ERGONOMIC SPACE DESIGN IN ENHANCING PERCEIVED WORK PERFORMANCE IN GREEN OFFICE BUILDING

Abdallah Muhamed Bashir

RESEARCH REPORT SUBMITTED TO THE FACULTY OF BUILT ENVIRONMENT, UNIVERSITY OF MALAYA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF FACILITIES AND MAINTENANCE MANAGEMENT

Master of Facilities and Maintenance Management
Faculty of Built Environment
University of Malaya
2017

UNIVERSITY OF MALAYA
ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: Abdallah Muhamed Bashir ███████████████████████

Registration/Matric No: BGG*160010*

Name of Degree: Master *of Facilities and Maintenance Management*

Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"): Ergonomic Space Design in Enhance Work Performance Perception in Green Office Building

Field of Study: Knowledge Management and Facilities Management

1) *I do* solemnly and sincerely declare that:
2) I am the sole author/writer of this Work;
3) This Work is original;
4) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work;
5) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
6) I hereby assign all and every rights in the copyright to this Work to the University of Malaya ("UM"), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
7) I am fully aware that if in the course of making this Work I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate's Signature ███████████████   Date: 19 / 11 / 2018

Subscribed and solemnly declared before,

███████████████████████

Witness's Signature   Date: 19 / 11 / 2018

Name: **Raha Sulaiman**

Designation: Pensyarah
              Jabatan Ukur Bangunan
              Fakulti Alam Bina
              Universiti Malaya
              50603 Kuala Lumpur

ii

ABSTRACT

Green Building industry has been growing rapidly at the recent time due its massive engorgement to develop sustainable environment. Sustainability has become the most drive factor for economic and social benefits. Therefore, companies and organisations started to pay prominent awareness to establish green building strategies within their premises. A certified green building usually receives more attention on energy consumption, indoor environment quality, sustainable materials and so on. However, in this new world of business, employees are exposed to alternative factors within their work places that can affect their work performance and productivity. Since employees spent about 8 hours average in daily basis indoor, it is important to consider ergonomics elements of their workplace. In the light of this research, the main objectives of this research are to study and identify ergonomics space design elements in office green building. Also, the study aims to investigate employee's satisfaction with their office ergonomics space design, IEQ and perceived ergonomics impact on work performance. The outline aims used to achieve these objectives is mixed mode approach of qualitative and quantitative analysis such as questionnaires survey, empirical measurement, interviews and observations. Nevertheless, this research has identified ergonomics space design elements in existing case study and findings showed that employees were satisfied about their workplace space design, IEQ and ergonomics due to good green practices. Finding on perceived ergonomic impact on work performance showed that office ergonomics believed to enhance work performance. The research concludes the importance of green ergonomics and recommends optimising ergonomics features in green office building.

Abstrak

Industri Bangunan Hijau telah berkembang dengan pesat pada masa yang lalu disebabkan pengukuhan besar-besaran untuk membangunkan persekitaran yang mampan. Oleh itu, syarikat dan organisasi mula membayar kesedaran yang jelas untuk mewujudkan strategi bangunan hijau di dalam premis mereka. Bangunan hijau yang disahkan biasanya mendapat lebih banyak perhatian terhadap penggunaan tenaga, kualiti alam sekitar dalaman, bahan-bahan yang mampan dan sebagainya. Walau bagaimanapun, dalam dunia perniagaan baru ini, pekerja terdedah kepada faktor alternatif di tempat kerja mereka yang boleh mempengaruhi prestasi kerja dan produktiviti mereka. Oleh kerana pekerja menghabiskan masa sekitar 8 jam setiap hari di dalam rumah, penting untuk mempertimbangkan elemen ergonomi di tempat kerja mereka. Berdasarkan kajian ini, objektif utama penyelidikan ini adalah untuk mengkaji dan mengenalpasti unsur reka bentuk ruang ergonomik di bangunan hijau pejabat. Selain itu, kajian ini bertujuan untuk mengkaji kepuasan pekerja dengan reka bentuk ruang ergonomik pejabat mereka, IEQ dan impak ergonomi yang dirasai terhadap prestasi kerja. Garis besar bertujuan untuk mencapai matlamat ini adalah pendekatan mod campuran analisis kualitatif dan kuantitatif seperti soal selidik kuesioner, pengukuran empirikal, wawancara dan pemerhatian. Walau bagaimanapun, kajian ini telah mengenal pasti elemen reka bentuk ruang ergonomik dalam kajian kes yang sedia ada dan penemuan menunjukkan bahawa pekerja berpuas hati dengan reka bentuk ruang kerja, IEQ dan ergonomik mereka kerana amalan hijau yang baik. Mencari impak ergonomik yang dilihat pada prestasi kerja menunjukkan bahawa ergonomik pejabat dipercayai meningkatkan prestasi kerja. Penyelidikan ini menyimpulkan kepentingan ergonomik hijau dan mengesyorkan mengoptimumkan ciri-ciri ergonomik di bangunan pejabat hijau.

ACKNOWLEDGEMENT

Table of content

List of Figures

List of Tables

List of symbols and abbreviations

WRMSD   : Work Related Musculoskeletal Syndrome Disorders

GBI   : Green Building Index

LEED   : Leadership in Energy and Environmental Design

IEQ   : Indoor Environment Quality

WP   : Work Performance

List of Appendix

CHAPTER 1

1.0 Introduction

1.1   Research Background

Constructions strategies have been developed to accommodate this rapid growth as human population is increasing rapidly. Development is associated directly to construction and building industry. For instance, construction industry has played vital role for the national growth, in terms of the social aspects, economic benefits and sustainable environment especially within office building (Giang & Sui Pheng, 2011). However, providing designs, which initiate comfort needs attentive attention to magnify employees' Work performance and satisfaction (Ropin, 1995). Thus, designing sustainable office environment deliver healthy work environment for employee and provide economic growth within the organisation (Goodell, 2010). As growth of population is enlarging over time, more employees are joining the sectors and more offices topped with employees. These employees practice different type of professions and perform various tasks. Thus, coming up with efficient space design of offices shall contribute to accommodate several work activities.

Buildings have become very important that it begins to become the place to accommodate companies and organizations. These companies and organizations have accommodated employees through office concepts. In the modern time, employees started to spend most of their time indoors. Studies by American Society of Heating (2010) have noted that employees spend about eighty to ninety percent of working time inside offices. Thus, employees' health effects and comfort have been essentially

1

associated with building characteristics. Therefore, building indoor environment has shown a potential of direct influence to the employee's health, behavior and productivity (Hua, Loftness, Kraut, & Powell, 2010).

1.2 Problem Statement

A building which receives green building certification will always have efficient energy consumption, sustainable structures and materials; and many positive experiences in terms of occupants' health, performance and satisfaction (Hedge. A & Dprsey. J. A, 2013). There were plenty of researches on the post-occupancy evaluation in green buildings where mostly to investigate the effect of the ambient indoor environment such as the temperatures, humidity, airflow, lighting and contaminants on the occupants. These parameters would greatly influence not only on the indoor environmental qualities but also very much related with the approach to reduce the energy consumption as well as the element of green features the building could have – something which usually people would say a sustainable building. Therefore, occupants' satisfaction on these elements would not be a problem.

However, building occupants who spend about 8 hours daily in the building would expose themselves with not only the ambient environment but also factors, which are unrelated to environmental qualities around them. As suggested by Schiavon and Altomonte (2014) the unrelated environmental element that would give impact on users' satisfaction are office type, spatial layout, distance from window, building size, gender, age, type of work, time at workspace, and weekly working hours. Hedge. A and Dprsey. J. A (2013) on the other hand added the element of ergonomic products at workstation, office workplace and office furniture that would include as green ergonomics features.

2

In an office building, workers do not have any choice to design their own workspace or rooms including any equipment, furniture, layout, location and others as these are up to the decision of the company's decision. Therefore, these restrictions would direct or indirectly influence their work performance and wellbeing.

1.3   Research Questions

Based on the research objectives, four (4) research questions are designed as follow:

1. What are the contributing elements of ergonomic Space design that influence employees work performance?

2. What are the ergonomic elements in new construction green office building (NRNC)?

3. What are the implications of ergonomic space design on employees' work performance and satisfaction in green office building?

4. How green ergonomics can enhance the assessment for green office building?

1.4   Research Objectives

Objectives of this research are:

1. To study green ergonomics space design elements in green office space that can affect the employee's work performance.

2. To identify green ergonomics space design features in new construction green office building (NRNC).

3. To investigate perceived employees' satisfaction on ergonomic space design elements in green office building.

4. To recommend green ergonomics that can be included in existing green building requirement.

3

1.5   Research Limitation

The limitation of this research is getting the access for data collection from head department of JKR. The initial stage of getting permission to access office areas, Permission was granted to access floor 29 and 31 from 4 selected floors in total. Therefore, conducting measurements at the other 2 floors were not permitted thereof.

Other limitation encountered was achieving maximum number of targeted respondents to participate in the questionnaire survey. Respondents achieved were 61 participants out of 155-targeted respondents due to limited time frame and workloads. Furthermore, limited sources of supporting documents such as records, floor plans and previous green building data. Moreover, lack of consideration of space design in green building standards and it is rating tools (Green Building Index, 2011).

1.6   Research Hypothesis

Ergonomic element in space design can positively enhance the perception of employees' work performance in green office buildings and create healthy environment.

1.7   Thesis Structure

The research is divided into 5 chapters. Chapter 1 is the introduction, which includes research background that contains history contexts about the research, problem statement that address the main issues of conducting the research, research objectives, research questions, research limitation and research hypothesis.

Chapter 2 is the literature review, which it is an action of making depth investigation at written literatures of foregoing researches, previous published Articles and online journal that are relevant to the research main objectives and conducted researches

4

related to space design impact on the improvement of work performance and employees' productivity. The main purpose of literatures review chapter is to build a constructive research of the foregoing findings and data in order to have supporting documents for research claims, which are made throughout the research establishing. Literature review acts a solid proof that information provided in the research are valuable and it is not based on false, unrelated theories.

Chapter 3 is the methodology. This chapter focuses at the entire procedure of the thesis structuring and constructing. The initial stage of inspecting through the literatures and reviews scientific articles related to the research subject. This chapter shall conduct through either of two methodologies. These methodologies are qualitative and quantitative method and if both methods used, it shall be called mixed mode methodology. These methodologies includes measurement tasks, the use of equipment, conducting personal interviews, distribution of questionnaire and any other further method used to conduct the research to meet the research objectives.

Chapter 4 covers the approaches case studies. This chapter focuses on all information that has been collected specifically from the potential case studies. The context of this chapter is mainly about the case studies. For example, a brief introduction about the approached case studies, locations of these buildings and further information regarding office layout design, demographic statistic of the office occupants, office arrangement, space management concept that have been applied. The importance of this chapter is to address a background study about the potential case studies and to give overviews for the readers about the case studies for better understanding of the addressed cases.

5

Chapter 5 is data analysis and finding. In this chapter focuses on analyzing the data collected and obtained. In addition, the analyzed data shall be used for the purpose of meeting the research objectives. The main components of space designs, personal perceptions and satisfaction level of employees about the current workplace design shall be the vital focus in this chapter. Findings through the Analysis of information obtained shall determine the existing issues in regard to workplace design and measure how these issues affecting employees' work performance and productivity. Plus, the findings shall give overview on space design act as a contributing part on employees productivity within an office in a green building and how space design should be considered in green building guidelines and standards. The importance of this chapter is to supply solid results based on experimental and constructive studies within the approached case studies.

Chapter 6 shall be covering conclusion and recommendation of this research report. Conclusion shall be a sum up of various components of the research report, which are made based on all information obtained and constructed findings throughout the study. The conclusion shall give summary of the researcher opinion obstructed throughout the study. Also the conclusion made to confirm that the report findings have met the research objectives. Recommendations shall be a sort of opinion to advocate problem solving of existing issues that have been found throughout the study. The recommendation is made based on findings and other information obtained through data analysis of the approached case studies to summarize researcher opinion on how to encounter existing issues.

CHAPTER 2

2.0 Literature Review

2.1 Introduction

In the last twenty years, there have been consistent arguments about office designs affect on work performance and comfort. Plus, the argument has extended to reach other qualities of offices spaces and their influence on social sector, comfort and satisfaction of employees (Clements, 2008). Companies and organizations have been striving to create better offices indoor surroundings that provide healthy and comfortable environment to employees (Al horr et al., 2016). Hence, This shall be one critical part that contributing to the economic and social values, as a huge slice of modern societies work style devote the most of their working hours in the office (Clements, 2008).

Physical environment is one of the very important elements that take into consideration office design plan or workplace. Additionally, the importance of design factor is demonstrated as a way to develop a healthy working environment for building occupants. According to Denyer (1969), offices are designed in certain ways for employees to conduct clerical operations. While Arora (1981), mentioned that offices are understood as a place in which organisation progress documentation of business process and conserving date information's obtained throughout business operations.

To add more, Kaplan and Aronoff (1996) emphasized that office buildings are usually described as a place where organisations conduct business operations, including documentation of information and business activities. Furthermore, office is

demonstrated a physical space provided to practice business tasks such as supervising, designing, filing, analyzing, planning, decision-making and communications. The development of office building is required to coordinate and facilitate employees' work activities during working hours.

2.2 Source of variables for questionnaires development

In general, Sources of variables are obtained from extensive research to find out contributing elements of ergonomic space design and Indoor Environment quality in enhance work performance perception in green building. These variables are described at the table below and cited as follow:

Table -2.1: Source of questionnaires variables

Component	Variables		Citation
Workplace Space design	Independent Variables	Interior Design	(Hedge. A & Dprsey. J. A, 2013) (Dul. J & Neumann, 2009)
		Space Design	
		Office Flexibility and Movement	
Indoor Environment Quality	Independent Variables	Temperature level and RH%	(Lee & Guerin, 2009) (Turner, 2006) (Hedge. A & Dprsey. J. A, 2013) (Radjiyev, Qiu, Xiong, & Nam, 2015) (MS1525, 2014)
		Lighting (Lux) level	
		Noise Level	
		Air Quality	
The workplace ergonomics	Independent Variables	The office furniture	(Dul. J & Neumann, 2009) (Kushwaha & Kane, 2016) (Lewis & Kraweie, 2002) (Hedge. A & Dprsey. J. A, 2013)
Dependent Variable		Perceived ergonomic impact on work performance	

2.3   Green Building Tools and Checklist

In the recent time, employees primary tend to spend most of the working time within buildings that are required to be ventilated, lighted and artificially designed to achieve suitable work environment. It is noted by US Energy Administration (2009) that commercial buildings consumes 20% of energy compared with office buildings. Findings have shown that office building consumes twice number of energy consumptions in comparison to other building types. Therefore, energy consumption has received significant concern due to its environmental impact as well as financial role to organisations. Although several green building standards and tools pay more attention to the mentioned factors previous, it is also very important to take measures regarding establishing healthy, productive and comfortable workplaces.

In reference to Hedge, Puleio, and Wang (2011), who noted evidence that show sufficient and adequate ergonomic design of office layout and office workplace is affiliated with common work related musculoskeletal disorders (WRMSDs). According to studies in the United states by Bureau of Labor Statistics (2009), demonstrated that 2.7 millions non-fatal injuries and illness cases of employees, which noted 50% decrease in productivity through work absence, work restrictions and job transfers. Additionally, illness through insufficient ergonomic consideration also contributes to those factors that have an impact on work performance.

Furthermore, In Leadership and Environmental Design (LEED) certified building, it is possible to decrease rate of injuries through proactive ergonomics measures, in which create cost reduction and enhance overall employees work performance (Lewis & Kraweie, 2002). Thus, The United State Green Building United State Green Building

9

Council (2010) acknowledged that performance optimisation in green building shall be optimised when energy efficiency is considered in line with employees' well-being, comfort and productivity. On the other hand, LEED system have been designed to certify building and communities that consider sustainability features, which provide protection to the environment and encourage overall health, well-being, and productivity of employees (Hedge, 2008). Therefore, LEED rated system has been developing and evolving throughout the time. Then in 2008, LEED enacted ergonomics programme credit point in commercial interiors rating system (v2009).

Table 2.2: LEED IEQ Checklist

Indoor Environmental Quality		Possible Points:	15
Prereq 1	Minimum IAQ Performance		
Prereq 2	Environmental Tobacco Smoke (ETS) Control		
Prereq 3	Green Cleaning Policy		
Credit 1.1	Indoor Air Quality Best Management Practices Indoor Air Quality Management Program		1
Credit 1.2	Indoor Air Quality Best Management Practices— Outdoor Air Delivery Monitoring		1
Credit 1.3	Indoor Air Quality Best Management Practices— Increased Ventilation		1
Credit 1.4	Indoor Air Quality Best Management Practices— Reduce Particulates in Air Distribution		1
Credit 1.5	Indoor Air Quality Best Management Practices— Facility Alterations and Additions		1
Credit 2.1	Occupant Comfort—Occupant Survey		1
Credit 2.2	Controllability of Systems—Lighting		1
Credit 2.3	Occupant Comfort—Thermal Comfort Monitoring		1
Credit 2.4	Daylight and Views		1
Credit 3.1	Green Cleaning—High Performance Cleaning Program		1
Credit 3.2	Green Cleaning—Custodial Effectiveness Assessment		1

Credit 3.3	Green Cleaning—Purchase of Sustainable Cleaning Products and Materials	1
Credit 3.4	Green Cleaning—Sustainable Cleaning Equipment	1
Credit 3.5	Green Cleaning—Indoor Chemical and Pollutant Source Control	1
Credit 3.6	Green Cleaning—Indoor Integrated Pest Management	1

Through reviews on space design policy in Green Building Green Building Index (2011) standards, it is noted that there is lack of consideration of space design and its impact on employees' productivity and work performance in green buildings. Though studies have shown several issues related to space design that influence employees' productivity and work performance. Therefore, these Issues should be considered when it comes to space design and performance measurement, which are sustainability, comfort and productivity (Saari, Topi, Esko, & Olli, 2006).

Table 2.3: GBI Non-Residential New Building Tool (NRNC)

EQ	Indoor environment Quality	
Air Quality		Points
EQ1	Minimum IAQ Performance	1
EQ2	Environmental Tobacco Smoke (ETS) control	1
EQ3	Carbon Dioxide Monitoring and Control	1
EQ4	Indoor Air Pollution	2
EQ5	Mould Preservation	1
Thermal Comfort		
EQ6	Thermal Comfort: controllability of system	2
EQ7	Air change Effectiveness	1
Lighting, Visual and Acoustic Comfort		
EQ8	Day lighting	2
EQ9	Daylight Glare Control	1
EQ10	Electric Lighting Level	1
EQ11	High Frequency Ballasts	1

EQ12	External Views	2
EQ13	Internal Noise Level	1
Ventilation		
EQ14	IAQ Before/During Occupancy	2
EQ15	Occupancy Comfort Survey: Verification	2

2.4 Space Design in Green Building

Several researches conducted by Crouch (1989) that categorised office environment in several categories. These categories are air quality, temperature, lighting, noise and existing openings. On the other hands, other researchers proposed these mentioned categories as components of physical environment. These elements shall be directly or indirectly influence behaviours, attitudes, satisfaction and performance of employees. Extensively, MacNaughton et al. (2017) has found in his paper that dissatisfaction of employees is very much connected to office temperature, lighting and noise condition. Comparably, high level of employees' dissatisfaction results decreasing on productivity level. Therefore, employees' concentration level during work is lower due to these influential factors.

