KINETIC SHADING DEVICES FOR BUILDING IN TROPICAL CLIMATE

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DEDICATION

This thesis is dedicated to my whole family, especially my wife, who has always been patient, loved, and supported me throughout my study & graduate school journey. I also wanted to thank my supervisor, university friends, principal architects & office colleagues for their encouragement and help in completing this thesis.

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ABSTRACT

In tropical climate districts, day lighting is plenteous but isn't completely utilized in building plan due to the undesirable sun oriented warm pick up. Shading system are significant in building plan especially for buildings within the tropical region. In any case, the inner day lighting level in buildings of Malaysia was efficiently due to the disgraceful utilize of settled shading devices. Motor shading system are competen t to progress the quality and quantity of day lighting in buildings within the tropical region as the active shading device can react to the energetic sky condition. The targets of the study is to recognize the variables that would affect the execution of motor shading devices building within the tropical country, to execute a active shading system that inter-atomic with the energetic sky conditions and to move forward the day lighting execution of the working environment with giving ideal indoor illuminance level. The methodology utilized in this study is blended mixed method research. Literature review and case studies contributed to the plan parameters of dynamic shading devices by perception and comparison. Six sorts of shading devices are proposed and being surveyed through the day lighting examination reenactment and try is conducted utilizing Velux Daylight Visualizer and Sketch Up. The day lighting execution of the proposed shading gadgets are evaluated through the computer recreation program, Velux Daylight Visualizer. The discoveries recognized the motor shading gadgets which seem give ideal day lighting execution at each introduction and times beneath tropical sky. This think about contributes to the investigation of motor shading devices plan and the usage of dynamic shading devices on buildings within the tropical region. All things considered, further studies are required to consider the energy utilization of active shading system and day lighting execution examination using genuine climate information.

ABSTRAK

Di kawasan iklim tropika, pencahayaan siang adalah banyak tetapi tidak digunakan sepenuhnya dalam reka bentuk bangunan kerana penambahan haba suria yang tidak diingini. Sistem teduhan adalah penting dalam reka bentuk bangunan terutamanya untuk bangunan pejabat bertingkat di kawasan tropika. Walau bagaimanapun, tahap pencahayaan dalaman dalam bangunan pejabat di Malaysia tidak mencukupi disebabkan oleh penggunaan peranti teduhan tetap yang tidak betul. Sistem teduhan kinetik mampu meningkatkan kualiti dan kuantiti pencahayaan siang di bangunan pejabat bertingkat di kawasan tropika kerana peranti teduhan kinetik boleh bertindak balas terhadap keadaan langit yang dinamik. Objektif kajian adalah untuk mengenal pasti faktor-faktor yang akan mempengaruhi prestasi peranti teduhan kinetik bangunan pejabat berbilang tingkat di kawasan tropika, untuk melaksanakan sistem teduhan kinetik yang berinteraksi dengan keadaan langit yang dinamik dan untuk meningkatkan prestasi pencahayaan siang hari. tempat kerja dengan menyediakan tahap pencahayaan dalaman yang optimum. Metodologi yang digunakan dalam kajian ini ialah kajian kaedah campuran. Kajian literatur dan kajian kes menyumbang kepada parameter reka bentuk peranti teduhan kinetik melalui pemerhatian dan perbandingan. Enam jenis peranti teduhan dicadangkan dan dinilai melalui simulasi analisis pencahayaan siang. Satu eksperimen dijalankan menggunakan *Velux Daylight Visualizer* dan *SketchUp*. Prestasi pencahayaan siang peranti teduhan yang dicadangkan dinilai melalui perisian simulasi komputer, *Velux Daylight Visualizer*. Penemuan mengenal pasti peranti teduhan kinetik yang boleh memberikan prestasi pencahayaan siang yang optimum pada setiap orientasi dan masa di bawah langit tropika. Kajian ini menyumbang kepada penerokaan reka bentuk peranti teduhan kinetik dan pelaksanaan peranti teduhan kinetik pada bangunan pejabat di kawasan tropika. Namun begitu, kajian lanjut diperlukan untuk mempertimbangkan penggunaan tenaga sistem teduhan kinetik dan analisis prestasi pencahayaan siang menggunakan data iklim sebenar.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Day lighting is exceptionally critical to maintain human health on both physical health and mental health (Wirz-justice et al., 2020). Day lighting is the essential source of Vitamin D which is vital for the human body inside the system, particularly for the assimilation of calcium (Mirrahimi et al., 2012). In augmentations, day lighting directs the human circadian system, which administers the physical well-being and physiological movements such as sleep quality and cognitive capacities (Ward et al., 2019). In terms of mental impact, normal daylighting increment fulfillment encourages stretch recupe ration and makes strides in inventive issue understanding. According to the studies conducted by Rot et al., (2008) and Zadeh et al. (2014) the participants who uncovered to common lighting appeared enhancement in disposi tion and friendliness. A work environment with adequate characteristic lighting and wonderful see towards open-air makes a difference in the progress efficiency of the representatives (Ward et al., 2019).

