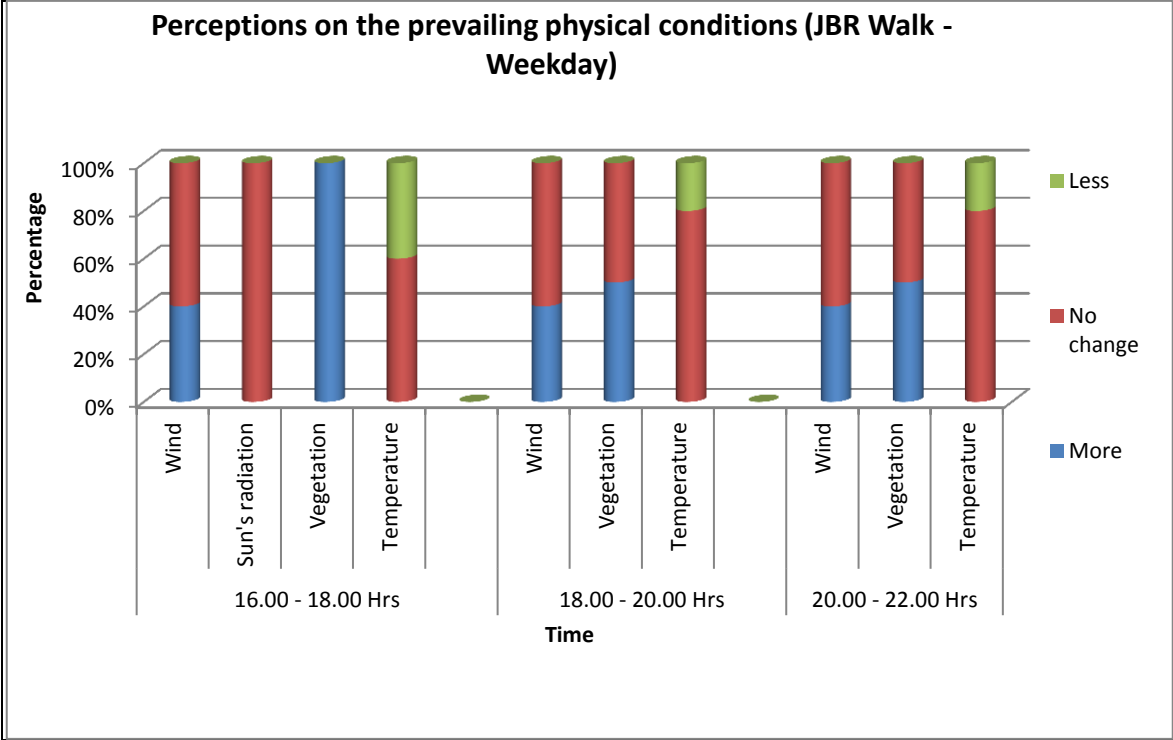


Figure 4.68: Perceptions on the existing physical conditions (JBR Walk – Weekday)

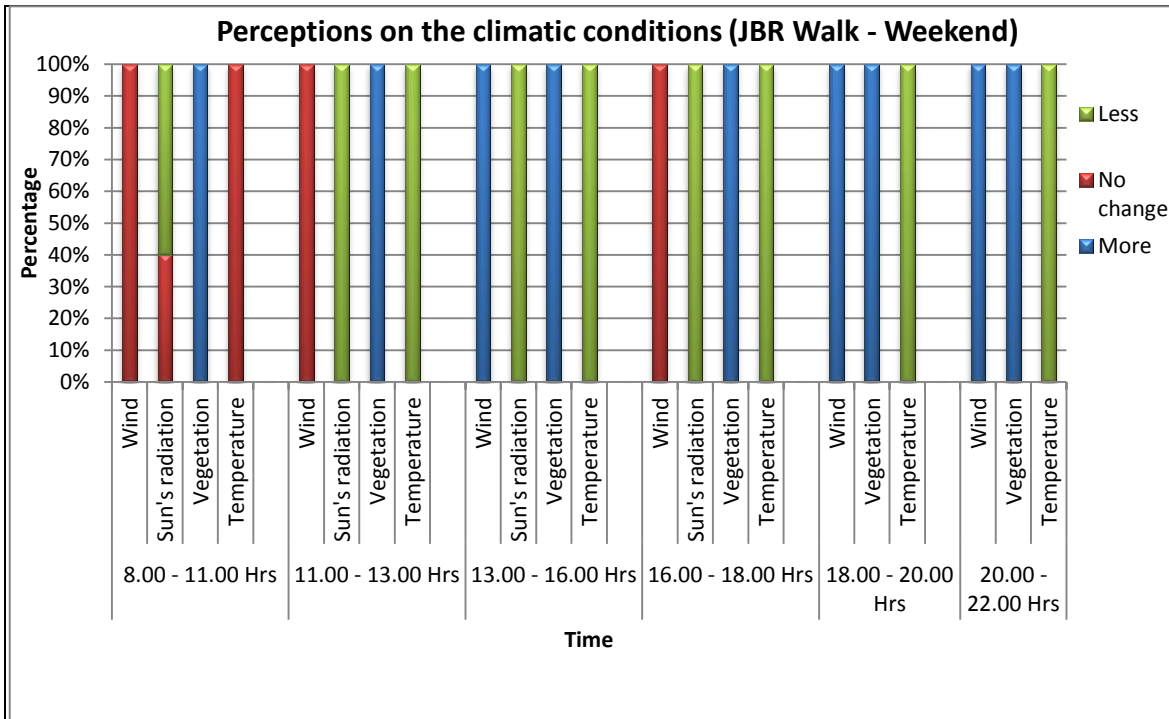


Figure 4.69: Perceptions on the climatic conditions (JBR Walk – Weekend)

Analysis on the crowd composition during different time intervals indicates that there are marked differences in the crowd and their activities in relation to time, which shows that some categories of people prefer some specific timing for spending outdoors. It is observed that during weekdays (Figure 4.70) families (about 40 %) and tourists (about 35 %) formed the major components of the crowd from 16.00 to after 17.00 hrs. It is seen that the percentage of tourists (35 %) and joggers (15 %) was more or less consistent throughout the survey period (16.00 to 22.00 hrs). But as time passed by the percentage of families at JBR Walk reduced while the adult groups increased and adult groups formed dominant components on or after 20.00 hrs. Assessments on the crowd composition on weekends revealed that tourists and adult groups were dominant components during the time period from 8.00 to 22.00 hrs except during 15.00 and 16.00 hrs the adult groups were very less. Joggers were more during 8.00 to 10.00 hrs and families were predominant during 15.00 to 16.00 hrs.

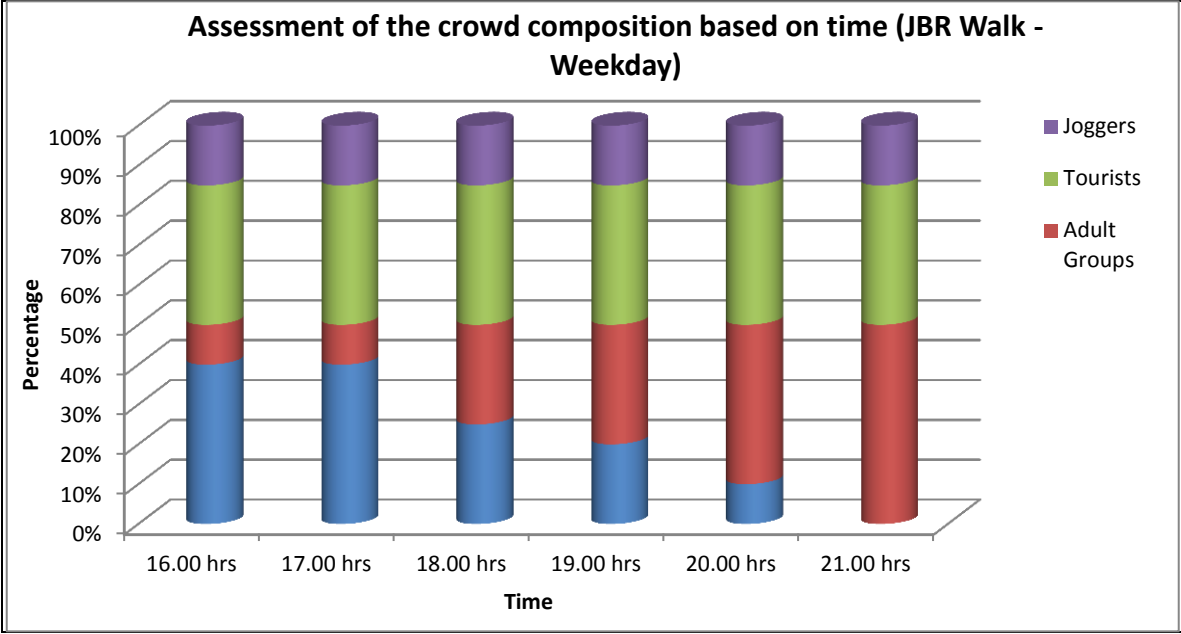


Figure 4.70: Variations in the crowd composition over time (JBR Walk – Weekday)