However, further research by Global office occupancy cost (2012), which has mentioned that a comparison is made between net of the available floor area to numbers of employees working in the same area inside the office. These chosen buildings are positioned in the center of different hectic cities in several countries. The actual net floor area comprised of workstations as well as other office spaces utilised by employees in the office. Additionally, companies in U.K, Japan and china showed an average of 10 m2 of offices space per person, in compare to several major western cities, the results of the research have shown an average of 20 m2 per person of office space provided. Therefore, questions are raised comparatively. These questions focus on

12

whether other organizations shall also consider improving space use efficiency in their own countries that not currently implementing those standards. Nevertheless, employee cost has risen relatively to the increasing number of employees that work within the same office space provided. Beside that, an effective use of space shall generate opposing consequences. For example, the heat loads by employees, the level of contamination and equipment use shall increase by an extensive use of space. Yet, it is possible to have an impact on the elements of indoor environment, in which affect the efficiency of indoor environment rating, for instance, indoor climate. Moreover, having not to consider providing adequate ventilation system and cooling shall excessively enlarge space use efficiency and that shall reduce quality of office indoor environment. Therefore, employee's performance during work may face possible reduction, which leads to lower productivity rate of employees. Consequently, it shall include losses of efficient space use and financial benefit.

2.5   Ergonomic Design

The importance of sustainable development is globally recognized (Radjiyev et al., 2015). Although ergonomic role is often considered, it has become the center of attention and concern for several researchers in various fields such as design, business and engineering (McLennan, 2004). Consequently, sustainable development aspects normally take into consideration economic and environmental dimensions, as well as social (Zink, 2014). Besides, human factor, which is known as ergonomic is defined as a science that consider scientific disciplines in reference to understanding human interaction with other elements of the system. Which help to generate theories, apply principles and design methods in order to optimise human well being with overall performance (Kushwaha & Kane, 2016).

Ergonomic concerns are considered in sustainable development to improve social goals and develop economic targets (Dul. J & Neumann, 2009). Likewise, the mentioned statements above indicated that both sustainability and ergonomic are human oriented approach (Legg & Brown, 2010). Another statement by boils (2014) stating that ergonomic design can play a vital role in assisting sustainable development transitions.

According to United States Green Building Council (2013) The green building strategies have been utterly presumed to produce considerable quality of daylight control, less air pollution emission and create better health path for employees. However, there have been collections of evidence collected from post occupancy studies that suggest alternative causes of health issues. Taking into consideration the fact that buildings are constructed, not only to accommodate business facilities but also to ensure healthy condition for employees and provide comfortable working environment. Furthermore, the relationship between sustainable development and occupants' health will be one of the very important drives for green building space in the next twenty years. Therefore, the theory has been established that health is not the only factor of concern for indoor environment but also a quality of ergonomic design. Thus, USGBC is on the verge to promote ergonomics credits strategies for Leadership in Energy and Environmental Design (LEED) v4 certification process. In addition, Hua and yang (2013) conducted a study, which covers ergonomics impact of physical environment on work activities and job satisfaction. The result shows the importance of ergonomic in green building design process. The study also concluded that ergonomic strategies can promote healthy and sustainable work environment. Therefore, the study strongly suggests formally including ergonomics credits to LEED and addressing the importance of physical environment.

14

2.6   Work Performance and Productivity in Office

Work performance tends to be influenced by several fundamental aspects that affect employees' perception towards office environment, for instance, office layout plan. Usually, workplace designs often provide individual private offices for employees. However, The open space concept is in constant increase. Since open space plan is cost effective and convenient for space layout arrangement. Hence, organisations have strived to implement new design techniques and concepts for the sake of improving employees' productivity and enhance level of comfort (El-Zeiny, 2012). Another study by Amina and Shehla (2009) focuses on the relationship between work performance and productivity. Through reviewing previous studies, it is concluded that workplace space design appears to be connected improving productivity, alongside with efficient management processes.

Dole and Schroeder (2001) demonstrated the relationship between work performance and productivity. The researchers elaborated that employees usually produce better work outcomes relatively to the workplace environment. The researchers noted that higher level of employees' satisfaction is linked with the physical environment of the workplace. Moreover, Springer (1992) have depicted a study about ergonomic relation to performance. It is also concluded that considering ergonomic design may increase employees' performance by 10 to 15 percent additionally.

According to Gensler (2009), which studied twenty hundreds of UK business organisations. The results provided proof that improving workplace shall uplift overall productivity and work performance by nineteen percent. In addition, boost productivity of an individual employee by seventeen percent. Those results may provide major

15

economic benefit to the organisation. In the United States, Gensler (2006) also continued the study by conducting survey that covered two thousands employees. The results have showed that ninety percent of the participants are convinced that improving offices layout and physical environment helps to generate better work performance rate. As mentioned by Campbell (1990), who identified performance as employees' behavior towards assigned tasks. The researcher impression is to differentiate consequences from performance. Consequences are defined as outcomes of employee's' performance towards their job tasks in the workplace. On the other hand, there are various elements, which distinguish office users behaviors and the consequences.

Brill, Margulis, and Konar (1984) highlighted various influencing factors, which play effective role on productivity and work performance of employees. Moreover, Brill have determined These factors in his research according to their importance to space design. For instance, temperature, flexibility of access, comfort, furniture, communication, noise, lighting and air quality. Furthermore, Interior design shall have a direct contribution on work performance as well. According to National Council for Interior Design Qualification (NCIDQ), which illustrated the definition of interior design. Interior design is depicted as a science driven by understanding behavior of building occupants to provide creative functionality within spaces, taking into accounts technical solutions.

2.7   Employees Health and Wellbeing

Human health and well-being factors have received a great amount of concern in regard to green building development (World Green Building Council, 2014). Building occupants behaviour is one vital component that contributes to influence energy use in office buildings, which basically depends on the satisfaction level of building occupants

16

as well as comfort criteria (Amina & Shehla, 2009). In addition, it is well known that overtime working is an ordinary phenomena in nowadays work requirement, which trigger serious burden of energy savings, as well as employees well-being (Michie, 2002). Furthermore, employees presented as one of the most significant supporters to the organisation's operations and development (Hraska, 2015). Therefore, organisations are compelled to improve health and well-being of their employees (Gou & Lau, 2012). Then, enhancing productivity of employees by optimising workplace environment, such as open spaces and other factors that influence comfort (Shahzad & Brennan, 2016).

In today's time, nemours of offices health strategies have been considered in numbers of green building rating systems such as LEED and China Green Building Evaluation Standards (Amina & Shehla). These green buildings qualities are illustrated in the following table. The main purpose is improving health and productivity, which is also compatible to improve energy efficiency and use of resources.

Table 2.4: LEED Rating Tool

Green Features	Rating System	Criteria
Natural Ventilation	LEED V4 Building Design and Construction.	Illustrate that the designed system for employee's spaces involves appropriate strategies in Chartered Institution of Building Service Engineers (CIBSE) application Manual AM10, March 2005, Natural Ventilation in Non-domestic building section 2,4
	BEAM Plus New Building V1.2	The building is designed to allow utilization of natural ventilation, which is required to make a minimal background ventilation available to control indoor air pollutants
	Green Mark New Building V4.1	It is encouraged for design to facilitate good natural ventilation with an average wind speed of 0.6 m/s within the functional space/units.
Daylight and View Quality	LEED V4 Building Design and Construction.	1. To associate building occupants with the outdoors and reduce the use of electrical lighting by introducing LEED V4 daylight into space. Building Design and Construction 2. To connect building occupants with the outdoor environment by providing quality views with a direct line of sight to the outdoors via vision glazing for 75% of all regularly occupied floor area. View glazing in the contributing area must provide a clear image of the exterior.
	BEAM Plus New Building V1.2	Encourage a holistic assessment of building design, site layout, in order to increase access to daylight and improved comfort and health.
	Green Mark New Building V4.1	it is encouraged to use design that optimizes day lighting effectively in order to minimise energy use for artificial lighting at green space
Green Space	LEED V4 Building Design and Construction.	Outdoor space shall be provided higher or equal to 30% of the total site area (including building footprint). A minimum of 25% of that outdoor space must be planted (turf grass does not count) or have overhead vegetated canopy.
	BEAM Plus New Building V1.2	Utilizing a minimum of 50% of previous materials of hard landscaped areas; provide suitable planting equal to at least 30% to 40% of the site area.
	Green Mark New Building V4.1	Provide greenery in the premises, taking into account rooftop garden and sky garden. Plot Ratio of greenery is calculated by considering the 3D volume covered by plants (Leaf Area Index).

According to Xue, Gou, and Lau (2016) who found out that many prior studies have put an effort to draw attention to the interrelations between health and well-being outcomes and employees' work environment. However, Xue and Gou noted the existing relationship between built environment and employees' health perception is barely discussed. The amount of pressure that is rapidly increasing by urbanization and overpopulation has triggered serious concern towards health and well-being qualities. Therefore, the significant contribution of health and well being in workplace has been promoted and became increasingly valued by public and private organization. The drives that brought these organization attentions to workplace health standards are essentiality to work quality improvement and workforce motivation for future business competitions globally. It is noticeable that the perceived health evaluation results in certified green building is mostly positive. It is due the set of strategies implied by green building standards, which aim to improve employees' satisfaction and health (Xue et al., 2016). To add more, natural ventilation is selectively prioritized due its effective strategies to energy cost reduction and indoor environment quality enhancements. Seppänen, Fisk, and Lei (2006) have studies the quantitative variables of work performance and evaluated its relationship with ventilation rate. The results relatively stated that fresh air can promote work efficiency and reduce tiredness in a positive scale. Additionally, enhancing indoor environment quality and fresh air supply in addition to sunlight exposure and having nice view through windows generate greater satisfaction and increase productivity.

2.8   MS 1525 Malaysian Standard

The department of Standard Malaysia enacted MS 1525, which known as Energy efficiency and use of renewable energy for non- residential buildings. This standard was implemented for the purpose of fostering and promoting standards, standardization, and advancing the means of national economy. Also, it is established for health benefits and protecting public consumers in addition to facilitating international and domestic trade within and outside the country (MS1525, 2014).

Lighting

According to MS1525 (2014) it is required to approve compliance with MS ISO 8995 in order comply with this clause. MS ISO 8995 is the minimum safety standard for interior lighting. Therefore, it is necessary to comply with the recommended average illuminance provided at the table shown below.

Table -2.5: MS 1525 Illuminance average recommended

Task and Application	Illuminance (Lux)	Minimum CRI
Entrance hall, lobbies, waiting room	100	60
General office, reading and writing	300-400	80
Infrequent reading and writing	200	80
Drawing office	300 0 400	85
Class room\ meeting room	300 - 500	80
Corridor, Passageways, stairs	100	40

Temperature and Relative Humidity (MS1525, 2014)

In reference to MS1525 (2014), the comfort of an individual depends on the metabolic heat that dissipate at the produced rate. An individual body needs to maintain a constant temperature of 37+ regardless of the prevailing ambient condition. When the space relative humidity (RH%) is high, the lower amount of heat transferred by human body.

Therefore, the purpose of room comfort condition and engineering designs, it must consider the three main factors, which are dry bulb Temperature, Relative Humidly and Air velocity. Thus, The indoor design condition of air conditioned space for comfort cooling should be as follow:

Table 2.6: MS 1525 Average Temperature and humidity standards

Task and Application	Level
Recommended design dry bulb temperature	24 ° C – 26 ° C
Minimum dry bulb temperature	23 ° C
Recommended design relative humidity	50 %- 70 %
Recommended Air movement	0.15 m\s – 0.50 m\s
Maximum air Movement	0.70 m\s

2.9   Conceptual Framework

Dependent Variables

```
                    ┌─────────────────────────┐
                    │ Perceived Work performance │
                    └─────────────────────────┘
                       │          │          │
```

Components

```
  ┌──────────────┐   ┌──────────┐   ┌──────────────────────┐
  │ Offic Ergonomic │  │   IEQ    │   │ Workplace space desgn │
  └──────────────┘   └──────────┘   └──────────────────────┘
         │                │                    │
```

Independent Variables

```
  ┌──────────────┐   ┌──────────────────┐   ┌──────────────────────┐
  │              │   │ Temperature And  │   │                      │
  │ Office Furniture │ │     RH%          │   │   Interior Design    │
  │              │   │                  │   │                      │
  │              │   │ Lighting (Lux)   │   │    Space Design      │
  │              │   │                  │   │                      │
  │              │   │  Noise Level     │   │   Office Flexibility │
  │              │   │                  │   │    and  movement     │
  │              │   │  Air Quality     │   │                      │
  └──────────────┘   └──────────────────┘   └──────────────────────┘
```
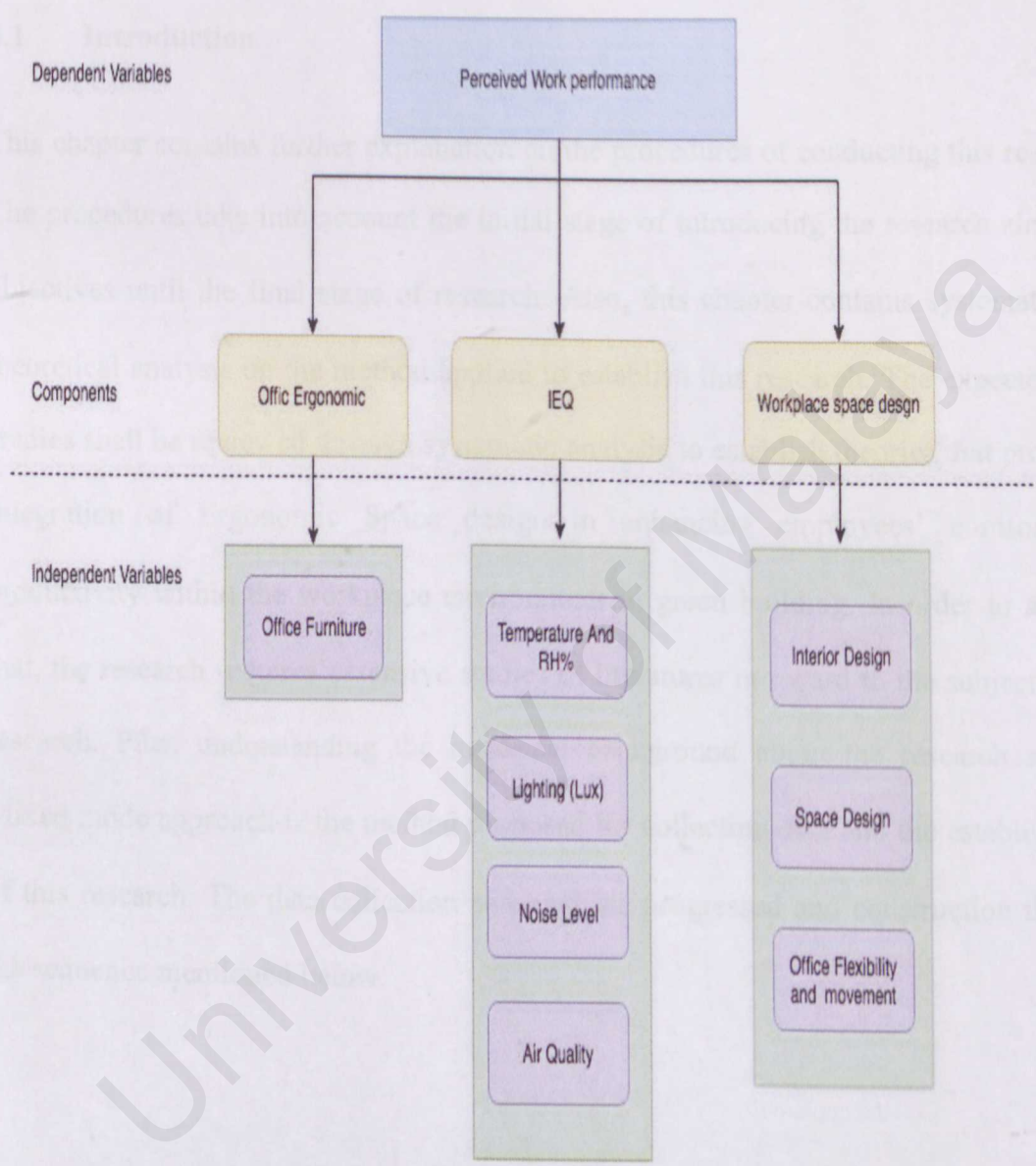
Figure -2.1: Conceptual Framework

CHAPTER 3

3.0 Research Methodology

3.1   Introduction

This chapter contains further explanation on the procedures of conducting this research.
The procedures take into account the initial stage of introducing the research aims and
objectives until the final stage of research. Also, this chapter contains systematic and
theoretical analysis on the method applied to establish this research. The expected case
studies shall be reviewed through systematic analysis to establish theories that prove the
integration of Ergonomic Space design in enhancing employees' comfort and
productivity within the workplace environment in green building. In order to achieve
that, the research requires extensive studies of literatures in regard to the subject of the
research. Plus, understanding the historical background about the research subject.
Mixed mode approach is the method proposed for collecting data and the establishment
of this research. The data collection and analysis progressed and construction through
the sequence mentioned below.

3.2   Quantitative Method

Quantitative method is an arranged and systematically organized method to conduct a study and obtaining results or findings. It is a data based method, including critical objectives that are based on scientific investigation or questions of quantitative properties, phenomenon and relationships.

3.2.1   Questionnaire Survey

Questionnaire is used to provide statistics and measures for the potential factors that affect work performance, health and comfort level of employees and building users. It is also used to help examining satisfaction level employees with their workplace. On top of that, it is used to determine different causes related to ergonomic space design and recommend alternatives for the health and well-being issues. Questionnaires shall be given out to participants. These participants are mostly the employees of Cawangan Dasar Dan Pengumsan Korporat. The Questionnaire comprise of 5 categories that are measured with scale, each category comprises of 5 minimum to seven (7) questions as maximum. The scale used is one to five measurements, starting from 1 that act very dissatisfied, 3 is natural and end with 5 acting as very satisfied. These categories are explained in Table 3.1.