Additionally, day lighting isn't as it were imperative for human well-being but contributes to vitality and productivity in buildings. The utilization of day lighting is one of the foremost successful methodologies to move forward indoor consolation and vitality productivity of the building as day lighting is inexhaustible within the tropical climate (Y. W. Lim, 2014). In tropical districts, the annual normal hour with daylight is 8 hours per day. In any case, the daylighting within the tropics is frequently related to strongly sun-oriented heat gain which causes thermal discomfort. In increments, too much tall worldwide illuminance, and sky illuminance within the tropics regularly causes non-uniform indoor illuminance conveyance and

visual inconvenience due to the eccentric illuminance design (Y. W. Lim et al., 2013). In this way, the foremost suitable day lighting approach for a building within the tropics is to conduct energetic day lighting collecting with solar control (Y. W. Lim et al., 2013).

Within the response to the green building development in Malaysia, the maintainability of building in Malaysia is assessed with different perspectives such as vitality effectiveness, water proficiency, and sustainable site management (G. H. Lim et al., 2017). In any case, the day lighting execution of the building is being assessed scarcely based on the Sunshine Figure without the thought of other lighting issues such as glare issues and non-uniform dispersion of light (G. H. Lim et al., 2017). According to the studies conducted by G. H. Lim et al. (2017), the day lighting performance of the green buildings in Malaysia showed a lacking "design gap" between the architect and the interior space usage by the users (G. H. Lim et al., 2017). Although both buildings are being recognized as green building, the occupants unsatisfied with the visual comfort in the building space (G. H. Lim et al., 2017). Subsequently, the day lighting plan of buildings in Malaysia confronts the issue of the need for interaction between inhabitants with day lighting with moo adaptability of day lighting control by the inhabitants.

Shading systems are one of the most efficient bio-climate solution for buildings in tropical regions. Thus, the design of building envelope for solar control are important to improving the day lighting performance and indoor visual comfort (Al-Masrani et al., 2018). Shading devices serve as a controller of solar radiation stream by changing over direct sunlight to diffuse light (Al-Masrani& Al-Obaidi, 2019). Based on the studies conducted by Ossen et al. (2005), the performance of the fixed shading device is different at multiple angles. The studies carried out by Y. W. Lim et al. (2012) claimed that the internal day lighting level in the building was inadequate due to inappropriate use of fixed shading device. Furthermore, the fixed shading devices are incapable to response to the dynamic sky