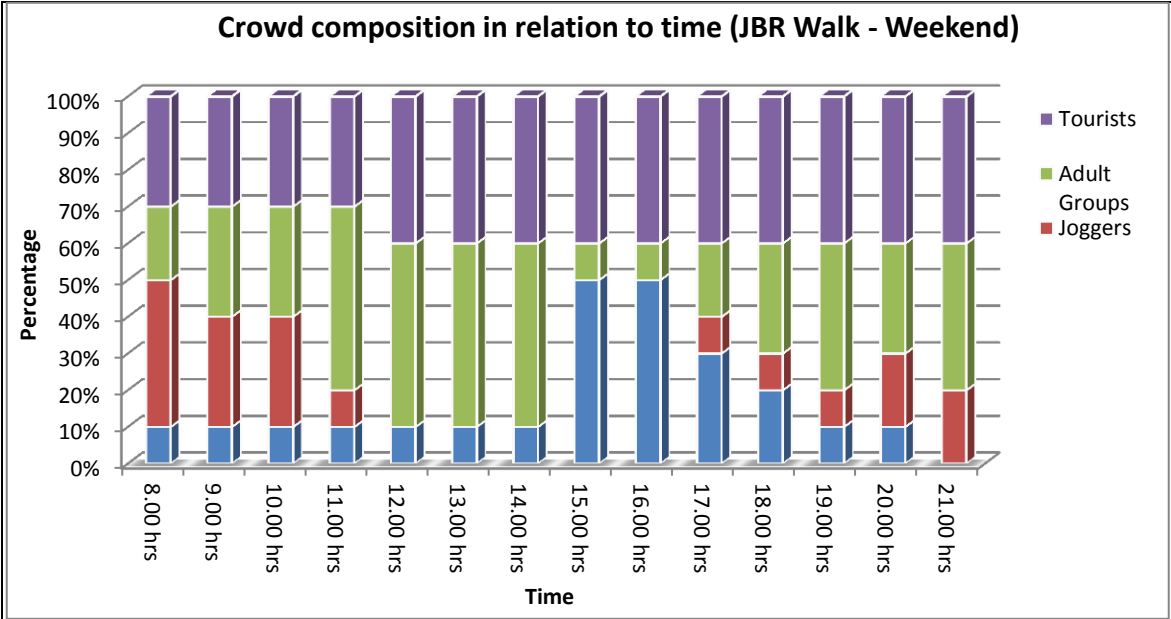


Figure 4.71: Crowd composition in relation to time (JBR Walk – Weekend)

Assessments for understanding the comfort levels of individuals in relation to temperature and humidity were done for JBR Walk both during weekdays and weekends and the Figures 4.72 and 4.73 represent the analysis made during weekdays and weekends respectively. In the figure X axis represents temperature (°C) and humidity (%) and the Y

axis gives the percentages based on the responses of the visitors. The analyses made during weekdays reveals that majority of the visitors were comfortable with the climatic conditions that prevailed during the survey period (16.00 to 21.00 hrs) since the responses were neutral at all times. During those times the temperature ranged between 24.5 and 26°C and the humidity values varied from 40 to 57 %. During weekends also almost similar pattern was visible and it is seen that all the surveyed visitors were found to be quite comfortable as they felt neutral about the prevailing climatic conditions during the time period from 8.00 hrs to about 21.00 hrs. The temperature which varied between 19 and 26°C and humidity values that appeared between 23 and 57 % were found to be within the comfort limits of individuals that were present at JBR Walk. Perhaps the comfortable conditions that prevailed in the region in addition to the availability of wide variety of quality food in the region, location specific features, etc might be the reason for making the region crowded throughout.

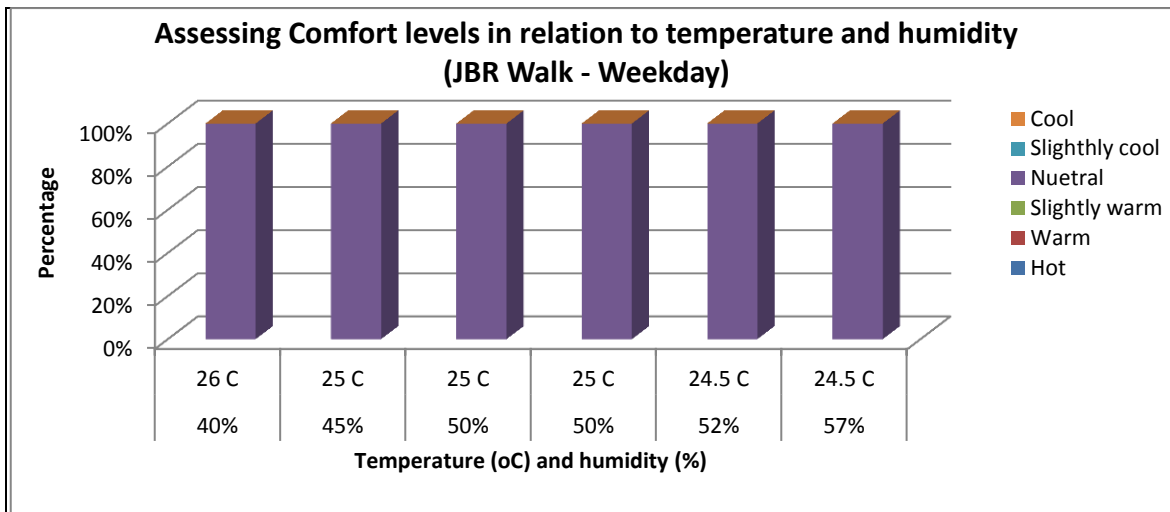


Figure 4.72: Assessment of comfort levels in relation to temperature and humidity (JBR Walk – Weekday)

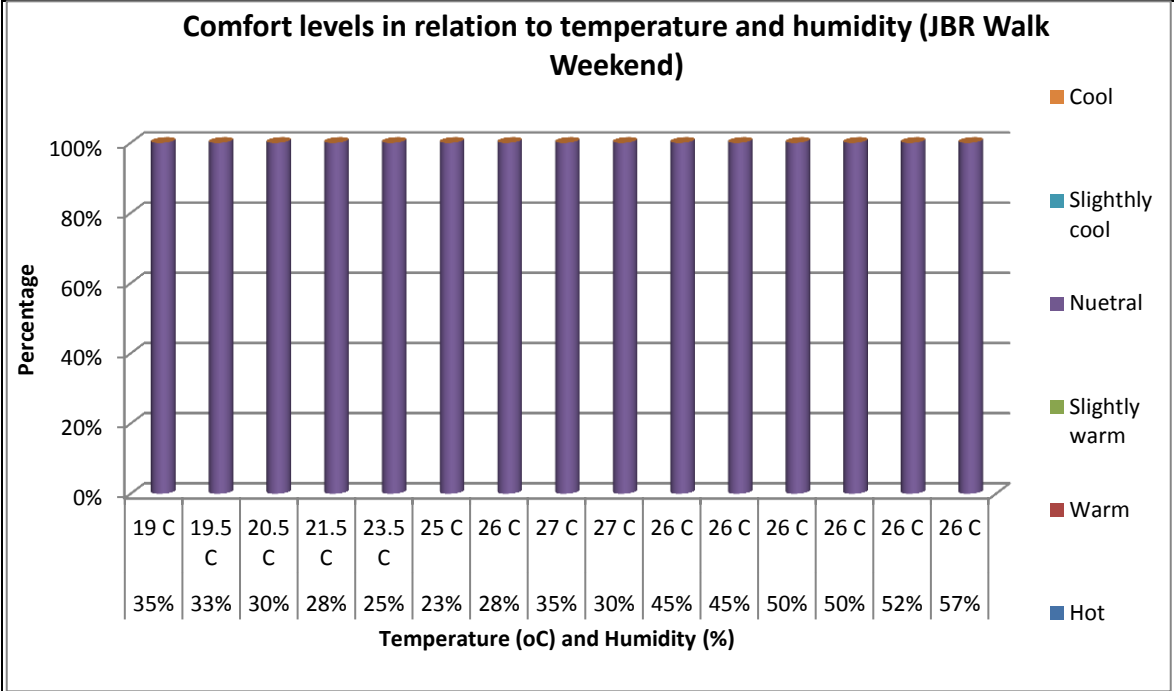


Figure 4.73: Comfort levels in relation to temperature and humidity (JBR Walk – Weekend)

### 4.2.8 Marina Walk

In Figure 4.74 the relationship between temperature, humidity and crowd behaviour during weekday is depicted. It can be seen that the temperature was stable and was from 28.5°C to 27°C and humidity was low ranging from 44%– 60%, hence the crowd was more during the weekday. As it was weekday it can be concluded that as the thermal conditions were favourable, and as the time passed and mostly after sunset the number of visitors also increased as people are busy with various works during weekday. The majority being mothers and kids from the neighborhood, they like to visit this place after sunset for their kids to enjoy.



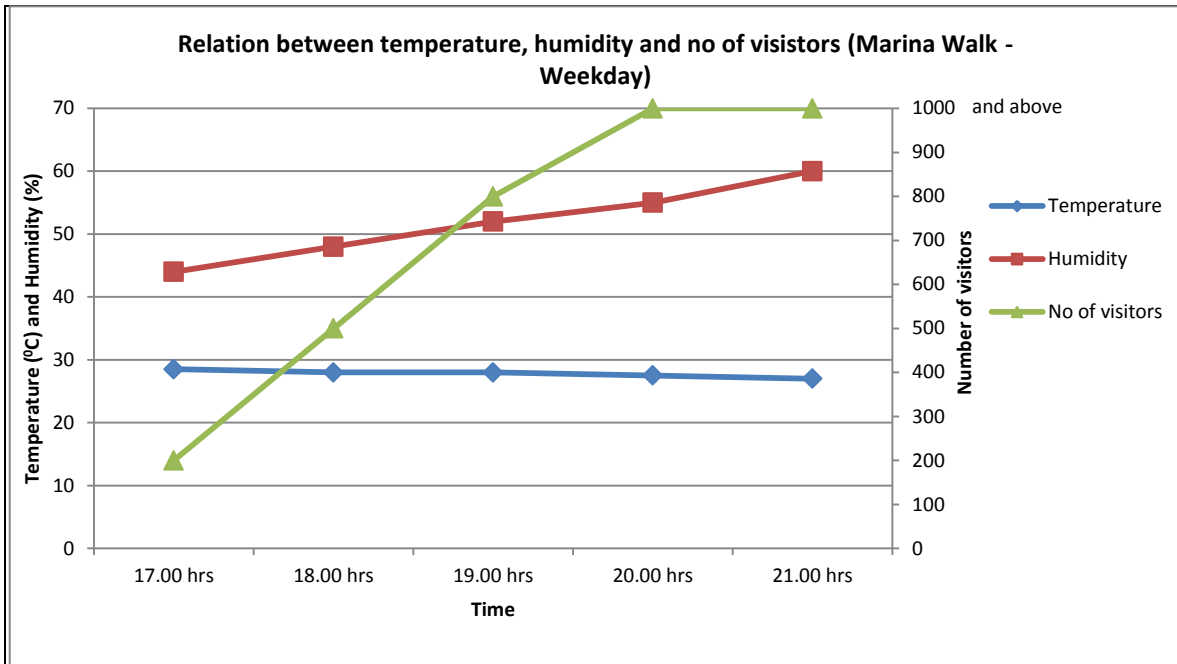


Figure 4.74: Relation between crowd behaviour, temperature and humidity (Marina Walk – Weekday)