Table 3-1 Questions Survey Sections

Section	Category	Scale Used
1	Demographic	Single answer
2	Workplace Space Design	1 to 5 scale
3	Indoor Environment Quality	1 to 5 scale
4	Office Ergonomic	1 to 5 scale
5	Perceived Employees Work Performance	1 to 5 scale

3.2.2 Selection of Respondents

In this section, selection of respondent is based on the targeted respondents working at Cawangan Dasar Dan Pengumsan Korporat. The targeted responded should be categorised in different lists. Respondent shall have different opinions that may influence the findings of this study. The respondents filling questionnaires surveys, seated up for personal interviews and observed to test office occupants throughout working hours. These potential respondents shall be categorized as follow:

- Managerial employees,

- Technical employees

- Administrative employees,

- Other staff and

- Building visitors\Clients

3.2.3 Questionnaires Development

Questionnaires help to develop bases and generate solid results to prove the existence of issued related and to obtain certain targeted results. The questionnaires include demographic section to input necessary identification information. Furthermore, the questionnaire investigates on subjects obstructed through literature reviews and further readings about the research subject. In addition, it is helpful to assist the respondents' opinions on factors that influencing their satisfaction level. The questionnaire basis consist of Dependent variables and their independent variables. These explained as showed in table 3.2:

Components	Variables	
Workplace space design	Independent Variables	Office Interior Design
		Office Space Design
		Office Flexibility and Movement
Indoor Environment Quality	Independent Variables	Temperature level and RH%
		Lighting (Lux) level
		Noise Level
		Air Quality
The workplace ergonomics	Independent Variables	The office furniture
Perceived ergonomic impact on work performance	Dependent variables	Office Interior Design
		Office Space Design
		Office Flexibility and Movement
		Temperature level and RH%
		Lighting (Lux) level
		Noise Level
		Air Quality
		Office ergonomics

3.2.4 Measurements

Measurement is a process to generate numbers to a characteristic of an object or event, which can be compared with other objects or events. It is also used to determine size, length, weight, capacity or other aspects. Measurement can be multiple levels, which would include nominal, ordinal, Interval and ratio scale and it is used to conduct scientific experiment and quantitative research. In this study, empirical measurements were conducted to obtain supporting results and determine positional issues related to Ergonomics, Space Design and office IEQ.

3.2.5 Office Space Measurements

Office space measurements have been carried out to determine the size of the office compared to space areas provided per an employee. The measurements were divided into 5 types of measurement. The measurement as follow:

- Measurement of individual cubic office provided per person

- Measurement of shared cubic desks.

- Measurement of distance between desks and windows

- Measurement of individual office room.

- Measurement of table size in each workstation

The measurement took place in the areas mentioned above. A 5 meter designed Measuring tape is used to measure the size of the mentioned area. The measurement was carried out at floor 29 and floor 31. Each category was measured individually and all measurements are based on approximate width and length observed while measuring.

3.2.6 Office Indoor Environment Quality Measurement

Office IEQ have been carried out through using suitable IEQ measuring device. The device called HOBO and it is a device that has been set to measure office temperature, Air velocity, Relative humidity and lux level. The device is set in 5 different locations in the office, plotted at the center of each 5 areas plotted (Figure 3.1). The measurement is carried out throughout the 3 days from the installation date. The device is set to records data every 5 minutes for 8 hours a day. The results are obtained and generated through the device and the accuracy of results depends on the quality and the functionality of the device.

Figure 3.1: Hobo device Location

3.3 Qualitative method
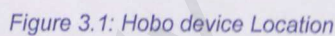
3.3.1 Selection of Case Study

This step is selecting appropriate case studies that suit the research development. Case studies act as a supporting illustration for thesis principles. Besides that, case studies are exercised to apply research theories and put them on tests. Moreover, selecting case studies shall be specifically for non-residential New construction buildings, certified by Green Building Index. The case studies selected shall be reviewed based on GBI categories and selected according to GBI classifications. The building suited as a case study shall be Cawangan Dasar Dan Pengumsan Korporat Block G Building JKR.

28

3.3.2 Interviews

Interview will be carried with one employee of the organization. The purpose is to collecting evidences and data relevant of office ergonomics space design satisfaction and its influence on work performance. Structured questionnaire with open ended shall be put forward to create general understanding about employees' perceptions with the office IEQ. Individuals' opinions shall be put into consideration during the interviews. Ideas, suggestions and recommendations will be freely accepted for discussions and taking into consideration for this research.

3.3.3 Observation

Observation is made through visiting the office area and observes the elements of ergonomics and space design, which can possibly influence employees work performance. Observation is made over office qualities and layout condition such as office furniture, office cleanness, seating positions and employees activities.

3.3.4 Literature reviews

Published articles shall be reviewed to establish hypothesis of the existing issues. Journals is shall be analysed to understand further the interaction of ergonomic space design and productivity as well as social enhancement in green buildings. The extensive studies of literature reviews shall assist to identify the research bases and guidance towards better understanding of research subjects.

3.4 Data Analysis

Obtaining results is the vital stage of finding relevant results. Results and findings are analysed through questionnaires collection, interviews of respondents, evaluation through observation, and assessment of architectural drawing and layout plan that has

been gathered within the expected case studies. Finalising results is the final stage. Assessment of result shall be progressed through final analysis. Besides that, Findings shall be conveyed and used to establish recommendations and suggestions that perhaps assist for better enhancement of satisfaction and comfort.

3.4.1 Inferential Analysis

Inferential analysis used to obtain samples data of respondents. This method is used to establish statistical analysis of probabilities between different groups of respondents. Additionally, findings are initiated from quantitative variables such as questionnaire survey, selection of respondents and thereof. However, Some findings may be dependable or perhaps have happened coincidentally throughout investigation. Questionnaires and Measurement results are processed through SPSS program.

Demographic analysis

The analysis begins with statistic demographic analysis. Descriptive statistic analysis is performed to generate means statistic in each values and to identify the standard deviation of each components. This analysis is performed to observe the frequencies of each value selected. The demographic analysis includes gender of responses, age, working hours, office type, employees' occupation and IEQ sickness related causes.

Normality test

To start with, data gathered where converted in unit numbers and imported to SPSS for statistic analysis. Then data important were labeled and set ready to use. Normality test is made to examine the assumption of normality and inspect the normality of distribution. In order to check normality, observe significant value under Kolmogorov-

30

Smirnov if the sample size is more than 100. And observe Sig. Value under Shapiro-Wilk if the sample size is less than 100. As mentioned previously, sample gathered is 60. Therefore, observe Shapiro- Wilks Sig. Value result. Note that if Sig. Value is less than 0.05, then normality assumption is violated. Therefore it is advised to use non-parametric analysis. But if sig. Value is more than 0.05 then normality is assumed. Therefore, it is advised to use non-parametric analysis.

Descriptive test (frequencies)

Descriptive test was performed afterward to measure frequencies of satisfaction of employees' in each category and identify the range of satisfaction level. The frequencies are ranged in scale 1 to 5. 1 acts as a minimum satisfaction and 5 act as maximum.

Non-Parametric test (Krusal-Willis)

he next stage was performing non-parametric tests. The non-parametric tests decided are Krusal-Willis, which is equivalent to one-way ANOVA. The test was performed to compare means of more than two groups or independent variables in order to determine the significant difference among different categories of employee's workplace and situations.

Reliability test

Reliability test was performed to ensure the reliability of the data gathered and analyised. Reliability test of all factors must show acceptable Cronbech's alpha results between < 0.95 and > 0.65.

3.4.2 Empirical Analysis

Empirical measurement is conducted to measure temperature, lighting, and relative humidity throughout the 8 to 9 hours per day. It is accomplished to generate related data in order to observe values changes throughout the day.

<u>Temperature and relative humidity Measurement</u>

Temperature measurement is conducted to measure temperature value throughout the day. The measurement is conducted from 8 to 9 hours per day. It is accomplished to generate related data in order to observe temperature values changes throughout the day. Relative humidity is also measured to detect percentage of humidity, which shall possibly, if not complied with standards, influence employees' satisfaction. Measurement is carried by HOBO device.

<u>Lighting Measurement</u>

Lighting level measurement is accomplished as well. Lighting level is measured to obtain data, which lead to check lux compliance with standards and GB guidelines. It is made to scale employees' satisfaction with office ergonomics and IEQ. Measurement is carried by HOBO device.

3.4.3 Observation and interview

Qualitative analysis shall be based on interview and observation. The interview is demonstrated as results granted through employee's perception, past records or previous studies that have been done. On the other hand, observation of o and participants is used as well. This method helps to establish theoretical analysis to understand the purpose of each and every influencing factors on office ergonomics.

32

3.5   Research Methodology Flowchart
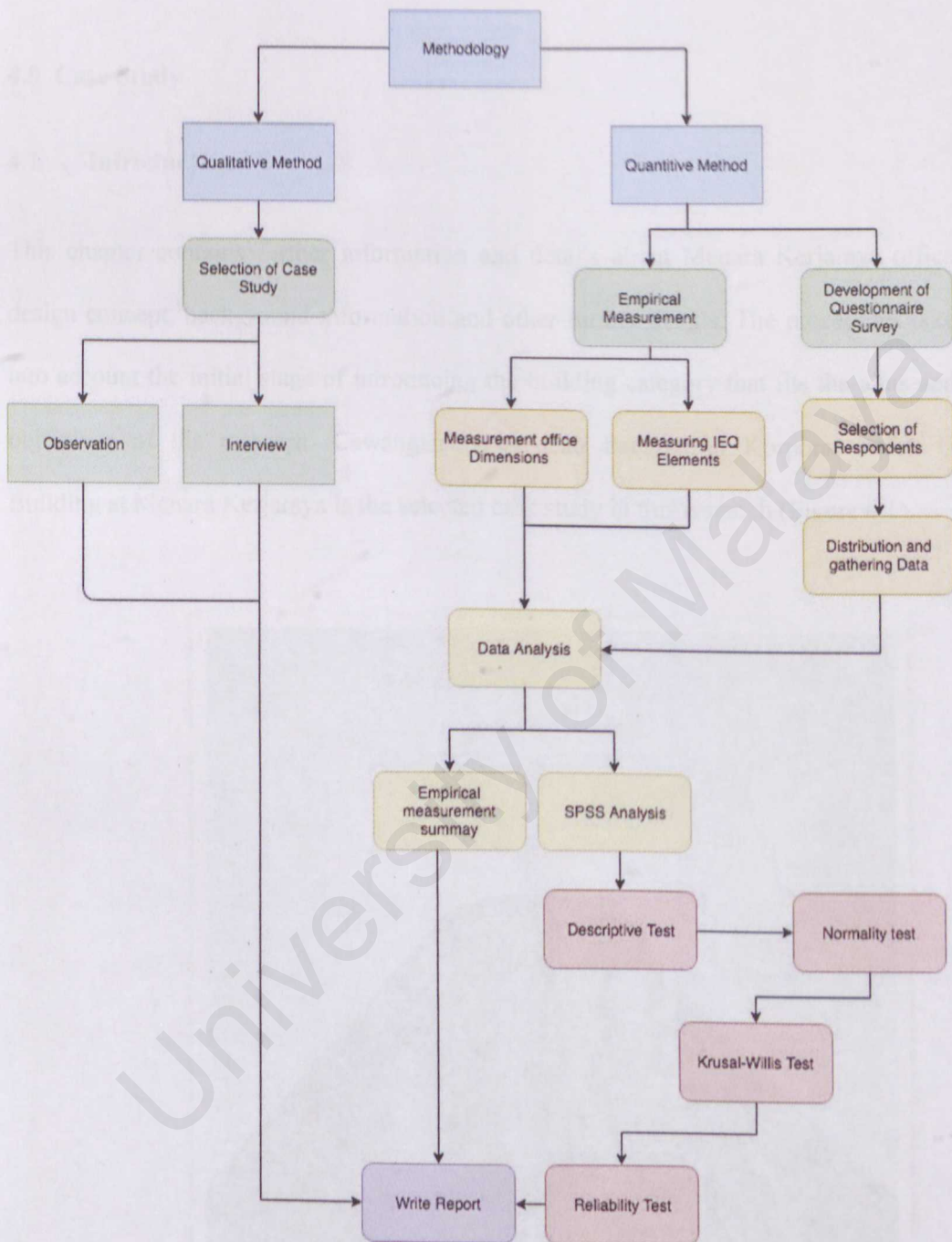
Figure 3.2: Research Methodology Flowchart

CHAPTER 4

4.0 Case Study

4.1 Introduction

This chapter contains further information and details about Menara Kerjaraya office design concept, background information and other further details. The procedures take into account the initial stage of introducing the building category that fits the aims and objectives of the research. Cawangan Dasar Dan Pengumsan Korporat Block G Building at Menara Kerjaraya is the selected case study in this research (Figure 4.1).

Figure 4.1: Menara Kerjaraya

4.2 JKR Background study

4.2.1 History of JKR

Japatan Kerja Raya as known as Malaysian Public work department. It was initially established 1954 when the local government implemented their own policies and programs respectively. Then in 1975, the ministry was recognized to function responsibilities of public work department and renamed as the ministry of work and transportation after several establishment stages and the federation of peninsula Malaysia. But in 1980s, the government renamed the department to ministry of works Malaysia and decided to specialize their responsibilities within the department until this time.

4.2.2 Location and accessibility of JKR

The Complex Kerja Raya is located at Sultan Salahuddin in the city of Kuala lumpur. The selected building identified as block G. Accessibility is very applicable, where cars, taxi and other personal means of transports can access it easily. The building is provided with numbers of car parks available for visitors. The pick up area is also provided with several spots for pick-ups. The pick up area also designed with waiting area available for long waited passanger. The location of JKR is near the major areas in KL such as Bank Negara and Masjid Jamik. It is also located at one of the very efficient, less busy main roads in Kuala Lumpur. Therefore it has easy directions and can be spotted easily around the area. There are securities services are provided in different spots, pointing at each block main entrance. It is provided to ensure safety of the people who wroks at JKR and its Visitors (Figure 4.2).

Figure 4.2: Location of Menara Kerjaraya

The Building is designed with 32 floors excluding the ground floor. But the selected offices areas are starting from floor 29 to floor 31. Registration is mandatory for visitors and it is done through the main counter reception area at ground floor. Visitors shall collect visiting card upon registration. It is meant for security purposes and safety.

4.2.3 Green Building Certification

Menara Kerja is categorized as a non-residential new construction (NRNC). Certified by Green Building Index Malaysia. Certification info as follow: (table 4.1)

Table 4.1: GBI certification

GBI Rating	PLATINUM
Certificate No	GBI-NRNC-0032
Validity Date	13th June 16 – 12th June 2019
Building Category	No-Residential New Construction
Year of Built	2010

4.3 Block G office Space Design and Concept

The department at the level 29 to 31 adopting open plan concept in general. The plan consisted of individual office rooms, cubic individual workstation, shared cubic workstation for 1 person and shared desks for 3 or 4 persons. Access and escape plans in case of emergency is shown in the figure below. Access ways has a minimum of 170cm in width, which observably allows free passage of 2 average size persons at the same time. The office is designed in U shape as shown at the floor plan below (figure 4.3)

Figure 4.3: Office Layout Plan

4.3.1 Individual Office Rooms

Individual offices rooms are mostly located at the right side of the building. It is the offices occupied by the manager of the department and executives. And these offices occupy a large spaces allocated. This office designed for one person but it is suitable for meetings and other means of discussions.

4.3.2 Cubic Offices

Cubic offices are located in different areas in the office. And it takes most of the office layout plans. The cubic offices are mostly located near the windows and it is set up to occupy one employee (figure 4.4)

Figure 4.4: Cubic Office

These cubic offices designed with similar sizes. There are slight differences in the size of these Cubic due its location and the shape of the building. The size are measured in cm as explained at Table below:

Table 4.2: Cubic offices Dimensions

Cubic Type	Width	Length
Type A	470 cm	440 cm
Type B	470 cm	450 cm
Table size	80 cm	200 cm

4.3.3 Detached Cubic Offices

Office layout and furniture are two important factors having a fair share in building an office environment. For instance, it can set up a comfortable office to enhance work performance of employees by choosing the right furniture and the right office layout (Figure 4.5).

Figure 4.5: Detached Cubic office

Detached cubic offices are the second common office design in the building. Cubic offices add standard design to the office and provide employees with the same working space. DCO also creates multiple workstations and allow convenient privacy. The space provided are described in the table below:

Table 4.3: detached cubic offices dimensions

Detached Cubic Type	Width	Length
Type A	190 cm	280 cm
Type B	180 cm	290 cm
Table size	70 cm	160 cm

4.3.4 Shared Workstation

Shared workstations are designed with no physical barriers and employees can interact among each other easily. This design helps to share important related information quickly if a project is being carried out. It is also facilitate assistance and quick teamwork response upon inquiry. It comes in a form of 4 employees in one shared area (Figure 4.6).

Figure 4.6: Shared workstation

This shared workstation comes in uniformed sizes. Each area is provided with one main table installed with personal PC monitoring and semi supporting table. The supporting table comes with storage wardrobe to preserve documents and thereof. The area dimentions are described in the table below:

Table 4.4: Shared workstation dimensions

Detached Cubic Type	Width	Length
Type A	160 cm	150 cm
Type B	160 cm	170 cm
Table size	70 cm	160 cm

4.4   Office Ergonomic elements

The office is provided with certain office furniture that comes to suit the needs with employees' job tasks. The office is divided managerial, Administrative and technical act as the main 3 categories of employees position. Therefore, The office is provided with these ergonomics elements such as Desktop tables, Adjustable seating chairs, PC monitors with visual screens and document lockers.

Figure 4.7: Office ergonomic elements

Based on observation conducted, these ergonomics elements mostly come in a unified color, size and shape. Office table size is measured approximately about 70 in width and 160cm in length. The chair can be adjustable and movable as desired by the employees and it has the ability to increase or decrease it height in order to adjust seating level of employees between the table and ground. This is also helpful to provide comfort position of wrist on the table. The office type determines the table size. As individual cubic and detached cubic has bigger stable size then shared desks and it is shaped in L shape. Lockers and file keeping space comes in a different size to suit the need of file storage. In Addition, the quality condition of this equipment are very observed. It is still in good condition and function as required. No complain detected about any of these furniture at the meantime.

CHAPTER 5

5.0 Data Analysis

5.1 Introduction

Chapter 5 consists of the data analysis. In this chapter, data collected is combined for revisions analysis. The data collected through questionnaires shall be analysed through Statistical package for the social sciences (SPSS) and reviewed accordingly. The empirical measurement is carried out and detailed in this chapter. The empirical measurements consist of IEQ elements, Space implementation and ergonomics furniture measurement. The scale rules start from 1 very dissatisfied to 5 very satisfied.

5.2 Demographic analysis

5.2.1 Gender of respondents

Table 5.1: Gender

		Frequency	Percent	Cumulative Percent
Valid	Male	19	31.7	31.7
	Female	41	68.3	100.0
	Total	60	100.0	

The questionnaires are distributed to 155 employees but only managed to obtain number of 61 respondents. The coverage areas are at floor 29, 30, 31 and 32. The table above shows the frequency of 19 male respondents and 41 female respondents out of 61 respondents in total. The schedule indicates that 31.7 percent of the respondents were male, while 41 percent of the respondents were females (Table 5.1).