conditions in the tropical region, resulting in incompatibility illuminance levels between direct and diffuse light in internal spaces (Al-Masrani et al., 2018). The external factors such as site restriction and aesthetically needs also reveal the failing of the fixed shading devices (Al-Masrani et al., 2018). The fixed shading device exhibit limitation in day lighting performance due to the inflexible operation method (Al-Masrani et al., 2018). The restriction of fixed shading system can be overcome by combination of shading devices with responsive design strategies (Al-Masrani & Al-Obaidi, 2019). Moveable and kinetic shading system need to be incorporated with the building orientation to improving the day lighting performance of the buildings. Kinetic shading devices shall be control by the intelligent system (AI) which enable the shading devices to response to the internal and external conditions (Al-Masrani et al., 2018). The day lighting amount and quality within the building all through different periods with varying sun angles ought to be utilized to assess the capabilities of active shading systems (Al-Masrani & Al-Obaidi, 2019). In brief, this consideration will center on the plan of the motor building envelope to progress the day lighting execution of the building within the tropical region.

1.2 Problem Statement

In tropical climate region such as Malaysia, the main issue to harvest day lighting is the broad intensity of solar emission, which caused in unwanted solar heat gain (Y. W. Lim et al., 2012). According to data from the Subang Jaya Meteorological Station, the annually maximum intensity level of solar emission falling horizontally is around 1000W per sqm, and on vertical facade (east and west facing surfaces) is around 850W per sqm. The occupier could experiencing uncomfortable glare if there are lack of control of the day lighting especially for office work (Y. W. Lim et al., 2012). Due to the direct glare problem in the building spaces, many building in Malaysia chose to cover their window or opening to block the glare using blinds. As a result, the energy consumption enlarged as the spaces became more dependent on artificial lighting (Kandar et al., 2011). According to Y. W. Lim et al. (2012), the 5 chosen buildings were not planned for day lighting utilization as the average daylight factor lower than 1.5% and poor daylight system uniformity. Moreover, the

performance of day lighting in every room is better than the open plan building with elongated planning. Thus, proper planning for day lighting performance is required for energy savings and visual comfort for buildings in Malaysia (Kandar et al., 2011).

The day lighting appraisal for government buildings carried out by Y. W. Lim et al. (2013) discovered that the fixed external shading devices such as overhang and vertical screen for all facades seem decrease direct solar radiation but not able to preserve the visual consolation within the spaces due to glare and destitute distribution of daylight. This is often since the fixed shading devices are non-responsive to the transcendentally intermediate tropical sky with dynamic cloud arrangement.

In this way, the plan of shading system in tropical climate ought to coordinated with dynamic mechanism and versatile plan components to overcome the limitation of the conventional inactive shading system (Al- Masrani et al., 2018). The harvesting of day lighting in tropical climate has to be accentuation on quality rather than quantity. The active shading devices got to be able to control adequacy of daylight levels at distinctive period, especially reaction to the sun angle (Al-Masrani & Al Obaidi, 2019). The performance of kinetic shading systems is planned based on two primary targets to be specific glare decrease and adequate indoor illuminance (Al-Masrani & Al-Obaidi, 2019).

1.3 Research Aim

The aim of the study is to examine the day lighting performance of the kinetic based shading devices system for the building in tropical climate region.

1.4 Research Questions

The questions of the research are:

(a) What is the significance of shading devices for multi-level building in the tropical region?

(b) What is the design configuration of shading device to achieve the optimum day lighting performance for multi-storey building in the tropical region?

(c) What is the design parameter to optimize the day lighting performance with a kinetic shading device?

1.5 Research Objectives

The objectives of the research are:

(a) To identify the factors that affects the performance of kinetic shading devices for multi-storey building in the tropical region.

(b) To implement a kinetic shading system that interacts with the dynamic sky conditions

(c) To improve the day lighting performance of the internal spaces with providing optimum indoor illuminance level.