In Figure 4.75, the relationship between humidity, temperature and number of visitors is shown during the weekend at various time intervals. In Figure 4.75, it can be observed that in the morning hours the number of visitors were less with only 70 visitors even though temperature and humidity were low at 24.5°C and 35%. During noon time the number of visitors increased to 500 as the humidity decreased to 23% but temperature slightly increased to 30.5°C. In the evening when humidity was high at 50% and temperature was also high at 28.5°C the number of visitors decreased to 100 but again in the evening after sunset even though the humidity increased to 60% and temperature was stable at around 27°C, the number of visitors was highest with more than 1000 people visiting the place. This might be because adult groups like to visit this place at night during weekends. It can be concluded that this place comes to life after sunset both during weekday and weekdays irrespective of the temperature or humidity. The visitors were seen walking or jogging around the marina or sitting in restaurants, having food or smoking shisha, some sitting on the benches and watching the kids. Kids were enjoying playing the water features or cycling.

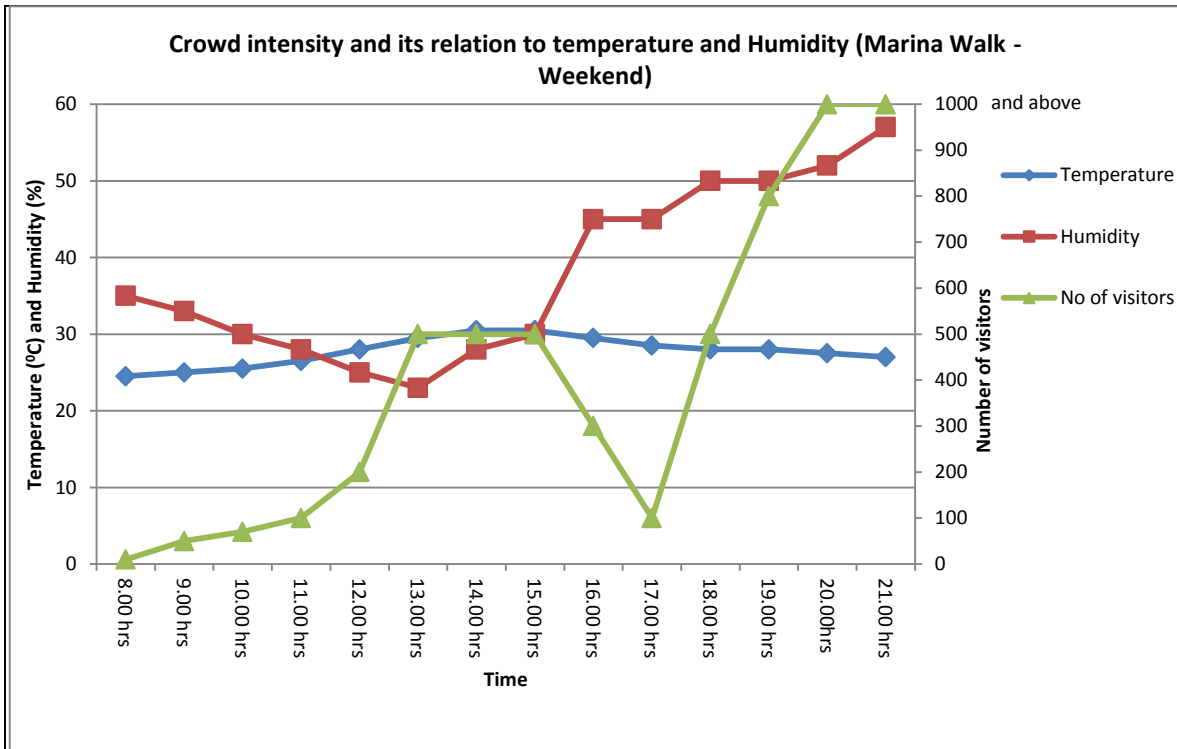


Figure 4.75: Relation between crowd intensity, temperature and humidity (Marina Walk – Weekend)

Figure 4.76 shows the crowd diversity during weekdays at various time intervals at Marina Walk. The majority were Middle easterners with 50% composing of Lebanese, Syrian, Turkish, Iranian, and G.C.C, then Westerners with 40% comprising of Europeans, Americans and South African. The remaining were 5% Easterners, Koreans and Filipinos and 5% Indian and Pakistanis. It was observed here that Middle Easterners Ladies were covering their hairs and wearing mostly full covered clothes and most of the tourists were wearing caps. During the weekends the crowd composition at Marina walk consisted of Middle Easterners 50% which included Lebanese, Syrian, Turkish, Egyptian, Iranian, and G.C.C and Westerners 40% comprising of Europeans, Americans, Russians and South Africans, 5% were Indian and Pakistani and 5% Easterners that is Filipinos and Koreans and represented in Figure 77. It was observed here that Emiratis, Pakistanis and G.C.C. national's ladies covered their hairs and wearing traditional outfit, tourists were wearing caps and all men were having short hairs.

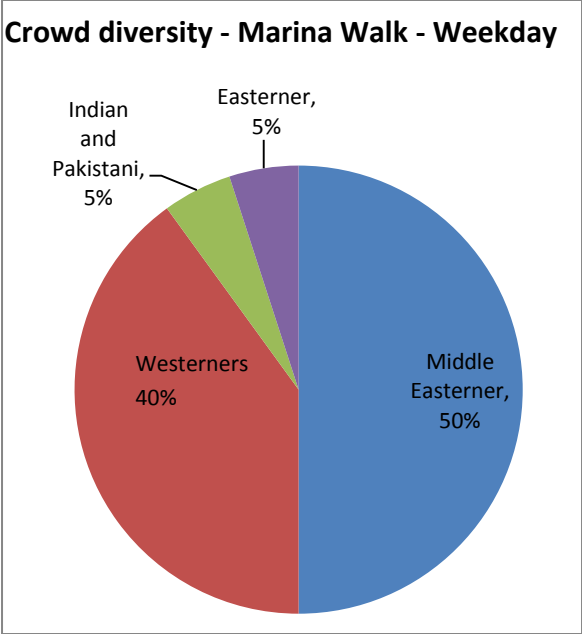


Figure 4.76: Crowd diversity (Marina Walk – Weekday)

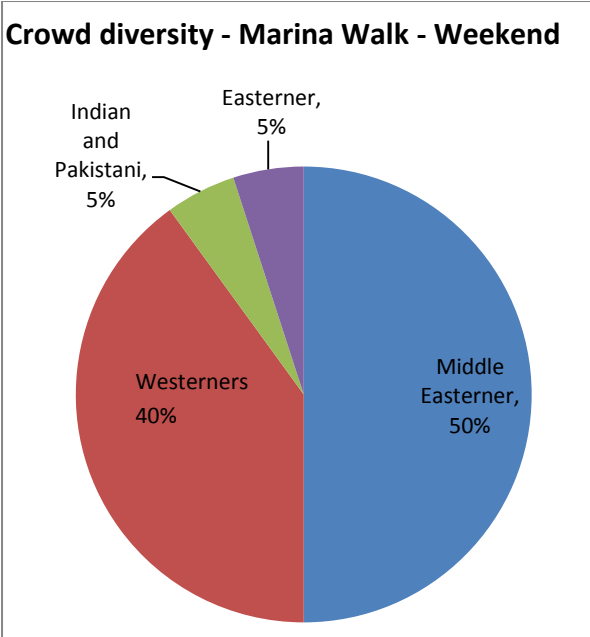


Figure 4.77: Crowd diversity (Marina Walk – Weekend)

Figure 4.78 gives the perception of respondents with regards to the temperature, wind, sun radiation and vegetation during different time intervals on weekday. From the

figure it is clear that all respondents wanted less temperature, more wind and more vegetation and no change in sun radiation during both the time intervals. Visitors were walking around the marina or sitting either in cafes or on the benches and watching the kids who were enjoying playing the water features or cycling before sunset as people were feeling hot about 70% of them had cool drink. And after sunset (late in the evening) 90% were seen enjoying warm food and 10% had only cool drink and their activity was also less as they were seen either sitting or walking.