5.2.2 Age of respondents

Table 5.2: Age

		Frequency	Percent	Cumulative Percent
Valid	20-30	20	33.3	33.3
	30-40	25	41.7	75.0
	40-50	8	13.3	88.3
	50>	7	11.7	100.0
	Total	60	100.0	

The Table shows average age of employees at Menara Kerjaya between the selected floors. The age varieties are categorized into four (4) categories as shown above. The results show a frequency of 20 respondents ranged between twenty (Amina & Shehla) to thirty (30) years old, accumulated with 33.0 percent in ratio. While indications show majority of respondents are ranged between 30 to 40 years old, accumulated with 41.7 percent in ratio. The rest of respondent ranged between 40 years old and above. The table above shows the indications of the respondents mentioned (Table 5.2).

5.2.3 Respondents per Floor

Table 5.3: Floor level

		Frequency	Percent	Cumulative Percent
Valid	floor 29	26	43.3	43.3
	floor 30	9	15.0	58.3
	floor 31	17	28.3	86.7
	floor 32	8	13.3	100.0
	Total	60	100.0	

The table shows frequency of respondents between 29 floor to 32 floors as viewed above. The results shows majority of respondents are from the 29 floor with 26 participants, accumulated with 43.3 percent in ratio. While the 31 floor shows 17 number of respondent participated with accumulated ratio of 28 percent (Table 5.3).

5.2.4 Respondents Positions

Table 5.4: Employees positions

		Frequency	Percent	Cumulative Percent
Valid	Managerial	11	18.3	18.3
	Technical	32	53.3	71.7
	Administrative	17	28.3	100.0
	Total	60	100.0	

The schedule shows the frequency of respondents based on the employees' positions in the named department of Cawangan Dasar dan Pengurusan Korporat. The indications shows majority of respondents are from technical positions with 32 participants, accumulated with 53.3 percent in ratio. While administrative employees indicate 17 respondents, accumulated with 28.3 percent in ratio. And only 18.3 percent of respondents were managers (Table 5.4)

5.2.5 Office Area

Table 5.5: Office type

		Frequency	Percent	Cumulative Percent
Valid	Individual office	10	16.7	16.7
	Individual Cubic	30	50.0	66.7
	Detached Cubic	6	10.0	76.7
	Shared desk	14	23.3	100.0
	Total	60	100.0	

The table shows the frequency of respondents according to the type of working area and design. The office is divided into 4 layouts consist of individual office rooms, individual glass cubic, detached cubic and shared desks. The results show that majority of respondents are located in individual cubic with 30 participants, accumulated with 50 percent in ratio. While 14 respondents are located at shared

desks, accumulated with 23.3 percent in ratio. The other respondents are from individual office, accumulated with 16.7 percent and detached cubic, accumulated with 10 percent only (Table 5.5)

5.2.6 Duration of Employment

Table 5.6: Employment duration

		Frequency	Percent	Cumulative Percent
	>6 months	6	10.0	10.0
	1 year	13	21.7	31.7
Valid	2 years	8	13.3	45.0
	3 years	33	55.0	100.0
	Total	60	100.0	

The table above shows the average duration of employment since joining Cawangan Dasar dan Pengurusan Korporat. The duration varieties are categorized into four (4) categories as shown above. The results show a frequency of 13 respondents ranged at 1year employment period, accumulated with 21.7 percent in ratio. While indications show majority of 33 respondents employed for 3 years, accumulated with 55 percent in ratio. The rest of respondent ranged between 40 years old and above. The table above shows the indications of the respondents mentioned. A frequency of 6 respondents ranged at less than 6 months employment period, accumulated with 10 percent in ratio. While only 13.3 percent of employees are employed for 2 years (Table 5.6). It is noticed that majority of employees have worked in this department for a long period of time. There is a great possibility that some of the participants who choose 3 years, have actually been working there for longer period. The choice limit decided at 3 years to limit the range of employments since 3 years is enough period to be familiarized with the office environment.

5.2.7 Working per days

Table 5.7: Working per week

		Frequency	Percent	Cumulative Percent
	5 days	58	96.7	96.7
Valid	7 days	2	3.3	100.0
	Total	60	100.0	

The table above shows that majority of 96.7 percent of employees work for 5 days a week following the standard working days per week. While only 3.3 percent of employees work for 7 days (Table 5.7).

5.2.8 Working per hours

Table 5.8: Working per hours

		Frequency	Percent	Cumulative Percent
	6 hours	2	3.3	3.3
	7 hours	2	3.3	6.7
	8 hours	38	63.3	70.0
Valid	9 hours	15	25.0	95.0
	Overtime	3	5.0	100.0
	Total	60	100.0	

The table above shows the average working of employees at Menara Kerjaya JKR between the selected floors. The age varieties are categorized into five (MS1525) categories as shown above. The results show a frequency of 15 respondents indicated to work for 9 hours a day, accumulated with 25 percent in ratio. While the table indications show majority of 38 respondents are working for 8 hours a day, accumulated with 63.3 percent in ratio. The table shows that only 5 percent of respondent work overtime (Table 5.8).

5.2.9 Employees Sickness due IEQ

Table 5.9: Sickness due IEQ

		Frequency	Percent	Cumulative Percent
Valid	Yes	14	23.3	23.3
	No	46	76.7	100.0
	Total	60	100.0	

The taable above shows that majority of 76.7 percent of employees feels that the office IEQ do not contribute to their sickness. While only 23.3 percent of employees believe that their working environment may contribute to their unexpected sickness such as flu and cold. Although minority number of employees represented as 14 employees believes that their sickness is caused from the office environment, it is suggested to put this finding into notice and examination. For the case of prevent increments of number in the coming future (Table 5.9).

5.2.10 Medical leave indications

Table 5.10: MC and Leaves

		Frequency	Percent	Cumulative Percent
Valid	1 Time\Month	23	38.3	38.3
	2 Times\Month	2	3.3	41.7
	3 Times\Month	1	1.7	43.3
	4 Times\Month	2	3.3	46.7
	Never	32	53.3	100.0
	Total	60	100.0	

The table above shows that majority of 53.3 percent of employees never took MC due to sickness. But only 38.4 percent of employees take 1 MC a month. While the other factors indicate various results between twice and 3 times a month (Table 5.10).

5.2.11 Employees job and tasks

Table 5.11: Employees job tasks

		Frequency	Percent	Cumulative Percent
Valid	Writing	39	65.0	65.0
	Calculating and Analysis	5	8.3	73.3
	Computing and Research	3	5.0	78.3
	Communication and service	8	13.3	91.7
	Correspondence	1	1.7	93.3
	Project Management	1	1.7	95.0
	PC Maintenance	1	1.7	96.7
	Storekeeper	1	1.7	98.3
	Project implementation	1	1.7	100.0
	Total	60	100.0	

The able shows that majority of 65% of employees perform writings as a main tasks routine, which is considered be 39 employees out the total number of participants. And only 13% of respondents perform communications and services. While there is about 5 employees execute calculating and analysis tasks, accumulated as 8% only. These tasks found in the table only represent the work field of the achieved participant in the questionnaires.

There are several work field description were not mentioned due to inability to reach those employees. The department is in charge of various task related to the cooperate section. Therefor, this data mentioned in the table only represent work field of participated employees (Table 5.11).

5.3   Normality Test

Normality test is made to inspect the normality of distribution. As mentioned previously, sample gathered is 60. Therefore, observe Shapiro- Wilks Sig. Value result.

5.3.1   Workplace space design

Interior Design

Table 5.12: Normality of Interior Design

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Architectural hindrances	0.855	60	.000
Office interior colours	0.838	60	.000
Office interior textures	0.851	60	.000
Quality of office furniture	0.844	60	.000
Office cleanliness	0.837	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

Space Design

Table 5.13: Normality of Space Design

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Adequacy of office space	0.856	60	.000
Personal space provided	0.852	60	.000
Space within open plan concept	0.842	60	.000
Space of meeting rooms	0.863	60	.000
Office layout arrangement	0.827	60	.000
Placement of office equipment	0.845	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

49

<u>Office flexibility and accessibility</u>

Table 5.14: Normality of office flexibility and accessibility

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Flexibility in movement	0.845	60	.000
office Flexibility allow layout changes	0.878	60	.000
office allow Interaction among employees	0.811	60	.000
Accessibility plans suits the work tasks	0.809	60	.000
Accessibility plan creates safe movement	0.809	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

5.3.2 Indoor Environment Quality

<u>Temperature level</u>

Table 5.15: Normality of Temperature level

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Thermal comfort level	0.843	60	.000
Office temperature level	0.832	60	.000
Office temperature level	0.815	60	.000
Office Humidity level	0.841	60	.000
Frequency of Temperature change	0.838	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

Lighting level

Table 5.16: Normality of Lighting level

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Electric lighting	0.83	60	.000
Appropriate light to read and write	0.854	60	.000
Daylight Glare Control	0.85	60	.000
Sunlight Access	0.838	60	.000
Visual comfort	0.828	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided

Noise level

Table 5.17: Noise Level

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Office noise level	0.846	60	.000
External Noise	0.824	60	.000
Noise caused by office equipment	0.827	60	.000
Noise control in quiet area	0.813	60	.000
Noise caused by discussions	0.816	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

Air quality

Table 5.18: Normality of Air Quality

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Office Ventilation performance	0.729	60	.000
Office odours and smell	0.818	60	.000
Office Tobacco Smoke control	0.845	60	.000
Office fresh air supply	0.839	60	.000
Office air movement and circulation	0.83	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided.

5.3.3 Office Ergonomics

Table 5.19: Normality of Office ergonomics

Tests of Normality	Shapiro-Wilk		
	Statistic	df	Sig.
Architectural hindrances	0.849	60	.000
Colours and texture	0.832	60	.000
Size of table provided	0.825	60	.000
Adjustment of furniture	0.888	60	.000
Comfort of seating chair	0.855	60	.000
Chair support to lower back	0.9	60	.000
Keyboard and mouse adjustment	0.815	60	.000
Space for wrist to rest on the desk	0.836	60	.000
PC position to comfort seating	0.824	60	.000
Screen glare control	0.835	60	.000

a Lilliefors Significance Correction

As observed at sig. value at Shapiro-wilks is less than 0.05. Therefore, normality is violated and non-parametric analysis is decided

5.4 Descriptive analysis of workplace space design

5.4.1 Interior Design

Table 5.20: Interior Design

Interior Design	Mean	Std. Deviation
Interior colors	3.8	0.819
Office cleanliness	3.8	0.755
Interior textures	3.75	0.795
Architectural hindrances	3.73	0.8
Quality of Office Furniture	3.53	0.873
Valid N (listwise)		

The table shown demonstrates variables scale from largest to smallest rank. A scale of 3.8 out of 5 range that employees are more likely to be satisfied with the office interiors colors, although the Std. Deviation results shows responses variations upon office interior colors. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total (Table 5.12)

Table 5.21: interior design Statistic Scale

Mean	Variance	Std. Deviation	N of Items
18.62	13.190	3.632	5

Reliability Statistics

Cronbach's Alpha	N of Items
.940	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.940 makes it < 0.95 and > 0.65

5.4.2 Space Design

Table 5.22: Space design

	Mean	Std. Deviation
Space in Meeting Room	3.57	0.851
Office layout arrangement	3.52	0.873
Personal space provided	3.48	0.792
The Space within open plan concept	3.48	0.911
Placement of office equipment	3.48	0.873
The adequacy of office space	3.47	0.947
Valid N (listwise)		

Table shoes satisfaction records from largest to smallest rank. A scale of 3.57 out of 5 range that employees are more likely to be satisfied with the space in meeting room. The Std. Deviation results show responses variations upon Adequacy of office space yet it indicates 3.47-satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor) (Table 5.14).

Table 5.23: Space design statistic scale

Mean	ariance	td. Deviation	of Items
21.00	21.085	4.592	6

Reliability Statistics

Cronbach's Alpha	N of Items
.938	6

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.938 makes it < 0.95 and > 0.65

54

5.4.3 Flexibility and Accessibility

Table 5.24: Flexibility and Movement

	Mean	Std. Deviation
Office layout allows interaction among employees	3.75	0.773
FM plan creates safe movement	3.7	0.696
FM plans suits the work tasks	3.67	0.752
Flexibility in movement	3.63	0.78
Office space flexible to allow layout changes	3.3	0.979
Valid N (listwise)		

Table shown indicate scale from largest to smallest in rank. A scale of 3.75 out of 5 range that employees are more likely to be satisfied with office layout to facilitate interaction with other employees. Although the Std. Deviation results shows responses were variations upon Office layout to allow interactions. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor). (Table 5.16)

Table 5.25: Flexibility and movement statistic scale

Mean	Variance	Std. Deviation	N of Items
18.05	12.150	3.486	5

Reliability Statistics

Cronbach's Alpha	N of Items
.919	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.919 makes it < 0.95 and > 0.65

5.5 Descriptive analysis of Indoor environment quality

5.5.1 Temperature level

Table 5.26: Temperature level

	Mean	Std. Deviation
Thermal comfort level	3.63	0.736
Office temperature level	3.55	0.769
Temperature stability level	3.47	0.791
Office Humidity level	3.43	0.673
Frequency of Temperature change	3.43	0.722
Valid N (listwise)		

Table has pointed up a scale from largest to smallest in rank. A scale of 3.63 out of 5 that employees are more likely to be satisfied with the office thermal comfort. The Std. Deviation results show responses are various upon temperature stability yet it indicates 3.47 satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor). (Table 5.18)

Table 5.27 statistic scale of temperature level

Mean	Variance	Std. Deviation	N of Items
17.52	10.830	3.291	5

Reliability Statistics

Cronbach's Alpha	N of Items
.935	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.935 makes it < 0.95 and > 0.65

5.5.2 Lighting Level (Lux)

Table 5.28: lighting level

	Mean	Std. Deviation
Sunlight Access	3.72	0.739
Electric lighting level	3.62	0.783
Daylight Glare Control	3.62	0.783
Appropriate light to read and write	3.6	0.785
The visual comfort	3.58	0.72
Valid N (listwise)		

Table shown indicate scale from largest to smallest in rank. A scale of 3.72 out of 5 that employees are more likely to be satisfied with the lighting level provided. The Std. Deviation results show responses are various upon appropriate light to read and write yet it indicates 3.6 satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor). (Table 5.20)

Table 5.29: lighting level Statistic scale

Mean	Variance	Std. Deviation	N of Items
18.13	11.541	3.397	5

Reliability Statistics

Cronbach's Alpha	N of Items
.935	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.935 makes it < 0.95 and > 0.65

5.5.3 Noise Level

Table 5.30: noise level

	Mean	Std. Deviation
External Noise	3.77	0.698
Noise control in quiet area	3.68	0.676
Noise office equipment	3.65	0.709
Office noise level	3.57	0.745
Noise caused by discussions	3.53	0.747
Valid N (listwise)		

The table shows scale from largest to smallest in rank. A scale of 3.77 out of 5 that employees are more likely to be satisfied with the office external noise. The Std. Deviation results show responses are various upon office noise level yet it indicates 3.57 satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor). (Table 5.22).

Table 5.31: Statistic scale noise level

Mean	Variance	Std. Deviation	N of Items
18.20	9.485	3.080	5

Reliability Statistics

Cronbach's Alpha	N of Items
.913	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.913 makes it < 0.95 and > 0.65

5.5.4 Air Quality

Table 5.32 Air Quality

	\Mean	Std. Deviation
Office Ventilation performance	3.68	0.567
Office odours and smell	3.62	0.691
Office Tobacco Smoke control	3.62	0.804
Office fresh air supply	3.5	0.813
Office air movement and circulation	3.5	0.834
Valid N (listwise)		

The table demonstrates scale from largest to smallest in rank. A scale of 3.68 out of 5 that employees are more likely to be satisfied with the office ventilation performance. The Std. Deviation results show responses are various upon fresh air supply yet it indicates 3.5 satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total. (Check appendix to check reliability of each factor) (Table 5.24).

Table 5.33: Statistic scale Air quality

Mean	Variance	Std. Deviation	N of Items
17.92	10.925	3.305	5

Reliability Statistics

Cronbach's Alpha	N of Items
.929	5

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.929 makes it < 0.95 and > 0.65

5.6 Descriptive analysis of office ergonomics

Table 5.34: Office furniture

	Mean	Std. Deviation
Space for wrist to rest on the desk	3.6	0.718
The monitor (Notarnicola et al.) position	3.58	0.696
Size of table	3.57	0.81
Keyboard and mouse adjustment	3.57	0.673
Furniture colours and texture	3.55	0.769
Screen glare control	3.55	0.723
Architectural hindrances of furniture	3.43	0.789
Comfort of seating chair	3.42	0.809
Adjustment of furniture	3.3	0.908
Chair support lower back	3.22	0.94
Valid N (listwise)		

The table shown indicates in scale from largest to smallest in rank. A scale of 3.6 out of 5 that employees are more likely to be satisfied with desk size. The Std. Deviation results show responses are various upon comfort of seating chair yet it indicate 3.42-satisfaction scale. In general, results have indicated major satisfactions among other factors, ranged between feeling natural and satisfied as a total (Table 5.26).

Reliability Statistics

Cronbach's Alpha	N of Items
.940	10

Reliability test of all factors has shown acceptable Cronbech's alpha results of 0.940 makes it < 0.95 and > 0.65

5.7 Descriptive analysis of Perceived Workplace performance

Table 5.35: Perceived work performance

	Mean	Std. Deviation
Interior design	3.68	.833
Space design	3.52	.873
Office flexibility	3.48	.873
Office temperature	3.62	.783
Office lightings	3.67	.795
Office noise	3.62	.865
Air quality	3.60	.867
Office ergonomics	3.55	.811

The table shown describes employees' perception about the effect of the items above on their work performance. The scales start from 1, which equal to poor to 5, which equal to excellent. The results show that majority of employees believe that these items mentioned have a good effect on their work performance. The highest scale reached by office interior design with a mean of 3.68. While the lowest scale reached by space design with a mean of 3.52.