1.6 Scope of Thesis

This research will focus on the plan and execution of active shading gadgets in day lighting gathering with solar control. The plan components of motor shading gadgets will be decided based on the rule and hypothesis of day lighting harvesting within the tropical climate. The design components of dynamic shading devices are categorized into two components specifically structural components and mechanical components. The engineering components incorporate the geometric shapes and development of the shading devices whereas the kinetic components alluded to the component to control the development of the shading devices. The study moreover incorporates the understanding of the tropical sky. Sky conditions of tropical climate especially in Malaysia are decided and the solar point on each introduction is recognized. Illuminance (lux) of the office spaces with diverse formats and sunshine calculate (%) of the inside's spaces are the parameters to survey the day lighting execution of different kinetic shading devices. The relationship between the physical appearance of the shading device and the capacity for daylight collecting will be explored through simulation utilizing "Velux", a computer program to evaluate day lighting execution.

1.7 Significance of Study

The kinetic shading device as a building envelope is an inventive arrangement for improving the day lighting performance of a building but to be connected to an office building in Malaysia. This investigation contributes to the advancement of motor shading devices plan to recognize the imperative plan components. The day lighting performance evaluation is the instrument for dissecting the capacity of dynamic shading gadgets to give ideal day lighting and make strides indoor visual consolation. The discoveries of the research can be utilized as a plan direct for originators and policymakers.

1.8 Research Methodology

The research framework is to assess the day lighting execution of dynamic shading devices in a multi-story building in tropical climates. This inquiry about conducted as a mixed inquiry about strategy which is subjective and quantitative approaches. A literature review is utilized to gather data and knowledge of the day lighting plan procedure used within the tropics. A case ponder was moreover conducted to investigate the shape and tasteful aspects of the building envelope plan. The quantitative strategy is utilized to decide the day lighting execution of the indoor spaces through computer software.

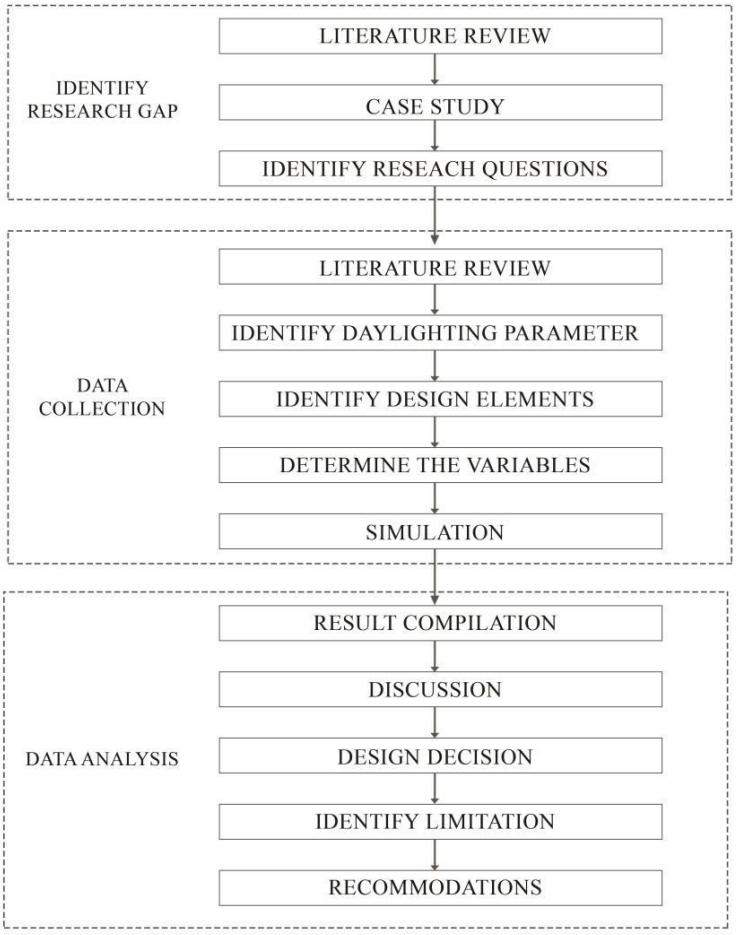

Figure 1.1 Research Methodology Flow Chart

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