DESIGN OF OUTDOOR SPACES AND ITS EFFECT ON THERMAL COMFORT IN EGYPTIAN UNIVERSITY

By

Hend Magdy Ali Amin

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Architecture

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

Prof. Dr. Maysa M. Abdel-Aziz

……

Professor of Architecture
Architecture
Faculty of Engineering, Cairo University

Prof. Dr. Mohammad H. Refaat

……

Professor and Head of Department
Of Urban Design
Faculty of Urban and Regional
Planning, Cairo University

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Approved by the
Examining Committee

_____
Prof. Dr. Maysa M. Abdel-Aziz, Thesis Main Advisor

_____
Prof. Dr. Mohammad H. Refaat, Advisor

_____
Prof. Dr. Ahmed F. Gamal EL Din Fahim, Internal Examiner

_____
Prof. Dr. Abbas M. Abbas El-Zafarany, External Examiner
- Professor and Dean of Faculty of Urban and Regional Planning, Cairo University.

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Engineer's Name: Hend Magdy Ali Amin
Date of Birth: 23/09/2018
Nationality: Egyptian
E-mail: hendalmoghazy@gmail.com
Phone: 01110036933
Address: 75 Abdelmonem Rayed-Alagouz-Al-Giza
Registration Date: …./…./……..
Awarding Date: …./…./……..
Degree: Master of Science
Department: Architecture

Supervisors:

Prof. Dr. Maysa Mahmoud Abdel-Aziz

Prof. Dr. Mohammad Hussein Refaat

Examiners:

Prof. Dr. Abbas Mohammad Abbas El-Zafarany (External examiner)
Prof. Dr. Ahmed Fahim Gamal EL-Din Fahim (Internal examiner)
Porf. Dr. Maysa Mahmoud Abdel-Aziz Thesis main advisor)
Prof. Dr. Mohammad Hussein Refaat (Member)

Title of Thesis:

The Design of Outdoor Space and Its Effect on Thermal Comfort in Egyptian University

Key Words:
ENVI-met, Outdoor Thermal Comfort, Predicted Mean Vote, Simulation, Outdoor Spaces, University Campus

Summary:
This research aims to investigate the climatic quality of outdoor spaces in Egyptian Universities and highlight campus microclimatic issues that play important role in the Design of Outdoor spaces especially in hot dry regions. To attain the research objective and question, a twofold classification was set between empirical research and literature; Empirical research including ENVI-met software simulation.

Predicted Mean vote (PMV) an outdoor thermal index was introduced to determine the effect of different trees scenarios on human comfort level in the two studied open spaces one in each campus Cairo University and German University in Cairo; the results reveal the following; there are significant differences in the air temperature, relative humidity, wind speed and PMV index. Trees alone can decrease temperature by 6.5∼9°C increase the humidity with 5%∼9% and decreasing PMV up to 1.19 ∼1.4 PMV ; these results are clearly attributed to the presence of vegetation.

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I. Research problem

As a public space, campus outdoor space is vital to students, faculty and staff, and community members who utilize the space. Nevertheless, in many campuses, outdoor space is empty and abundant much of the time; this due the following:

- Lack of activity.
- Lack of appropriate settlement for the students to be part of their learning environment.
- Major climatic problem such as lack of shade and pedestrain dis-comfort.

II. Research objective

The aim of this research is to investigate the climatic quality of campus outdoor space using simulation software and to study the effect of different vegetation scenarios on user comfort level in the college outdoor space.

III. Research Hypothesis

The hypothesis of this study that with the aid of vegetation ; it's possible to create a comfortable and aesthetically pleasing outdoor space ; which will increase the usability of campus outdoor space.

IV. Research Questions

There are some important questions which this research will try to find answers to them.these questions are :

- What's the suitable assessment tool to evaluate the effect of the plantation and other landscape elements on improving the micro climate?
- How to translate the climate landscape knowledge to enhance user experiment, in the context of a university campus, via simulation software?

Abstract

Universities, colleges, and higher institutes has expand in the last two decades; in this context, the campus outdoor space has gained an increasing attention among Architects and Urban designers due to its great importance to Campus image and its influential role on campus users. it involves a huge part of student activities, in addition to its Environmental and ecological benefits.

This research aims to evaluate landscape of outdoor spaces in Egyptian Universities and highlight campus Microclimatic issues that play important role in the Design of Outdoor spaces especially in hot dry regions. Trees among other landscape elements has a great impact on pedestrian thermal comfort and mitigating mean radiant temperature.

Thus the hypothesis of this study is that with the aid of softscape ; it's possible to create a comfortable microclimate together with aesthetically pleasing outdoor space ; thus will increase the usability of campus outdoor space .This will be achieved through a comparative analytical study between two University ; Cairo University and German University in Egypt ,One Outdoor space in each campus was Climatically simulated using ENVI-met ; climatic simulation program to fulfill the aim of the research , based upon meteorological data recorded by ETMY WMO station 623660 in Cairo international airport , taking in consideration built environment and the existing landscape.

Predicted Mean vote (PMV) an outdoor thermal index was introduced to determine the effect of different trees scenarios on human comfort level in the two studied open spaces in each campus; the experimental study showed that there are significant differences in the air temperature, relative humidity, wind speed and PMV index. Trees alone can decrease temperature by 6.5∼9°C increase the humidity with 5%∼9% and decreasing PMV up to 1.19 PMV in Cairo University and 1.4 PMV German University in Cairo ; these results are clearly attributed to the presence of vegetation since The 'Without Trees' case has a higher PMV in all cases. This cooling effect is due to reducing solar heat gain through shading and evaporation, in addition to altering wind direction and reducing its velocity causing a significant improvement in pedestrian thermal comfort.