5.8   Perceived work performance among employees positions

5.8.1   Workplace design.

Table 5.36: Kruskal-Willis Perceived WP among employees' position for workplace design

	Employees' position	N	Mean Rank
Interior design	Managerial	11	23.45
	Technical	32	32.16
	Administrative	17	31.94
	Total	60	
Space design	Managerial	11	25.27
	Technical	32	30.36
	Administrative	17	34.15
	Total	60	
Office flexibility	Managerial	11	26.41
	Technical	32	30.03
	Administrative	17	34.03
	Total	60	

	Interior design	Space design	Office flexibility
Chi-Square	2.594	2.054	1.538
df	2	2	2
Asymp. Sig.	.273	.358	.463

a. Kruskal Wallis Test

b. Grouping Variable: Employees' position

This test is made to measure the significant difference of work performance among Employees' position through workplace space design. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.8.2   Indoor Environment Quality

Table 5.37: Kruskal-Willis Perceived WP among employees' position for IEQ

	Employees' position	N	Mean Rank
Office temperature	Managerial	11	23.23
	Technical	32	31.13
	Administrative	17	34.03
	Total	60	
Office lightings	Managerial	11	29.27
	Technical	32	30.19
	Administrative	17	31.88
	Total	60	
Office noise	Managerial	11	25.50
	Technical	32	32.16
	Administrative	17	30.62
	Total	60	
Air quality	Managerial	11	24.95
	Technical	32	31.08
	Administrative	17	33.00
	Total	60	

	Office temperature	Office lightings	Office noise	Air quality
Chi-Square	3.081	.204	1.453	1.796
df	2	2	2	2
Asymp. Sig.	.214	.903	.484	.407

a. Kruskal Wallis Test

b. Grouping Variable: Employees' position

The test measures the significant difference of work performance among employee's position. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.8.3 Office ergonomics

Table 5.38: Kruskal-Willis Perceived WP among employees' position for office ergonomic

	Employees' position	N	Mean Rank
Office ergonomics	Managerial	11	27.05
	Technical	32	30.08
	Administrative	17	33.53
	Total	60	

	Office ergonomics
Chi-Square	1.171
df	2
Asymp. Sig.	.557

a. Kruskal Wallis Test
b. Grouping Variable: Employees' position

The table above shows the significant difference of work performance among employees' position through office ergonomic. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.8.4 Summary

In summary, the results indicate that employees work performance have not been affected by the position of the employees. The Kruskal-Willis test results show that employees at different positions receive good implementations of ergonomics space designs and office environment quality. Therefore, it is concluded that employees at different positions are satisfied and believe that office elements enhance their work performance.

5.9 Perceived work performance among different type of office

5.9.1 Workplace design.

Table 5.39: Kruskal-Willis Perceived WP among different type of office for workplace design

	Cubic, Shared, Individual	N	Mean Rank
Interior design	Individual office	10	21.55
	Individual cubic	30	29.67
	Detached cubic	6	43.83
	Shared desks	14	32.96
	Total	60	
Space design	Individual office	10	23.90
	Individual cubic	30	30.62
	Detached cubic	6	40.00
	Shared desks	14	30.89
	Total	60	
Office flexibility	Individual office	10	25.15
	Individual cubic	30	29.42
	Detached cubic	6	42.00
	Shared desks	14	31.71
	Total	60	

	Interior design	Space design	Office flexibility
Chi-Square	7.651	3.817	4.335
df	3	3	3
Asymp. Sig.	.054	.282	.228

a. Kruskal Wallis Test

b. Grouping Variable: Cubic, Shared, Individual

The analysis determines the significant difference of work performance among different type of office area through workplace space design. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.9.2 Indoor Environment Quality

Table 5.340: Kruskal-Willis Perceived WP among different type of office for IEQ

	Cubic, Shared, Individual	N	Mean Rank
Office temperature	Individual office	10	20.80
	Individual cubic	30	30.22
	Detached cubic	6	42.83
	Shared desks	14	32.75
	Total	60	
Office lightings	Individual office	10	34.60
	Individual cubic	30	27.23
	Detached cubic	6	34.00
	Shared desks	14	33.07
	Total	60	
Office noise	Individual office	10	34.25
	Individual cubic	30	27.22
	Detached cubic	6	35.67
	Shared desks	14	32.64
	Total	60	
Air quality	Individual office	10	24.20
	Individual cubic	30	30.62
	Detached cubic	6	38.50
	Shared desks	14	31.32
	Total	60	

	Office temperature	Office lightings	Office noise	Air quality
Chi-Square	7.364	2.562	2.756	3.120
df	3	3	3	3
Asymp. Sig.	.061	.464	.431	.373

a. Kruskal Wallis Test

b. Grouping Variable: Cubic, Shared, Individual

The table emphasized the significant difference of work performance among different type of office area through IEQ. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.9.3 Office ergonomics

Table 5.41: Kruskal-Willis Perceived WP among different type of office for office ergonomics

	Cubic, Shared, Individual	N	Mean Rank
Office ergonomics	Individual office	10	27.20
	Individual cubic	30	30.55
	Detached cubic	6	36.33
	Shared desks	14	30.25
	Total	60	

	Office ergonomics
Chi-Square	1.255
df	3
Asymp. Sig.	.740

a. Kruskal Wallis Test

b. Grouping Variable: Cubic, Shared, Individual

To sum up, the table shows the significant difference of work performance among different type of office area through Office Ergonomic. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.9.4 Summary

In summary, the results indicate that employees work performance have not been affected by employees office area or type. The Kruskal-Willis test results show that employees at different office areas receive good implementations of ergonomics space designs and office environment quality. Therefore, it is concluded that employees at different office areas are satisfied and believe that office elements enhance their work performance.

5.10 Perceived work performance among working hours

5.10.1 Workplace design.

Table 5.42: Kruskal-Willis Perceived WP among Working hours for workplace design

	Working Hours	N	Mean Rank
Interior design	6 Hours	2	25.50
	7 Hours	2	8.25
	8 Hours	38	32.95
	9 Hours	15	30.43
	Overtime	3	18.00
	Total	60	
Space design	6 Hours	2	28.75
	7 Hours	2	16.00
	8 Hours	38	32.72
	9 Hours	15	29.17
	Overtime	3	19.83
	Total	60	
Office flexibility	6 Hours	2	23.25
	7 Hours	2	17.50
	8 Hours	38	33.33
	9 Hours	15	27.87
	Overtime	3	21.33
	Total	60	

	Interior design	Space design	Office flexibility
Chi-Square	6.732	3.828	4.212
df	4	4	4
Asymp. Sig.	.151	.430	.378

a. Kruskal Wallis Test

b. Grouping Variable: Working Hours

The table above shows the significant difference of work performance among employee's' working hours through workplace space design. The results decide that there was no statically significant difference, because P value is more than 0.05.

68

5.10.2 Indoor Environment Quality

Table 5.43: Kruskal-Willis Perceived WP among Working hours for IEQ

	Working Hours	N	Mean Rank
Office temperature	6 Hours	2	27.75
	7 Hours	2	21.25
	8 Hours	38	31.99
	9 Hours	15	29.70
	Overtime	3	23.67
	Total	60	
Office lightings	6 Hours	2	38.00
	7 Hours	2	38.00
	8 Hours	38	31.92
	9 Hours	15	27.33
	Overtime	3	18.33
	Total	60	
Office noise	6 Hours	2	38.00
	7 Hours	2	9.50
	8 Hours	38	32.36
	9 Hours	15	29.90
	Overtime	3	19.00
	Total	60	
Air quality	6 Hours	2	26.75
	7 Hours	2	21.50
	8 Hours	38	31.33
	9 Hours	15	30.37
	Overtime	3	29.17
	Total	60	

	Office temperature	Office lightings	Office noise	Air quality
Chi-Square	1.605	3.509	6.114	.875
df	4	4	4	4
Asymp. Sig.	.808	.477	.191	.928

a. Kruskal Wallis Test

b. Grouping Variable: Working Hours

69

The test shows that the significant difference of work performance among employees' working hours through IEQ. The table shows that there was no statically significant difference, because P value is more than 0.05.

5.10.3 Office ergonomics

Table 5.44: Kruskal-Willis Perceived WP among Working hours for office ergonomics

	Working Hours	N	Mean Rank
Office ergonomics	6 Hours	2	28.00
	7 Hours	2	22.25
	8 Hours	38	33.12
	9 Hours	15	27.40
	Overtime	3	20.00
	Total	60	

Test Statistics[a,b]

	Office ergonomics
Chi-Square	3.532
df	4
Asymp. Sig.	.473

a. Kruskal Wallis Test
b. Grouping Variable: Working Hours

According to the table, the significant difference of work performance among employee's position through Office Ergonomic resulted that there was no statically significant difference, because P value is more than 0.05.

5.10.4 Summary

In summary, the results indicate that employees work performance have not been affected by employees working hours. It is concluded that employees working from 6 to 9 hours daily including overtime are satisfied and believe that office elements enhance their work performance.

5.11   Empirical Analysis

Empirical analysis is described as a type of analysis that based on evidence observed, verified measurement or interpretation of approached knowledge or information. The empirical approach is based on realistic figures and real metric data, which are resulted or generated through applied theories and concepts. It is also a sort of integration of scientific method to investigate subjects or find quantified, probable answers. Empirical analysis is based on observed and studied figures and generated answers. In this case study, empirical analysis is used to measure three (3) main factors that can be possibly influence employees work performance in Menara Kerjaya, These 3 factors are office temperature, office lighting (lux) and office relative humidity. The analysis starts with placing Indoor Environment quality (IEQ) device in the center of each plotted area. The office was divided into 5 locations Starting from area A to E due the size and potential IEQ affects that can be possibly detected. To add more, these five (MS1525) areas comes with either mix office layout design and office furniture placement or similar one. Therefore, it is significant to divide the office. Applied to floor 29 and 31 as shown in the figure

Figure 5.1: Hobo Location

71

5.11.1 Office IEQ

Results shown below focused on three (3) major components of IEQ mentioned above. These components are summarized for easy understanding. The schedule below contains measurement generated from HOBO device. This device is designed to measure Temperature, Lighting level (Lux) and Relative Humidity (RH%) within the workplace.

The measurements are programmed through 8 hours per day, starting from 9am to 6pm based on the standard working hours. The device detects and produce data each 5 minuets within 1 hour. Therefore, The findings were summarized into 2 floors, these floors are divided into locations, each location is measured in 3 combined timing, which are period of 9:00am-12:00pm, 12:01pm - 3:00pm and 3:01pm – 6:00pm. After that, durations given are progressed of minimum, average and maximum findings for each of the 3 factors mentioned above.
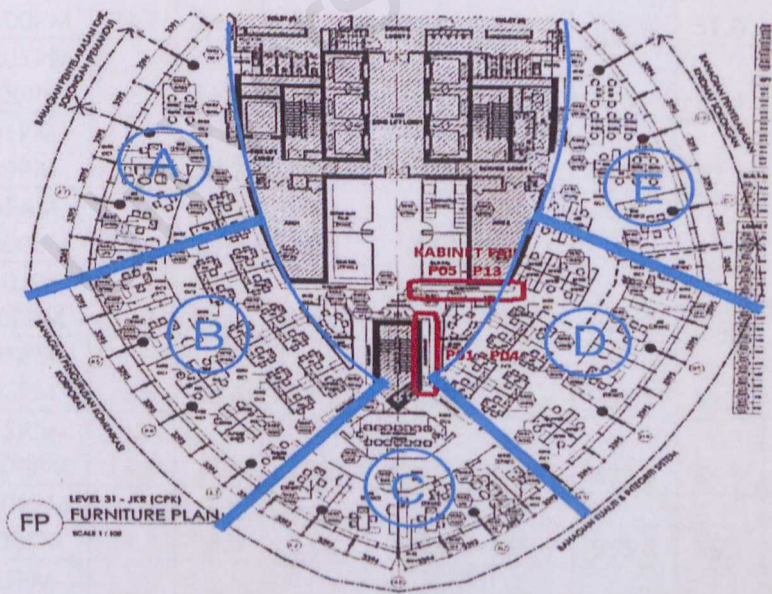

Figure 5.2: Hobo Location

Menera Kerjaya Level 29

This schedule contains results generated from measuring the 31 floor of Menara Kerjaya JKR. The measurements carried are the Temperature, Lighting level (Lux) and Relative Humidity (RH%) within the workplace.

Table 5.45: empirical measurement floor 29

Floor 29										
Area	date	Temp, °C			Lux			RH, %		
	13\12\17	Min	Avrg	Max	Min	Avrg	Max	Min	Avrg	Max
A	9:00AM-12:00PM	21.4	22.1	24.8	3666.	938.9	366.6	57.0	59.7	60.3
	12:01PM-3:00PM	21.2	21.7	22.3	240.5	376.4	634.6	58.3	59.4	60.6
	3:01PM-6:00PM	22.4	22.9	24.5	114.3	200.2	272	57.1	58.7	61.9
B	8:45AM-12:00PM	22.3	22.9	25.6	90.7	154.0	90.7	59.0	60.7	61.4
	12:01PM-3:00PM	22.1	22.3	22.5	74.9	92.2	106.4	60.0	60.5	61.4
	3:01PM-6:00PM	22.5	22.9	24.1	51.2	82.8	98.5	59.3	60.4	62.4
C	8:45AM-12:00PM	22.7	23.2	25.7	216.8	273.2	216.8	57.0	58.3	59.4
	12:01PM-3:00PM	22.6	22.8	23.2	224.7	308.1	358.7	57.4	58.1	58.6
	3:01PM-6:00PM	22.8	23.2	24.5	153.7	247.0	319.3	57.3	58.3	61.2
D	8:45AM-12:00PM	23.5	23.9	25.6	540	791.2	540	57.5	58.9	60.1
	12:01PM-3:00PM	23.1	23.2	23.4	713.5	769.8	831.7	58.4	59.2	60.0
	3:01PM-6:00PM	23.0	23.4	25.1	650.4	745.9	792.3	58.7	59.8	63.1
E	8:45AM-12:00PM	23.7	24.0	25.2	374.5	452.5	508.5	54.5	56.3	58.5
	12:01PM-3:00PM	23.3	23.6	23.8	366.6	435.6	555.8	55.1	56.0	56.7
	3:01PM-6:00PM	23.3	24.0	26.2	201.0	524.3	658.3	52.7	55.8	59.4

To start with, the numbers in the schedule for level 29 can be summarize into the minimum, average and maximum of each IEQ throughout the day. The figures show that the minimum temperature detected at area A throughout the working hours is 21.2 degree, which is timed between 12pm to 3pm. While the average temperature detected is 21.7 degree and the maximum rate detected is 24.8 degree. Furthermore, the minimum lighting detected at area A throughout the working hours is 114.3 lux timed between 3pm to 6pm. While the average lux detected is 376.4 lux and the maximum lux detected is 634.6 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 57 percent. While the average percentage detected is 59.4 percentage and the maximum percentage detected is 61.9 percentage timed between 3pm to 6pm.

Secondly, table 5.31 shows that the minimum temperature detected at area B throughout the working hours is 21.1 degree, which is timed between 12pm to 3pm. While the average temperature detected is 22.3 degree and the maximum rate detected is 25.6 degree. Furthermore, the minimum lighting detected at area B throughout the working hours is 51.2 lux timed between 3pm to 6pm. While the average lux detected is 92.2 lux and the maximum lux detected is 106.4 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 59 percent. While the average percentage detected is 60.5 percentage and the maximum percentage detected is 62.4 percentage timed between 3pm to 6pm in the afternoon.

Thirdly, The table 5.31 shows that the minimum temperature detected at area C throughout the working hours is 22.6 degree, which is timed between 12pm to 3pm. While the average temperature detected is 23.2 degree and the maximum rate detected

is 25.7 degree. Furthermore, the minimum lighting detected at area C throughout the working hours is 153.7 lux timed between 3pm to 6pm. While the average lux detected is 273.2 lux and the maximum lux detected is 358.7 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 57 percent. While the average percentage detected is 58.3 percentage and the maximum percentage detected is 61.2 percentage timed between 3pm to 6pm in the afternoon.

Fourthly, The table 5.31 shows that the minimum temperature detected at area D throughout the working hours is 23 degree, which is timed between 3pm to 6pm. While the average temperature detected is 23.4 degree and the maximum rate detected is 25.6 degree. Furthermore, the minimum lighting detected at area D throughout the working hours is 540 lux timed between 9am to 12pm. While the average lux detected is 769.8 lux and the maximum lux detected is 831.7 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 58.4 percent. While the average percentage detected is 59.2 percentage and the maximum percentage detected is 63.1 percentage timed between 3pm to 6pm in the afternoon.

Finally, The table 5.31 shows that the minimum temperature detected at area E throughout the working hours is 23.3 degree, which is timed between 12pm to 3pm. While the average temperature detected is 24 degree and the maximum rate detected is 26.2 degree. Furthermore, the minimum lighting detected at area E throughout the working hours is 201 lux timed between 3pm to 6pm. While the average lux detected is 435.6 lux and the maximum lux detected is 658.3 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The

75

minimum RH percentage detected is 55.1 percent. While the average percentage detected is 56 percentage and the maximum percentage detected is 59.4 percentage timed between 3pm to 6pm in the afternoon.

Menera Kerjaya Level 31

This schedule contains results generated from measuring the 31 floor of Menara Kerjaya JKR. The measurements carried are the Temperature, Lighting level (Lux) and Relative Humidity (RH%) within the workplace.

Table 5.46: empirical measurement floor 31

Floor 31										
Area	Time	Temp, °C			Lux			RH, %		
13\12\17		Min	Avrg	Max	Min	Avrg	Max	Min	Avrg	Max
A	9:00AM-	22.0	24.1	24.6	461.2	2112.7	3401.8	53.5	55.6	63.8
	12:01PM -3:00PM	23.7	24.3	24.7	658.3	1242.8	2290.2	52.8	53.6	54.6
	3:01PM- 6:00PM	23.0	23.5	25.2	319.3	634.2	910.6	54.9	56.6	59.0
B	9:00AM-	20.3	21.0	22.8	130.1	324.8	484.9	62.7	64.7	66.1
	12:01PM -3:00PM	20.9	21.5	21.6	130.1	184.0	224.7	62.5	63.0	64.8
	3:01PM- 6:00PM	21.5	21.9	23.5	114.3	426.8	642.5	62.3	63.1	64.9
C	9:00AM	22.0	22.3	22.9	106.4	199.1	500.6	60.3	61.3	64.0
	12:01PM -3:00PM	21.6	21.8	22.1	106.4	141.9	169.5	61.0	61.5	61.9
	3:01PM- 6:00PM	21.8	22.3	23.8	90.7	338.6	532.2	60.6	61.4	62.9
D	9:00AM-	21.2	21.4	22.7	11.8	284.6	342.9	64.5	65.7	66.3
	12:01PM -3:00PM	20.7	21.0	21.2	193.2	290.4	335.1	65.5	65.9	66.8
	3:01PM- 6:00PM	20.8	21.3	23.2	122.2	254.9	358.7	65.2	66.7	70.1
E	9:00AM-	21.1	21.3	22.6	11.8	437.3	508.5	61.0	63.2	64.2
	12:01PM -3:00PM	20.8	21.0	21.2	177.4	325.0	500.6	62.9	63.3	63.8
	3:01PM- 6:00PM	21.2	21.8	23.9	161.6	491.2	768.7	59.9	62.2	65.4

First of all, the numbers in the schedule for level 31 can be summarize into the minimum, average and maximum of each IEQ throughout the day. The figures show that the minimum temperature detected at area A throughout the working hours is 22 degree, which is timed between 9am to 12pm. While the average temperature detected is 24.1 degree and the maximum rate detected is 25.2 degree. Furthermore, the minimum lighting detected at area A throughout the working hours is 319.3 lux timed between 3pm to 6pm. While the average lux detected is 1242.8 lux and the maximum lux detected is 3401.8 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 52.8 percent. While the average percentage detected is 55.6 percentage and the maximum percentage detected is 63.8 percentage timed between 9am to 12pm.