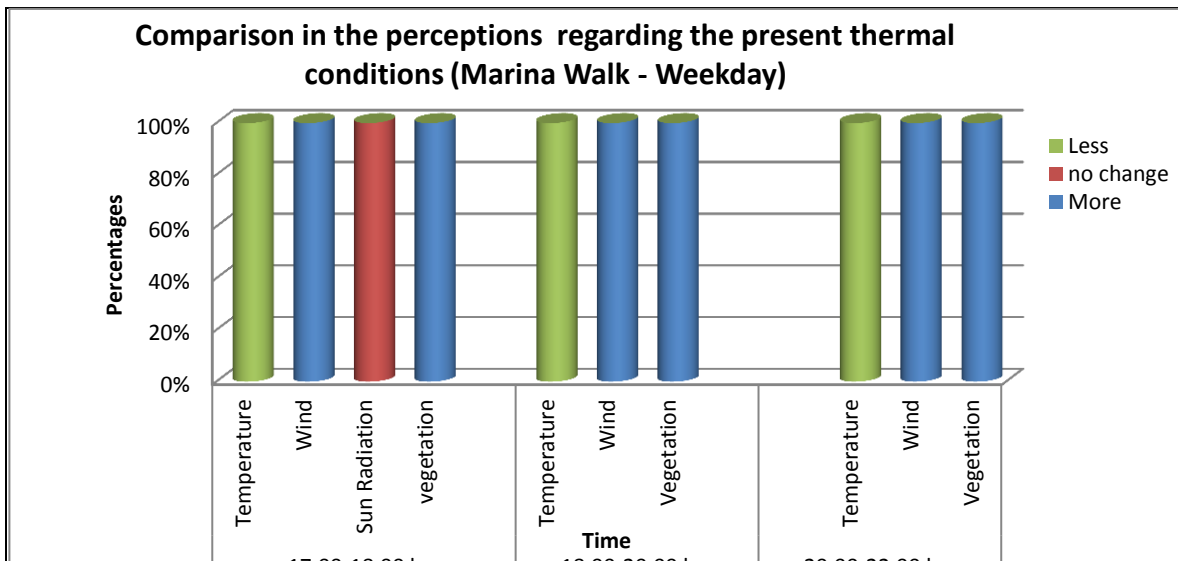


Figure 4.78: Comparing perceptions with regard to the prevailing thermal conditions – (Marina Walk – Weekday)

During the weekends there was no much change in the perception of respondents regarding the prevailing thermal conditions as seen in Figure 4.79. All of them wanted less temperature, more wind, less sun radiation and more vegetation during various time intervals. Their perception did not change over time during the weekend. By having the thermal conditions more favorable to them they wanted to enjoy the outdoor space more and increase their activities as of now they were jogging, resting, sitting or walking around the marina.

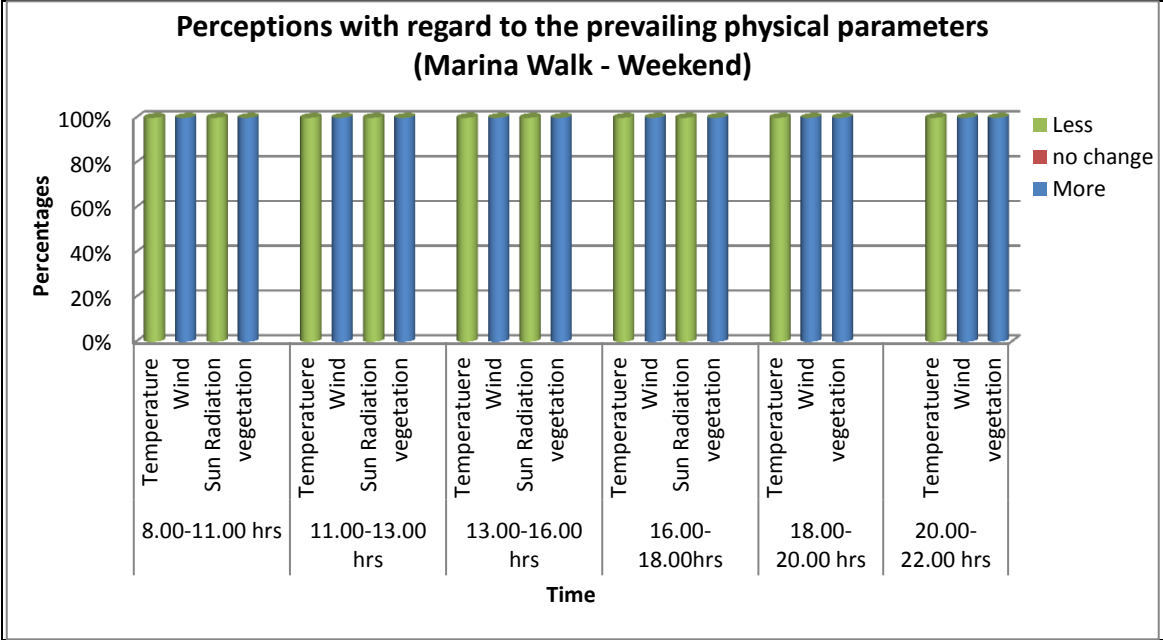


Figure 4.79: Perceptions in relation to the physical conditions (Marina Walk –Weekend)

The Figure 4.80 shows the changes in crowd composition with relation to time, on a weekday at Marina Walk. In the early evening more families with kids from the neighborhood and tourists can be seen visiting the walk. But as the time passes the number of adult groups starts increasing and families with kids diminishes over time. The number of tourists and athletes remains constant. Adult groups like to visit the place more after sunset and stay till late evening whereas families with kids come before sunset and leave after sunset and early evening.

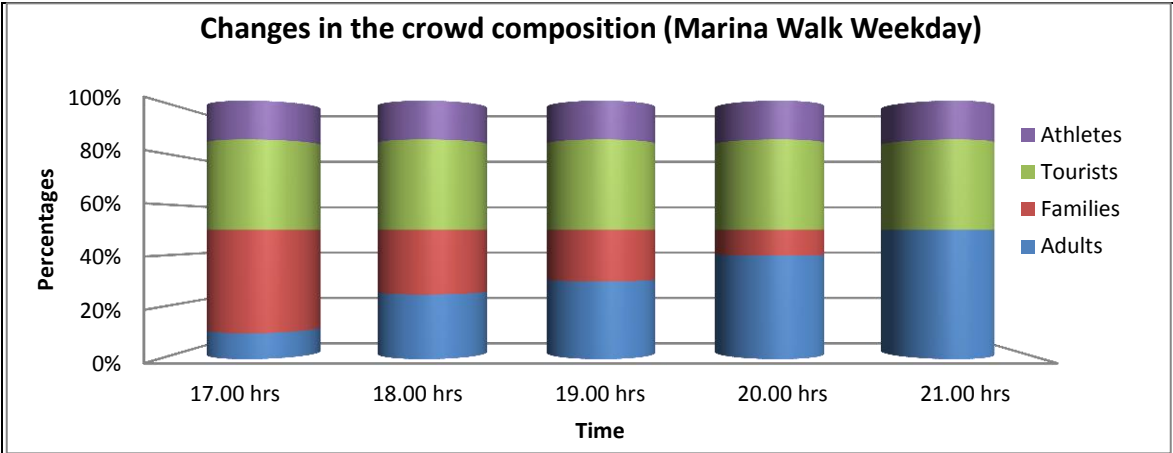


Figure 4.80: Crowd composition in relation to time (Marina Walk – Weekday)

In the Figure 4.81 the crowd composition with relation to time is given during the weekend at the Marina Walk is given. It can be observed that in the mornings hours the place is visited by adult groups, tourists and athletes and no families visit the walk at that time. But as the time passes the number of athletes decrease and families start coming to the place. The walk is visited by good number of tourists throughout the day. During weekends adult groups are present throughout the day and athletes can be seen in the morning and late evening. The crowd is very diverse and it attracts many visitors as 90% of the respondents like this place because of the restaurants and cafes which gives them the vast variation, 50% like the place because of the long jogging path way all along the marina. 30% like the place for the Friday market kiosks, 80% like place because of the marina view and the ambient, and 50% like there since their kids want to be there for cycling or water feature. All visitors found the atmosphere blessing. It was also observed during the survey that mostly the visitors were chubby and some overweight hence they like the place which gives them the opportunity to jog and walk along its long walkway with its serene beauty.

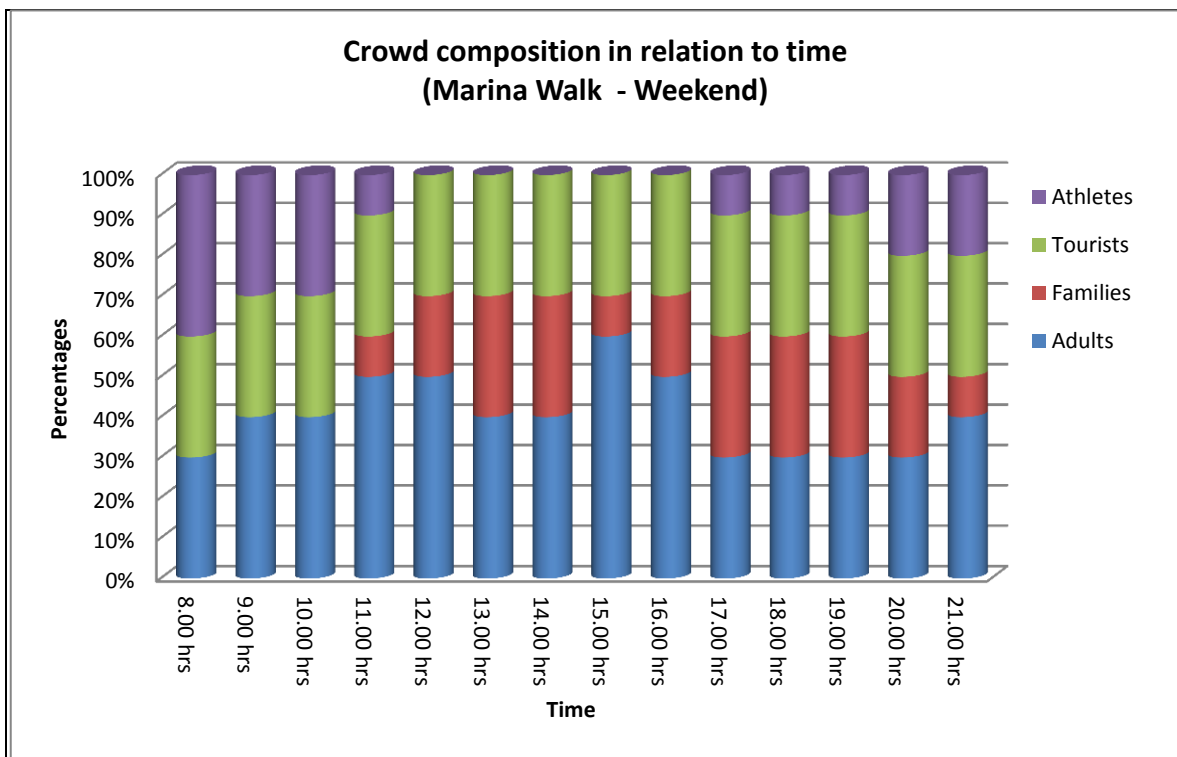


Figure 4.81: Crowd composition in relation to time (Marina Walk – Weekend)

Figure 4.82 shows the relationship between comfort levels, temperature and humidity on weekday at various time intervals in Marina Walk. The graph shows that when temperature was high at 28.5°C and with humidity of 44% 60% of the respondents were feeling slightly warm and 40% of them were neutral to the thermal conditions. But later when temperature decreased slightly to 28°C and then to 27°C, the humidity rose to 60% but respondents answered that they are feeling neutral to the thermal conditions they are neither feeling warm or cold. This may be perhaps because they have adjusted themselves physically, physiologically or psychologically and are better able to cope up with the thermal conditions.