Secondly, The table 5.32 shows that the minimum temperature detected at area B throughout the working hours is 20.3 degree, which is timed between 9am to 12pm. While the average temperature detected is 21.5 degree and the maximum rate detected is 23.5 degree. Furthermore, the minimum lighting detected at area B throughout the working hours is 130.1 lux timed between 9am to 12pm. While the average lux detected is 324.8 lux and the maximum lux detected is 642.5 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 62.3 percent. While the average percentage detected is 63.1 percentage and the maximum percentage detected is 66.1 percentage timed between 9am to 12pm in the afternoon.

Thirdly, The table 5.32 shows that the minimum temperature detected at area C throughout the working hours is 21.6 degree, which is timed between 12pm to 3pm. While the average temperature detected is 21.3 degree and the maximum rate detected is 23.8 degree. Furthermore, the minimum lighting detected at area C throughout the working hours is 11.8 lux timed between 9am to 12pm. While the average lux detected is 199.1 lux and the maximum lux detected is 532.2 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 60.3 percent. While the average percentage detected is 61.3 percentage and the maximum percentage detected is 64.0 percentage timed between 9am to 12pm in the afternoon.

Fourthly, The table 5.32 shows that the minimum temperature detected at area D throughout the working hours is 21.2 degree, which is timed between 9am to 12pm. While the average temperature detected is 23.4 degree and the maximum rate detected is 23.2 degree. Furthermore, the minimum lighting detected at area D throughout the working hours is 11.9 lux timed between 9am to 12pm. While the average lux detected is 284.6 lux and the maximum lux detected is 358.7 lux throughout the working hours. In addition, the relative humidity RH% percentage is presented in the schedule above. The minimum RH percentage detected is 64.5 percent. While the average percentage detected is 65.7 percentage and the maximum percentage detected is 70.1 percentage timed between 3pm to 6pm in the afternoon.

Finally, The table 5.32 shows that the minimum temperature detected at area E throughout the working hours is 21.1 degree, which is timed between 9am to 12pm. While the average temperature detected is 21.3 degree and the maximum rate detected

78

is 23.9 degree. Furthermore, the minimum lighting detected at area E throughout the

working hours is 201 lux timed between 3pm to 6pm. While the average lux detected is

437.3 lux and the maximum lux detected is 768.7 lux throughout the working hours. In

addition, the relative humidity RH% percentage is presented in the schedule above. The

minimum RH percentage detected is 59.9 percent. While the average percentage

detected is 63.2 percentage and the maximum percentage detected is 65.4 percentage

timed between 3pm to 6pm in the afternoon.

5.11.2 High Efficiency HVAC system

MRK has achieved high efficiency energy saving compared to normal building in

Malaysia and low energy conception by incorporating the following energy efficiency

HVAC system:

- High efficiency water-cooled centrifugal chiller.

- High motor and fan efficiency.

- Electrostatic Precipitation air filter.

- VAV ventilation system (with variable speed drive fans).

- CO2 sensor ventilation strategy.

- Centralized heat recovery system.

- Photovoltaic panels.

In details, or achieving low energy air-conditioning system, each component had to be

designed to be efficient at all load conditions, not only at design load. Air handling unit

(AUH) had to be capable to suit varying cooling loads, which would be dependent on

sky conditions, outdoor temperature occupancy internal light and plug power.

Air distribution is based on multi-zone variable air volume, air mixed ventilation scheme. Two centralized air-handling units fitted with variable speed drives provide cooling each floor. The building management system (BMS) controls the AHUs and allows the fan to reduce to 50% fan speed when cooling loads are low. Ducting design and grille selection further limits the AUHs discharge static pressure to be more than 250Pa. Each zoned temperature is controlled by VAV boxes, when temperature at zones has achieved its set point, the VAV boxes reduce airflow to as low as 30% of the design flow.

The selected chiller plants comprises of 2 nos 600RT centrifugal water cooled chillers (2 duty and 1 standby) has been able to operate at an overall system COP of 4.5 to 5.0. This has been achieved by not only selecting more efficient chillers, but by achieving a low pump head for both chilled water and condenser water pumps (<25m head).

Heat recovery wheels are employed at the main outdoor air intake fan to recover the cool from the exhaust air onto the outdoor air. Additionally, the outdoor air delivery system incorporate demand controlled ventilation system, utilizing CO_2 sensors on main return ducting to AHUs as an indicator of occupancy level. When CO_2 level in the return air below 700ppm, indicating low occupancy level, outdoor air supply to the AHU is reduced to minimum.

5.11.3 Lighting efficiency system

Much emphasis has been placed on installing energy efficiency electric lighting in the building. The general office lighting are celling suspended pendant luminaires with electronic ballasts and with T5 tubes installed.

80

Occupancy sensors are installed in the corridors, toilets and meeting rooms to switch on the lighting only when required. This will help to save on lighting energy because these areas are not occupied all the time and do not need the lights to be switched on all the time. There is also proper lighting zoning in the open office so that only the areas require to be used are lighted instead of having to light up the whole area.

There are panel of switches at the entrance to the office space. When occupants arrives at the office, the occupants will switch on the lights for respective corridor areas and some library, office areas away from facades. This will help to conserve the energy required for lighting as several circuits particularly for partially daylight areas may not be switched on for most of days.

5.11.4 Compliance with MS1525

The guideline provides standards for acceptable measures for temperature level, lighting and relative humidity. The compliance check is made to ensure that data gathered for temperature level, lighting and relative humidity are in compliance and at acceptable level. The average illuminance (lux) for general office should be between 300 - 400 lux. Therefore lighting level at the office is at the acceptable range and in compliance with MS1525. Moreover, the designed indoor condition of air-conditioned space for comfort should be around 24 ° C – 26 ° C dry bulb temperature and minimum recommended temperature should be 23º C. Additionally, humidity recommended level should be between 50% - 60% and therefore results show compliance with the recommended level of temperature level and humidity.

5.12   Interview Results

Interview is conducted to investigate theoretical opinions about the ergonomic space design elements and its contribution to work performance. It is also made to gain insight into different opportunities that helps to support questionnaires results. The interview took a place with one staff of cooperate department and it was divided into 10 questions. The first 3 questions were about workplace space design, another 4 questions about IEQ and the last 3 questions about office ergonomics. The focuses of these questions are basically to investigate employees' satisfaction in addition to work performance perceptions.

Theatrical analysis is used to input the results of data gathered. It started with reading through the answers; summaries the answers, codding the important words then label the relevant factors and most connected to the study. The findings have been divided into 3 themes. The first themes focuses on Workplace space design, the second theme focuses on IEQ and the third theme focuses on Office Ergonomics.

<u>Workplace Space design</u>

The first theme focuses on the interior design, spaces design and office flexibility and accessibility. The results entail that the interior design such as color and texture are in a satisfactory level. But it is suggested that it can be improved with better colours, especially for the carpet. On the other hand, it is believed that the office space design is restricted for arrangement. Yet it is acceptable at this moment but receiving more employees may cause discomfort due to having more person sharing one space. Therefore, office flexibility for rearrangement and accommodation believed to be at its peak and it is at risk of dropping work performance.

82

Office IEQ

The second theme is office IEQ, which focuses on office temperature level, lighting level, noise level and Air quality. Throughout the interview, it is believed that office keeps median temperature level as it is set to 24 degree. Therefore, there are no measurable thermal or humidity issues. Nevertheless, it is proposed to relocate and revise placement of lighting zones. It is believed that some workstations do not receive enough lighting thereof. On the other hand, it is believed that ventilation level is acceptable but need to be improved. It is entailed that odour and smell in takes a longer time to be replaced with fresh air. Nosise is a satisfactory level and no opinion given about it.

Office ergonomics

Office ergonomics consist of ergonomics elements such as chair, table functionality and space for movement and adjustment. It is believed that the functionality of office furniture is good and it is still at a good quality and function as desired. The chair is adjustable to suit the desirable height and chairs comes with lower back support, which gives more comfort for longer time setting. Chairs are moveable and in a good condition. Tables come with acceptable space for PC and documents reviewing. It is also believed be in a good condition and comes with adequate space.

Summary

In summary, the interview indicated that employees are satisfied with the current office ergonomics and space design and believe that the current office condition helps to maintain work performance and productivity. A slight improvement needed in the future if employees number increased.

5.13   Discussion

This research focuses on evaluating satisfaction level of employees and office ergonomic space design effects on work performance. Menara karjaraya is a certified as green building by Green building index. Furthermore, Results has shown that the building has complied with Malaysian Standards such as average temperature level, humidity percentage and lighting level. The office was design in order to generate comfortable work environment and encourage healthy environment practices. The office has been divided into 4 main workstation designed to suit the job tasks such as individual office, individual cubic, detached cubic and shared desk. And these offices comes in different sizes as prescribed in the table below:

Table 5.47: Office Areas Dimensions

Cubic Type	Width	Length
Type A	470 cm	440 cm
Type B	470 cm	450 cm
Cubic Type	**Width**	**Length**
Type A	176 cm	180 cm
Type B	169 cm	178 cm
Type C	160 cm	178 cm
Shared desk	160 cm	160 cm

The measurement provided at the table 5.33 shows personal area designed per individual employee. Therefore, satisfaction evaluation predominantly depends on every employee's satisfaction on his personal working area. In addition, through investigating distance between employees who have offices near windows, it is observed that the nearest or minimum distance between windows and seating position to those employees is 170 cm. As observed, it is found to be an acceptable distance to avoid direct exposure of sunlight and heat transferred through the glass windows. Yet

84

these areas maintain average temperature, which is within acceptable level advised by Malaysian Standards MS 1525. Thus, this results supports Lee and Guerin (2009) whom stated in their study that performance was profoundly enhanced by excellent practice of indoor environment quality. And results procreated from question survey and empirical measurement received sufficient satisfaction among employees and satisfactory IEQ outcomes. It its interesting that good indoor environment policies implied brings high satisfaction results solutions. As satisfaction results were about 3.5 out of 5 average means score showing that majority of employees strongly agrees that IEQ condition improved work performance and health. While another satisfactory results shows that majority of employees participated in this study believe that office furniture and workstation space design beneficially enhanced comfort level and work performance as well. For that point, another study by Lee and Guerin (2009) showed occupants who experienced good IEQ and ergonomic conditions had more positive responses to their work performance compared with occupants who are not integrated with LEED designs or any GB regulations. The study indicated that these occupants showed least positive attitude toward the workplace environment and ergonomics. In the light of this study, there were several indicators of frequent eyestrains and musculoskeletal discomfort, especially with wrist or hand issues. Whereas, Cawangan Dasar Dan Pengumsan Korporat employees have showed no reports for constant discomfort of the office environment, neither ergonomic physical issues due to good implementation of Space design, ergonomics and IEQ measures. Such lighting system and efficient HVAC system mentioned previously.

This study has encountered several limitations; it was difficult to reach to the 155-targeted respondents working at the named department. Plus, it was difficult to get permission to another certified green office building to create reasonable comparison between data resulted. This is suggested to find supporting evidence regarding IEQ and ergonomic space design in enhancing work performance. This study was purposely made for academic purposes. Therefore, limitation of timeframe presented to complete major survey with higher number of responses and so on generate adequate data to support the recommend strategies for the importance of ergonomic strategies at the end of this study. Participants were constantly and repeatedly were invited to do the survey but due to workload it wasn't possible to reach out. Moreover, it was not available to conduct empirical measurement at the 30 and 32 floor access permission was not granted. So IEQ and ergonomics features of these 2 floors were not considered to be part of the data anlaysed.

Notwithstanding with the mentioned methodological limitations, the outcomes resulted from this study shows major agreement with the outcomes of other studies (Turner, 2006). Finding states various aspects of current implementation of green building design are successfully contribute to enhance work performance and comfort. To support that, Kruskal-willis test on various factor showed that work performance was not affected. Although green building potentially provides improved work environment condition to Menara Kerjaraya employees compared to other conventional or uncertified green building, there a considerable opportunities for a better integration of ergonomics workplace strategies with IEQ section in GB standards in order to results better enhancement of employees work performance.

5.14   Key Finding of Objectives

The research is constructed on 4 main objectives, which are considered to be the vital

aims of this report. These objectives are detailed as shown below

Objective 1:

Objective 1 is to study green ergonomics elements in green office space that can affect

the employee's work performance. This objective achieved through the extensive study

of literature reviews. The constructive studies of the literature review has identified the

possible ergonomics elements that can possibly enhance work performance, which are

Workplace space design elements (interior design, space management, office

flexibility), office ergonomic (office furniture, ergonomics strategies on office

equipment) and its effect on health and wellbeing, the interaction of employees work

space with Indoor environment quality (temperature level, humidity, lighting level).

Objectives 2

Objective 2 is to identify green ergonomics elements in new construction green office

building (NRNC). This objective achieved through side visit and personal observation

and documentation of the existing elements. It is also achieved through the revision of

literature reviews and confirms the reliability of the elements through the previous

studies. These elements identified are mentioned in chapter 4 case study section. It can

be summarized as type of office area provided, personal space provided per employees,

the quality of office furniture and its ergonomics features.

Objectives 3

Objective 3 is to investigate employees' satisfaction on ergonomic elements in green office building. This objective is covered at chapter 5 data analysis. This objective is achieved through distributing questionnaire survey among employees of Cawangan Dasar dan Pengurusan Korporat. As shown at chapter 5, the results are constructive data generated from 61 employees out of 155-targeted employees. It is difficult to accomplish the targeted number due to the limitation mentioned previously. Nevertheless, the results obtained from the survey showed high percentage of satisfaction among the named department. The results show satisfactory outcomes. And it was concluded due to the implementation of green building standards, which mainly focus on energy efficiency, indoor environment qualities in integration with the ergonomic strategies practiced. The survey included Workplace space design, indoor environment quality, office ergonomic and work performance (check appandex A, B and C) as well as chapter 5 for further details. Interview was conducted to illustrate the impact of these elements of employees' satisfaction and work performance and act as support findings to objective purposes.

Objectives 4

Objective 4 is to propose green ergonomics recommendation that can be included in existing green building requirement. This objective is achieved throughout the writing of this research project. The recommendations are results of finding throughout conducing this research and the validity of these findings is basically found in previous studies in addition the finding of this research. These recommendations are described in chapter 6, which is conclusion and recommendation.

6.0 Conclusion and Recommendation

6.1   Conclusion

In conclusion, this research has identified ergonomic elements that can substantially improve work performance of employees and enhance working experience. As employees spent most of the working hours within premises, it is very important to take into consideration several strategies that ensure healthy and safe working environment. It is economically beneficial for companies and organization to enhance work performance as well as health and comfort of employees. Therefore, green building policies focuses on strategies that ensure positive environment inside the office. It is suggested throughout this research to obtain maximum advantage of green building strategies in cooperation with ergonomics and space design strategies to maximize the outcomes of positive working attitude and increase satisfaction of employees. Nevertheless, ergonomics space design is not considered to be important factors that can possibly affect or enhance work performance alongside with Indoor environment quality rating tool in all green building standards. Although initiative movement from LEED to include ergonomics elements, it is not yet considerably focused on. It is important to notice that this research has shown constructive evidence of satisfaction of employees has extensively increased due integration of ergonomics space design with indoor quality policies. In this way, green building shall constantly achieve more human related benefits such as health, comfort and sustainable working environment. It also can promote to consider green building industry to grow wilder and play as a contributing factor for a sustainable development.

6.2   Recommendations

This research has mainly focused on investigating on employees' satisfaction on their office ergonomic space design and indoor environment, which contribute to enhance work performance. As Menara Kerjaya is Platinum certified green, satisfaction level appeared to be at its maximum. Therefore, it supports the statement that ergonomic features and space design are very recommended elements to be added to GBI checklist and rating tool. Thus, the recommendations are as follow:

1. To provide standard measure for the size of personal space area provided per employees based on the office type, minimum space 2-meter square.

2. To consider equipping the office with ergonomics furniture such as chairs and tables, to reduce work related musculoskeletal disorders and other related syndromes.

3. To establish standards for distance between employees opening such as windows, especially if the office is constructed with window glass wall, to avoid direct exposure of sunlight and eyestrains. Suggested as minimum as 1.7 m distance.

7.0 References

Administration, U. E. I. (2009). Lighting in commerical building.

Al horr, Y., Arif, M., Katafygiotou, M., Mazroei, A., Kaushik, A., & Elsarrag, E. (2016). Impact of indoor environmental quality on occupant well-being and comfort: A review of the literature. *International Journal of Sustainable Built Environment, 5*(1), 1-11. doi:https://doi.org/10.1016/j.ijsbe.2016.03.006

American Society of Heating, R. a. A.-C. E. (2010). ASHRAE handbook: Fundamentals. Atlanta *GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers.*

Amina, H., & Shehla, A. (2009). Impact of office design on employee's productivity. A case study of banking Organizations of Abbottabad, Pakistan (n.d.). Retrieved from. doi: http://www.scientificjournals.or/journals2009/articles/1460.pdf.

Arora, S. (1981). Office organization and management. *New Delhi : Vikas.*

Brill, M., Margulis, S., & Konar, E. (1984). Using Office Design to Increase Productivity. Buffalo, N.Y.:. *Workplace Design and Productivity Buildings IAQ, 1*(2), 495-500.

Clements, D. J. (2008). Work performance, productivity and indoor air. *SJWEH Suppl*(4), 69-78.

cost, G. O. O. (2012). Global Office Occupancy cost. Debenham Tie Leung.

Council, U. S. G. B. (2010). USGBC U.S Green building Council. How to achieve certification.

Council, U. S. G. B. (2013). *A report from the summit on green building and human health. updated 2013, cited 2014 Aug 31]. Available from.* Retrieved from http://www.usgbc.org/sites/default/files/GBHH_Final_1.pdf.

Crouch, A. (1989). Perceived facilitators and inhibitors of work performance in an office environment. *Environment and Behavior, 21*, 206-226.

Denyer, J. C. (1969). *Office management*

Dole, C., & Schroeder, R. (2001). The impact of various factors on the personality job satisfaction and turnover intentions of professional accountants. *Managerial Auditing Journal, 16*(4), 45-234.

Dul. J, & Neumann, W. P. (2009). Ergonomics contributions to company strategies. *Appl Ergon., 40*, 745-752.

El-Zeiny, R. M. A. (2012). The Interior Design of Workplace and its Impact on Employees' Performance: A Case Study of the Private Sector Corporations in Egypt. Procedia. *Social and Behavioral Sciences, 35*(0), 746-756. doi:http://dx.doi.org/10.1016/j.sbspro.2012.02.145

Gensler. (2009). Gensler Design + Performance Index. the U.S. Workplace Survey.

Giang, D. T. H., & Sui Pheng, L. (2011). Role of construction in economic development: Review of key concepts in the past 40 years. *Habitat International, 35*(1), 118-125. doi:http://dx.doi.org/10.1016/j.habitatint.2010.06.003

Goodell, L. (2010). how to create a productive office environment Inc. *1.*

Gou, Z., & Lau, S. (2012). Sick Building Syndrome in Open-Plan Offices: Workplace Design Elements and Perceived Indoor Environmental Quality. *Facilities Management, 10*, 256-265.

Green Building Index. (2011). GBI AssessmentCriteria. Non-Residential new construction Building (NRCN) *First Edition*. Kuala Lumpur, Malaysia Geen Building Index SDN BHD.

Hedge, A. (2008). The Sprouting of Green Ergonomics. *Bulletin of Human Factors and Ergonomics Society, 51*(12), 1-3.

Hedge, A., Puleio, J., & Wang, V. (2011). Evaluating the impact of an office ergonomic programe in Proceeding of human factor and ergonomic society 55th annual

meeting. *Human factors and ergonomics*, 594-598.

Hedge. A, & Dprsey. J. A. (2013). Geen building need good ergonomics. *Ergonomics, 53*(3), 492-506. doi:10.1080/00140129.2012.718367

Hraska, J. (2015). Chronobiological Aspects of Green Buildings Daylighting. *renewable energy, 59*, 67-72.

Hua, Y., Loftness, V., Kraut, R., & Powell, K. (2010). Workplace collaborative space layout typology and occupant perception of collaboration environment. *Environment and Planning B: Planning and Design, 37*, 429-448.

Kaplan, N., & Aronoff, S. (1996). Productivity paradox: work settings for knowledge work. *Facilities, 14*(2-4), 6-14.

Kushwaha, D. K., & Kane, P. V. (2016). Ergonomic assessment and workstation design of shipping crane cabin in steel industry. *International Journal of Industrial Ergonomics, 52*, 29-39. doi:10.1016/j.ergon.2015.08.003

Lee, Y. S., & Guerin, D. A. (2009). Indoor environment quality related to occupant satisfaction and performance in LEED certified Building. *Indoor and Built Environment, 18*(4), 293-300.

Legg, S., & Brown, C. (2010). Achieving transition to sustainability: lessons from human factors and ergonomics. In. *Proceedings of the 4th International Conference on Sustainability Engineering and Science.*

Lewis, R., & Kraweie, M. (2002). Musculoskeletal disorders worker compensation cost before and after an office ergonomic programe. *International Journal of Industrial Ergonomics, 20*, 95-99.

MacNaughton, P., Satish, U., Laurent, J. G. C., Flanigan, S., Vallarino, J., Coull, B., . . . Allen, J. G. (2017). The impact of working in a green certified building on cognitive function and health. *Building and Environment, 114*, 178-186. doi:https://doi.org/10.1016/j.buildenv.2016.11.041

McLennan, J. F. (2004). **The Philosophy of Sustainable Design**. *the Future of Architecture. Ecotone LLC, Kansas City*, 2-8.

Michie, S. (2002). Causes and Management of Stress at Work. *Occupants and Environment, 59*, 67-72.

MS1525. (2014). *Energy efficiency and use of renewable energy for non-residential buildings - Code of practice (Second revision)*. Malaysia.

Notarnicola, B., Sala, S., Anton, A., McLaren, S. J., Saouter, E., & Sonesson, U. (2017). The role of life cycle assessment in supporting sustainable agri-food systems: A review of the challenges. *Journal of Cleaner Production, 140*, Part 2, 399-409. doi:http://dx.doi.org/10.1016/j.jclepro.2016.06.071

Radjiyev, A., Qiu, H., Xiong, S., & Nam, K. (2015). Ergonomics and sustainable development in the past two decades (1992-2011): Research trends and how ergonomics can contribute to sustainable development. *Appl Ergon, 46 Pt A*, 67-75. doi:10.1016/j.apergo.2014.07.006

Ropin, S. H. M. (1995). Habitat international. *19*(4), 401-652.

Saari, A., Topi, T., Esko, V., & Olli, S. (2006). The effect of a redesigned floor plan, occupant density and the quality of indoor climate on the cost of space productivity and sick leave in an office building – A case study. *Building and Environment, 41*(12), 961-972. doi:http://dx.doi.org/10.1016/j.buildenv.2005.07.012

Schiavon, S., & Altomonte, S. (2014). Influence of factors unrelated to environmental quality on occupant satisfaction in LEED and non-LEED certified buildings. *Building and Environment, 77*, 148-159. doi:10.1016/j.buildenv.2014.03.028

Seppänen, O., Fisk, W. J., & Lei, Q. H. (2006). Ventilation and Performance in OfficeWork. *Indoor Air, 16*, 28-36.

Shahzad, S., & Brennan, J. (2016). Theodossopoulos, D.; Hughes, B.; Calautit, J.K. Building-Related Symptoms, Energy, and Thermal Control in the Workplace: Personal and Open Plan Offices. *sustainability, 8*, 331-350.

92

Statistics, B. o. L. (2009). Workplace injuries and illiness. Occupational Outlok handbook: Department of Labor.

Turner, C. (2006). LEED building performance in the Cascadia region. a post occupancy environment report. Poland *cascadia Region Green Building.*

World Green Building Council. (2014). Health, Wellbeing & Productivity in Offices: The Next Chapter for Green Building. In Health, Wellbeing and Productivity. *World Green Building Council, Ed.;World Green Building Council: London.*

Xue, F., Gou, Z., & Lau, S. (2016). Human Factors in Green Office Building Design: The Impact of Workplace Green Features on Health Perceptions in High-Rise High-Density Asian Cities. *sustainability, 8*(11), 1095. doi:10.3390/su8111095

Zink, K. J. (2014). Designing sustainable work systems. *the need for a systems approach. Appl. Ergon., 45,* 126-132.

APPENDEX A: Questionnaires Survey

Ergonomics Space Design in Enhance Employees' Productivity Perception in Green Office Building

My name is Abdallah Bashir. I am a master student, doing facilities management studies. This questionnaire survey is conducted to get an understanding and overview of the office ergonomic space design and its impact on employees' productivity in green building. The survey covers areas related to satisfaction and behaviour. Including factors that possibly influence productivity and work performance within the office.

The questionnaire will be divided into five (5) main categories, each category has it is own individual answer

your participation would be highly appreciated and Thank you in advance for your time and cooperation.

This survey is conducted for academic purposes and will remain confidential. No harm or private information shall be shared with any external parties other than University of Malaya

Please do not hesitate contact me for any inquires or further questions:

Name:　　　　　　　　Abdallah Muhamed Bashir
Student Metric no:　BGG 160010
Email:　　　　　　　　Bashoo191@gmail.com
Phone number:　　　+6012 212 45 21

*Required

Demographic

Please answer the questions as follow below:

1. Gender *
Mark only one oval.

◯ Male

◯ Female

2. Age *

_____

3. Which floor you are working at? *
Mark only one oval.

◯ 29 floor

◯ 30 floor

◯ 31 floor

◯ 32 floor

4. Employees' position *
Mark only one oval.

◯ Managerial

◯ Technical

◯ Administrative

5. Where do you usually perform your job tasks? *
Mark only one oval.

◯ Individual Office (office\Room)

◯ Individual cubic area (one person at one cubic office)

◯ Shared cubic area (2 person in one room\ cubic office\desk\table)

◯ shared desk (3 and above people in one cubic area)

6. How long have you been working with your company\organisation? *
Mark only one oval.

◯ Less than six (6) months

◯ One (1) year

◯ Two (2) years

◯ Three (3) years and above

7. How many days do you work a week? *
Mark only one oval.

◯ 4 days

◯ 5 days

◯ 6 days

◯ 7 days

8. How many hours do you work a day? *
Mark only one oval.

◯ 6 hours

◯ 7 hours

◯ 8 hours

◯ 9 hours

◯ I usually do over-time (if it happens very often)

9. What tasks do you perform in the office? *
Mark only one oval.

◯ Writing (reports, Letters, Memos, Emails)

◯ Computing and researching (web searchings, designs, etc)

◯ Calculating and analysing (data, informations)

◯ Communication and services

◯ Other: _____

10. How often do you take a leave\MC in a month? *
Mark only one oval.

○ 1 time a month

○ 2 times a month

○ 3 times a month

○ 4 times and more

○ Never

11. In your opinion, the cause of your sickness was mainly due to the environment of your workstation? *
Mark only one oval.

○ Yes

○ NO

Workplace space design

Please rate how satisfied you are by choosing one of the follow options below

12. Interior Design *
Mark only one oval per row.

	Very Dissatisfied	Dissatisfied	Neutral	Satsified	Very satisfied
The overall office architectural hindrances	○	○	○	○	○
The office interior colours	○	○	○	○	○
The office interior textures (the feel, appearance, or consistency of the interiors)	○	○	○	○	○
The overall quality of office furnitures	○	○	○	○	○
The overall office cleanliness	○	○	○	○	○

Comments: (Optional)

13. Space Design *
Mark only one oval per row.

	Very Dissatisfied	Dissatisfied	Neutral	Satsified	Very satisfied
The adequacy of office space to employees' number	○	○	○	○	○
The adequacy of personal space provided	○	○	○	○	○
The Space within open plan concept	○	○	○	○	○
The Space of meeting rooms	○	○	○	○	○
The office layout arrangement (placement of cubic offices, shared tables, etc)	○	○	○	○	○
The Placement of office equipment (printing, vending machines, etc)	○	○	○	○	○

Comments: (Optional)

14. Flexibility and accessibility *

Mark only one oval per row.

	Very Disagree	Disagree	Neutral	Agree	Very agree
The size of the office supports flexibility in movement	◯	◯	◯	◯	◯
The office space flexible enough to allow layout changes	◯	◯	◯	◯	◯
The office layout allows interaction among employees	◯	◯	◯	◯	◯
The office accessibility plans suits the work tasks	◯	◯	◯	◯	◯
The Accessibility plan creates safe movement throughout the office	◯	◯	◯	◯	◯

Comments: (Optional)

The office Indoor Environment Quality

15. Please rate the office temperature level *

Mark only one oval per row.

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
Thermal comfort level (your individual feel of temperature wearing your uniform\clothing)	◯	◯	◯	◯	◯
The office temperature level (Overall)	◯	◯	◯	◯	◯
The office Humidity level	◯	◯	◯	◯	◯
The temperature stability level (maintain office temperature level)	◯	◯	◯	◯	◯
Temperature change effectiveness (frequency of Temperature change)	◯	◯	◯	◯	◯

Comments: (Optional)

16. Please rate how satisfied you are with office lighting *

Mark only one oval per row.

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
Electric lighting level	◯	◯	◯	◯	◯
Appropriate light to read and write	◯	◯	◯	◯	◯
Daylight Glare Control	◯	◯	◯	◯	◯
Sunlight Access	◯	◯	◯	◯	◯
The visual comfort	◯	◯	◯	◯	◯

Comments: (Optional)

17. Please rate the office noise level *
Mark only one oval per row.

	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
Office noise level	◯	◯	◯	◯	◯
External noise level (coming from outside the office)	◯	◯	◯	◯	◯
Noise caused by office equipments (printing, vending machines)	◯	◯	◯	◯	◯
Noise control in quiet area	◯	◯	◯	◯	◯
noise caused by discussions					

Comments: (Optional)

18. Please rate the air quality level *
Mark only one oval per row.

	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
The Office Ventilation performance	◯	◯	◯	◯	◯
The office odours and smell	◯	◯	◯	◯	◯
The office Tobacco Smoke control	◯	◯	◯	◯	◯
The office fresh air supply	◯	◯	◯	◯	◯
The office air movement and circlation	◯	◯	◯	◯	◯

Comments: (Optional)

The workplace ergonomics

19. The office furnitures *
Mark only one oval per row.

	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
The furniture have architectural hindrances	◯	◯	◯	◯	◯
Thr furniture colours and texture	◯	◯	◯	◯	◯
The size of table provided	◯	◯	◯	◯	◯
The ability to adjust furniture to meet my tasks needs	◯	◯	◯	◯	◯
The comfort of seating chair	◯	◯	◯	◯	◯
The chair support to your lower back	◯	◯	◯	◯	◯
The Keyboard and mouse to your elbow hight	◯	◯	◯	◯	◯
The allowed space for wrist to rest on the desk	◯	◯	◯	◯	◯
The monitor (PC) position to your comfort seating	◯	◯	◯	◯	◯
The screen glare control					

5/6

Comments: (Optional)

Employees' Work performance
Please rate the effects of item below on your work performance:

20. *
Mark only one oval per row.

	Poor	Fair	Average	Good	Excellent
The overall interior design	⬭	⬭	⬭	⬭	⬭
The overall space desigs	⬭	⬭	⬭	⬭	⬭
The overall office flexibility	⬭	⬭	⬭	⬭	⬭
The overall office tempreture	⬭	⬭	⬭	⬭	⬭
The overall office lightings	⬭	⬭	⬭	⬭	⬭
The overall office noise	⬭	⬭	⬭	⬭	⬭
The overall air quality	⬭	⬭	⬭	⬭	⬭
The overall office ergonomics	⬭	⬭	⬭	⬭	⬭

Please specify how your work performance is effected by any of the components above if applicable: (optional)

Powered by
Google Forms

Appendix B: SPSS Analysis

Demographic

Statistics

		Gender	Age	Floor	Position	area	Employment	Wday	Whours	Tasks	MC	Sickness
N	Valid	60	60	60	60	60	60	60	60	60	60	60
	Missing	0	0	0	0	0	0	0	0	0	0	0
Mean		1.68	2.03	2.12	2.10	2.40	3.13	1.03	3.25	2.08	3.30	1.77
Median		2.00	2.00	2.00	2.00	2.00	4.00	1.00	3.00	1.00	5.00	2.00
Mode		2	2	1	2	2	4	1	3	1	5	2
Std. Deviation		.469	.974	1.121	.681	1.028	1.081	.181	.751	1.880	1.92	.427
Variance		.220	.948	1.257	.464	1.058	1.168	.033	.564	3.535	3.70	.182
Skewness		-.809	.729	.360	-.126	.472	-.774	5.334	-.202	1.980	-.311	-1.294
Std. Error of Skewness		.309	.309	.309	.309	.309	.309	.309	.309	.309	.309	.309
Kurtosis		-1.394	-.351	-1.362	-.787	-.949	-.900	27.360	2.110	3.702	1.90	-.339
Std. Error of Kurtosis		.608	.608	.608	.608	.608	.608	.608	.608	.608	.608	.608
Range		1	3	3	2	3	3	1	4	8	4	1
Minimum		1	1	1	1	1	1	1	1	1	1	1
Maximum		2	4	4	3	4	4	2	5	9	5	2
Sum		101	122	127	126	144	188	62	195	125	198	106

Descriptive and Reliability test

Interior Design Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Architectural hindrances	14.88	8.444	.883	.917
The office interior colours	14.82	8.423	.861	.921
The office interior textures	14.87	8.660	.834	.927
Quality of Office Furnitures	15.08	8.281	.826	.929
Office cleanliness	14.82	9.034	.791	.934

Space Design Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
The adequacy of office space	17.53	14.321	.818	.927
Personal space provided	17.52	15.101	.870	.921
The Space within open plan concept	17.52	14.593	.813	.927
Space in Meeting Room	17.43	15.673	.696	.941
Office layout arrangement	17.48	14.322	.908	.915
Placement of office equipment	17.52	14.932	.799	.928

Temperature level Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Thermal comfort level	13.88	7.393	.724	.938
Office temperature level	13.97	6.745	.875	.910
Office Humidity level	14.08	7.637	.737	.935
Temperature stability level	14.05	6.455	.933	.898
Frequency of Temperature change	14.08	6.993	.869	.912

Lighting (Lux) Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Electric lighting leve	14.52	7.305	.856	.915
Appropriate light to read and write	14.53	7.270	.863	.913
Daylight Glare Control	14.52	7.745	.730	.938
Sunlight Access	14.42	7.773	.783	.928
The visual comfort	14.55	7.438	.913	.905

Noise level Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Office noise level	14.63	6.101	.769	.895
External Noise	14.43	6.216	.799	.889
Noise office equipments	14.55	5.981	.866	.875
Noise control in quiet area	14.52	6.220	.832	.883
Noise caused by discussions	14.67	6.497	.638	.923

Air Quality Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Office Ventilation performance	14.23	7.979	.819	.919
Office odours and smell	14.30	7.637	.736	.927
Office Tobacco Smoke control	14.30	6.959	.782	.920
Office fresh air supply	14.42	6.518	.902	.895
Office air movement and circlation	14.42	6.484	.882	.900

Office Furniture Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Architectural hindrances of furniture	31.35	33.791	.650	.939
Furniture colours and texture	31.23	33.673	.685	.937
Size of table	31.22	32.478	.784	.933
Adjustment of furniture	31.48	32.017	.734	.936
Comfort of seating chair	31.37	32.033	.840	.930
Chair support lower back	31.57	31.368	.771	.934
Keyboard and mouse adjustment	31.22	34.071	.745	.935
Space for wrist to rest on the desk	31.18	33.406	.778	.933
The monitor (Notarnicola et al.) position	31.20	33.451	.800	.933
Screen glare control	31.23	32.928	.835	.931

Work performance Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Office flexibility	7.07	2.673	.879	.937
Space desigs	7.03	2.609	.913	.911
Office ergonomics	7.00	2.847	.891	.929

Work performancy by group Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Office flexibility	9.47	4.151	.786	.604
Space desigs	9.43	4.114	.800	.596
Office ergonomics	9.40	4.447	.761	.629
Cubics, Shared, Individual	10.55	5.947	.141	.949

APPENDEX C: Empirical Measurement

Plot Title: A

#	Date Time, GMT+08:00	Temp, °C (LGR S/N: 10099741, SEN S/N: 10099741)	RH, % (LGR S/N: 10099741, SEN S/N: 10099741)	Intensity, Lux (LGR S/N: 10099741, SEN S/N: 10099741)	Air Vel, m/s (LGR S/N: 10099741, SEN S/N: 10099741)	DewPt, °C (LGR S/N: 10099741, SEN S/N: 10099741)
1	12/13/17 08:00:00PM	26.426	62.892	11.8	0.018	19.036
2	12/13/17 08:05:00PM	26.304	61.581	11.8	0.023	18.597
3	12/13/17 08:10:00PM	26.036	61.076	11.8	0.023	18.217
4	12/13/17 08:15:00PM	25.525	60.224	11.8	0.024	17.52
5	12/13/17 08:20:00PM	25.065	60.028	11.8	0.024	17.036
6	12/13/17 08:25:00PM	24.895	61.539	11.8	0.026	17.255
7	12/13/17 08:30:00PM	25.089	62.519	11.8	0.026	17.679
8	12/13/17 08:35:00PM	25.331	62.498	11.8	0.026	17.903
9	12/13/17 08:40:00PM	25.186	62.321	19.7	0.026	17.722
10	12/13/17 08:45:00PM	24.823	59.589	19.7	0.026	16.697
11	12/13/17 08:50:00PM	24.605	59.956	27.6	0.026	16.585
12	12/13/17 08:55:00PM	24.46	59.625	27.6	0.026	16.365
13	12/13/17 09:00:00PM	24.315	59.633	27.6	0.026	16.23
14	12/13/17 09:05:00PM	24.171	59.518	27.6	0.027	16.065
15	12/13/17 09:10:00PM	24.098	59.661	19.7	0.026	16.033
16	12/13/17 09:15:00PM	23.016	56.994	1115.6	0.034	14.329
17	12/13/17 09:20:00PM	22.25	59.034	1068.2	0.038	14.135
18	12/13/17 09:25:00PM	21.939	59.659	1107.7	0.043	13.999
19	12/13/17 09:30:00PM	21.795	60.248	1123.4	0.044	14.01
20	12/13/17 09:35:00PM	21.724	60.297	1178.6	0.046	13.955
21	12/13/17 09:40:00PM	21.676	60.198	1194.4	0.047	13.885
22	12/13/17 09:45:00PM	21.628	60.343	1178.6	0.047	13.876
23	12/13/17 09:50:00PM	21.604	60.339	1186.5	0.047	13.852
24	12/13/17 09:55:00PM	21.628	60.282	1131.3	0.047	13.861