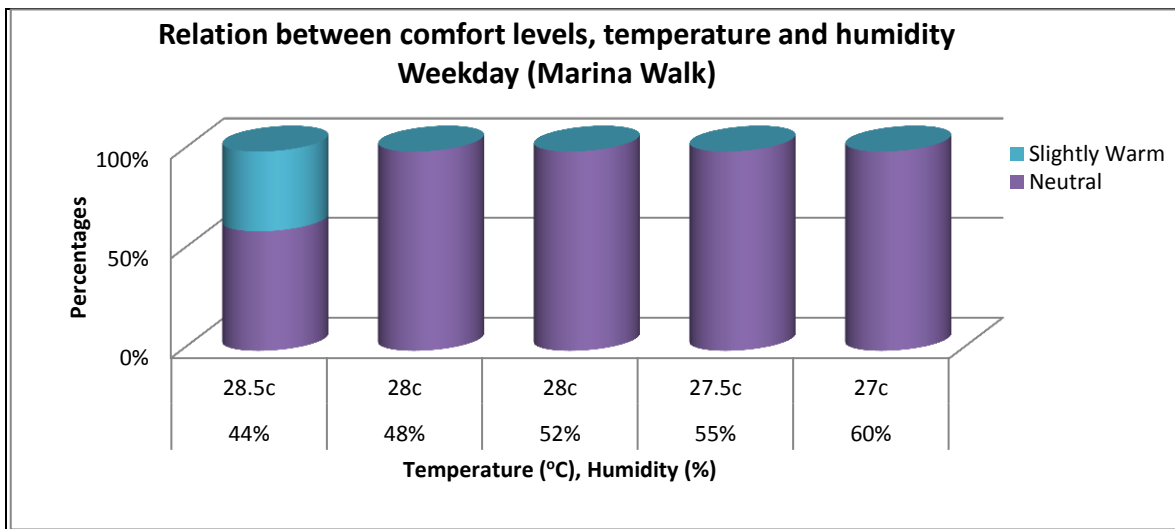


Figure 4.82: Relation between comfort levels, temperature and humidity (Marina Walk – Weekday)

In the Figure 4.83 it can be seen that when temperature and humidity were low at 24.5°C to 25.5°C and humidity at 35% people were neutral to the thermal conditions but as the temperature increased to 30.5°C even though humidity remained low visitors were feeling slightly warm and but again after sunset the temperature decreased to 27.5°C and humidity increased to 57%, visitors were neutral to the thermal conditions. It can be concluded that comfort level was affected more by temperature rather than humidity. They were trying to adjust to the hot thermal conditions by adopting physical measures like

wearing a cap, short hairs and 90% had warm food and hot drink, 50% had cold drink. For adapting more psychologically they wanted more vegetation.

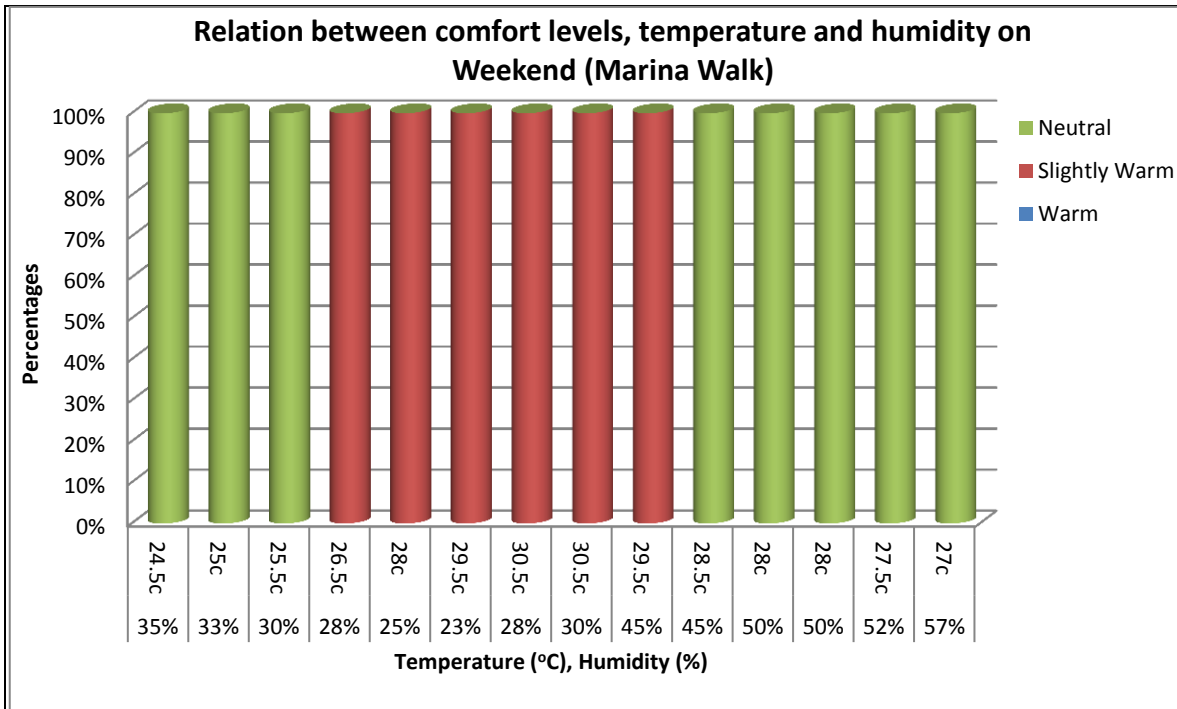


Figure 4.83: Relation between comfort levels, temperature and humidity (Marina Walk – Weekend)

### 4.3 Summary of the Results

Based on the data analysis done for 6 parks and 2 walkways in Dubai as a part of the research study aimed at understanding thermal comfort levels of individuals in relation to psychological adaptation, the following observations has been made.

It was seen that thermal comfort is influenced by a number of parameters like temperature, humidity, wind, vegetation, psychological adaptations, physical activities, purpose of visit, timings, etc. Such patterns were visible in all the surveyed areas. In addition, it was seen that during weekdays the parks were more crowded during 16.00 – 18.00 hrs and it was seen that from 16.00 to almost 18.00 hrs the crowd was mostly of mothers, kids and maids, while towards the night the visitors at the park are mostly adult groups. Perhaps the school timings and office timings have some role in this type of crowd



behaviour. Such a pattern was observed in Zabeel Park, Safa Park, Jumeirah Beach Park, etc.

It was noted that people prefer to remain in hot conditions rather than highly humid conditions. The results from Zabeel Park, Mushrif Park, Jumeirah Beach Park, Marina Walk, etc could be considered as an indication of such a trend. However, results from Zabeel Park, shows that people (mostly families) prefer to remain outdoors during 13.00 to around 18.00 hrs during weekends even if the temperature is higher. Similar results have been obtained from Creek Park, Safa Park and Mushrif Park. While in Jumeirah Beach Park and Al Mumzar Beach Park the crowd intensity was high during 11.00 to about 16.00 hrs during weekends. Both adult groups and families contributed to the crowd at Jumeirah Beach Park during those periods.

As observed in Zabeel Park, Creek Park, Safa Park, etc, the people were found to be quite tolerant of higher temperatures (around 32 to 36.5°C) during day time. This might be because they had experienced extremely hot conditions (around 50°C) in the recent past or they might have expected slightly more temperatures at that time of the day, which made them to remain comfortable even at higher temperatures.

The analysis shows that the JBR walkway was crowded from 16.00 hrs to 21.00 hrs during weekdays and from morning (10.00 hrs) until night (21.00 hrs) during weekends. Such a phenomenon was not observed in any of the six parks and at Marina Walk that were analyzed during the study. The reason for high crowd intensity for such long hours might be because the walkway has lot of shaded areas as there are many skyscrapers around JBR. In addition to that there are many hotels near this location, which are preferred by tourists. Cafes, restaurant, beach excesses, beach view, sea breeze, straight long walk way path, outdoor events such as kiosk market might be reason too.

Creek Park, Zabeel Park, Safa Park, etc results show that people's preference to remain outdoors either during weekends or weekdays or both have some relation to their culture, profession, purpose of visit, location features, etc. Presence of large number of Filipinos in the park only during weekends is an example of this.

It was seen that the visitors preferred some amount of alterations in the climatic conditions like reduced temperature, reduced solar radiation, increased wind speed and increased vegetation in order to make them feel more comfortable. At the same time, with regard to the prevailing conditions majority of the visitors claimed that they were quite comfortable as their responses mostly ranged between slightly cold to slightly warm.

The study shows that people are not absolutely choosy about the outdoor thermal conditions and they adapt considerably for making themselves comfortable in the present conditions perhaps because they consider it a necessity to remain outdoors at least once a week for entertainment, fitness related, etc activities. But at the same time, people flock to areas where the thermal conditions are comfortable, the results from JBR Walk is an indication of such a behaviour.