109

#	Time						
25	12/13/17 10:00:00PM	21.628	60.343		1123.4	0.047	13.876
26	12/13/17 10:05:00PM	21.628	60.16		1036.7	0.047	13.831
27	12/13/17 10:10:00PM	21.652	59.981		1099.8	0.047	13.809
28	12/13/17 10:15:00PM	21.676	60.137		1013.1	0.046	13.87
29	12/13/17 10:20:00PM	21.676	59.801		1068.2	0.046	13.787
30	12/13/17 10:25:00PM	21.7	59.805		1060.4	0.046	13.811
31	12/13/17 10:30:00PM	21.7	59.744		997.3	0.046	13.795
32	12/13/17 10:35:00PM	21.652	59.675		989.4	0.046	13.733
33	12/13/17 10:40:00PM	21.628	59.763		1005.2	0.046	13.733
34	12/13/17 10:45:00PM	21.652	59.645		950	0.046	13.726
35	12/13/17 10:50:00PM	21.652	59.431		973.6	0.046	13.672
36	12/13/17 10:55:00PM	21.652	59.737		973.6	0.046	13.748
37	12/13/17 11:00:00PM	21.676	59.465		942.1	0.046	13.703
38	12/13/17 11:05:00PM	21.7	59.347		918.5	0.044	13.696
39	12/13/17 11:10:00PM	21.7	59.255		855.4	0.044	13.673
40	12/13/17 11:15:00PM	21.7	59.041		768.7	0.043	13.62
41	12/13/17 11:20:00PM	21.652	58.972		366.6	0.04	13.557
42	12/13/17 11:25:00PM	21.604	59.056		429.7	0.038	13.534
43	12/13/17 11:30:00PM	21.533	59.504		831.7	0.041	13.578
44	12/13/17 11:35:00PM	21.509	59.622		800.2	0.043	13.585
45	12/13/17 11:40:00PM	21.485	59.832		792.3	0.043	13.615
46	12/13/17 11:45:00PM	21.509	59.775		540	0.041	13.623
47	12/13/17 11:50:00PM	21.461	59.828		681.9	0.041	13.591
48	12/13/17 11:55:00PM	21.437	60.038		713.5	0.041	13.621
49	12/14/17 12:00:00AM	21.437	60.008		705.6	0.043	13.613
50	12/14/17 12:05:00AM	21.366	59.966		618.9	0.043	13.535
51	12/14/17 12:10:00AM	21.366	60.149		303.5	0.04	13.58
52	12/14/17 12:15:00AM	21.318	60.05		634.6	0.04	13.511
53	12/14/17 12:20:00AM	21.294	60.29		350.8	0.04	13.548

54	12/14/17 12:25:00AM	21.223	60.37	406	0.04	13.5
55	12/14/17 12:30:00AM	21.246	60.099	532.2	0.04	13.456
56	12/14/17 12:35:00AM	21.294	59.833	335.1	0.038	13.435
57	12/14/17 12:40:00AM	21.294	59.802	571.6	0.04	13.427
58	12/14/17 12:45:00AM	21.318	59.745	406	0.04	13.436
59	12/14/17 12:50:00AM	21.318	59.745	358.7	0.038	13.436
60	12/14/17 12:55:00AM	21.318	59.928	500.6	0.04	13.481
61	12/14/17 01:00:00AM	21.413	59.882	453.3	0.04	13.56
62	12/14/17 01:05:00AM	21.7	59.744	453.3	0.038	13.795
63	12/14/17 01:10:00AM	21.915	59.839	398.1	0.038	14.022
64	12/14/17 01:15:00AM	22.106	59.349	421.8	0.037	14.079
65	12/14/17 01:20:00AM	22.058	59.433	406	0.037	14.055
66	12/14/17 01:25:00AM	21.867	59.281	406	0.037	13.837
67	12/14/17 01:30:00AM	21.748	59.262	374.5	0.037	13.72
68	12/14/17 01:35:00AM	21.604	58.934	382.4	0.037	13.503
69	12/14/17 01:40:00AM	21.485	58.854	366.6	0.037	13.37
70	12/14/17 01:45:00AM	21.461	59.432	303.5	0.037	13.493
71	12/14/17 01:50:00AM	21.461	59.767	350.8	0.037	13.576
72	12/14/17 01:55:00AM	21.604	60.156	390.2	0.038	13.807
73	12/14/17 02:00:00AM	21.891	60.598	303.5	0.037	14.186
74	12/14/17 02:05:00AM	22.058	60.167	390.2	0.037	14.238
75	12/14/17 02:10:00AM	22.226	59.674	311.4	0.035	14.273
76	12/14/17 02:15:00AM	22.298	59.072	295.6	0.035	14.19
77	12/14/17 02:20:00AM	22.154	58.344	240.5	0.034	13.87
78	12/14/17 02:25:00AM	22.034	58.356	264.1	0.035	13.761
79	12/14/17 02:30:00AM	21.939	58.863	279.9	0.035	13.8
80	12/14/17 02:35:00AM	21.867	58.423	303.5	0.035	13.62
81	12/14/17 02:40:00AM	21.963	58.437	287.8	0.035	13.714
82	12/14/17 02:45:00AM	22.106	58.521	272	0.035	13.87

83	12/14/17 02:50:00AM	22.202	58.29	287.8	0.035	13.901
84	12/14/17 02:55:00AM	22.274	58.608	295.6	0.035	14.05
85	12/14/17 03:00:00AM	22.345	58.681	295.6	0.035	14.135
86	12/14/17 03:05:00AM	22.369	58.408	272	0.034	14.088
87	12/14/17 03:10:00AM	22.393	58.473	208.9	0.034	14.128
88	12/14/17 03:15:00AM	22.417	58.6	153.7	0.034	14.182
89	12/14/17 03:20:00AM	22.417	58.477	232.6	0.034	14.151
90	12/14/17 03:25:00AM	22.417	58.354	177.4	0.034	14.12
91	12/14/17 03:30:00AM	22.465	58.392	240.5	0.034	14.174
92	12/14/17 03:35:00AM	22.417	58.015	256.2	0.034	14.033
93	12/14/17 03:40:00AM	22.417	57.738	224.7	0.034	13.961
94	12/14/17 03:45:00AM	22.465	57.776	256.2	0.034	14.016
95	12/14/17 03:50:00AM	22.489	57.934	248.3	0.034	14.079
96	12/14/17 03:55:00AM	22.489	57.626	248.3	0.034	13.999
97	12/14/17 04:00:00AM	22.513	57.475	240.5	0.034	13.983
98	12/14/17 04:05:00AM	22.513	57.814	232.6	0.034	14.071
99	12/14/17 04:10:00AM	22.513	57.814	232.6	0.034	14.071
100	12/14/17 04:15:00AM	22.537	58.126	232.6	0.034	14.173
101	12/14/17 04:20:00AM	22.513	58.03	232.6	0.034	14.126
102	12/14/17 04:25:00AM	22.513	57.907	122.2	0.032	14.095
103	12/14/17 04:30:00AM	22.537	57.91	161.6	0.032	14.118
104	12/14/17 04:35:00AM	22.537	58.095	232.6	0.032	14.166
105	12/14/17 04:40:00AM	22.513	58.338	248.3	0.034	14.205
106	12/14/17 04:45:00AM	22.609	57.921	224.7	0.034	14.188
107	12/14/17 04:50:00AM	22.681	57.716	216.8	0.032	14.203
108	12/14/17 04:55:00AM	22.729	57.693	216.8	0.032	14.241
109	12/14/17 05:00:00AM	22.753	57.11	201	0.032	14.112
110	12/14/17 05:05:00AM	22.8	57.858	201	0.032	14.352
111	12/14/17 05:10:00AM	22.824	58.047	193.2	0.032	14.423

112	12/14/17 05:15:00AM	22.824	60.442	177.4	0.032	15.028
113	12/14/17 05:20:00AM	22.92	61.617	177.4	0.032	15.408
114	12/14/17 05:25:00AM	23.136	61.896	169.5	0.032	15.679
115	12/14/17 05:30:00AM	23.424	61.118	161.6	0.031	15.762
116	12/14/17 05:35:00AM	23.689	60.732	145.8	0.031	15.916
117	12/14/17 05:40:00AM	23.905	60.215	145.8	0.029	15.991
118	12/14/17 05:45:00AM	24.098	60.061	145.8	0.029	16.134
119	12/14/17 05:50:00AM	24.267	59.903	138	0.029	16.253
120	12/14/17 05:55:00AM	24.412	59.679	122.2	0.027	16.333
121	12/14/17 06:00:00AM	24.508	59.632	114.3	0.027	16.412
122	12/14/17 06:05:00AM	24.605	59.277	98.5	0.027	16.412

Assalamu Alaikum Sir, Dr. ...

Here is the Interview Questions prepared to be answered, So please try whatever you could answer this question in interview.

1. have attached you are with what questions I am going to interview below
2. How do you feel the categories interfering in enhancing your work performance

- you are not able answer to all of this questions to be in a special interview but you can answer this answers if it helps you to answer it [illegible]. It helps you to watch in the questions to help you to describe the important factors to get asked.

- The questions have chance to done into when to read. Answers should be based on what you personally feel about ...

- Below is your to feel the all your factors it, you therefore to ...[illegible]... that is work performance factors.

Appendix D: Interview Questions

- The ... [illegible] ...
  asked.

- You can put you have on in this is down ...

There will be 10 questions ... [illegible] **... question ... the of [illegible] below:**

Workplace Surroundings:

1. **Interior Decoration.** How satisfied you are with the interior element, such as the furniture, color inside, window, artifacts and textures, and overall office cleanliness and how do you describe in your perception enhancer to affect your work performance?

2. **Spatialization.** How satisfied you are with office layout design element, such as adequacy of personal space provision, office layout and arrangement and placement of equipment? and how described in your perception enhancer to affect your work performance?

3. **Office Flexibility and Accessibility.** How satisfied you are with office F&A element, such as accessibility that create easy movement of the employee with its capability to support tasks and do without the layout constraints? and how does that in your perception enhancer to affect your work performance?

Assalamo Alikom Mrs. Izyana
Here is the interview Questions prepared to be answered. So basically you should
answer this question in terms of:

1- how satisfied you are with each category i am going to mention below
2- How do you feel this categories contribute to enhance\effect your work performance

- you can merge it into one answer as well. it does not have to be in a separate answers.
  but you can separate the answers if it helps you to illustrate better. (i have put key
  words in the questions to help you brainstorm the important factors, in red colour)

- This is opinion based answer so there is no wrong or right. Answers should be based on
  how you personally feel about it.

- Example: yes\no i feel dis\satisfied because ... etc. therefore I feel it enhance\ effect my
  work performance because ... etc.

- The analysis is confidential. The name of participant will not be used, only the
  answers.

- You can put you answers in blue colour.

There will be 10 questions, divided into 3 sections. Please proceed below:

Workplace Space Design

1- **Interior Design:** How satisfied you are with the interiors element, Such as
the Architecture hindrance, Interior colours and textures, and overall office cleanliness
and quality? and how does that in your perception enhance or effect your work
performance?

2- **Space Design**: How satisfied you are with office Space design elements. Such
as adequacy of personal space provided, office layout and arrangement and placement
of equipment? and how does that in your perception enhance or effect your work
performance?

3- **Office Flexibility and accessibility**: How satisfied you are with office F&A
elements. Such as accessibility plan create free movement, size of access ways,
suitability to ur work tasks and its support for layout changing? and how does that in
your perception enhance or effect your work performance?

Indoor Environment Quality

4- **Temperature level:** How satisfied you are with overall office temperature. such as thermal comfort, humidity level and frequency of temperature changing? and how does that in your perception enhance or effect your work performance?

5- **Office lighting**: How satisfied you are with overall office lighting. Such as appropriate light to read and write, electric light level, Daylight glare control and visual comfort? and how does that in your perception enhance or effect your work performance?

6- **Office Noise:** How satisfied you are with the office noise level? and how does that in your perception enhance or effect your work performance?

7- **Air Quality:** How satisfied you are with office Air quality. Such as Office ventilation, odours and smell, fresh air supply and tobacco control? and how does that in your perception enhance or effect your work performance?

Office Ergonomic

8- **Furniture Architecture hindrance:** How satisfied you are with furniture design. Such as design shape, Coluor and texture? and how does that in your perception enhance or effect your work performance?

9- **Table functionality**: How satisfied you are with the functionality of the table to help you achieve your task targets. Such as table size, space allowance for hand to rest, space for read and write, equipment positioning (PC, mouse, keyboard)? and how does that in your perception enhance or effect your work performance?

10- **Chair functionality**: How satisfied you are with the chair functionality. Such as ability to adjust the seating position, support to your lower back, increase and decrease the height and comfortability of the chair? and how does that in your perception enhance or effect your work performance?

Thats all for now. Appreciate your valuable time and effort

Appendix E: Floor Plan

SUB-ZON C RUBY

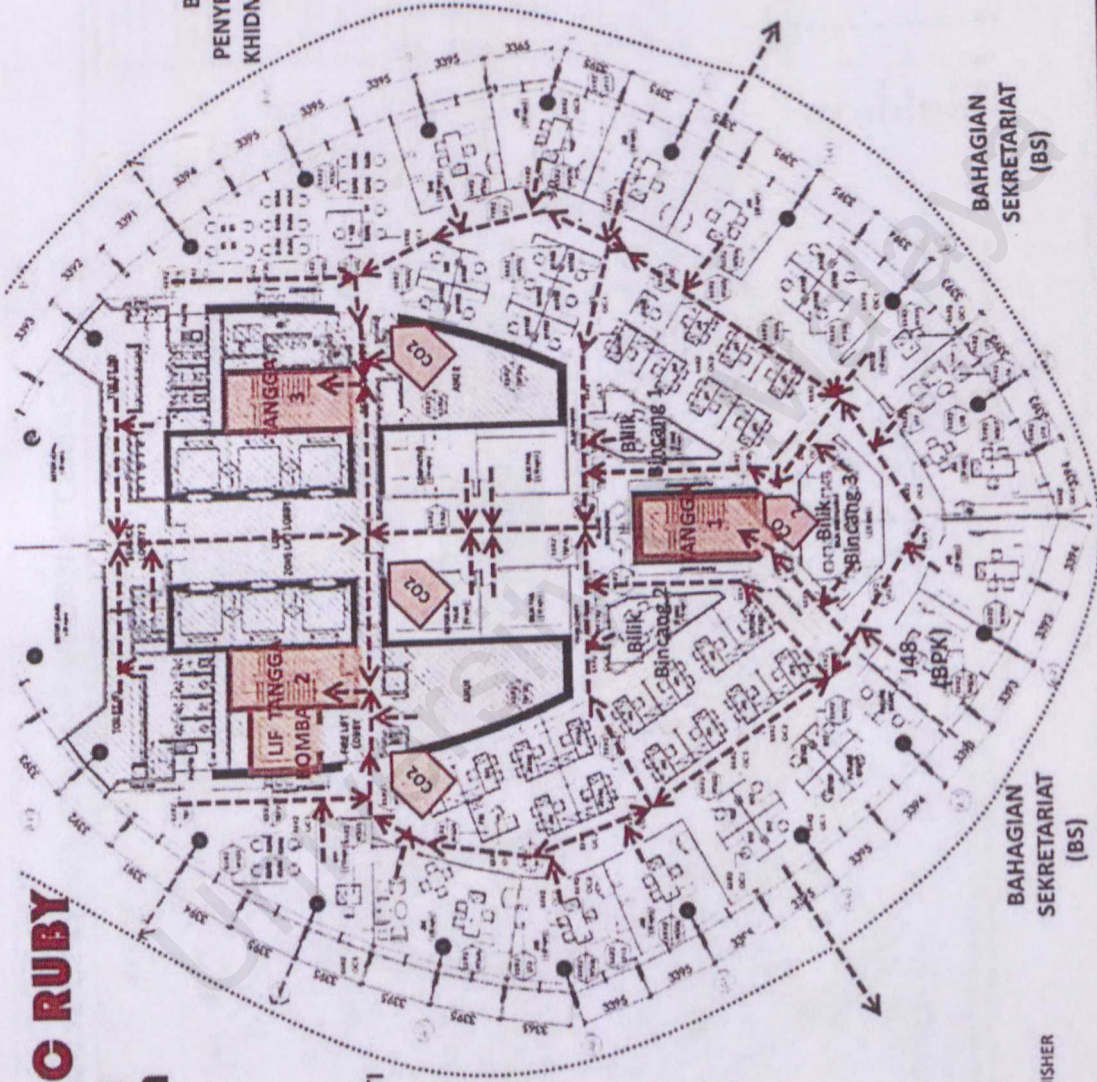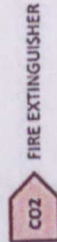## PELAN LARIAN KESELAMATAN
ARAS 31

BAHAGIAN PENYELARASAN DAN KHIDMAT SOKONGAN (BPKS)

BAHAGIAN SEKRETARIAT (BS)

BAHAGIAN SEKRETARIAT (BS)

BAHAGIAN PENGURUSAN KUALITI (BPK)

PETUNJUK:

CO2   FIRE EXTINGUISHER

PELAN TINDAKAN KETIKA KEBAKARAN DAN KECEMASAN

PETUNJUK:

PERGERAKAN KECEMASAN

PEMADAM API

TANGGA KECEMASAN

ANDA DI SINI

TANGGA KECEMASAN

PINTU KELUAR 1

PINTU KELUAR 2

PINTU KELUAR 3

LEVEL 29 - JKR (CPK)

FURNITURE PLAN
SCALE 1 : 200

- BAHAGIAN PENGURUSAN SUMBER MANUSIA (BPSM)
- BAHAGIAN PENGURUSAN PRESTASI PROJEK (BPPP)