In most of the parks (e.g. Zabeel Park, Jumeirah Beach Park, Mushrif Park, etc) the crowds were mostly from the neighborhood locations and they tried to adjust to the variations in the thermal conditions by making alterations in their dressing, activity, and consumption patterns etc. Conversely, Creek Park, JBR Walk and Marina were found to have more international tourists at all times compared to other surveyed locations both during both day and evening time.

The previous exposures to extreme conditions, expectations, etc, might have some influence on the thermal comfort levels and perception of individuals. This was quite indicative in the behaviour of people who preferred outdoors even when the temperatures were higher as observed at Zabeel Park, Al Mumzar Park. The previous exposure to severe heat conditions in Dubai could be considered as a probable cause for this.

The behaviour of the Filipinos to remain under the hot sun when majority of the people from different cultures remained in the shaded portions of the park might point to the fact that as the Filipinos are exposed to worst and harsher conditions in their home country their tolerance for such conditions might have increased.

Time also play a dominant role in altering the expectations with regard to thermal comfort levels of the individuals. That is, a person coming to the park after sunset expects lesser temperatures and a person who visits the park at noon or afternoon expects more temperatures and this could affect the thermal comfort levels of individuals. For instance, neutral responses obtained at temperatures around 36.5°C at 16.00 hrs and slightly warm responses obtained at temperatures around 27.5°C at 19.00 hrs. Changes in the crowd composition or alterations in any other physical parameters also might be sighted as a reason for such a change in the comfort levels of individuals.

## CHAPTER 5. DISCUSSION

### 5.1 Introduction

This research study mainly investigated the effect of psychological adaptation in determining thermal comfort in public outdoor places and also analyzed the various factors that influence thermal comfort in Dubai. Qualitative and quantitative research methods were employed for this research study. The primary data collected from 8 selected locations (6 parks and 2 walkways) in Dubai were analyzed and it was found that in addition to the three physical parameters (temperature, humidity and wind speed), vegetation in the area and psychological adaptation also seem to play a dominant role in deciding the thermal comfort of individuals. The crowds in the parks were mostly multi cultural, which consists mostly of Middle Easterners, G.C.C. Arabs, Filipinos, Indians, Pakistanis and Westerners and majority of the visitors were found to be residing in the nearby locality itself. It was also noticed that the cultural diversity in the population of the region also influenced the thermal comfort levels to some extent. Out of the 8 outdoor locations surveyed during the research study, only Creek Park, JBR Walk and Marina Walk had fairly good numbers of international tourists. Other parks had more domestic tourists and were residents from the neighboring areas. Since most of the public outdoor places surveyed during the study attracted only local tourists or residents of the nearby areas, there is need for designing these spots for catering to the needs, demands and expectations of the international tourists in order to convert Dubai in to highly sort after location at international levels as well. Studies like this would provide better insights and useful tips for developing Dubai in to a major international tourism destination. This chapter would mostly discuss the important findings of the present research study and critically evaluate the findings in the light of previous and relevant literatures.

Major limitations of this research study was time, accessibility, quality of responses and location of the selected outdoor places, which in fact prevented the researcher from doing more in depth analysis in this regard. Since the parks were mostly deserted during weekdays in the daytime it was impossible to make comparisons between weekday and weekend data particularly during day hours. In order to minimize the effect of the

constraints on the research outcome, the research study was structured systematically and multiple research techniques were employed. As a result of which the researcher was able to come up with valid and highly relevant research outcome that has relevance academically and practically.

## **5.2 Major Findings and Discussion**

The highlight of the findings of the current research study is providing better understanding on the different parameters that affects thermal comfort and on the role of psychological adaptation in affecting thermal comfort in public outdoor places in Dubai. Most of the findings of the study are in agreement with the previous researches made in this regard. Despite the above said constraints this research study was able to come up with findings that have academic and practical significance and the major findings are discussed in detail.

### **5.2.1 Factors Influencing Thermal Comfort**

According to Moreno et al (2008), air temperature, wind speed, solar radiation, cloud cover, humidity, metabolic rates, clothing, building design and nature, building materials, vegetation, adaptability of individuals, etc do influence the thermal comfort levels of people to a considerable extent. In accordance with this research, the findings of the present study also showed that the comfort levels of individuals vary based on a combination of these parameters. Based on the current research it was seen that people were comfortable at higher temperatures at noon hours while during evening hours, even at lower temperatures the surveyed individuals were found be quite uncomfortable (See Figure 4.9). Such observations were obtained from most of the surveyed locations (e.g. Zabeel Park, Safa Park, etc) as well. This variation in the comfort of individuals might be due to changes in a number of factors like humidity, expectations based on time, psychological condition of the individuals, alterations in the crowd diversity and composition, physical activities, etc, which proves beyond doubt that the thermal comfort of individuals depends on different factors.

Khodakarami (2006) is of the opinion that as thermal comfort is dependent on physiological, psychological and behavioural factors and the comfort preferences of individuals normally fluctuate within a range of values. In agreement with these views, the current research study also showed that there is no specific value at which the individual is thermally comfortable at all times. But the comfort levels of individuals appear to vary within a range of values of temperature, humidity and wind depending on the time of the day, expectations, experience, purpose of visit, individual's condition, activity, etc. In the present study, from the same location similar climatic conditions generated different responses in individuals based on the presence or absence of vegetation. That is, during noon hours the individuals were found to be thermally uncomfortable and felt hot directly under sun while individuals who occupied the shaded places of the park felt only slightly warm or some even made neutral responses. Similar observations were made from all the surveyed parks (e.g. Mushrif Park, Creek Park, etc). These findings are in conformity with the works of Huang et al (2009) who opines that the comfort levels of individuals are also influenced by the degree of vegetation in the region. Huang et al (2009) claims that places with little or excessive shading might have shorter thermal comfort periods and hence there is need for optimizing the vegetative cover for the studied areas.

The presence of high crowd intensity at JBR Walkway almost throughout the daytime during weekends and in the evening hours during weekdays might be due to availability of the required amounts of shaded areas in the region, which in turn might have made the region more thermally comfortable for more individuals as well. It is seen that JBR Walkway and Creek Park was able to attract lots of international tourists since there were lot of entertainment, relaxation and food related options available to them. These spots also had relatively more shaded areas, both natural and created, that have the capability to bring thermally comfortable conditions acceptable to a relatively more numbers of people and this could also be considered as one of the reason for attracting more international travelers in to those regions. So there is need for further redesigning and developing other outdoor locations in Dubai by including more opportunities for the tourists for relaxation, sport activities, health related, food etc based on their priorities and preferences in view to drive more foreign crowds in to these regions as well. According to

Lin et al (2010) in order to increase the crowd preference for any outdoor spots there is need for including different types and categories of shading options for the people, which in turn permit them to select their favorite thermal comfort conditions.

In addition to the impact of microclimatic conditions, researches by Aljawabra and Nikolopoulou (2009) revealed that socio economic background and cultural differences also seems to influence thermal comfort of individuals. In accordance with these findings, the present research study also showed that based on the results from Creek Park, Zabeel Park, Safa Park, etc there appear some relation with the culture, economic factors, social factors, purpose of visit, location features, etc and the people's choice to spent time outdoors, whether it be only during weekends or only during weekdays or during both times. Only very limited numbers of Filipinos were seen during weekdays and the presence of large number of Filipinos in the park mostly during weekends (see Figure 4.4) in fact indicates that they have specific preference for weekend outings. This pattern was observed in most of the surveyed parks like Zabeel Park, Creek Park, Safa Park and Jumeirah Beach Park. Such preferences showed by different cultures and various categories of people might influence the thermal comfort as well. Variations in the thermal comfort levels of individuals during weekends, weekdays as well as during different time intervals are found to have some relation to the alterations in the crowd composition and intensity observed during those periods. This indicates that the perceptions and preferences of people with regard to thermal comfort is subjected to vary based on crowd composition and diversity and hence there is need for assessing the potential visitors to these locations for making the planning process up to date and precise.

Studies done by Nicol and Humphreys (2007) stressed the relevance of adaptive behaviour and adaptive capabilities in deciding the thermal comfort of individuals. People become inclined to make themselves comfortable in a particular condition, by making changes or adjustments (adaptations) to their clothing, movement or actions and posture, as well as to their thermal environment itself (Nicol and Pagliano, 2008). In the present study also it was seen that special efforts were taken by most of the visitors for adapting themselves to the prevailing climatic conditions through adjustments with regard to

clothing, activity, drinking patterns, etc. That is, when the conditions were relatively hotter it was seen that majority of the people preferred to wear light colored clothing and dresses made of light material, consumed either cold snacks or cold beverages or both and were found to be less active or confine themselves to the shaded areas. Humpreys (1994); Nicol and Raja (1996) pointed that behavioural adjustments like alterations in the clothing, activities, variations in the consumption patterns, etc appear to have a strong positive correlation with the outdoor thermal conditions.

It was observed that majority of the surveyed individuals opined that they expect outdoor tourist spots to have lots of greenery and vegetation, secured environment, entertainment for kids and even for adults, enough shades, benches or resting places, refreshing kiosk and even variety in restaurants and cafes. But at the same time they were willing to make compromises within certain ranges of physical parameters under which they were found to be rather comfortable. This shows that though expectations influences thermal perceptions of individuals the impact of other parameters like purpose of visit, mental state, scope for more entertainment, etc seems to enable people to adapt or adjust accordingly within certain ranges but most probably not under extreme conditions. Factors like adaptability and acclimatization also have the capability to bring about changes in the thermal comfort levels of individuals (Shakir, 2009).

Responses from all the different parks and walkways selected for the analysis showed that despite their preferences for lesser temperatures, lesser sun's radiation, increased vegetation and increased wind speed, etc, majority of the visitors were found to be comfortable under the prevailing physical conditions, which enabled them to enjoy their outdoor visits. Majority of the people expressed their willingness to visit the same location quite frequently. These findings in fact might indicate that the choice to spent time in outdoor locations also depends on need and conveniences of individuals or groups as well and hence the thermal comfort also seems to be influenced by these factors. That is, different categories of people, for example, the ladies and kids preferred to remain outdoors during 16.00 to 18.00 hrs and adult groups wished to visit outdoor places mostly after sunset (e.g. Zabeel Park, Safa Park, Al Mumzar Beach Park, etc) even at relatively



hot and medium levels of humidity during weekdays. Such a trend was more visible in parks that had lesser international tourists and in the parks where the visitors were mostly from the nearby areas. Here the preference for outdoor locations seems to have much relation with the school and office timings and this could be the major reason for the changes in crowd diversity during different time periods especially during weekdays. Perhaps extremes in climatic conditions might reduce the impact of convenient timings on the choice for remaining in outdoor public places. These findings can be slightly contradicting to the previous researches by Nicol et al (2008) which indicated that there is limitation to how much people can adapt themselves psychologically to thermal conditions. Perhaps the limitations are more visible when the thermal conditions are extreme.

### **5.2.2 Psychological Adaptation and Thermal Comfort**

According to Lin (2009), the variations in thermal comfort and the tolerance levels at outdoor places is found to be influenced by the mental and behavioural conditions and related aspects of individuals when compared to the indoors. In concurrence with the findings of Lin (2009) the present study also reveals that psychological adaptation has a major role in determining the thermal comfort levels of individuals, which in turn might influence the usage of outdoor spaces. Nikopoulou et al (2001) have also expressed the fact that the usage of outdoor places do depend on the prevailing microclimatic conditions of the region. But in the current research it was seen that adaptive activities (both behavioural and psychological) also play a dominant part in altering the tolerances and preferences for the particular ranges of thermo climatic conditions and thereby thermal comfort levels also varies. Perhaps psychological adaptation or any other adaptive activities have minimal role in influencing the thermal comfort when the micro climatic conditions are extreme.

Nikolopoulou and Steemers (2003) are of the opinion that different factors like “naturalness” of the place; expectations, experience, time of exposure, perceived control, environmental stimulation, etc can bring about psychological adaptation and thereby influence the thermal comfort levels of individuals. The findings of the current study also

are in agreement with these and it was seen that in some of the surveyed locations (Safa Park, Zabeel park, Creek Park, etc) people seemed to tolerant to higher temperatures (around 36.5°C) as the responses of the majority were either neutral or slightly warm. This might be because the people of Dubai had experienced extremely hot conditions in the recent past, which might have made them expect higher temperatures during daytime especially the noon time and after noon. If the environment is found to possess more natural things and lacks pretensions then the people are found to be more tolerant to the changes in the environmental conditions (Nikolopoulou, 2008).

The current research study found that the people were not completely selective about the outdoor thermal conditions with regard to their outings and they seems to adapt considerably for making themselves comfortable in the present conditions perhaps because they consider it a necessity to remain outdoors at least once a week for entertainment, fitness and health related activities. Hence the people were found to be more adaptive in the prevailing conditions. But at the same time, people flock to areas where the thermal conditions are comfortable, the results from JBR Walk is an indication of such a behaviour. This is in accordance with the findings of Yao (2007) who states that humans make use of different levels of adaptations to adjust or get acclimatize to the prevailing thermal conditions as well as to remain comfortable within certain range of thermal conditions

The behaviour of the Filipinos to remain under the hot sun when majority of the people from different cultures remained in the shaded portions of the park might point to the fact that as the Filipinos are exposed to worst and harsher conditions in their home country their tolerance for such conditions might have increased. Such behaviour was observed in most of the parks like Zabeel Park, Jumeirah Beach Park, Al Mumzar Beach Park, etc. Psychological adaptation that had occurred within the Filipinos might have made them more tolerant to higher temperatures and direct sun's radiation. Studies by Knez and Thorsson (2006) indicates that the psychological state of an individual in conjunction with emotions, perceptions, attitudes, etc of the individual do play a major role in deciding the thermal comfort indices of humans.

Based on this research study it was observed that visitors from conservative societies like Pakistan, Middle East and G.C.C. were covering their heads and wearing traditional clothes to adhere to their traditions and practices despite hot thermal conditions. It can be concluded that physical adaptations are constrained by culture and they adapt more psychologically than any other measures or socio cultural factors play an important role in determining thermal comforts as concluded by ALJawabra and Nikolopoulou, (2009).

Time of exposure was considered as a factor that might influence the thermal comfort levels of individuals (Nikolopoulou and Steemers, 2000). The current research also revealed that time of exposure has a dominant role in altering the expectations with regard to thermal comfort levels of the individuals. The level of expectations of the individuals or groups varies depending on the time of exposure. Individual who go for outings during noon time expect higher temperatures and people who visits the outdoor spaces during evenings or night expects much lower temperatures and hence the tolerance for higher temperatures are more for the first category and less for the second category. For example, neutral responses obtained at temperatures around  $36.5^{\circ}\text{C}$  at 16.00 hrs and slightly warm responses obtained at temperatures around  $27.5^{\circ}\text{C}$  at 19.00 hrs (Figure 4.10). Changes in the crowd composition or alterations in any other physical parameters, variations in the expectations of individuals, etc might be the reason for such alterations in the comfort levels of individuals. Paciuck (1990) is of the opinion that expectations and experience seems to influence the responses of individuals in different situations and it is found to be true with regard to thermal comfort as well.

De Dear and Brager, (1998) opined that when thermal conditions are unfavorable people avoid outdoor spaces and limit the time or their activity. Quite contrary to the above findings the studies from Dubai indicated that people that despite higher thermal conditions the visitors were present in large numbers and were staying in the park for more than an hour whether it be an international traveler or a visitor from a neighborhood and they were effectively making use of physical, physiological and psychological adjustments to make themselves comfortable in the prevailing conditions. This perhaps point out to the

fact that though people do not completely avoid outdoor spaces during unfavorable conditions but could alter or modify their activity and probably affects their time of stay to a certain extent. It is seen that the activities of the human being's are affected by the thermal conditions within their environment. Activities change when thermal conditions change, (Nicol and Pagliano, 2008). This was the case noticed in majority of the surveyed areas like Al Mumzar Beach Park, Jumeirah Beach Park, Mushrif Park, etc, as the thermal conditions were hot, visitors movement and activities were limited they were resting under the shade and they were seen adopting physical, physiological and psychological measures to combat the heat and when temperature and humidity were tolerable their activities increased and they were seen playing in the sun and the beach.

## CHAPTER 6. CONCLUSION

### 6.1 Conclusion

The role of psychological adaptation in determining thermal comfort in public outdoor spaces and the different factors that influence thermal comfort with special emphasize on Dubai were analyzed as a part of the current research study. Primary data was collected from 8 different outdoor locations in Dubai using survey method and both primary and secondary data were assessed for the purpose of this research study. Based on the analysis it was seen that psychological adaptation does play a predominant part in influencing thermal comfort in public outdoor places in Dubai. Thermal comfort of individuals in outdoor spaces is found to be influenced by different parameters, which include physical parameters like temperature, humidity, wind speed and solar radiation; behavioural adaptation and psychological adaptations. Most of the results of this present study are in accordance with the previous researches. It was seen that thermal comfort at different time intervals also seems to alter and these changes were found to be mostly dependent on the physical parameters like temperature and humidity and psychological adaptations to a considerable extend.

The present research study revealed that people of Dubai seemed to have more tolerance for higher temperatures and for moderate levels of humidity. This might be because the region has relatively higher temperatures during most of the months and the surveys were taken after the hot summer conditions and so the high temperatures (up to around 36°C) does not seem to be harsh for them, which can also be considered as an adaptive behaviour. Majority of the visitors were found to adapt to these high temperatures by remaining in the shaded areas, taking cold drinks or cold snacks or both, reducing or altering their activity levels, alterations in the clothing, etc (Nicol and Pagliano, 2008). This study partly agrees with the views of de Dear and Brager (1998) that unfavorable conditions might limit the activities of the visitors in outdoor place to a certain extent. But at the same time avoidance of public outdoor places was not visible in the current study as observed by de Dear and Brager (1998). Perhaps such observations have greater

applicability under extreme conditions. It was noticed that there are no specific values of temperature, humidity, wind speed, etc, under which the individuals are comfortable at all times and the comfort preferences vary within a range of values. These variations were found to be very much dependant on the time of the day, expectations, experience, purpose of visit, individual's condition, activity, socio cultural status, etc. Dubai being a multicultural society the thermal comfort variations might also be the effect of cultural diversities and differences.

It was noticed that the presence of vegetation also seems to influence thermal comfort considerably and the presence of large number of visitors in JBR Walkway throughout daytime and nighttime during weekends and evening to night time during weekdays is an indication of this relationship. This might be due to availability of optimum levels of shaded areas in the region and as a result of which the region might have become more thermally comfortable for greater number of individuals. Differences in the thermal comfort levels were found to have some relation with the variations in the crowd diversity and cultural differences. It was also seen that the choice to spent time in outdoor locations also depends on need and conveniences of individuals or groups as well and hence the thermal comfort also seems to be influenced by these factors. School timings and office timings also were found to have influenced the crowd intensity and the changes in the crowd composition in most of the parks during weekdays, which in turn might affect the thermal comfort as well.

In the current research it was seen that adaptive activities (both behavioural and psychological) also play a dominant part in altering the tolerances and preferences for the particular ranges of thermo climatic conditions and thereby thermal comfort levels also varies. According to the current research study it was noted that the preferences for remaining in public outdoor places are not specifically dependant on the thermal conditions of the region alone, but the people were found to be more adjustable and adaptive to make themselves comfortable in the prevailing conditions as they prefer to stay outdoors at least once or more during weekdays and weekends for different purposes like

fitness related, entertainment related, etc. Experience and expectations also seem to alter the thermal comfort levels of individuals considerably.

In general, it was seen that international tourists were observed in large numbers only at Creek Park, JBR walk and Marina Walk and the most of the visitors to other surveyed parks in Dubai were domestic tourists and people with different nationalities who are residing in the nearby locality. Hence there is need for developing more parks in the region by including more entertainment, fitness related and other possible options for different categories of people based on the regional potential, needs and demands in view to attract more international tourists for converting Dubai in to a tourism hub.

## **6.2 Recommendations**

Based on the current research study it was seen that the thermal comfort in outdoor public places in Dubai are influenced by different factors like psychological adaptation, behavioural adaptations, physical parameters like temperature, humidity, wind speed and vegetation. The recommendations for bettering the tourism prospects of the region by making use of the understanding of thermal comfort studies are given below.

- Develop optimum levels of vegetation in all outdoor public spaces especially the parks and walkways in Dubai based on demand (Huang et al, 2009). This would provide more options for the visitors to spent comfortable time outdoors even in higher temperatures. The current study revealed that people preferred to have more vegetation in almost all the surveyed areas as the presence of vegetation could ease the impact of higher temperatures particularly during the time before noon, afternoon and evenings. Dubai being a place where the temperatures are relatively high throughout the year and hence optimizing the vegetative cover of the public outdoor place would have greater applicability in developing Dubai in to an international tourist destination.
- Design the spaces in such a way as to provide the needed thermal comfort across seasons. That is, during hot periods different shading options are a must, but on the

other hand during cold period there is need for more options for getting exposure to sun. Hence there is need for optimizing the various options taking into consideration the region's changing climate patterns (Nikopoulou et al, 2001). Customer focused development of all the parks especially the beach parks would be a good option for making further advancements in the tourism sector.

- Tailor made solutions for Dubai to be implemented, related with seasonal variations with regard to temperature, humidity, wind speed etc prior to optimizing the design of outdoor spaces should be considered. Bruse, (2009) have clearly pointed out that public outdoor places need to be developed in the view to bring about favorable microclimatic conditions, that has adequate proportions of sunlight and shade or protection from wind, etc.
- The current research study revealed that psychological adaptation forms a major role in influencing the thermal comfort levels of individual in public outdoor places in Dubai. Hence due priority should be given for understanding the probable psychological adaptations and behavioural adaptation that can be made by the people prior to designing outdoor spaces. There by provide them plenty of opportunities for resorting to the much needed adaptive behaviours (Taylor and Guthrie, 2008). An Understanding on the possible adaptive behaviours of individuals under the different values of physical parameters like temperature, humidity, wind speed, etc would be handy for designing public outdoor places.
- There is need for attracting both the present and prospective users through providing them with the right blend of features that matches with the ecological conditions, social set up, and other user preferences (Bruse, 2009). Proper assessment of both the potential and prospective users is a must for rightly designing the area for suiting user preferences and priorities.



- It was noticed that the main purpose of visit of majority of the people were entertainment, fitness, health, sports related etc. Include more entertainment, fitness and health related options for different categories of people in order to keep them engaged for longer periods. Such customer centric developments could in fact draw more visitors both national and international.
- Dubai being a multi cultural society food preference also varies considerably and hence there is need for developing multi cuisine eateries near to public outdoor places. Develop more culinary options to attract more varieties of people in to the region. As the tourist destinations would be frequented by people with diverse traits, different comfort levels, needs, requirements, expectations, etc it would be appropriate to design these spaces with ample choices and features to cater to different categories of people (Matzarakis, 2007).
- It is seen that thermal comfort is influenced by cultural factors and so Dubai being a multi cultural society the possibility for marked variations in thermal comfort levels is relatively higher. So there is need for developing more entertainment related, health and fitness related with plenty of opportunity for adapting to the current conditions. According to Panagopoulos (2008) designing tourist locations or other spots where different classes and categories of people are expected to frequent it is imperative to include lot of shading options like multiple shading types and levels, provide entertainment options for different categories and classes of people as well as include additional features for catering to the needs and demands of wide categories of people. This in fact would provide greater options for the visitors to choose places based on one's preferences and priorities with regard to their thermal comfort.

### **6.2.1 Recommendations for Further Research**

Thermal comfort studies of both outdoor and indoor spaces are essential for the design and development of public outdoor and indoor places respectively. So many more studies of different magnitude and proportion are essential for developing clear cut

understanding on the thermal comfort and the extent of influence of the different parameters. Studies covering different seasons would be of greater applicability for developing the outdoor places in such a way as to be useful for the development of touristic areas and the associative activities centers in the region. Dubai being a multi cultural society, studies for unraveling the differences between the thermal comfort levels and psychological adaptation of people from different cultures would be useful in planning the transformation of Dubai in to a tourist spot. Climate form an important factor that influences the tourism capabilities of the region and tourists mostly respond to the combined effects of the climate. Hence, the Tourism Climate Index (TCI) calculations that takes in to considerations different parameters like temperature, relative humidity, wind, rain, sunshine, etc might appear more effective and have greater practical applicability. Since the primary data collections were done form different public outdoor places, most of the visitors were quite hesitant to participate in the surveys as they felt it might affect their privacy as well as their entertainments. There is need to make the questions more interesting in order to increase the response rates.

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## Appendix 1. Thermal comfort questionnaire

**This questioner is for estimation visitors' thermal comfort in this open area, so please do not hesitate to skip any question which you wish to.**

**Gender:** Female / Male

**Nationality:**

**Age:**

### Question 1: Comfort

How do you feel right now? (circle suitable answer)

Cool---Slightly Cool----Neutral---Slightly Warm-----Warm-----Hot-----Hazardously Hot

### Question 2: Temperature

Right now, you prefer to be in (circle suitable answer)

Warmer temperature

No change in temperature

Cooler temperature

### Question 3: Wind

Right now, would you like (circle suitable answer)

More air movement

No change in air movement

Less air movement

### Question 4: Sun

Right now, would you like (circle suitable answer)

More sun

No change

More shade

### Question 5: Vegetation

Would you like (circle suitable answer)

More greenery

No change

Less greenery

### Question 6: Clothing

Circle all the items closest to what you are wearing now:

Abaya

Dishdasha

Scarf

Shawl

Cap

Tie

Long Dress

Short Dress

Long Skirt

Short Skirt

Long Pants

Short

Pants Jeans

Shoes

Socks

Sandals

Jacket

Coat

Sleeved Less Shirt

Short Sleeved Shirt

Long Sleeved Shirt

**Question 7: Activity**

For the last half an hour have you been mostly (circle appropriate answer)

Sitting      Standing      Walking      Running      Cycling      Playing Physical Game

**Question 8: Food / Drink**

For the last half an hour have you been eating/drinking (circle appropriate answer)

Only Drinking Cold      Only Drinking Hot      Hot Drink with Food  
Cold Drink with Food      Only Eating Warm Food      Only Eating Cold Snack  
Eating Neutral Food      None

**Question 9: Social Visit**

Please circle the appropriate answers

- a. Before coming here, you thought for how long your visit could stay?  
Less than an hour      More than an hour
- b. Considering the current condition this space is offering, would you like to stay here more?  
Yes      No
- c. Is it your first visit?      Yes      No
- d. How many times a week do you visit here?      Once      Twice      Three or more
- e. When will be your next visit?      Probably never      As soon as I can      Not sure
- f. What is the purpose of your visit?  
Entertainment      Fitness      Relaxing      Meeting      Business
- g. Did you choose to be here?      Yes      No
- h. Do you live nearby?      Yes      No

Please write short appropriate answers

\*What do you like about this place?-----  
-----  
-----

\*What is your perception about a good outdoor space?-----  
-----

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**Question 10: Residency**

Please circle appropriate answers

- a. For how long have you been in Dubai?  
+ 5 years                      Between 1 and 5                      Less than 1                      Just for visit
  
  - b. You have not leaved UAE since?  
Last week                      Last month                      More than a month
  
  - c. Have you lived in any other country for at least one year in the past five years?  
Yes                      No
- If yes, which countries and for how long

Name of the country	From (Year)	To (Year)

**Appendix 2. The Questioner Noted by Researcher**

**Site:** -----  
PM/AM

**Date:** --/--/--

**Time:** --:--

**Observation:**

What is the total number of visitors who came to the place during the one hour time period which survey has happened?

+ 100      +200      +300      +400      +500      +600

The visitors are mostly    Ladies,      Gents,      Youths,      Elderly,      Kids.

---

**Volunteer Information:**

**Gender:**      F/M

**Age:**      Under 20      20's      30s'      40's      Over 50

-----  
**1: Color and Textile**

His/her cloths are mainly    Light Color,    Dark Color,    Heavy Material,    Light Material

-----  
**2: Appearance**

Circle the hair style which is closest to what he/she has

Short Hair      Bald      Middle Size Long hair  
Fair color hair      Dark color hair  
Fastened      Freestyle      Up do

-----  
**3: Nationality**

What is her/his nationality?

East Asian      European/American      Middle Eastern      Indian/Pakistan  
African      South American      Russian/East European      G.C.C

**4: Clothing**

What does he/she wear?

Abaya	Dishdasha	Long skirt	Long pants	Jeans
Short skirt	Sleeved Less Shirt	Short sleeved Shirt	Long Sleeved shirt	Scarf
Shoes	Socks	Shorts	Sandals	Shawl
Short dress	Jacket	Coat	Cap	

-----  
**5: Condition**

She/he is Alone, Couple, With Group, With Family, With Kid

She/he is under the shade under the sun

-----  
**6. Weight**

How much is his/her weight?

Thin Normal Chubby Fat Overweight



### Appendix 3. Major parks in Dubai



Appendix 4. Walks in Dubai





**Appendix 5. Photographs of the different surveyed locations**



The Walk at JBR, weekend, 11:00



Marina Walk, weekend, 11:00



Safa Park, weekend, 11:00



Jumeirah Beach Park, weekend, 11:00



Mumzar Park, weekend, 11:00



Zabeel Park, weekend, 11:00



Mushrif Park, weekend, 11:00



Creek Park, weekend, 11:00